Patterns of healthcare utilisation in older people: secondary data analysis of service evaluation and epidemiological data

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I confirm that the word count of this thesis is less than 100,000 words excluding the title page, contents, acknowledgements, summary or abstract, abbreviations, footnotes, diagrams, maps, illustrations, tables, appendices, and references or bibliography.

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Dedication

“Ar scáth a chéile a mhaireann na daoine”

I ndíl chuimhne ar m’athair dílís Micheál Rua Ó h-Earcáin.

Cara, laoch agus grá mór mó shaol.

Inné, inniu agus amárach.

Ar dheis Dé go raibh a anam uasal.

Summary

Advances in life expectancy without commensurate improvement in healthy life expectancy has resulted in increased demand for healthcare services, particularly among older adults. Consequently, healthcare services must adapt to accommodate this increased demand. Influences on healthcare service usage are multidimensional, including demographic, social and health need factors; those which are modifiable serve as potential targets for intervention to improve capacity and service delivery. Novel models of pharmaceutical care for older adults have been developed within intermediate care and care homes in Northern Ireland, providing an opportunity to explore individual variation in healthcare usage by older adults. Older adults are more sensitive to medications and often receive inappropriate prescribing. Thus, improving prescribing appropriateness, via pharmacist intervention, may serve as a modifiable target with respect to health service usage by older adults. Secondary data analysis of data from the Northern and Western Health and Social Care Trusts was conducted to evaluate the effectiveness of pharmacist case management in intermediate care (N=532) and care home (n=1095) settings. A significant reduction in inappropriate prescribing was achieved in both settings, with pharmacist intervention types found to influence subsequent healthcare resource usage. Previous healthcare utilisations were consistently predictive of post-intervention healthcare usage. Longitudinal patterns of healthcare utilisation were explored in a complementary cohort. A latent transition analysis of The Irish Longitudinal Study of Ageing (TILDA) (N=8175) identified heterogeneity in healthcare utilisation by community dwelling older adults. Three latent statuses of usage were identified across three data collection waves: 'effective referral', 'multiple utilisation' and 'primary care only utilisation'. Variation in longitudinal healthcare utilisation was influenced by a range of factors including the number of medications, frailty, falls and depression. This thesis serves to extend theory regarding healthcare utilisation specific to older adults, advocating for an integrated approach to healthcare delivery in order to address the needs posed by multi-complexity.

Abbreviations

ACP	Advanced care planning
AD	Alzheimer's Disease
ADE	Adverse drug event
ADLs	Activities of daily living
AIC	Akaike Information Criteria
BIC	Bayesian Information Criteria
BNF	British National Formulary
CAPI	Computer-assisted personal interview
CES-D	Center for Epidemiological Studies-Depression scale
CFI	Comparative Fit Index
CH	Care homes
CKD	Chronic kidney disease
COPD	Chronic obstructive pulmonary disease
COPNI	Commissioner for Older People for Northern Ireland
DALYs	Disability adjusted life years
DHSSPSNI	Department of Health, Social Services and Public Safety Northern Ireland
DOHC	Department of Health and Children
DOHNI	Department of Health Northern Ireland
DRP	Drug-related problem
ED	Emergency Department
ELSA	English Longitudinal Study of Ageing
EMCI	Early mild cognitive impairment
EMI	Elderly mentally impaired
GMM	Growth mixture model
GMS	General Medical Services Scheme
GP	General Practitioner
HADS-A	Hospital Anxiety and Depression Scale-Anxiety scale
HCP	Healthcare professional

HHD	Hypertensive heart disease
HRS	Health and Retirement Study
HSCBNI	Health and Social Care Board Northern Ireland
HSCT	Health and Social Care Trust
IADLs	Instrumental activities of daily living
IC	Intermediate care
ICD	International Statistical Classification of Diseases and Related Health Problems
IHD	Ischaemic heart disease
IIOP	Irish Institute of Pharmacy
IMM	Integrated Medicines Management
ISSDA	Irish Social Science Data Archive
LCA	Latent class analysis
LGCM	Latent growth curve modelling
LL	Log likelihood
LMCI	Late mild cognitive impairment
LMR	Lo-Mendell-Rubin
LRTI	Lower respiratory tract infection
LTA	Latent transition analysis
LTI	Long Term Illness Scheme
MAI	Medication Appropriateness Index
MEAAP	Mid and East Antrim Agewell Partnership
MLR	Maximum Likelihood Robust
MMSE	Mini Mental State Examination
MOIC	Medicines Optimisation and Innovation Centre
MOOP	Medicines Optimisation in Older People
NAO	National Audit Office
NCDs	Non-communicable diseases
NHS	National Health Service
NHSCT	Northern Health and Social Care Trust
NI	Northern Ireland

NICOLA	Northern Ireland Cohort for the Longitudinal Study of Ageing
NICPLD	Northern Ireland Centre for Pharmacy Learning and Development
NISRA	Northern Ireland Statistics and Research Agency
NSF	National Service Framework
OECD	Organisation for Economic Co-operation and Development
OOH	Out of hours
ORECNI	Office for Research Ethics Committees Northern Ireland
PACT	Primary and Community Together
PCP	Pharmaceutical Care Plan
PHA	Public Health Agency
PIP	Potentially inappropriate prescribing
PPI	Proton pump inhibitors
RCT	Randomised controlled trial
RMSEA	Root mean square error of approximation
ROI	Republic of Ireland
SCQ	Self-completion questionnaire
ssBIC	Sample size adjusted Bayesian Information Criteria
SSRIs	Selective serotonin reuptake inhibitors
START	Screening tool to alert to right treatment
STOPP	Screening tool of older people's prescriptions
TCAs	Tricyclic antidepressants
TILDA	The Irish Longitudinal Study on Ageing
TLI	Tucker Lewis Index
TYC	Transforming Your Care
UK	United Kingdom
UNDESA	United Nations Department of Economic and Social Affairs
URTI	Upper respiratory tract infection
US	United States
UTI	Urinary tract infection
VLMR	Vuong-Lo-Mendell Rubin

WHO	World Health Organisation
WHSCT	Western Health and Social Care Trust
YLD	Years living with disability

1 Introduction

1.1 Changing healthcare landscape

Worldwide, life expectancy at birth has risen considerably from 1990 to 2013 (Murray et al., 2015). Improvements in public health and social systems globally has meant that there has been considerable progress in reducing age-standardised rates for a wide range of causes of death (Murray et al., 2015). However, healthy life expectancy is increasing more slowly than life expectancy, resulting in more years spent living with illness and disability, as evidenced by the lack of decline in age-standardised years living with disability (YLD) rates (Murray et al., 2015). In fact, the number of disability adjusted life years (DALYs) for non-communicable diseases (NCDs) has increased steadily during the same 23-year period, likely owed to a growing, ageing population (Murray et al., 2015). Increases in DALYs have been shown for NCDs such as ischaemic heart disease, diabetes, chronic obstructive pulmonary disease, depression, and stroke (Murray et al., 2015). Thus, the disparity between our extended life expectancy and our healthy life expectancy has placed an additional demand on healthcare services across the world.

An increase in the number of older adults living with more than one chronic condition (multimorbidity) exerts further demand upon global health systems. The management of chronic conditions has been estimated to account for three quarters of healthcare expenditure, accounting for 80% of general practitioner (GP) consultations and 60% of hospital bed days (Department of Health and Children: DOHC, 2008). Multimorbidity is associated with increased healthcare usage across many points within the healthcare system, including increased physician visits, the prescribing of multiple medications, an increased risk of hospitalisation and longer hospital admissions (Cassell et al., 2018; Glynn et al., 2011; Marengoni et al., 2011; Palladino, Lee, Ashworth, Triassi & Millett, 2016). The greater the degree of multimorbidity, the greater the costs incurred. It has been estimated that healthcare

spending for one chronic condition is three times of that for someone with no chronic illness (Anderson, 2010). Multimorbidity has been suggested to be associated with a 33% increase in costs for each additional condition and that the healthcare spend for those with ≥5 long term conditions is 17 times greater than that for those with no chronic illnesses (Anderson, 2010; Båhler, Huber, Brungger & Reich, 2015).

The future impact of multimorbidity on healthcare systems is likely to prove even more challenging when one considers future projections for multimorbidity prevalence. Kingston, Robinson, Booth, Knapp, and Jagger (2018) conducted a simulation study to determine the future prevalence of multimorbidity among the older population in England by 2035 using a base sample of individuals aged ≥35 years. Between the years 2015 and 2035 the simulation estimated that the proportion of individuals ≥65 years living with four or more conditions would increase from 10% to 17% (Kingston et al., 2018). Furthermore, approximately one third of those living with four or more morbidities are expected to have mental ill-health such as depression, dementia, or cognitive impairment. The simulation further predicted that approximately half of those aged 65 years and over would report two or more chronic diseases, with a greater proportion of increase occurring in the 85+ year category. Accordingly, an increased burden will be placed on primary and secondary healthcare usage in order to cope with this increased demand.

Thus, one of the largest challenges facing governments globally is the need to ensure there are adequate provisions made for an ageing population. Older people are an increasingly important cohort of individuals admitted to hospitals (Abrahamsen, Hauglan, Nilsen and Ranhoff, 2014). Hospital admissions and readmissions have risen sharply among this cohort, with acute hospital admissions reported to rise by 16% from the period of 2006/07 to 2012/13 (Smith, McKeon, Blunt & Edwards, 2014). It has been suggested that 30-60% of healthcare costs are consumed by older people (Hasan, Thiruchelvam, Kow, Ghori & Babar, 2017).

Woodford and George (2010) argue that the rise in demand has not been met with a commensurate increase in bed capacity, resulting in a reduction in hospital length of stay. This has been evidenced in the findings of Godden, McCoy, and Pollock (2009) who found a trend of reduced numbers of NHS beds in England for the period of 1987/88 to 2006/07. Godden et al., (2009) further report that from 1998/99 to 2006/07 the number of annual hospital admissions continued to rise, whilst mean length of stay reduced. Furthermore, during the same period, a rise in emergency readmissions within 28 days was found for both adults aged 16-74 years and for those aged 75 years and older.

In England, since 1979, there has been a 65% reduction in the number of beds used for geriatric care, in contrast to the 35% reduction in acute care beds observed during the same period (Appleby, 2013). Reductions in overall numbers of beds are not restricted to the United Kingdom (UK) context, with almost all Organisation for Economic Cooperation (OECD) countries showing a reduction in acute care beds during the period from 1995 to 2010, save for Korea, Turkey, and Greece (Appleby, 2013). With a growing population with increased levels of comorbidity to treat but fewer beds available, the resultant effect is a trend towards a shorter length of hospital stay as reported by Godden and colleagues (2009). From 1979 to 2011 it has been estimated that the average length of hospital stay for an acute case in England has decreased from 9.4 days to approximately 3 days (Appleby, 2013). Bakken, Ranhoff, Engeland & Ruths (2012) argue that the combination of highly specialised hospital departments and short durations of stay may not be suitable for older people who may require longer rehabilitation and a more comprehensive multidisciplinary approach. Consequently, healthcare systems need to adapt in order to accommodate the increased demand created by a growing number and proportion of older persons within the population.

1.2 Older adults as a cohort

The United Nations, Department of Economic and Social Affairs, Population Division (UNDESA; 2015) predict that between 2015 and 2030, the number of persons aged 60 years or over globally, will rise by 56%, reaching 1.4 billion, and that by 2050 this figure will approach 2.1 billion. The UN further predicts that the proportion of those aged 80 years or over will grow even faster, with 2050 projections estimating a three-fold increase on 2015 figures. In fact, globally, the number of older persons is growing at a faster rate than any other age group (UNDESA, 2015).

It must also be remembered that there is considerable variability in the risks of morbidity and mortality across individuals of the same age, attributed to individual differences in biological, social, and environmental factors (UNDESA, 2015). The complex interplay of factors such as genetic polymorphisms, educational attainment, location, and service uptake creates a context that is unique to the individual. Within older people this context may also include the amalgamation of many factors over a considerable period of time. In addition, individual variability in health risk behaviours such as alcohol and tobacco consumption introduce considerable heterogeneity in morbidity patterns in a given cohort, and as such must be considered with respect to medical care (UNDESA, 2015). Consequently, older persons should not be seen as a relatively homogenous group for which morbidity and associated treatment remain consistent across all members of the cohort. Rather, there exists considerable variability in their experiences of health and illness, owed to these individual differences. Therefore, health and social care provision must be appreciated at an individual level.

1.3 Healthcare utilisation by older adults

Among older people, the reasons for hospital admissions are multifactorial. Andersen and Newman (1973) propose that the decision to access healthcare services is influenced by

several factors, *predisposing factors* (e.g. age), *enabling factors* (e.g. education level) and *need factors* (e.g. chronic disease). Each of these factors have shown differential but significant associations with health services use (Babitsch, Gohl & von Lengerke, 2012). Thus, chronic disease and comorbidity are important aspects to consider when examining healthcare resource utilisation by older people. Chronic conditions are associated with high health service utilisation (Hutt, Rosen & McCauley, 2004; Lehnert et al., 2011) and account for a third of emergency admissions to NHS hospital beds among those aged 65 years and older (Hutt et al., 2004). Those with four or more chronic conditions are more than 90 times more likely to experience a hospital admission that could have been prevented with appropriate primary care as those without chronic conditions (Wolff, Starfield & Anderson, 2002).

Whilst a hospital admission may be welcome with respect to resolving acute illness through medical intervention, acute hospitalisation has been shown to be related to a decline in functional status among older adults (Hirsch, Sommers, Olsen, Mullen & Winograd, 1990). Functional status is the person's ability to perform basic and instrumental activities of daily living (ADLs). Basic ADLs include feeding, dressing, personal hygiene, and walking (Katz, Ford, Moskowitz, Jackson & Jaffe, 1963). Instrumental activities (IADLs) are those which facilitate the person to remain living independently within their own community. Examples include the ability to prepare meals, manage their own finances and take their medications (Lawton & Brody, 1969). Functional status on discharge from acute care has been shown to be poorer when compared with functional status on admission (Covinsky et al., 2003). Recovery from this decline in functional status occurs at a much slower rate than recovery from the acute illness itself (Hirsch et al., 1990). The very old (> 90 years' age) have been found to be at particularly high risk of poor outcomes, as they have been shown to be less likely to recover function lost before admission and more likely to develop new functional deficits whilst in acute care (Covinsky et al. 2003).

Declining functional status among older people serves to reduce their ability to live independently at home. Abrahamsen and colleagues (2014) argue that a high proportion of those discharged from acute care are at risk for increased dependency and institutionalisation if appropriate treatment and opportunity for rehabilitation is not delivered. Providing opportunities to recover functional deficits may facilitate a return to home for older adults who may otherwise transition into a long-term care setting. Intermediate models of care have been developed with the aim of supporting the individual back to wellness, and to regain the ability to live as independently as possible. Bridging the gap between acute hospital discharge and return to home, intermediate care serves to facilitate the recovery of functional status lost during acute hospitalisation, and delay institutionalisation of older people.

In recent years attention has also been drawn to healthcare utilisation by care home residents, in particular their presentation to hospital emergency departments (ED). A systematic review, comprised of 77 studies, found that 4-55% of transfers from the nursing home to ED were classified as inappropriate (Lemoyne et al., 2019). However, the varied operationalisation of what constitutes an inappropriate ED transfer limits the comparisons that can be made between studies. The commonly identified reasons for ED transfer included trauma, altered mental status, infection, fever, respiratory, gastrointestinal, and cardiovascular symptoms (Lemoyne et al., 2019). Numerous factors are believed to interact to increase the likelihood of transfer from residential care to ED, including inadequate numbers or skill mix among care home staff; access to GPs, particularly out of hours; the absence of end of life advanced care planning; pressure from family members to seek active treatment (Arendts, Riebel, Codde & Frankel, 2010). Interventions that have sought to increase attendance of clinicians within residential care facilities have been shown to reduce ED presentations and hospital admissions (Lemoyne et al., 2019). A ‘hospital in the nursing home’ intervention involving ED-based nurses working in partnership with nursing home staff to manage care of residents who would otherwise require an ED presentation or hospital admission resulted in a

reduction in ED attendances by 17% and hospital admissions by 47% (Fan et al., 2016). The use of telemedicine has also shown positive results with reductions in hospitalisation and ED visits observed (Mierdel & Owen, 2015; Shah et al., 2015).

1.4 Prescribing for older adults

The ageing population present numerous challenges to the funding and operation of healthcare services globally. If we are spending a greater number of years living with illness, it follows that we are spending a greater number of years consuming treatments to eradicate or minimise the impact of disease on quality of life. Medicines are the most common medical intervention worldwide (Mair, Kinnear, Hurding, Michael & Wilson, 2017), owed largely to the pervasiveness of the biomedical model in how we conceptualise illness. The biomedical model supports the view that drug prescribing is a fundamental aspect of treatment solutions. Prescribed medication, and associated drug monitoring costs, serve as a significant stressor on health budgets. It is estimated that, at any one time, 70% of the population consume a prescribed or over the counter medicine to treat or prevent illness (Scott & Fleming, 2017). Furthermore, it has been projected that global expenditure on medicines will reach nearly $1.5 trillion by 2021 (QuintilesIMS Institute, 2016). At a time when global health systems are under increasing financial pressure, drug therapies are being increasingly interrogated in terms of their benefits relative to economic cost. Given their relative high consumption of medication, and the aforementioned considerable heterogeneity within the cohort, prescribing for older people requires an additional degree of specialism to ensure that they receive the most benefit from their prescribed therapies.

Despite considerable global expenditure on medications it is highly probable that healthcare funders may not be receiving the best return on their investment. The World Health Organisation (2018) estimates that more than half of all medicines are supplied inappropriately, and that half of all patients fail to take them correctly. They further argue that

the overuse, underuse, or misuse of medicines not only poses a serious health hazard, but also generates considerable wastage of scarce resources. At present, annual expenditure on medicines in Northern Ireland (NI) is estimated to be in the region of £550 million, which is higher than other regions of the UK, in terms of both cost and volume (Scott & Fleming, 2017). Of this expenditure, it is estimated that £18 million is wasted on medicines annually in Northern Ireland (Health and Social Care Board Northern Ireland: HSCBNI, 2015).

Prescribing for older persons requires an acknowledgement of the physiological changes that occur in older age, in particular the reduced ability to maintain homeostasis under conditions of physiological stress (Mangoni & Jackson, 2004). This loss of functional reserve underpins the vulnerability associated with older age. In terms of major metabolic organ systems, there is a decline in renal and liver blood flow with age (Mangoni & Jackson, 2004). There is also a change in overall body composition with advancing age, such that there is a reduction in total body water and lean body mass (Mangoni & Jackson, 2004). Age-dependent changes in body composition and function can thus alter both the pharmacodynamics and pharmacokinetic responses to medication.

Pharmacokinetics are concerned with how the organism processes a drug including aspects such as drug absorption, metabolism, and clearance. Medications that undergo extensive first-pass metabolism in the liver are consequently impacted by age-related declines in liver function, leading to higher bioavailability (Mangoni & Jackson, 2004). Conversely, pro-drugs, which depend on the liver for activation, are also impacted resulting in lower activation. Changes in body composition, in terms of total body water and lipid quantities results in altered serum drug levels owed to differences in volumes of distribution for hydrophilic and lipophilic drugs (Mangoni & Jackson, 2014). Reduction in renal function in older people alters the clearance of many drugs, which can be of particular concern for those drugs with a narrow therapeutic index. It has been suggested that decreased excretion via the kidney is of more

relevance than decreases in hepatic drug metabolism (ElDesoky, 2007). Pharmacokinetic changes are further compounded by the impact of chronic diseases on organ systems, such as nephropathy secondary to diabetes.

Pharmacodynamics, on the other hand, represents the physiological response to drugs, in other words how the drug affects an organism. Pharmacodynamic changes are frequent among older people and are often related to alterations in sensitivity to drugs (ElDesoky, 2007), including anticoagulants, cardiovascular and psychotropic drugs (Mangoni & Jackson, 2004). Advancing age is associated with an increased sensitivity to the sedating properties of benzodiazepines, of which the exact mechanism remains unclear (Mangoni & Jackson, 2004).

Despite an awareness of altered physiological responses to medications, older people are often excluded from clinical trials. Therefore, our understanding of medication safety among older people often only emerges in the post-marketing surveillance period following the launch of a medicinal product onto the market. What has been elucidated is that older people are more vulnerable to drug-related problems (DRPs), owed due to the combination of age-related and disease-related metabolic changes, multimorbidity, increased numbers of prescribers and higher medication burden (Lehnert et al., 2011; Merle, Laroche, Dantoine & Charmes, 2005; Shelton, Fritsch & Scott, 2000; Somers, Mallet, van der Carmen, Robays & Petrovic, 2012). Interactions between two medications, referred to as drug-drug interactions, are a common source of adverse drug events (ADEs), and are found to occur more frequently in older compared with younger patients (Shelton et al., 2000). An ADE is an injury resulting from medical intervention related to a drug (National Coordinating Council for Medication Error Reporting and Prevention, 2015) and can be considered to occur at any dose, whether a standard therapeutic dose or not.

Whilst in many cases hospitalisations are necessary to appropriately treat an emergent acute illness, it must be recognised that a proportion of these admittances are avoidable. Adverse drug event related hospitalisations are more prevalent among older people; approximately 11% of hospitalisations in this cohort believed to be related to ADEs (Alhawassi, Krass, Bajorek & Pont, 2014; Kongkaew, Noyce & Ashcroft, 2008). In contrast, it is estimated that 5.3-6.5% of hospitalisations amongst the general population are due to ADEs (Kongkaew et al., 2008; Pirmohamed et al., 2004). Fatal ADEs account for approximately 3% of deaths in the general population (Wester, Jönsson, Spigset, Druid & Hägg, 2008), and are estimated to be the sixth leading cause of death in the United States (US) (Lazarou, Pomeranz & Corey, 1998). However, ADEs represent a preventable source of hospital admission with almost three quarters (72%) of ADE-related hospital admissions considered to be preventable (Pirmohamed et al., 2004).

Furthermore, ADEs contribute a considerable cost burden to health systems, estimated to cost the NHS £446 million annually (Pirmohamed et al., 2004). In conjunction with associations with unplanned hospital admissions, ADEs are also associated with greater numbers of ED visits, longer hospital stays, greater outpatient health service usage and overall higher healthcare costs (Bond & Raehl, 2006; Hohl et al., 2011; Wu, Bell & Wodchis, 2012). Given that many ADEs are considered preventable, healthcare attendances could be reduced through a rational and cautious approach to prescribing for older people.

1.5 Inappropriate prescribing

Inappropriate prescribing is considered to be the use of medications where the risk of an ADE outweighs the clinical benefit to the patient, especially when safer alternatives are available (Beers et al., 1991; Gallagher, O'Connor & O'Mahony, 2011; Spinewine, Schmader, et al., 2007). Inappropriate prescribing also includes the omission of clinically indicated medications in the absence of a clear contraindication (Gallagher, et al., 2011; Spinewine,

Schmader, et al., 2007). There has been a move within the literature to refer to inappropriate prescribing in terms of potential and not absolute risk. As such, many papers refer to potentially inappropriate prescribing in clear recognition that such prescribing is not always inappropriate. For the purposes of the present discussion the terms inappropriate prescribing and potentially inappropriate prescribing are considered to be interchangeable. Potentially inappropriate prescribing (PIP) is not merely the presence of at risk medications, or the absence of clinically indicated medications, but also encompasses a range of misprescribing practices such as inappropriate durations of therapy and unsuitable formulations for the patient (Hanlon et al., 1992; Samsa et al., 1994; Simonson & Feinberg, 2005).

Inappropriate prescribing is common among older patients, and is associated with poorer outcomes (Cahir, Bennett, Teljeur & Fahey, 2014; Cahir, Moriarty, Teljeur, Fahey & Bennett, 2014). Prevalence estimates of PIP among older persons have been reported to range from 19.8 to 52.7% (Moriarty, Bennett, Fahey, Kenny & Cahir, 2015), 28-42% (Cahir, Moriarty, et al., 2014), and even as high as 63% (Hudhra et al., 2016) and 71.2% (Recoche et al., 2017). Furthermore, prevalence of PIP has also been found to increase longitudinally among older adults (Moriarty, Bennett, Fahey, et al., 2015; Moriarty, Hardy, Bennett, Smith & Fahey, 2015).

Inappropriate prescribing is a driver for ADEs in older people (Hamilton, Gallagher, Ryan, Byrne & O'Mahony, 2011). Inappropriate prescribing for older Irish adults has been shown to be associated with ADEs, hospitalisation and inefficiencies in the healthcare system. Within the Irish context, patients with more than two inappropriate medications were twice as likely to have experienced an adverse drug event and to be at a nearly two-fold risk of an ED visit (Cahir, Bennet, et al., 2014). Similarly, Cahir, Moriarty, et al., (2014) found inappropriate prescribing to be associated with a one third increase in hospital attendance in those who had at least two potentially inappropriate medications, even after adjusting for covariates. Furthermore, Moriarty, Cahir, Fahey & Bennett, (2014) also found that PIP was independently

associated with increased healthcare utilisation. It was found that the incidence rate ratio for hospitalisation was 1.24 for each additional inappropriate medication consumed. PIP has also been shown to be associated with increased numbers of ED and GP visits (Moriarty, Bennett, Cahir, Kenny & Fahey, 2016). Thus, within the Irish context inappropriate prescribing is associated with increased healthcare utilisation.

However, the international evidence is more equivocal. Jano and Aparasu (2007) conducted a systematic review to examine the associations between inappropriate prescribing, when assessed using the Beer's criteria, and healthcare outcomes. Three out of four studies which examined the association with hospitalisation among community dwelling older people found an association between inappropriate medication and time to hospitalisation (Fillenbaum et al., 2004), acute hospitalisation (Klarin, Wimo & Fastbom, 2005) and the number of inpatient visits (Fick, Mion, Beers & Waller, 2008). No association was found with other healthcare services within the community, and studies examining healthcare resource usage by nursing home residents exposed to inappropriate prescribing were inconclusive (Jano & Aparasu, 2007). A more recent systematic review, examining the relationship between PIP and healthcare costs reported evidence of a significant relationship between PIP and hospitalisation (Hyttinen, Jyrkka & Valtonen, 2016). Twenty-two out of 39 studies examined reported a significant association between PIP and hospitalisation (Hyttinen et al., 2016). However, five studies reported no significant association (Hyttinen et al., 2016), suggesting the relationship may not be as clearly delineated as previously thought. Therefore, chronic disease management within this cohort becomes a delicate balance of symptom control and adverse event avoidance. Such a balance is even more difficult to strike when one considers the number of medications being consumed within this population.

1.6 Polypharmacy

Polypharmacy as a term has evolved over the years. Originally conceptualised as a means of describing issues related to multiple medication consumption, including excessive drug use, it has come to mean different things to different people. A cursory glance at the literature would lead one to consider polypharmacy in terms of a numerical threshold of medications, above which the patient would be considered to be experiencing polypharmacy. Nonetheless, one would quickly find that there is considerable variance in the numbers proposed as a threshold figure. A total of 138 definitions for polypharmacy have been identified within the literature (Masnoon, Shakib, Kalisch-Ellett & Caughey, 2017). This lack of consensus on a definition has made interpreting studies purported to investigate the phenomenon a difficult terrain to navigate.

More recently, there has been a call to move away from a 'many drugs' approach to that of a 'too many drugs' approach, with an emphasis placed on the appropriateness of the medication regimen (Cadogan, Ryan & Hughes, 2016). The multimorbid patient will likely consume a considerable number of medications, all of which might be highly appropriate for meeting the patient's therapeutic goals. The conversation thus requires reframing such that we are less concerned with the total number of prescription medicines being consumed by the patient, but rather the suitability of each individual medication, not just in isolation, but also in combination with the entirety of the regimen. The rationale should therefore become one of quality of prescribing and not volume of prescribing (Stuijt, Franssen, Egberts & Hudson, 2008).

Cadogan et al., (2016) argue that when viewed negatively, polypharmacy could be a driving force behind underprescribing, which in itself is an inappropriate prescribing practice. Solely focusing on the number of medications would therefore fail to address inappropriate prescribing in its entirety by not addressing the underprescribing element. Rather, Cadogan and colleagues prudently argue that the number of clinical conditions a patient has needs to

be considered when evaluating drug therapy. This is of particular importance when one considers that many clinical guidelines are predicated on a single disease state rather than focusing on multimorbid patients. The mismatch between prescribing guidelines for specific conditions and the range of complexity that exists in the patient with multiple morbidities can result in polypharmacy, which can be both appropriate and inappropriate (Mair, Fernandez-Llimos & SIMPATHY Consortium, 2017). Accordingly, Cadogan et al., (2016) advocate for a move towards qualifying the clinical appropriateness of a medication and away from quantifying the number of medications.

However, we should not completely disregard the value of knowing the number of medications a patient is consuming, as the number of repeat medications has been consistently shown to be an independent predictor of inappropriate prescribing (Bradley et al., 2012; Bradley et al., 2014; Hudhra et al., 2016; McMahon, Cahir, Kenny & Bennett, 2014). Among the Northern Irish population aged ≥70 years, those who received seven or more medications were five times more likely to receive PIP, compared with those who consumed between zero and three medications (Bradley et al., 2012). When defined as ≥4 medications, Bradley et al., (2014) found that polypharmacy resulted in an 18-fold increase in the risk of PIP among the UK population ≥70. Older Irish fallers (≥70 years) presenting to ED on ≥4 medications were four times more likely to be in receipt of inappropriate prescribing (McMahon et al., 2014). Jiron et al., (2016) found that the number of medications taken by participants increased their risk of PIP 7.5-fold. Thus, polypharmacy may still serve as a useful guide in highlighting patients that would benefit from optimisation of their medication regimen.

Polypharmacy is also related to health outcomes. Cahir, Bennett, et al., (2014) found that the number of repeat drug classes to be significantly associated with ADEs and an increased risk of ED visits. Polypharmacy has been shown to be related to frailty status among

older adults (Palmer et al., 2019; Saum et al., 2017), with those frail older adults who receive polypharmacy shown to have longer hospital admissions, more discharges to residential care and are more likely to experience a hospital readmission (Rosted, Schultz & Sanders, 2016).

Polypharmacy can occur as the result of many different processes. It can arise as a consequence of stringent application of clinical guidelines, aimed at standardising practice. However, guidelines should be seen as exactly that, and not an attempt to replace the judgement of the clinician. Stefanacci & Khan (2017) argue that such application of clinical guidelines is often required by value-based payment models. Thus, attempts to rationalise the medication budget within a health system may lead to over-application of clinical guidelines to the detriment of the actual patient. Multiple prescribers, in particular those who are not experienced in geriatric medicine, as well as multiple transitions of care can also result in polypharmacy. Similarly, the treatment of an adverse drug reaction caused by one medication, with another medication can quickly result in a prescribing cascade (Figure 1-1) and increase the patient's number of medications in a dramatic fashion (Rochon & Gurwitz, 1995, 1997, 2017).

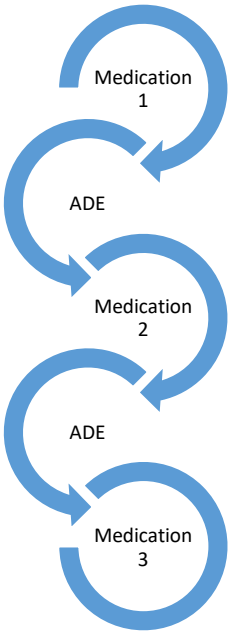

Figure 1-1: Visual representation of the prescribing cascade

Blozik, Rapold, von Overbeck and Reich (2013) argue that polypharmacy and inappropriate prescribing are closely related but remain distinct. To simply look at it as a numbers issue is to risk missing the point about appropriateness completely. Whilst the number of repeat medications has been shown to be a consistent predictor of inappropriate prescribing, it is the number of inappropriate medications that poses a greater risk to the patient than just the number of medications per se. When the number of clinical conditions is accounted for, the association between number of drugs and unplanned hospital admissions has been shown to reduce (Payne, Abel, Avery, Mercer & Roland, 2014). Morath et al., (2017) further argue that a patient's number of medications is a modifiable risk factor associated with unplanned hospital admittance and suggest that the pharmacist is clinically placed to provide an appropriate intervention.

Given their inherent vulnerability to drug-related problems any review of pharmacotherapy in older people should consider appropriateness as a key focus (Somers et al., 2012). However, the lack of a standardised assessment of PIP has made it difficult to determine the true prevalence of PIP (Bregnhøj, Thirstup, Kristensen & Sonne, 2005), with estimates shown to vary depending on the screening tool used (Cahir, Moriarty, et al., 2014; Moriarty, Bennett, et al., 2015; Morin, Fastbom, Laroche, & Johnell, 2015).

1.7 Detecting inappropriate prescribing

Several instruments have been developed over the years aimed at detecting inappropriate prescribing. These can be broadly characterised as either explicit or implicit measures. Explicit tools provide lists of medications to be avoided, and/ or scenarios (disease states) whereby a medication is considered inappropriate. In contrast, implicit tools involve a judgement-based approach on the part of the clinician, by taking the patient's clinical state into consideration.

Early attempts to provide guidance with respect to prescribing appropriateness resulted in the development of explicit lists of medications not suitable for use in older adults. Examples include the American Beers' Criteria (Beers et al., 1991), which has been revised and updated in 2015 (American Geriatrics Society, 2015), and the Screening Tool of Older People's Potentially Inappropriate Prescriptions (STOPP; Gallagher, Ryan, Byrne, Kennedy & O'Mahony, 2008), which is better suited to the European context. Furthermore, the Screening Tool to Alert Doctors to Right Treatments (START; Gallagher et al., 2008) can be used to identify prescribing omissions, which themselves are considered to be an inappropriate prescribing practice. Used together, STOPP/START address different aspects of inappropriate prescribing practices, commission, and omission, and thus provide a comprehensive resource to refer to. Both STOPP/START have been applied and validated within the literature (Gallagher et al., 2008; Gallagher et al., 2009).

Prescribing guidelines are not restricted to Beers and STOPP/START. Kaufmann, Tremp, Hersberger and Lampert (2014) suggests that there are 36 tools to assess PIP among older adults in existence. Indeed, there are a great many country specific guidelines and explicit lists, including the Scottish Polypharmacy Guidance, the French Laroche list, the German PRISCUS list, and the Norwegian NORGEP listing. The sheer volume of prescribing assessment tools in operation precludes any direct comparisons being made between studies in the wider literature on inappropriate prescribing.

Regardless of their nature, both explicit and implicit tools have a number of limitations (Table 1-1). Explicit measures fail to consider the entirety of the medication regimen, focusing on each medication in isolation. In such instances explicit tools can underestimate the potential for drug-drug interactions. Such inadequacies prevent a comprehensive, patient-centred assessment (Shelton et al., 2000), thereby obstructing true medicines optimisation. Whilst implicit measures, which incorporate room for clinician decision making, provide more

scope for patient-centred care, those that lack structure run the risk of not being reliable (Shelton et al., 2000).

Explicit measures provide a means for standardisation of patient care, albeit at the expense of a patient-centred approach. However, systematising the autonomous judgements of a clinician may not always be in the best interests of the patient. Certainly, equity of access, and a consistently high standard of care for all patients is a motivating factor for most clinicians. Nevertheless, failing to consider the patient holistically, which explicit measures are oft to do, is reductionist, and perhaps ethically wrong. For example, Shelton et al., (2000) argue that medication should not be withheld simply because a patient is an older adult. Furthermore, the application of explicit criteria in a rigid manner somewhat suggests that there is no added value provided by clinical pharmacists, which rather demeans their training and experience. It has been argued that there is sufficient evidence to suggest that the combination of a structured approach to review prescribing, in tandem with clinical judgement is the optimum method of assessing prescribing appropriateness (Somers et al., 2012; Shelton et al., 2000). A combination approach allows for a comprehensive assessment that can be delivered in a reproducible manner (Shelton et al., 2000).

Table 1-1: Comparison of explicit and implicit tools to assess appropriateness of prescribing

	Explicit	Implicit
Conceptual Origin	Developed from literature	Developed from expertise
Pros	Allow standardisation of care Low cost	Patient centred Considers entire regimen
Cons	Does not consider comorbidities Requires constant revision Poor generalisability	Time consuming Can be unreliable if unstructured

Several studies, including those in older Irish adults, have found prevalence estimates of inappropriate prescribing to vary depending on the screening tool used (Cahir, Moriarty, et al., 2014; Moriarty, Bennett, et al., 2015; Hudhra et al., 2016). Moriarty, Bennett, et al., (2015) conducted a retrospective assessment of inappropriate prescribing among community-dwelling older Irish adults and identified a prevalence of 52.7% when the STOPP criteria were used, in comparison with a much lower estimate of 30.5% when the Beers' list was used. Similarly, Cahir, Moriarty, et al., (2014) found Beers to detect PIP in 28% community-dwelling older Irish adults compared with STOPP, which identified PIP in 42% participants. Consequently, Cadogan et al., (2016) argue that the predictive validity of prescribing assessment tools has not been adequately determined.

More recently, Hudhra et al., (2016) found that the version of the explicit tool that is used must also be considered. A comparison of different versions of STOPP within the same sample revealed a prevalence of 34.5% for the 2008 criteria, compared with 63% when the 2014 criteria were used. Whilst it is intuitive that revised criteria, containing more indicators

would identify a higher prevalence of PIP, it highlights the need for a screening tool that remains adaptable to advances in clinical knowledge.

A limitation of many studies of inappropriate prescribing, including many conducted within Irish samples, is that many have involved the application of explicit measures such as STOPP/START in a retrospective manner, through the analysis of prescribing databases. Such an approach limits the use of the screening tool to only those indicators which do not require the concomitant examination of the individual's medical notes. The variance in the number of indicators applied within the literature limits the comparisons that can be drawn between studies. For example, Bradley et al., (2014) found that, in a retrospective cohort study of those UK adults aged 70 years or over, PIP prevalence using only 28 STOPP indicators to be 14.9%, compared with 29% when 52 out of the 65 indicators were used. Similarly, Galvin et al., (2014) found a prevalence of PIP of only 14% when using 26 indicators of STOPP in a sample of community-dwelling adults aged ≥65 years. Thus, the use of a restricted number of STOPP indicators may underestimate the true prevalence of inappropriate prescribing within a sample.

Retrospective database studies fail to account for pertinent information that may provide insight into the prescribing culture for a particular individual. Information regarding other treatments trialled as a first-line option may not be apparent. Furthermore, information regarding contraindications may not be included. Such databases may also provide misleading information regarding duplication of therapy, a recognised aspect of inappropriate prescribing. In some cases, the patient's record may indicate a duplicated drug class, however this may not be reflective of what was actually dispensed to the patient, nor what was consumed by the patient. Consequently, database reviews fail to provide true estimates of PIP prevalence given the lack of information contained within them. In essence, such reviews cannot account for

occasions where seemingly inappropriate medications have been determined to be appropriate for the specific patient in question.

1.8 Quantifying inappropriate prescribing: The Medication Appropriateness Index

The Medication Appropriateness Index (MAI) is a ten-item weighted questionnaire that provides a quantitative assessment of the appropriateness of a medication for a given patient (Hanlon et al., 1992). It has been successfully applied in a number of different patient settings including hospitals, long term care facilities and community settings (Hanlon & Schmader, 2013). Shelton et al., (2000) considers it to be a combination prescribing tool that allows for an explicitly structured review process whilst retaining implicit judgements.

Each of the ten items of the MAI assesses a different aspect of the medication which, if unaddressed, has the possibility of resulting in inappropriate therapy. These aspects include clinical indication, effectiveness, correct dosage, correct directions, practical directions, drug-drug interactions, drug-disease interactions, duplication, duration, and expense (refer to Chapter 2). It formalises a clinical pharmacist review and provides a standardised score for each medication, ranging from 0 to 18. Higher scores reflect less appropriate prescribing. Each of the ten items is weighted to reflect the relative importance of the item, a clear recognition that certain aspects, such as effectiveness, are more important than others, such as cost considerations.

The particular advantage of the MAI is that it allows for quantification of appropriateness, through the reduction of considerable data into a standardised metric. In doing so, one can compare findings between studies and visualise trends in prescribing appropriateness, in an efficient manner. By incorporating a structured approach with implicit judgements, as suggested by Shelton et al, (2000) as the ideal prescribing assessment tool, the MAI may bridge the gap between explicit and implicit tools. In addition, instead of considering

the implicit nature of the measure to be solely comprised of the pharmacist's clinical knowledge, one must accept that explicit measures often form this implied knowledge. As a consequence, where explicit lists have failed, the MAI may remain robust to advances in clinical knowledge by not requiring constant revision.

The predictive validity of the MAI has been shown in early studies examining the relationship between MAI score and health outcomes. Schmader et al., (1997) found higher MAI scores to be significantly associated with unscheduled ED visits and inadequate blood pressure control. However, Schmader and colleagues (1997) found no significant association between higher MAI and hospital admissions. In contrast, Gillespie et al., (2013) found higher MAI scores to be significantly associated with drug-related hospital admissions, suggesting that the relationship between MAI score and hospital admission is predicated on the experience of an adverse drug event. Notably, Lund, Carnahan, Egge, Chrischilles & Kaboli (2010) found that higher MAI scores using a modified MAI significantly predicted adverse drug reactions.

Like any instrument, MAI is not without its limitations. Stuijt, Franssen, Egberts & Hudson, (2009) caution that the MAI score should only be calculated by experienced clinicians who have full access to the patient's clinical information. The MAI does not provide a means of assessing adverse drug events (ADEs), an important consideration associated with drug therapy. However, Shelton et al., (2000) justly argue that there are several other tools which serve this function, and as such MAI need not concern itself with this objective. For the practitioner, this may necessitate the use of multiple assessment tools, and may unnecessarily extend the review process. An additional criticism levelled at MAI is that it has been argued it does not detect underprescribing, and indeed its structure does not include a specific indicator to this end. However, one would be dismissing the clinical knowledge of the experienced clinician if one did not concede that this may already form part of their implicit thought processes. Just because there is not an indicator to alert to underprescribing does not mean

the pharmacist would not consider this. Shelton and colleagues (2000) suggested that, at the time of writing, it was the closest to a reliable and comprehensive instrument to assess prescribing appropriateness. Hanlon & Schmader (2013) argue that in the absence of a gold standard for identifying inappropriate prescribing, it remains a valuable research tool by providing a structured process for medication review, in tandem with a quantitative measure.

1.9 Medication use in older adults

Numerous medication classifications have been identified as particularly risky for use in older people. Specific concerns have been raised as far back as 1987, when federal oversight regulations regarding the use of antipsychotics in nursing homes were introduced in the US (Kales et. al., 2011). Antipsychotic medications are often used to treat behaviour and psychological symptoms of dementia (BPSD), however they are associated with an increased risk of cerebrovascular events and sudden death (Ray, Chung, Murray, Hall & Stein, 2009; Wu, Tsai & Tsai, 2015). In 2009 they were estimated to cause 1800 deaths and 1620 cerebrovascular accidents in the United Kingdom (Banerjee, 2009), despite an earlier regulatory warning in 2004 by the Medicines and Healthcare Products Regulatory Agency (MHRA) regarding the risk of stroke with risperidone and olanzapine (MHRA; 2004). This warning was further extended to include all antipsychotics in 2009 (MHRA, 2009).

However, adverse drug events for older people are not reserved to cerebrovascular accidents with antipsychotics. Several drug classes have been identified as increasing the risk of falls including antihypertensives, diuretics, sedatives, antipsychotics, antidepressants, benzodiazepines, and nonsteroidal anti-inflammatories (Woolcott et al., 2009). Falls resulting in fractures can lead to prolonged complicated sequelae for older people. Thus, it is vital that any assessment of inappropriate prescribing does not solely focus on the quantitative severity of the issue but also retains a qualitative element regarding the medication classifications that are contributing to objectionable pharmacotherapy for older adults.

The nature of inappropriate prescribing of psychoactive medications among older adults is particularly concerning, especially among nursing home residents (Barry, Parsons, Passmore & Hughes, 2015; Patterson, Hughes & Lapane, 2007) and people with dementia (Renom-Giuteras et al., 2018). The high prevalence of psychoactive prescribing among care home residents warrants attention given concerns that such medications are being used as a form of chemical restraint. A high proportion of older patients (73.9%) receive at least one psychoactive medication; more than half of these are considered to be prescribed inappropriately (Arnold et al., 2017). Psychotropic medication use has been found to be higher among nursing home residents compared with those residing in the community, and to increase sharply following admission to such facilities (Maguire, Hughes, Cardwell & O'Reilly, 2013). Given the increased susceptibility to the pharmacodynamic effects of many medications, the use of psychoactive medication in older people can result in harmful outcomes. For example, the use of benzodiazepines, to which older people are more sensitive (ElDesoky, 2007) is associated with an increased risk of falls (Díaz-Gutiérrez, et al., 2017), and can thus be a contributing factor in the return of a care home resident to an acute care setting if a fracture is experienced. The higher levels of psychoactive prescribing observed in care homes point to a clear need for pharmacist input to ensure that medicine use is optimised and that the risk of medication related harm is eliminated.

1.10 Pharmaceutical care needs of older adults

A central tenet to which pharmacists adhere is to optimise pharmacotherapy for patients whilst at all times ensuring they receive safe and efficacious treatments. Pharmaceutical care can be considered as the processes by which a pharmacist liaises with patients and/or other healthcare professionals to optimise pharmacotherapy, through the implementation and monitoring of goals that will produce specific therapeutic outcomes for patients (Spinewine, Fialova & Byrne, 2012).

Older adults may require pharmaceutical care more than most, increasing the potential for mediation related harm, and thus, associated healthcare utilisation. Polypharmacy, multimorbidity, inappropriate prescribing and age-related physiological changes creates a perfect storm for an adverse drug event to occur. Social factors such as residence in a care home, premature discharge from hospital due to an increased demand for beds may further the need for pharmaceutical care. Furthermore, irrespective of whether medication-related or not, a hospital admission can have deleterious effects on the functional and cognitive status of older adults. Thereby increasing the potential for future healthcare utilisation. Addressing those modifiable aspects of risk of hospital admission, such as medication-related factors may serve to limit the harm to older adults and the impact upon health services.

Pharmaceutical care services have undergone somewhat of an evolution over the last twenty years. The Fleetwood Model, when launched in 1995 in the US was considered an innovative approach to delivering pharmaceutical care to nursing home residents (Spinewine et al., 2012). The Fleetwood Model advocated for the identification of potential drug related problems and subsequent liaison with the prescriber to resolve these problems (Spinewine et al., 2012). In doing so, the Fleetwood Model set the foundation for the development of a 'consultant pharmacist' role, which commonly involved a medication review and management of the patient's regimen (Hughes & Lapane, 2011). Alldred et al., (2007) consider a medication review to be multidimensional. Accordingly, a medication review can be considered as 'a review performed by a healthcare professional, taking into consideration a patient's health status and medications, with access to full medical and care records, in conjunction with a consultation with the patient and their carer' (Hughes & Lapane, 2011, p. 107).

The Fleetwood Model was considered a successful approach, resulting in an estimated $3.6 million reduction in healthcare costs, owed to consultant pharmacist input into drug-

related problems in nursing homes (Bootman, Harrison & Cox, 1997). It has also been argued that this new consultant pharmacist role allowed for better integration of the pharmacist into the multidisciplinary team (Spinewine et al., 2012). The model also highlighted the challenges with respect to inappropriate prescribing within care homes. An evaluation of the Fleetwood Model in 12 nursing homes in the US identified 40% of residents were at high risk of drug-related problems, and 27% were in receipt of a potentially inappropriate medicine (Lapane & Hughes, 2006).

However, despite the clear advantages of pharmacist-led medication review, more often it is the case that hospital pharmacists are preoccupied with medication reconciliation, aimed at identifying the correct up to date list of a patient's medication. The occurrence of medication errors during patient transitions, for example from home to hospital admission, has dictated that need for medication reconciliation (Aronson, 2017). Whilst such an exercise is a prerequisite for a patient safety and a high standard of care, it is nevertheless time consuming, and may not be the best use of a clinical pharmacist's time.

Dalton & Byrne (2017) argue that traditional medicines reconciliation services are insufficient in reducing post-discharge clinical outcomes, and that the exercise needs to incorporate a medication review in order to be impactful. Similarly, Shelton et al., (2000) argue that good pharmaceutical care involves sufficient monitoring of therapy in terms of both beneficial and detrimental outcomes. Therefore, it is now generally accepted that a core element of the pharmacist's role is to systematically review each individual's pharmacotherapy, with a view to medicines optimisation (Christensen & Lundh, 2016). The inherent value of clinical pharmacist input can be appreciated in the considerable evidence available to support the acceptance of pharmacist suggestions by the wider prescribing team (Viktil & Blix, 2008).

Dalton & Byrne (2017) propose that pharmacists can contribute considerable savings to healthcare systems via immediate cost savings and future cost avoidance. For example, the clinical outcomes directly influenced by the clinical pharmacist's intervention can be calculated. In addition, future cost avoidance of drug related problems that have been resolved may also be quantified. This is particularly relevant when one considers that many drug related problems are considered preventable (Pirmohamed et al., 2004).

1.11 Consultant pharmacist roles

The US consultant pharmacist role is distinctive from the consultant pharmacist role in the UK. The publication of 'A Vision for Pharmacy in the New NHS' sought to develop consultant pharmacist positions to recognise the clinical excellence and leadership of experienced pharmacists (Department of Health; DOH, 2003). The primary aim of these consultant pharmacist posts was to provide patients with access to expertise from a practitioner who was not only leading the profession through practice but was also involved in research and teaching within their specialist area (Specialist Pharmacy Service Medicines Use and Safety Team, 2017).

Consultant pharmacists in the UK are required to have the necessary skills and experience to work across four key areas: clinical practice, professional leadership, education and mentoring of practice, and to conduct evaluative and service development research (Consultant Pharmacist Short Life Working Group, 2020; DOH, 2005; Specialist Pharmacy Service Medicines Use and Safety Team, 2017). These consultant pharmacist roles were created as distinctive posts that pharmacists could be appointed to, provided the necessary competency requirements were met. This advanced role sought to "provide a dynamic link between clinical practice and service development to support new models for delivering patient care" (DOH, 2005, p4.). Thus, this UK consultant pharmacist role is quite different from that in the US, where the purpose of the role is to identify and resolve medication related

problems, particularly for those who are resident in nursing homes (Spinewine et al., 2012). Consultant pharmacist posts have been established across the UK in diverse areas such as cardiology, antimicrobials, anticoagulation, paediatrics and older people's care (Specialist Pharmacy Service Medicines Use and Safety Team, 2017, 2020).

1.12 Pharmaceutical care interventions for older adults

With respect to medicines optimisation interventions targeted towards older adults, pharmacists have been active participants, and in many instances, have led the agenda when developing initiatives (Spinewine et al., 2012). Despite this involvement, an examination of the evidence surrounding the effectiveness of pharmacist interventions raises some contradictory findings (Christensen & Lundh, 2016; Verrue, Petrovic, Mehuys, Remon & Stichele, 2009).

An integrated medicine management (IMM) service, incorporating increased pharmacist input throughout the hospital patient journey, has been shown to significantly reduce hospital length of stay by two days, decrease the rate of readmission and significantly increase the time to readmission (Scullin, Scott, Hogg & McElnay, 2007). The IMM service has also been shown to be reproducible as part of routine clinical practice with significant reductions in hospital length of stay observed (Scullin, Hogg, Luo, Scott & McElnay, 2011). In contrast, a recent Cochrane review examining medication reviews as an intervention for hospitalised patients showed a decrease in emergency department admissions but no decrease in hospitalisations or all-cause mortality (Christensen & Lundh, 2016).

In the nursing home context, pharmacist-led medication reviews have been shown to result in a non-significant reduction in the number of medications prescribed and consequently in associated drug costs (Furniss et al., 2000). However, no effect on subsequent morbidity or mortality was observed. Roberts et al., (2001), on the other hand, found that when pharmacist-led medication reviews were combined with a focus on professional relationship building and nurse education, a significant decrease in number of medications was

observed. When considering health outcomes, Zermansky et al., (2006) found that a pharmacist-led medication review resulted in a significant number of drug changes, and a significant reduction in falls, compared with a control. However, no significant difference was observed between the intervention and control groups for GP consultations, hospitalisation, deaths, or number and/or cost of drugs per patient.

The inclusion of the pharmacist into a multidisciplinary case conference approach to nursing home care has shown more success, with a significant improvement in appropriateness of prescribing (Crotty, Halbert, et al., 2004) and a reduction in prescribing of antipsychotics, benzodiazepines, and antidepressants (Schmidt, Claesson, Westerholm, Nilsson & Svarstad, 1998). In contrast, a pharmacist-led education intervention reported no significant differences in psychotropic prescribing, when compared with a control group (Crotty, Whitehead, et al., 2004). When acting as a coordinator at the transition of care between hospital and nursing home, intervention by the pharmacist has been shown to prevent worsening in level of prescribing appropriateness compared with a usual care control group (Crotty, Rowett, Spurling, Giles & Philips, 2004).

More recently, Huiskes et al., (2017) set out to assess the effectiveness of medication review as an isolated short-term intervention, irrespective of patient population. In their systematic review, 31 randomised controlled trials (RCTs) with a duration of less than three months were reviewed. Best evidence synthesis was conducted for 22 outcome measures. No effect on clinical outcomes, save for a decrease in falls was found. Similarly, no effect on quality of life or economic outcomes was observed. However, an effect was found for drug-related problems. Their conclusion was that despite showing effects for most drug-related outcomes, no conclusion could be drawn on the effect of the interventions on clinical and economical outcome measures. On the balance of such evidence, Huiskes and colleagues advocate for a cessation of widespread medication reviews as an aspect of standard care and

consider examining high-risk individuals instead. Such a conclusion underscores the need to clearly identify who these high-risk individuals are.

In their review of 107 studies, Faria, Barbieri, Light, Elliot and Sculpher (2014) found that most studies evaluated were predicated on the measurement of intermediate outcomes. Intermediate outcomes, such as blood pressure and error rates, may impact on final outcomes, such as health resource usage and mortality. However, as Faria and colleagues (2014) notably argue, none of the studies included in the review attempted to link the intermediate outcomes with final outcomes, undermining the inherent presumption in the utility of intermediate outcomes. They further argue that any association between intermediate outcomes and final outcomes may vary as a function of the disease in question. Furthermore, the absence of a standardised measurement approach prevents comparisons of multiple study findings.

Whilst the evidence regarding effectiveness of clinical pharmacist interventions provides conflicting results, it must be recognised that many studies are not comparable based on the differing outcomes assessed. Such heterogeneity in study design and limitations in terms of the outcomes measured precludes a true assessment of medicines optimisation interventions (Faria et al., 2014). Furthermore, when considering healthcare utilisation as an outcome of any intervention for older adults, one must appreciate the myriad of factors which influence healthcare utilisation generally speaking, but also those factors which are particularly relevant in older cohorts.

1.13 Healthcare utilisation by older adults: myriad of antecedents and consequences

The risk for hospital admission increases for those older adults who experience cognitive impairment (Toot, Devine, Akporobaro & Orrell, 2013). Once hospitalised, those with cognitive impairment are likely to experience a longer admission and are also more likely to be readmitted within 28 days of discharge, compared with those without cognitive impairment

(Tropea, LoGiudice, Liew, Gorelik & Brand, 2018). The experience of a hospital admission can also result in altered cognition and delirium among older adults (Inouye, Westendorp & Saczynski, 2014).

Variation in cognitive function and functional status of older adults has been shown to be related to depression (Song, Meade, Akobundu & Sahyoun, 2014) and may exhibit a bidirectional relationship, with poorer functional and cognitive status related to greater depressive symptomology in older adults (Vankova, Holmerova, Andel, Veleta & Janeckova, 2008). Furthermore, depression may intensify the relationship between chronic illness and healthcare usage (Dickens et al., 2012). For example, the coexistence of depression or anxiety among those with chronic obstructive pulmonary disease (COPD) has been shown to be related to greater levels of healthcare usage and increased costs (Laurin et al., 2009; Maurer et al., 2008; Gudmundsson et al., 2005; Xu et al., 2008).

Frailty is a multidimensional syndrome described as the inability to maintain homeostasis in the presence of stressors due to an age-related decline in physiological reserve (Rockwood et al., 2005; Xue et al., 2011). The presence of frailty increases the risk of falls, increased level of disability, hospitalisation, transfer to long term care and death (Ensrud et al., 2008; Fried et al., 2001; Rockwood et al., 2004). Frailty has also been shown to increase the numbers of consultations with GPs and practice nurses and to be associated with longer hospital admissions (Han, Clegg, Doran & Fraser, 2019).

Chronic disease management is associated with higher levels of healthcare utilisation (Cassell et al., 2018; Glynn et al., 2011; Hutt et al., 2004; Lehnert et al., 2011; Marengoni et al., 2011; Palladino et al., 2016) and is found to be more prevalent among older adults (Barnett et al., 2012; Britt, Harrison, Miller & Knox, 2008; Cassell et al., 2018; Violan et al., 2013; Zulman et al., 2015). Multimorbidity and frailty both increase the risk of polypharmacy among older adults (Palmer et al., 2019; Saum et al., 2017), thereby increasing the risk for additional

healthcare utilisation. Furthermore, those with both frailty and polypharmacy have been shown to have longer hospital admissions, more nursing home transfers and have a higher risk of hospital readmission (Rosted et al., 2016). As previously discussed, polypharmacy increases the risk of inappropriate prescribing.

There are numerous mechanisms by which medications can increase the need for healthcare utilisation among older adults, with falls a particular conduit. An increased sensitivity to the pharmacodynamic effects of sedative medications such as benzodiazepines (ElDesoky, 2007) can increase the risk of falls in older adults (Bloch et al., 2011; Díaz-Guitérrez, et al., 2017; Hill & Wee, 2012; Landi et al., 2005). As a consequence, an escalation of care may be required, particularly if a fracture is experienced. Falls and associated fractures are often a contributing factor in the transfer of a care home resident to an acute care setting (Carey & Laffoy, 2005; NHS Scotland, 2016; Quinn, 2011; Smith, Sherlaw-Johnson, Ariti & Bardsley, 2015). Orthostatic or postural hypotension as a consequence of antihypertensive medications can also result in falls among older adults (Tinetti et al., 2014). The adverse effects of anticholinergic medications, including postural hypotension, blurred vision, and confusion, further increase the risk of falls and subsequent negative outcomes such as fractures or traumatic brain injuries (Carey & Laffoy, 2005).

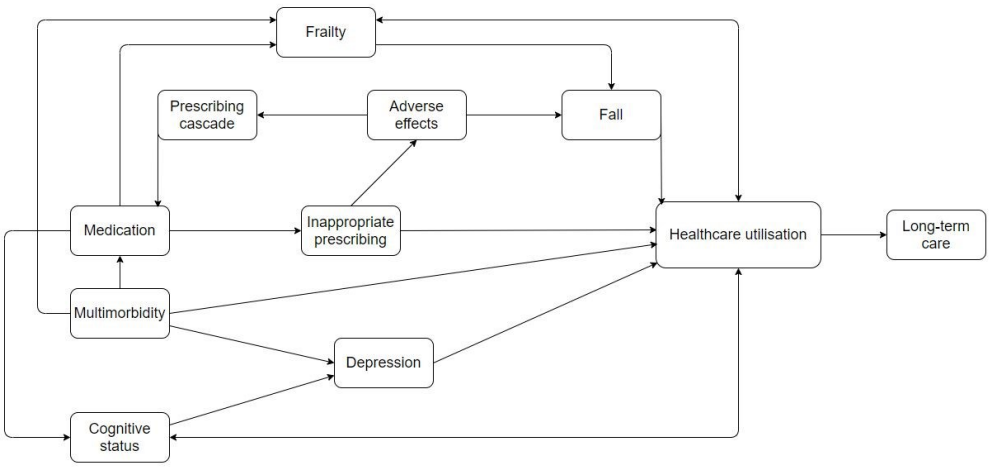

Figure 1-2: Complexity of factors which influence healthcare utilisation by older adults

Given the intimate associations between medication use and negative outcomes resulting in increased healthcare utilisation, it can be argued that pharmacist intervention may serve as a leverage point from which an improved experience of aging can be achieved. Thus, perhaps the words of Spinewine and colleagues (2012) remain valid such that "opportunities exist for multi-centre, European-based, pharmacist-intervention trials in all settings, to determine the effectiveness and economic benefit of pharmacist involvement in the optimisation of pharmacotherapy in older persons'" (p. 508).

1.14 Health service provision in Northern Ireland (NI)

Since 1999, responsibility for health services has been a function of the devolved government of Northern Ireland. Consequently, public health decisions, including policies and expenditure, are made locally in Northern Ireland. Unlike the remainder of the United Kingdom, Northern Ireland has a single organisation that purchases services for the whole population (National Audit Office; NAO, 2012). The Health and Social Care Services (HSC) in Northern Ireland coordinates the provision of integrated services to the population, across six health trusts. These are Belfast HSC Trust, South Eastern HSC Trust, Western HSC Trust, Southern HSC Trust and Northern HSC Trust. The sixth trust is the Northern Ireland Ambulance Service, which operates a single service across the territory. HSC Trusts manage and administer hospitals, health centres, residential homes, day centres and other health and social care facilities, whilst also providing a wide range of services throughout the community (Health and Social Care Northern Ireland, 2018). In addition to patient facing organisations, the HSC in Northern Ireland also coordinates a number of additional agencies and programmes concerned with a wide range of activities including public health, clinical trials, health screening, research and development and education.

Northern Ireland has been adjudged to have the highest average health need per person, compared to the rest of the United Kingdom (NAO, 2012), based upon indicators such as population age, levels of disability and wealth etc. Funding for public services in Northern Ireland comes from the Treasury, the amount of which is calculated primarily based upon historical levels (NAO, 2012). Despite the autonomy to determine how to fund health and social care services, NI has had the most variability in health spending from one year to the next. Simultaneously, NI also has devoted the lowest proportion of public spending to health when compared with other parts of the UK.

1.15 Demand for healthcare services for older adults in NI

The demand for health services in Northern Ireland will increase substantially when one considers the disproportionate rate of population growth among the older generation. There has been a consistent increase in the number and proportion of older people living in Northern Ireland. In the period from 2004 to 2014, the number of adults aged 65 years and over increased by 23.1%, which was more than three times higher than the total population growth rate (7.4%) over the same period (Office of the First Minister and Deputy First Minister, 2015). During the same period, the proportion of the population aged 85 years and older increased by 41% (Office of the First Minister and Deputy First Minister, 2015). It is estimated that by 2024, those aged over 65 years will increase by 25.8% in Northern Ireland (Northern Ireland Statistics and Research Agency; NISRA, 2018). This is juxtaposed with the marginal projected growth of 0.8% predicted to occur among those of working age (NISRA, 2018). By mid-2039 it is estimated that almost one quarter (24.7%) of the population will be aged 65 years and over, with 4.4% of the population projected to be 85 years and over (Office of the First Minister and Deputy First Minister, 2015). It is therefore imperative that future health service provision is suitably organised and sufficiently resourced in order to cater to the unique demands of this patient profile.

Previous studies of inappropriate prescribing among the older people in NI have estimated the prevalence to be approx. 34%, representing approximately 5% of the health budget (Bradley et al., 2012). Similar prevalence estimates were observed in the Republic of Ireland (ROI), with 36% of participants of a database review found to have at least one inappropriate medication (Cahir et al., 2010). When examined in greater detail, inappropriate prescribing among older adults in Northern Ireland was found to be associated with polypharmacy and female gender (Bradley et al., 2012). However, these associations are based upon retrospective database review of those aged 70 years and older, using only 28 STOPP indicators (Bradley et al., 2012). As previously argued, database reviews may underestimate the prevalence of PIP owed to a limited number of inappropriate prescribing indicators being available to analyse, such as the case of Bradley and colleagues' (2012) findings. Similarly, whilst Bradley and colleagues identified inappropriate prescribing in NI to be associated with polypharmacy and female gender, the relationship between PIP and healthcare resource utilisation was not explored.

1.16 Pharmaceutical care for older adults in NI

Northern Ireland has enshrined a patient-centred approach with respect to pharmaceutical care within its Medicines Optimisation Quality Framework (Department of Health, Social Services and Public Safety Northern Ireland; DHSSPSNI, 2016). This framework seeks to support better health outcomes for the Northern Irish population by improving the way that medicines are used. Among its key recommendations the framework called for the introduction of a Regional Model for Medicines Optimisation to engage health and social care professionals in the delivery of best practices across the region (DHSSPSNI, 2016). This regional model was designed to be delivered by a multidisciplinary medicines optimisation workforce, with pharmacists involved in all settings (DHSSPSNI, 2016). Furthermore, the framework called for the development, testing and scale up of services and for best practices to be co-designed with patients (DHSSPSNI, 2016).

In recognition of the innovation and outcomes demonstrated in medicines management, Northern Ireland was selected as a reference site with the European Innovation Partnership for Active and Healthy Ageing and was awarded '3 star' status in 2013 (Scott & Fleming, 2017). This recognised Northern Ireland as a leading region in addressing the health and social care needs of the older population (Scott & Fleming, 2017). It would then go on to become one of seven regions in Europe to be awarded '4 star' status in 2016 (Scott & Fleming, 2017). Northern Ireland serves as a partner country in the 'Stimulating Innovation Management of Polypharmacy and Adherence in the Elderly' (SIMPATHY) project which comprises of 10 organisations representing eight EU countries (Scullin, Fleming, Scott & Harrison, 2016).

Accordingly, the Medicines Optimisation and Innovation Centre (MOIC) was established with a mandate to deliver the best outcomes for the patient through facilitating best practice with respect to medicine use, in a consistent way (MOIC, 2016). Such has been the success of their activities that Northern Ireland is considered as a leading region in Europe for medicine optimisation for older people (Scott & Fleming, 2017). The development of MOIC in NI can be considered as a prudent response to the increased demand on health and social care services owed to a growing, ageing population with chronic comorbidities (MOIC, 2016). The MOIC platform provides space for regional development of innovative solutions aimed at safer, more rational use of medications.

Recent advances within the region include the development of a new model of consultant pharmacist-led pharmaceutical care and case management for older people within intermediate care (Miller, Darcy, Friel, Scott & Toner, 2016). Within this care model the implementation of individualised pharmaceutical care plans by consultant pharmacists was found to significantly improve prescribing appropriateness from admission to discharge (Miller et al., 2016). Given that intermediate care as a setting has been developed to ease the burden

on acute care, and to prevent early admission into care homes, it may provide an ideal point at which to intervene with respect to drug related problems. Pharmacotherapy interventions to reduce inappropriate prescribing in intermediate care have not received as much research attention when compared with other settings (Millar, 2016). In particular, how the reduction in inappropriate prescribing relates to later healthcare resource usage has also not been fully elucidated. If such an intervention were to improve the outcomes of the individual patient post-discharge from intermediate care, this could result in greater numbers of older people returning to their own homes and ward off transfer into a longer-term care home setting.

Additionally, a consultant pharmacist-led outreach clinic to nursing homes showed similar successful outcomes, with a significant improvement in prescribing appropriateness achieved (McKee, Miller, Cuthbertson, Scullin & Scott, 2016). This model of care addresses a particular ethical issue with respect to respecting the autonomy of older people in addressing any concerns that they may have regarding their pharmacotherapy. Care home residents often do not receive direct access to a pharmacist, with medication being supplied via the care home staff. The older person living well within the community may have more opportunity to engage with pharmacy services, have their medications reviewed, discuss any apparent issues with the pharmacist and thus exhibit greater autonomy over their medication. Traditionally such access has not been available to care home residents.

1.17 Need for further investigation

Against a backdrop of an ageing population who are living for longer with more chronic conditions, an increased level of scrutiny is being placed on the ability of health services to address the unique health needs of older adults. The projected growth among older people in Northern Ireland, coupled with the increased level of prescribing within the region, points to an increased need for pharmaceutical care services that ensure older adults obtain the greatest benefit from their medicines, with minimal harm. To date, several studies have

indicated that inappropriate prescribing is prevalent among those older adults living in the community (Bradley et al., 2012), intermediate care (Millar, 2016; Miller et al., 2016) and in care homes (Maguire et al., 2013; McKee et al., 2016) within Northern Ireland.

This need is not unique to the Northern Irish context but rather is increasingly becoming a global priority. Indeed 'Medication without harm' has become the third WHO Global Patient Safety Challenge, with high-risk situations such as prescribing for older adults, polypharmacy and transitions of care identified as priority areas (WHO, 2017). Given the impact of factors such as frailty, polypharmacy, inappropriate prescribing, and falls on healthcare utilisation by older adults, it is not surprising that increasing attention is being paid to the need to develop integrated care strategies to support older adults to age well (DHSSPSNI, 2011a; Health Service Executive: HSE, 2017).

The Department of Health (DOH) published a National Service Framework (NSF) for Older People in 2001, advocating for a person-centred care approach, whereby older people would be enabled to be active participants in choices regarding their own care (DOH, 2001). As part of this NSF a new layer of care, intermediate care, was proposed. Interfacing between primary care and specialist services, this new point of care was designed to promote independence via enhanced services from the NHS and prevent unnecessary hospital admissions, enable early discharge from hospital and prevent early or unnecessary admission to long-term residential care (DOH, 2001). Accordingly, intermediate care has emerged as a key location for the care of older adults following discharge from acute care. Acting as a 'bridge' between hospital and home, intermediate care provides an opportunity to address those modifiable factors that can support the older person to remain independent within their own homes for longer.

Thus, intermediate care may serve as an ideal location for medicines optimisation for older adults. Given that many medication-related hospitalisations of older people are

avoidable, and that increased clinician input in residential care results in reduced healthcare usage, it stands to reason that an intervention to address inappropriate prescribing may also result in reduced healthcare usage by care home residents. Thus, there is a need to understand the implications of pharmacist intervention to improve prescribing appropriateness in terms of additional secondary outcomes such as healthcare utilisation. An examination of healthcare usage at both primary and secondary care level will provide an insight into the escalation of care within this context. Concerns have been raised within the literature regarding the appropriateness of transfers of care home residents to hospital emergency departments (Lemoyne et al., 2019).

The literature also points to an increasing concern regarding the use of psychoactive medication among older adults, and in particular those living within residential care. There is evidence to suggest that such prescribing is prevalent in Northern Irish care homes (Maguire et al., 2013). However, to focus solely on inappropriate prescribing of one classification of medications does little to inform of the broader prescribing culture within such care settings. Thus, as the Medicines Optimisation in Older People (MOOP) care services continue to develop throughout the region there is a greater need to understand the effectiveness of both care models at a deeper level.

Both of these pharmaceutical care models have shown significant improvements in prescribing appropriateness and also considerable drug cost savings. Such outcomes suggest that there are considerable advantages to pharmacist-led medicines optimisation services that are not reflected within the findings of previous systematic reviews. A greater understanding of what drives the improvement in prescribing appropriateness observed in both models can be used to inform the future directions of the service.

Whilst there has been a wealth of research examining the prevalence of and risk factors for inappropriate prescribing globally, there is a dearth of research examining the

relationship between improvements in prescribing appropriateness and subsequent healthcare utilisation. As such, there is no clear consensus as to the characteristics of patients who are at risk of poorer health outcomes associated with inappropriate prescribing. A better understanding of how addressing the medicines optimisation needs of older adults is related to subsequent use of healthcare services may serve to support the further development and refinement of services.

However, it must be appreciated that hospital readmissions are a complex phenomenon and are influenced by sociocultural factors in as much as by health need (Cooksley et al., 2016; Hubbard et al., 2017). Thus, it is not surprising that many risk prediction models for hospital admission perform poorly (Kansagara et al., 2011). This is despite theorists alerting us to the multidimensional factors that influence healthcare access as far back as 1968 (Andersen, 1968). Moving away from the reductionist nature of the biomedical model, theorists such as Bronfenbrenner (1979) and Engel (1980) proposed that clinicians and theorists adopt a broader ecological systems perspective. Nevertheless, many studies which have sought to examine healthcare utilisation in a multifactorial manner, using the Andersen Behavioural Model (Andersen, 1995; Andersen & Newman, 1973), have failed to adopt multivariate approaches in order to accommodate the complexity of factors involved (Babitsch et al., 2012).

The evaluation of healthcare interventions, such as pharmaceutical care models can be further augmented by a complementary examination of healthcare utilisation over a considerable period of time. Longitudinal data sources provide an opportunity to examine more data points and develop a more nuanced view of what influences healthcare usage in a representative sample, thus providing a broader context within which to examine intervention studies. Furthermore, the examination of healthcare usage in an isolated manner limits our understanding of the multifactorial nature of healthcare utilisation as particularly with respect

to older adults who, as a cohort, which exhibit considerable complexity. Andersen (1995) recommended that studies consider healthcare usage patterns longitudinally, as healthcare usage in itself may predict future healthcare usage. Longitudinal cohort studies that collect information on demographic and socioeconomic factors, as well as clinical information provide an opportunity to address such a question.

1.18 Aims and objectives of the thesis

There is a clear need to identify the true prevalence and characteristics of inappropriate prescribing among older people in Northern Ireland, and further to examine associated healthcare outcomes. The present thesis seeks to address this by examining data collated by the MOOP pharmacists appointed to deliver inappropriate prescribing interventions within intermediate care and care home settings. These interventions were conducted in the Western and Northern HSC Trusts using the Medication Appropriateness Index as a review tool and metric. Patient MAI scores were calculated by the MOOP pharmacist at baseline and on discharge from intermediate care or upon completion of the intervention in the care homes.

This thesis seeks to address two principal aims. The first is to examine whether a relationship exists between improvements in prescribing appropriateness and subsequent healthcare resource usage, in those patients who receive a specialist pharmacist case management service. Furthermore, the study aims to identify those individuals who receive the most benefit from the case management interventions and those who are most at risk of poorer health outcomes, operationalised as subsequent healthcare resource usage. In doing so, future interventions may be targeted more effectively in order to reduce inappropriate prescribing in Northern Ireland, with potential scope for more universal application. At a time when health resources are under significant strain, risk stratification with respect to inappropriate prescribing will serve to increase efficiencies within the health and social care

services in Northern Ireland. Similarly, the present study seeks to examine those classes of medicines, identified as inappropriate at baseline, that are found to be associated with increased healthcare resource usage. The identification of novel classes of high-risk medications may then be used to inform future prescribing guidelines.

Secondly, this thesis seeks to examine the broader contextual factors that influence healthcare service usage by older adults, using complementary analyses in a longitudinal cohort study of older people. The multifactorial nature of healthcare usage by older people makes it particularly challenging to appreciate the impact of interventions on subsequent healthcare resources. Thus, the thesis seeks to provide more detail of the context within which interventions to support older people should be interpreted. The present study sets out to achieve these aims by means of the following objectives:

i. Calculation of the change in total MAI from baseline to intervention completion for patients reviewed by case management pharmacists in intermediate care and care homes in the Northern and Western HSC Trusts.
ii. Identification of the proportion of variability in healthcare resource usage over 30- and 90-days' post intervention completion that is explained by the change in MAI.
iii. Identification of which patients have reduced healthcare resource usage in association with a reduced MAI score and those which show no decrease or even increased healthcare resource usage, despite a reduction in MAI score.
iv. Identification of classifications of medications that are frequently prescribed inappropriately at baseline for both care home and intermediate care patients.
v. Establish whether improvements in prescribing appropriateness of these classifications leads to a change in healthcare resource usage 30- and 90-days' post intervention.
vi. Identify latent longitudinal trajectories of healthcare utilisation by older people using a comparable cohort study.

vii. Summarise longitudinal change in a range of covariates with a known or theoretical association with healthcare utilisation by older people.

viii. Identify those contributory factors that explain variation in longitudinal healthcare utilisation patterns by older adults.

1.19 Overview of thesis structure

In order to deliver the thesis objectives, the remainder of the thesis is presented as follows:

- Chapter 2 forms the foundation for the method sections of subsequent empirical chapters, thereby serving as a landmark for the reader. It introduces the methodology applied in the thesis by providing information on the data sources, measures and sample characteristics, before providing an overview of the analytic plan for the thesis.
- Chapter 3 examines variability in healthcare utilisation by older adults following the receipt of a novel pharmaceutical care intervention within intermediate care settings in Northern Ireland. Prior to examining the impact of this intervention on healthcare utilisation, preliminary exploration of the prevalence of inappropriate prescribing and an examination of variability in MAI score improvement is conducted.
- Chapter 4 examines the same objectives as those explored in Chapter 3 in relation to care homes settings in Northern Ireland.
- Chapter 5 augments the findings of Chapters 3 and 4 with respect of the prescribing culture in intermediate care and care home contexts in Northern Ireland. The medication classifications most frequently prescribed inappropriately in both care contexts are identified. Furthermore, an examination is conducted of the appropriateness of prescribing of psychoactive medications. Healthcare utilisation following medicines optimisation of these individual medication classifications is then examined.

- Within Chapter 6, longitudinal variation in healthcare utilisation is examined using the Irish Longitudinal Study of Ageing, a nationally representative study of community dwelling older adults in the Republic of Ireland. Heterogeneity in healthcare utilisation over time is investigated through the application of latent variable modelling in the form of latent class and latent transition analyses.
- Chapter 7 serves as a foundational chapter for subsequent empirical findings presented in Chapter 8. Within Chapter 7, potential covariates which may explain differences in healthcare utilisation patterns identified in Chapter 6 are operationalised for inclusion in the analyses presented in Chapter 8. Latent growth curve models are used as a means of data reduction, capturing longitudinal change in several pertinent variables identified from the literature.
- Chapter 8 integrates the findings of Chapters 6 and 7 through further analysis. Covariates operationalised in Chapter 7 are explored as predictors of healthcare utilisation patterns identified in Chapter 6 using logistic regression analyses.
- The concluding chapter, Chapter 9, integrates the findings from the medicines optimisation intervention evaluation and the findings obtained from the longitudinal cohort study, providing a discussion of the implications of overall thesis findings for theory, future research and clinical practice.

2 Methodology

2.1 Chapter overview

This chapter outlines the methodology adopted in the present thesis with a particular focus on data sources, data collection, measures, and sample characteristics. The purpose of this chapter is to serve as a reference landmark to the methods sections of subsequent empirical chapters.

2.2 Introduction

Conducting research on older adults highlights several key points that must be considered. Older people are often excluded from clinical trials on medications, largely due to variation in physiological changes in key metabolic systems. As such our understanding of the relative safety of medicinal products in older cohorts tends to only surface in the post-marketing surveillance period. Not only does this result in a dearth of research into how medication affects older people specifically, but it also enshrines the view that older people are inherently vulnerable, and that research poses a greater risk to them that the wider population. This is somewhat of a contentious issue, ethically speaking, as it removes the active participation of older people in research topics that are directly relevant to them. Whilst there is an obvious need to protect any individual from succumbing to research-related harm it is overly simplistic to deduce that all older people are vulnerable. Instead it reinforces an ageist approach that is pervasive in many research fields.

The ‘gold-standard’ approach to research is that of randomised studies that control for possible confounders. Doing so provides the best possible means for gathering a robust evidence base from which conclusions may be drawn. However, within the context of healthcare, and in particular healthcare for older people, randomisation to a control or ‘usual care’ group introduces the possibility of denial of efficacious treatments in the pursuit greater

academic rigour. This in itself raises additional ethical concerns, particularly when considering research conducted in end-of-life scenarios.

Attrition within studies due to age-related declines in health and death makes research within older cohorts particularly challenging with respect to maintaining statistical power. One must counterbalance the need for a sufficiently large sample size at the outset with the possibility of a large control group receiving no benefit from the intervention under examination. Craig et al., (2008) argue that a balance must be struck between the importance of the intervention and the value of evidence that can be gathered within the research design. Furthermore, there may be ethical objections to the use of experimental methods, despite their superiority as a research design (Craig et al., 2008). The time taken to design, pilot, and conduct a randomised controlled trial (RCT) can add considerable delay to the evaluation of an intervention. Whilst such a design may be required to adequately examine secondary outcomes, such as healthcare utilisation following clinical intervention, an RCT design may be excessive to examine a primary outcome such as improvements in prescribing from pre- to post-intervention. Thus, it may be difficult to justify the time required to conduct an RCT to those future service users who experience a delay in receiving the benefits of the intervention.

Rather, the best available methods should be employed as despite lacking internal validity they may still yield useful results (Craig et al., 2008). Craig and colleagues (2008) caution that researchers must be cognisant of the limitations of non-experimental methods when interpreting study findings and argue that the use of complementary evidence sources may offset the potential weakness of non-experimental methods. Craig and colleagues (2008) further argue that a key consideration when evaluating interventions is whether the intervention is effective in everyday practice.

There are additional challenges when examining outcomes in frail older adults, who may be approaching end of life. Their exclusion from trials raises some ethical concerns

regarding the suitability of the study to be generalisable to their needs. Higginson et al., (2013) argue that it is more ethical to offer patients and their families the opportunity of participation, especially when they are willing to engage with research. Thus, a study design that is time intensive (e.g. ethical approval, randomisation procedures with intention to treat analyses) may not serve the needs of the population under examination.

Those who participated in the Methods of Researching End of life Care (MORECare) consultation reported the need for timely research results in order to influence service developments (Higginson et al., 2013) and that RCTs are not the limit for robust evaluation data. Higginson and colleagues (2013) argue that secondary data analysis can be particularly beneficial, especially in the context of high-quality data, including that which is gathered in routine clinical practice. Furthermore, randomisation may not be possible if the policy decision regarding the intervention has already been made (Craig et al., 2008). The additional costs of an experimental design must be counterbalanced with the reliability of the information (Craig et al., 2008). Should an observational study provide high quality information at a reduced cost, then more expensive randomised study may not be justifiable.

Furthermore, the current digital age means that there are already a multitude of readily available data sources which provide an opportunity for novel research designs. It is imperative that we interrogate the data already available to us before needlessly gathering more. Thus, a natural tension exists within healthcare between that which is service evaluation and that which is research.

Many healthcare professionals may not view their roles as that of researchers and yet their desire to innovate and to improve service delivery to meet the changing demands of the populations they serve suggests otherwise. Many new service models undergo small scale pilot work whereby innovations to practice are evaluated on an economic basis. Those which show a positive return on investment are rewarded with scaled up implementation. Such a

process can be viewed with academic disdain given the inherent limitations that such an approach confers. Yet the ends justify the means as service evaluation pieces can be conducted in a shorter timeframe and can result in alterations to practice that the entire population can readily benefit from.

An alternative approach is to examine existing data, such as service evaluation data, which may provide additional insights beyond that of which was intended during the initial data collection period. By doing so we can also remove a duplication of effort; rather than seeking to reinvent the wheel we can concern ourselves with the characteristics that inform its optimal performance.

The use of established data sources is becoming an increasingly popular means of research within the social sciences (Vartanian, 2011), given the inherent advantage that it is less resource intensive. Furthermore, many existing secondary data sources contain a large sample size (Vartanian, 2011), that is often gathered in a stratified manner to ensure that it is representative of the population (Boslagh, 2007). Thus, secondary data often overcomes the challenges posed by smaller studies which make use of smaller convenience samples that have limited generalisability (Boslaugh, 2007).

Secondary data analysis is not without its challenges given that the data was not collected with a view to the specifics of the researcher's question (Boslaugh, 2007). As such, the researcher may be faced with examining variables that are not direct indicators of the phenomenon in question but rather serve as a proxy for them. Furthermore, the analysis that can be conducted is limited by the extent to which the collected data has been recorded. Notwithstanding these limitations secondary data analysis provides an opportunity to cross-pollinate research in a manner that has perhaps not been considered previously. A researcher from one discipline examining data gathered in another will approach this data from a different perspective, offering the possibility of alternative data manipulations and

interpretations. For example, information relating to product sales can inform of both the economic position and behavioural habits of a sample population.

Secondary data analysis is also an efficient means of examining longitudinal data, a labour intensive yet rich source of data. Longitudinal studies, where data is collected form the same participants on more than one occasion, allows for the investigation of temporal relationships within the data. Such studies allow for the identification of within-individual differences as well as those between-individual differences, providing a more nuanced view of a phenomenon that would otherwise be considered as static by a cross-sectional study.

As such, longitudinal study allows for the examination of potential antecedents and consequence of the phenomenon under investigation. Thus, the examination of change within a phenomenon can be better facilitated by more than one data capture. Longitudinal study is not without its limitations. In particular, it is particularly vulnerable to the effects of attrition which needs to be accounted for during study design, often resulting in the recruitment of a large sample at phase one. This increased level of recruitment increases the costs associated with data collection, which is already considered to be a costlier type of research design (Brannon, Feist & Updegraff, 2013). Notwithstanding these limitations, there is merit in conducting secondary data analysis using both service evaluation and longitudinal data. The use of more than one data source will allow for complementary analyses that may not have been possible using both sources.

2.3 Medicines Optimisation in Older People data

2.3.1 Data source

The analyses reported in Chapters 3-5 involved the use of data sets obtained from the Medicines Optimisation in Older People (MOOP) team, which operates under the guidance of the Medicines Optimisation and Innovation Centre (MOIC). The implementation and evaluation of these service models has generated a rich source of clinical data, beyond that

found in many database studies examining prescribing appropriateness. Thus, it may fulfil the recommendations of Higginson and colleagues (2013), particularly when examined with complementary sources of evidence.

Development of the MOOP models: historical context

The 2001 publication of the NSF for Older People called for a person-centred approach to care, whereby older people would be active participants in their own care choices (DOH, 2001). Shortly afterwards, the DOH (2003) published 'A Vision for Pharmacy in the New NHS'. This position paper sought to enshrine convenient ease of access to medicines and pharmaceutical advice for patients. It recognised that the environment within which patients accessed health services was changing, and that the profession needed to adapt to this, whilst maintaining high levels of professional standards. It advocated for increased medicines management services, including medication reviews, and in particular highlighted the NSF for Older People as a key cohort where a clinical need for review existed. It also called for innovation with respect to delivering pharmacy services across the primary and secondary care interface.

At a time when there was a shortage of pharmacists, the position paper called for focusing the pharmacist's time on where value could be added and identify tasks that could be carried out by others. Within the hospital pharmacy sector, it was proposed that consultant pharmacist positions would be developed, recognising the clinical excellence and leadership of experienced pharmacists. It was envisaged that these consultant pharmacists could also be supplementary or independent prescribers or provide other specialist clinical services. Their role would thus focus on medicines management services within hospitals but would also influence the use of medicines in the local community.

Thereafter, in 2005, the DOH published guidance for the development of consultant pharmacist posts. A further update has recently been published in 2020 (Consultant

Pharmacists Short Life Working Group, 2020). These guidance documents outline the four key functions of the role: expert practice; research, evaluation and service development; education and mentoring of practice; and professional leadership (Royal Pharmaceutical Society of Great Britain, 2020). Through this role patients could receive access to high level expertise from practitioners leading the profession, through practice, research and training, in their specialist area (Specialist Pharmacy Service Medicines Use and Safety Team, 2017).

Recognising the needs of the ageing population within Northern Ireland, a policy shift occurred that was largely driven by the 2011 publication of Compton Review: 'Transforming Your Care' (TYC) (DHSSSPS, 2011a; Miller, 2018). This position led to a move from focusing on provision of health services within the secondary hospital setting to developing services within primary care that also encompassed a social care element. The refocus on delivery in primary care 'closer to home' was supported by the redistribution of £83 million from hospital services to primary care services (DHSSPSNI, 2011a). In conjunction with a move towards more patient-centred integrated care services, there was also a recognition that workforce development should also become a priority. At around the same time it was apparent that consultant pharmacist posts had been developed in England, but such posts did not exist within Northern Ireland.

In response to the call to action that was TYC, the Western and Northern Health and Social Care Trusts (WHSCT and NHSCT respectively) set out to address the needs of the older population by establishing consultant pharmacist posts and introducing novel innovative models of care that were led by these consultant pharmacists. In the WHSCT region the focus was on delivery of a service for intermediate care settings, whilst in the NHSCT an outreach service to care home residents was developed (McKee, Miller, Cuthbertson, Scullin & Scott, 2016; Miller et al., 2016). The development of these novel pathways was facilitated by the engagement of stakeholders across primary and secondary care (Miller, 2018).

Both of these models followed a case management approach. Case management is considered to involve planning, coordination, management, and review of the care of an individual to improve the quality of life through an integration of services around individual need (Hutt et al., 2004; Ross, Curry & Goodwin, 2011). Rather than comprising a single intervention, case management refers to a package of care that can vary widely in its delivery (Hutt et al., 2004; Ross et al., 2011). In principle, case management involves an assessment of the individual's needs, the development of a personalised plan to address these needs, the arrangement of suitable care and the continual communication with patients, their families and other professionals within the health and social care team (Ross et al., 2011). Since medicines management issues are commonly experienced in case management models (Challis et al., 2010; Sargent, Pickard, Sheaff & Boadten, 2007), pharmacists would appear to be ideally placed to deliver such a model of care. Ross and colleagues (2011) consider prescribing qualifications to be a key skill for effective case managers, highlighting the expanded role that exists for those pharmacists who are qualified as independent prescribers.

The MOOP case management models both commence with an initial patient assessment, where all prescribed medications are reviewed by the case management pharmacist. The MAI was applied to assess prescribing appropriateness. Following this assessment, a person-centred pharmaceutical care plan (PCP) to resolve identified medication related issues is developed. Necessary clinical interventions are enacted and liaison with other members of the healthcare team occurs, when required. Following the implementation of necessary interventions, the case management pharmacists recalculates the MAI scores for each medication and proceeds to monitor the individual, intervening further if deemed necessary.

2.3.2 Intermediate Care Model of Care

Within the intermediate care (IC) pathway, the initial assessment occurs on entry into IC (Figure 2-1). MAI scores are recalculated at the point of discharge from IC, after which case

management continues for a period of approximately 30 days. This duration of this case management period varies dependent upon individual patient needs and during this time the case management pharmacist conducts follow-up telephone calls and home visits, where necessary, to monitor patient progress. Additional interventions may be required during this monitoring period. Healthcare usage in the form of unplanned hospital readmissions and ED visits not leading to a readmission are monitored for 90 days following discharge from IC.

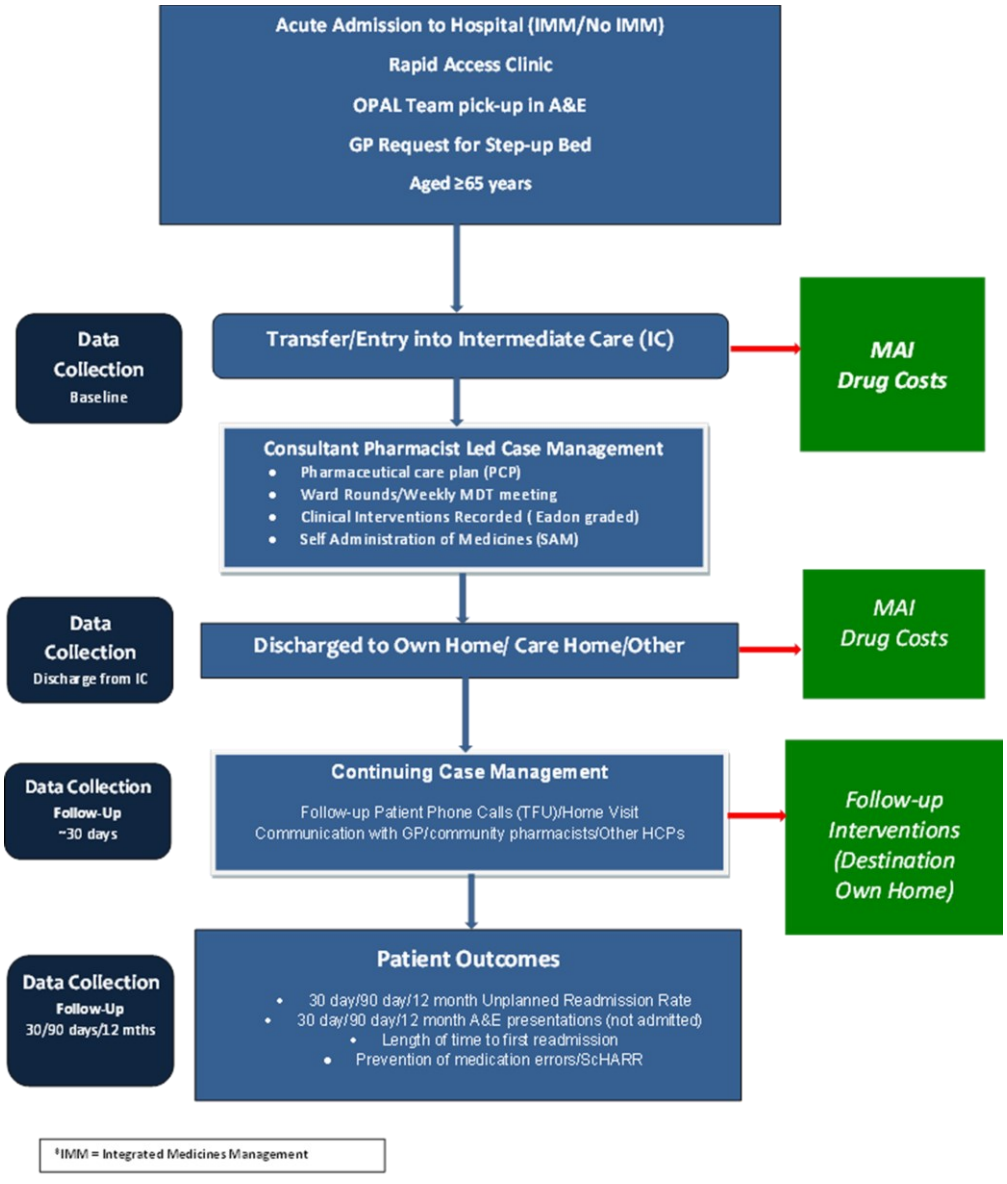

Figure 2-1: Consultant pharmacist-led pharmacy team case management of older people in intermediate care (courtesy of the Medicines Optimisation in Older People Team)

This novel pharmaceutical care model within IC has moved the pharmacy service beyond that of a 'supply only' service to one focused on patient outcomes. The initial development of the IC pathway occurred in the Western HSCT, where a significant improvement in MAI scores was observed, and estimated annual drug cost savings of £68,000 were made (Miller et al., 2016). The model was successfully reproduced in the Northern HSCT in 2016 where again significant reduction in MAI scores was observed and considerable drug cost savings made (Miller et al., 2017a; Miller, 2018).

2.3.3 Care Home Model of Care

The care home (CH) MOOP model is broadly similar to the IC model but also includes a care home specific aspect for care home selection (Figure 2-1). In the development of the CH model selection of care homes was based upon high rates of presentation to ED. Within the CH model there is an initial baseline assessment (t_0) where demographic information is collated, and an initial assessment of prescribing appropriateness is conducted using MAI. An individualised PCP is developed, and clinical interventions are implemented where necessary. Within the CH model, the number of weekly visits conducted by the case management pharmacist are specific to the needs of the individual older person, resulting in a patient specific component. As a consequence, each older person receives a number of visits that is unique to their clinical need (t_x). Following completion of the pharmaceutical care plan (t_x) prescribing appropriateness is reassessed using MAI.

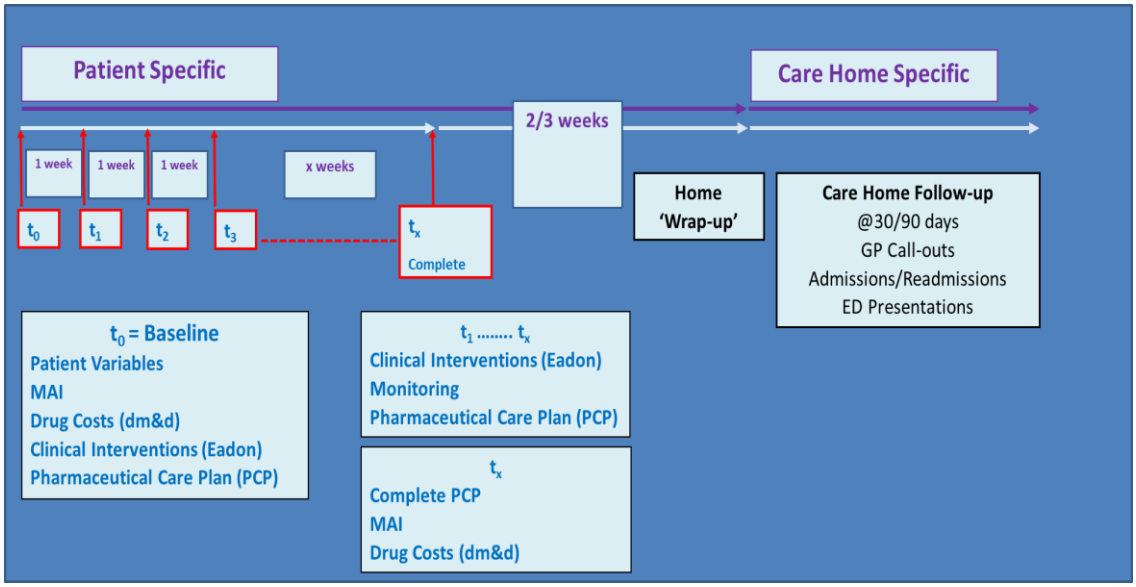

Figure 2-2: Consultant pharmacist-led pharmacy team case management of older people in care homes (courtesy of the Medicines Optimisation in Older People Team)

The CH model was developed in the NHSCT and also reported similar improvements in prescribing appropriateness and annual drug cost savings as those delivered by the intermediate care model. Furthermore, a reduction in inappropriate attendances to ED were also noted (McKee et al., 2016).

In the original development of the CH model outreach visits to care homes were conducted in conjunction with a consultant geriatrician. The model was found to be equally effective when delivered by pharmacists alone in comparison with the more human resource heavy collaboration with a consultant geriatrician (Miller, 2018). As a consequence, the service evolved to one that was led by the pharmacist but included a facility for referral to a geriatrician when it was deemed medically necessary.

The further development of both MOOP models was facilitated by the Change Fund in 2015, where funding to examine the reproducibility of both models in a different geographical region was accessed. Thus, the IC model was tested within the NHSCT and the CH model replicated in the WHSCT. The replication of the CH model within the WHSCT allowed for the opportunity to examine alternative models of communication with GPs. The original model

developed in the NHSCT communicated clinical interventions and recommendations to GPs via letter. In addition to these letters of recommendation, the case management pharmacists within the WHSCT care home service used teleconferencing and direct access to the GP's computer system.

Both patient centred MOOP models have been shown to be reproducible and have now been rolled out across Northern Ireland as a fully funded service (Miller, 2018). As the pharmacist case management models embed across Northern Ireland there is a need to develop a greater understanding of the nature and extent of inappropriate prescribing among older people in intermediate care and in care homes. As previously stated, our understanding of the prevalence of inappropriate prescribing in intermediate care has been limited by the sheer lack of studies conducted in this setting. Similarly, whilst there is an increasing concern regarding the use of psychotropic medications in care homes and there is evidence to suggest that this is prevalent in Northern Ireland (Maguire et al., 2013), less is known about the nature of inappropriate prescribing of other medication classifications. Furthermore, as the service continues to develop throughout the region there is a greater need to understand the effectiveness of both models at a deeper level. A greater understanding of what drives the improvement in prescribing appropriateness observed in both models can be used to inform the future directions of the service.

2.3.4 Participants

Data was collected by the MOOP team in the WHSCT and NHSCT between 2015 and 2016. During this period both care models were being delivered by Band 8a case management pharmacists, all of whom were independent prescribers, whilst being led and mentored by consultant pharmacists. The study population involves all individuals ≥ 65 years of age who were assessed by case management pharmacists in the intermediate care and care home settings. The models of care were delivered to all inpatients and residents in both settings,

irrespective of age, as it was deemed that it would have been unethical to not deliver the same standard of care to all inpatients/residents. For the purposes of this thesis data pertaining to those aged <65 years were excluded.

The IC sample comprised of 532 participants and the CH sample comprised of 1095 individuals. Participants in the IC sample ranged in age from 65 to 99 years (M = 82, SD = 7.6 years). Participants in the CH sample were slightly older (M = 84, SD = 7.5, range = 65 to 102 years). In the IC sample, data was collected from three sites across both HSCTs. In the CH sample, data was collected from 32 homes across both HSCTs. The sample characteristics can be observed in Table 2-1.

Table 2-1: Descriptive statistics for participants in intermediate care (N = 532) and care homes (N = 1095) datasets

Characteristic	Intermediate Care n (%)	Care Homes n (%)
Age		
65-69 years	34 (6.4)	39 (3.6)
70-74 years	62 (11.7)	95 (8.7)
75-79 years	100 (18.8)	153 (14.0)
80-84 years	115 (21.6)	212 (19.4)
85+ years	221 (41.5)	596 (54.4)
Sex		
Female	353 (66.4)	773 (70.6)
Male	179 (33.6)	322 (29.4)
Marital status		
Married/cohabiting	181 (34.1) †	-
Single (never married)	68 (12.8) †	-
Divorced/separated	13 (2.4) †	-
Widowed	178 (33.5) †	-
HSC Trust		
Northern	322 (60.5)	530 (48.4)
Western	210 (39.5)	565 (51.6)

Note. † = (N = 440) IC participants; marital status information not requested in CH data collection

2.3.5 Measures

2.3.5.1 Medication information

Prescribed medicines were recorded in the initial data collection according to their British National Formulary (BNF) 70th Edition chapter subclassification (Joint Formulary Committee, 2015). The BNF classifies medications into chapters according to the physiological system within which they are licensed to treat (Figure 2-3). These physiological categories are further subdivided in terms of mechanism of action of medication. Two additional subclassifications in addition to the BNF sub-categories were used to capture information relating to clinical trial medications and unlicensed medications which would not feature within the BNF.

1. Gastro-intestinal system
2. Cardiovascular system
3. Respiratory system
4. Nervous system
5. Infection
6. Endocrine system
7. Genito-urinary system
8. Immune system and malignant disease
9. Blood and nutrition
10. Musculoskeletal system
11. Eye
12. Ear, nose, and oropharynx
13. Skin
14. Vaccines
15. Anaesthesia

Figure 2-3: British National Formulary (BNF) 70th Edition chapter classifications

Participants in the CH cohort were prescribed greater numbers of medications for the nervous and gastrointestinal systems, even when the larger sample size is considered (Figure

2-4). Similarly, the CH cohort were prescribed considerably greater numbers of medications from the skin chapter of the BNF[1].

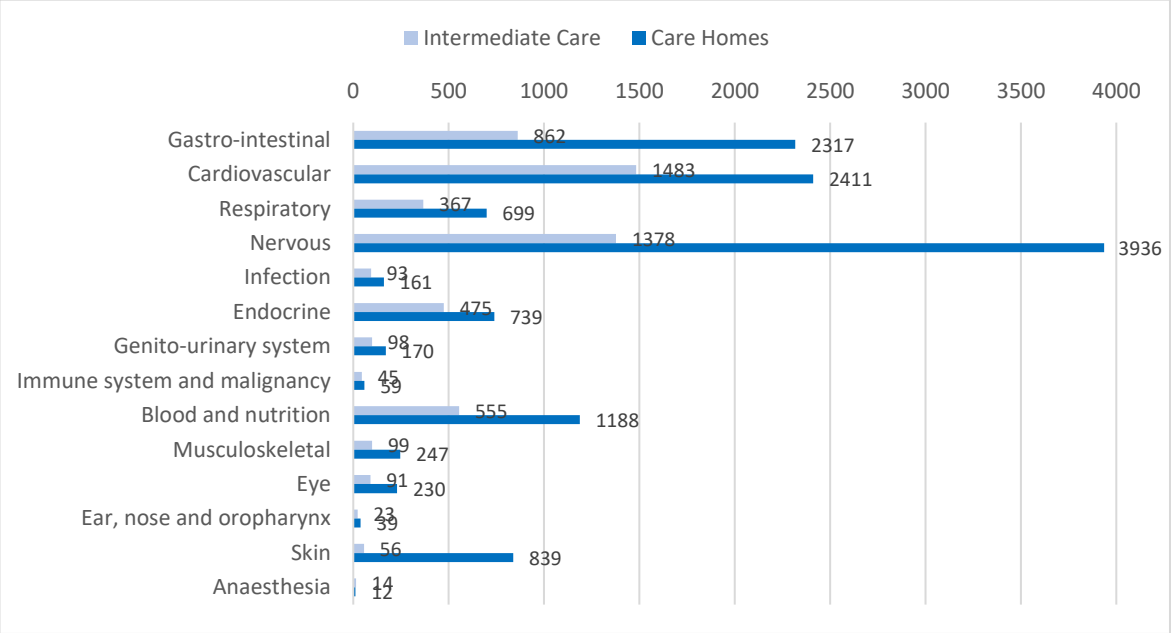

Figure 2-4: Counts for medications by BNF chapter in IC (N = 532) and CH (N = 1095) cohorts

The number of medications prescribed by polypharmacy category can be observed in Table 2-2. A greater proportion of CH participants were prescribed more than 15 medications in comparison to the IC cohort. A greater proportion of IC participants were prescribed 0-5 medications in comparison with the CH cohort.

Table 2-2: Frequencies for each polypharmacy category in IC (N = 532) and CH (N = 1094) samples

Polypharmacy category	**Intermediate Care**	**Care Homes**
	***n* (%)**	***n* (%)**
0-5 medicines	50 (9.4)	67 (6.1)
6-10 medicines	223 (41.9)	354 (32.3)
11-15 medicines	191 (35.9)	443 (40.5)
16-20 medicines	61 (11.5)	179 (16.3)
>20 medicines	7 (1.3)	51 (4.7)

Note. Information regarding the number of medications at baseline was missing for one CH participant

[1] Three CH participants were prescribed one clinical trial medication and one CH participant was prescribed an unlicensed medication which is not included in Fig 2-4.

2.3.5.2 Medication Appropriateness Index

All individual medications prescribed to participants in both IC and CH datasets were scored by the case management pharmacist according to the Medication Appropriateness Index (MAI: Hanlon et al., 1992). The MAI is a ten-item weighted questionnaire (Table 2-3), with each item rated as either 0 '*appropriate'* or 1 '*marginally appropriate or inappropriate*'. Each item has a differential weighting to reflect the relative importance of that item. A total score is computed for each medication by summating the scores for items 1-10. Thus, the possible score for each medication ranges from 0 to 18.

Table 2-3: Medication Appropriateness Index (Hanlon et al., 1992)

	Question	Score
1	Is there an indication for the drug?	3
2	Is the medication effective for the condition?	3
3	Is the dosage correct?	2
4	Are the directions correct?	2
5	Are the directions practical?	2
6	Are there clinically significant drug-drug interactions?	2
7	Are there clinically significant drug-disease interactions?	1
8	Is there unnecessary duplication with other drug(s)?	1
9	Is the duration of therapy acceptable?	1
10	Is this drug the least expensive alternative compared with others of equal utility?	1
	Maximum score of inappropriateness	18

Scores for each medication were computed and total MAI scores were computed for each participant by summating the individual drug MAI scores. MAI scores were recalculated for each participant upon discharge from IC or following completion of the pharmaceutical care plan for CH participants. A MAI score change variable was calculated by subtracting the

total MAI score on completion of case management (post-score) from the baseline total MAI score (pre-score).

Good reproducibility of MAI scores has been shown irrespective if the ratings were conducted by two pharmacists, a pharmacist and a physician or two physicians, with kappa statistics ≥ 0.59 (Hanlon et al., 1992; Gallagher et al., 2011; Kassam, Martin & Ferris, 2003; Samsa et al., 1994; Spinewine, Dumont, Mallet & Swine, 2006). Intra-rater reliability has also been shown in a number of studies (Bregnhøj et al., 2005; Hanlon et al., 1992; Stuijt et al., 2009). It has been argued that the MAI is sufficiently sensitive to detect even small departures from best prescribing practice. Samsa and colleagues (1994), on developing the weighting system for each of the ten items, found that whilst only 16% of medications were deemed to be inappropriate based on the indication or effectiveness indicators, the MAI was able to detect some element of suboptimal prescribing practice in approx. 75% patients.

2.3.5.3 Interventions

Information pertaining to the type of intervention completed by the case management pharmacists were also recorded. Interventions types included medication discontinuation, medication initiation, dose changes, blood testing, addressing Kardex issues, referral to other HCPs and patient education. Less commonly delivered interventions were recorded as 'other'. These include interventions such as liaison with community pharmacists to coordinate prescription dispensing cycles. Patient education was not offered as a possible intervention in the CH model due to challenges with respect to patient communication.

2.3.5.4 Eadon

The clinical significance of each clinical intervention enacted by the case management pharmacists was assessed using the Eadon (1992) grading system (Table 2-4). Interventions were self-rated by the case management pharmacists on a six-point scale, with higher ratings indicating more clinically significant interventions.

Table 2-4: Eadon grading of clinical pharmacist interventions used in the MOOP datasets (Eadon, 1992)

Score	Clinical significance
1	Intervention which is detrimental to a patient's well-being
2	Intervention is of no significance to patient care
3	Intervention is significant but does not lead to improvement in patient care
4	Intervention is significant and results in improvement in the standards of care
5	Intervention is very significant and prevents major organ failure or adverse reaction of similar importance
6	Intervention is potentially lifesaving

Participant follow up for those in IC was conducted using both telephone calls and home visits, where required. For both cohorts if additional medication-related issues were identified in during follow-up, additional interventions were conducted and scored using the Eadon criteria.

2.3.5.5 Healthcare utilisation

Data pertaining to healthcare utilisation was collated for both 30- and 90-days following pharmacist intervention. Information was collated regarding hospital admission for both cohorts. In the case of CH participants, data was also collected regarding ED visits, GP visits and out of hours (OOH) GP visits. Baseline levels of healthcare utilisation were collected in both cohorts. For both cohorts, the number of hospital admissions in the 12 months prior to pharmacist intervention was recorded. For CH participants counts of ED visits, GP visits and OOH GP visits in the 30 and 90 days before pharmacist intervention was also collected.

2.3.5.6 Clinical history

Participants in both cohorts experienced a diverse range of previous medical histories. The top 20 most frequently endorsed diagnoses, as classified by the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10: WHO, 1992), for participants in IC and CH can be observed in Figure 2-5 and Figure 2-6, respectively. A diagnosis of 'essential primary hypertension' was prevalent in both care contexts.

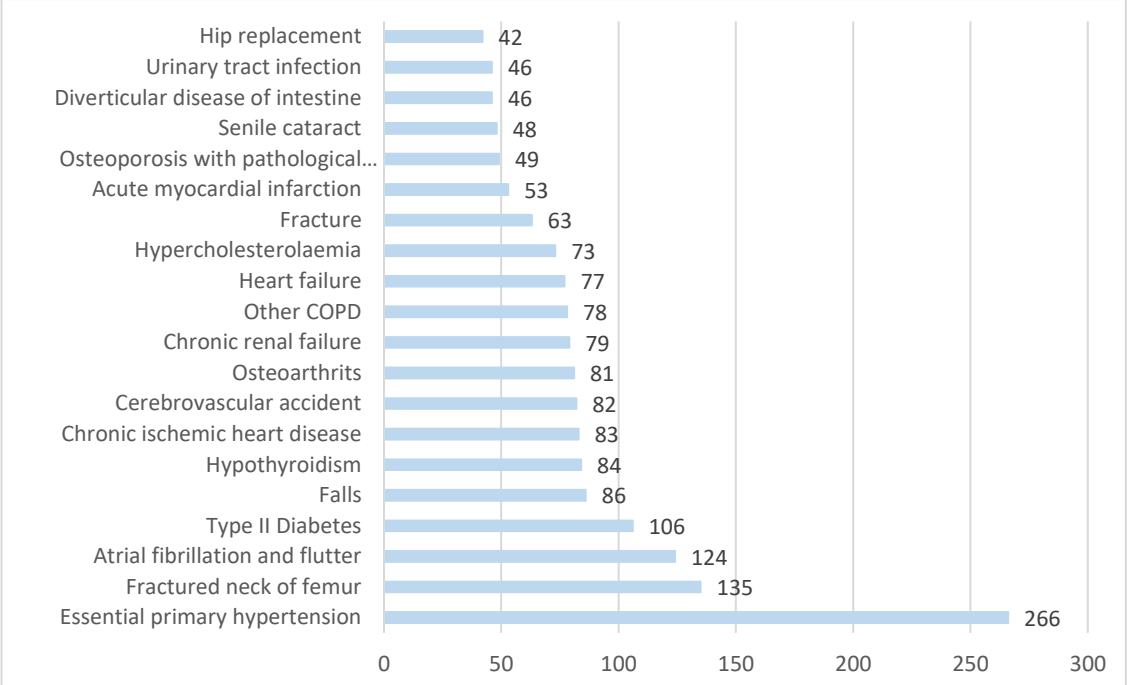

Figure 2-5: The top 20 most frequently endorsed medical histories by ICD-10 coding in the IC sample (N = 532)

Cardiovascular diagnoses of 'atrial fibrillation and flutter', 'chronic ischemic heart disease', 'hypercholesterolaemia' and 'heart failure' were also common in both datasets. In the CH dataset, the diagnosis of 'unspecified dementia' was the most prevalent with 379 instances recorded for CH residents. Additional cognitive impairments were common among CH residents including 'Alzheimer's disease' and 'vascular dementia'. Such cognitive impairment diagnoses were not a common feature in the IC sample. Similar counts of 'fractured neck of femur' and 'falls' were recorded for participants in both datasets.

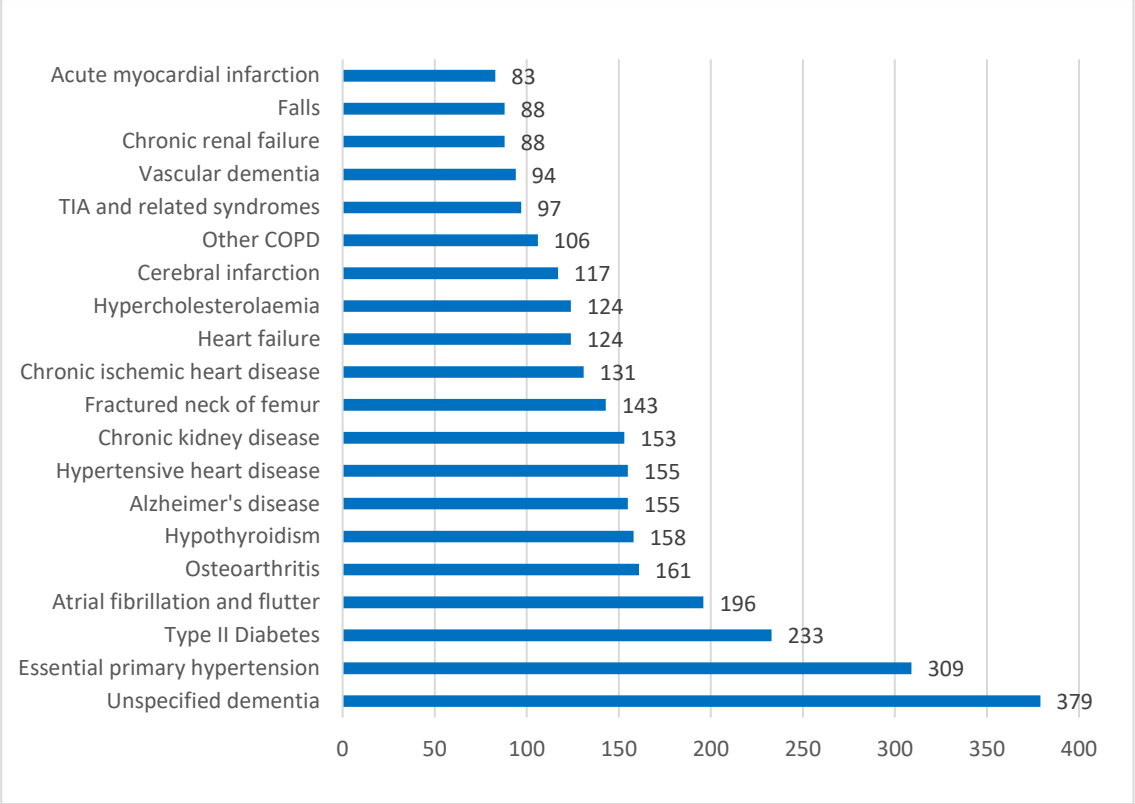

Figure 2-6: Top 20 most frequently endorsed medical histories by ICD-10 coding in the CH sample (N = 1095)

2.3.5.7 Pharmacist intervention

In both datasets, the most frequent clinical intervention completed by the case management pharmacists was medication discontinuation; a total of 948 instances of discontinued medicines were counted within the IC sample and 2003 instances recorded in the CH sample (Figure 2-7). Information regarding the classification of intervention type was missing for one baseline intervention in the CH dataset.

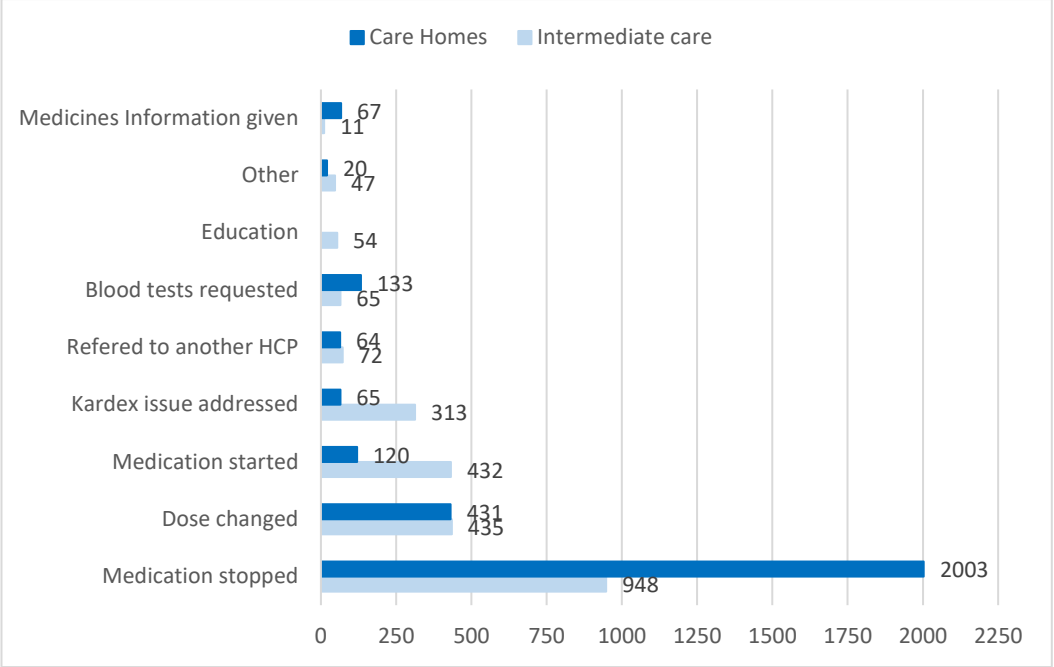

Figure 2-7: Counts for each intervention type in both IC (N = 532) and CH (N = 1095) at baseline

Table 2-5 outlines the frequency of participants who endorsed a minimum count of one for each clinical intervention type. A greater proportion of IC participants had a medication initiated or a medication dose changed in comparison with CH participants. The percentage of participants who had at least one medication discontinued was similar in both cohorts.

Table 2-5: Frequency of participants who experienced at least one count for each intervention type at baseline

Intervention type	**Intermediate Care (*N* = 532)**	**Care Homes (*N* = 1095)**
	***n* (%)**	***n* (%)**
Medication stopped	411 (77.3)	821 (75.0)
Medication started	267 (50.2)	103 (9.4)
Blood tests	62 (11.7)	132 (12.1)
Medicines information	11 (2.1)	66 (6.0)
Medication dose changed	292 (54.9)	339 (31.0)

Referral to another HCP	69 (13.0)	61 (5.6)
Kardex issue addressed	197 (37.0)	62 (5.7)
Education	53 (10.0)	-
Other	44 (8.3)	18 (1.6)

Note. Education was not a possible intervention in the CH dataset. Some CH participants received additional clinical interventions-details reported below.

The clinical significance of each intervention was assessed by the case management pharmacists using the Eadon classification system, with higher numerical grades indicating the more clinically significant the intervention. Frequency counts for each grade can be observed in Figure 2-8. The most frequently recorded grade was for Eadon 4 'significant and improves the standard of care'. No interventions were graded as 'not significant to patient care' (Eadon 2).

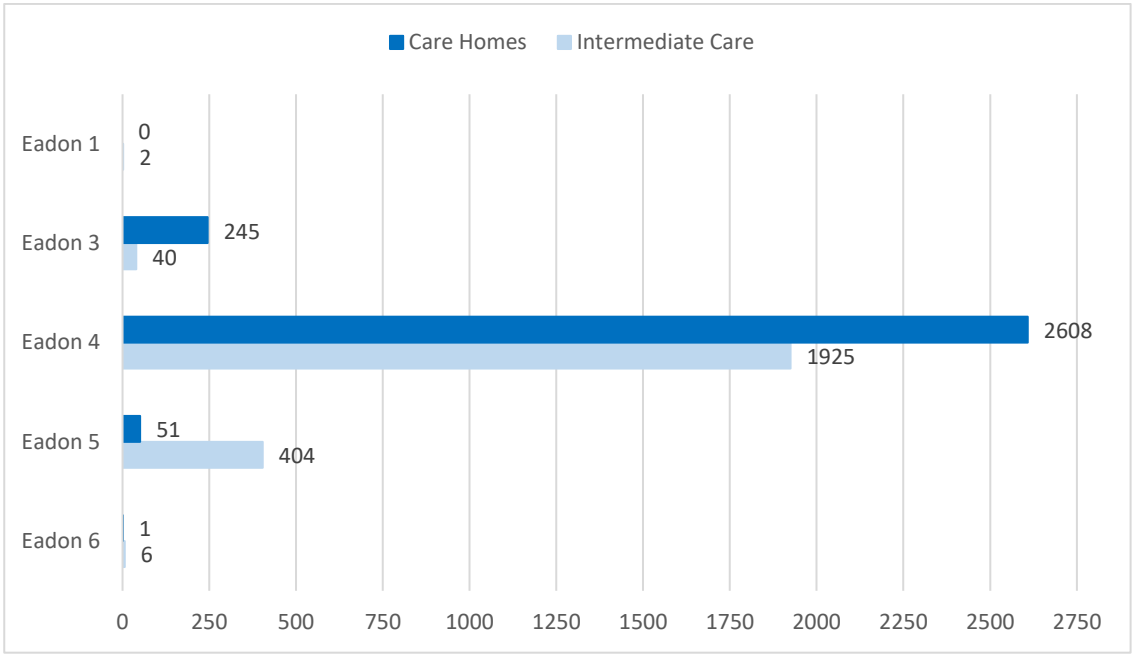

Figure 2-8: Counts for each baseline intervention by Eadon grading in IC (N = 532) and CH (N = 1095) datasets

The majority of intermediate care (89.1%) and care homes (84.6%) participants received a clinical intervention that was assessed as 'significant and improves the standard of

care'. Except for one individual who received a clinical intervention graded as 'detrimental to patient well-being' all participants in both datasets received clinical interventions rated as at least clinically significant (≥ Eadon 3). Clinical interventions rated as Eadon 5 and 6 were more prevalent for IC participants (Table 2-6).

Table 2-6: Frequencies of participants who endorsed at least one count for each Eadon grade in IC (N = 532) and CH (N = 1095) datasets

Eadon Grade	**Intermediate Care**	**Care Homes**
	n (%)	**n (%)**
1	1 (0.2)	0 (0)
2	0 (0)	0 (0)
3	27 (5)	182 (16.6)
4	474 (89.1)	926 (84.6)
5	212 (39.9)	50 (4.6)
6	5 (0.9)	1 (0.1)

The model of case management in care homes allows for a patient-specific number of visits by the case management pharmacist to the care home on a weekly basis. Thus, information regarding interventions conducted during these discrete visits was also available for examination in addition to information relating to interventions conducted at baseline. A total of 106 participants received additional pharmacist interventions with 76 participants receiving only one additional intervention, 25 receiving two interventions and 5 receiving three interventions. In total 141 additional clinical interventions were completed during these additional patient-specific visits to the care homes (M= 0.28, SD = 0.70, range 0-9). Counts for each clinical intervention type can be observed in Figure 2-9. In total, from beginning to completion of the intervention the number of clinical interventions for CH participants ranged from 0 to 12 (M = 3.23, SD = 2.08).

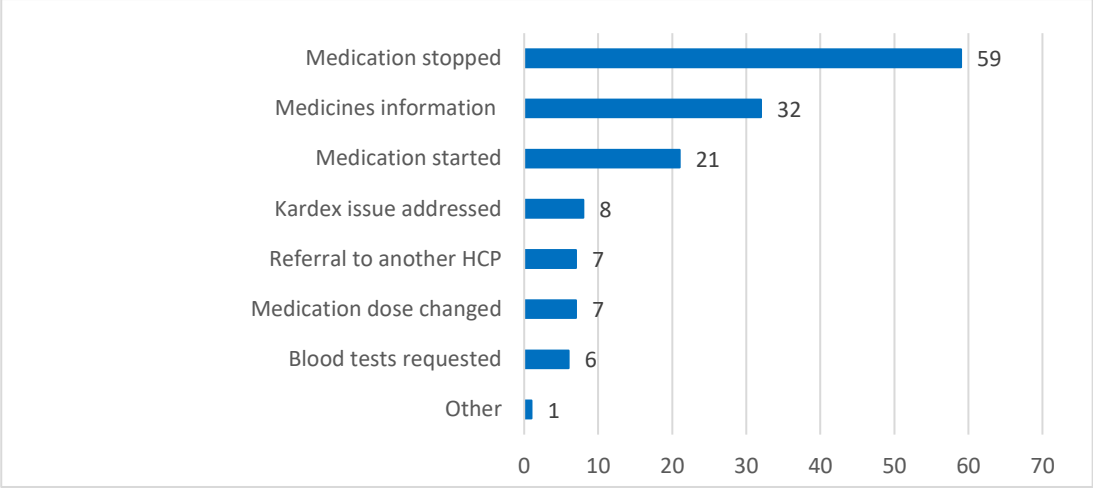

Figure 2-9: Counts for additional clinical interventions completed for CH participants during the monitoring period (N = 106)

The majority (84%) of additional clinical interventions implemented for CH participants were graded as 'intervention is significant and results in an improvement in standard of care' (Eadon 4). None of the additional interventions completed were graded as 'detrimental to the patient's wellbeing' (Eadon 1) or as 'potentially life-saving' (Eadon 6). Information on the Eadon grading was missing for one intervention (Figure 2-10).

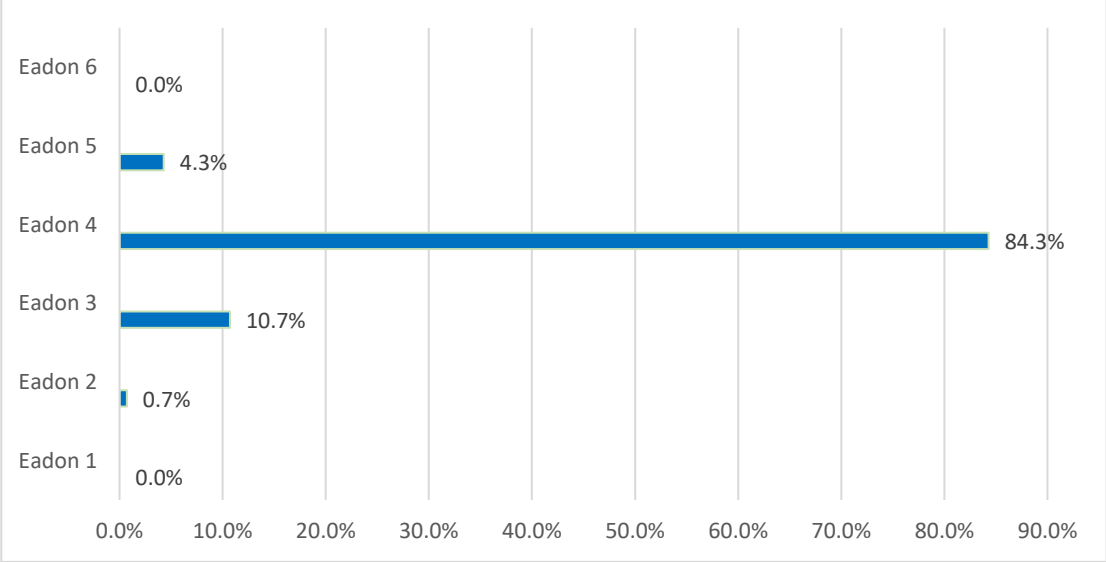

Figure 2-10: Proportions of Eadon gradings for additional clinical interventions completed in CH (N = 106)

2.3.6 Ethical approval

Ethical approval for the study was granted by Office for Research Ethics Committees Northern Ireland (ORECNI) under protocol number 17/NI/0052 (Appendix A). This initial approval was subsequently amended to allow the study to become the subject of the present thesis. A substantial amendment was submitted to ORECNI and was subsequently approved for implementation on 9th March 2018 (Appendix B). This amendment included the author as a PhD student on the project, conducting analysis of the data, and also facilitated the addition of Ulster University School of Psychology staff members as supervisors on the project. Access to the data was received following the approval of this substantial amendment. A further non-substantial amendment was submitted to include the use of Mplus statistical software to support data analysis in the event of data non-normality. This non-substantial amendment was approved for implementation from 31st May 2019 (Appendix C).

2.3.7 Funding

The further development of both MOOP models was facilitated by the Change Fund in 2015, where funding to examine the reproducibility of both models in a different geographical region was accessed. Thus, the IC model was tested within the NHSCT and the CH model replicated in the WHSCT.

2.4 Selection of a comparable longitudinal cohort

Several longitudinal cohort studies of older people are currently in progress internationally, including in the United Kingdom and Ireland. In England, the English Longitudinal Study of Ageing (ELSA) began in 2002 and has been collecting data from people aged 50 years and older on a two-yearly basis. Similarly, the Irish Longitudinal Study on Ageing (TILDA) has been collecting data since 2010 on a two-yearly basis in the Republic of Ireland. Both ELSA and TILDA form part of the Gateway to Global Aging Data initiative to facilitate data harmonisation and international cross-country research. The Northern Ireland Longitudinal

Study of Ageing (NICOLA) commenced in 2014 and was designed to be compatible with the approaches taken by ELSA and TILDA, whilst also including questions specific to the Northern Irish context. At the time of conducting the research presented in the present thesis the NICOLA study did not have sufficient data collection time points to facilitate a thorough longitudinal examination of healthcare utilisation. Thus, longitudinal analysis was conducted using the TILDA cohort.

2.5 The Irish Longitudinal Study on Ageing (TILDA)

2.5.1 History/background to study

The Irish Longitudinal Study on Ageing (TILDA) is a nationally representative study of people living in Ireland aged 50 years and older. Its conception was designed to increase our understanding of the health, social and financial circumstances of the people in Ireland as they age (TILDA, 2020). TILDA is modelled on the Health and Retirement Study (HRS) design. The study was designed to be representative of members of the Irish community aged 50 years and over who were living within the community. As such it does not represent individuals residing in long term care (TILDA, 2020).

2.5.2 Sampling/recruitment

The sampling strategy commenced with all postal addresses in Ireland being assigned to one of 3155 geographic clusters, from which a sample of 640 clusters were selected, stratified by socio-economic group and geography in order to create a sample representative of the population (TILDA, 2020). Clusters were selected with a probability proportional to the number of participants within each cluster aged 50 years and older (TILDA, 2020). As it had been estimated that 25,600 addresses would be required in order to achieve a sample size of 8000, 40 households were selected from each cluster (TILDA, 2020). Each of these addresses was visited by an interviewer with all individuals aged 50 years and over and their partners were invited to take part in the study (TILDA, 2020). In short, a response rate of 62% was

achieved (TILDA, 2020). Further details on data collection have previously been widely published (Donoghue et al., 2018; Kenny et al., 2010; Whelan & Savva, 2013).

2.5.3 Design

Each participant completed a home interview conducted by a trained interviewer (TILDA, 2020). At the time of the home interview each participant was given a self-report questionnaire for completion and return by post. This questionnaire contained more sensitive questions regarding aspects such as relationship quality, emotional wellbeing, and health behaviours (TILDA, 2020). Participants were also asked to undertake a health assessment at Waves 1 and 3, which were conducted in a dedicated health assessment centre or in their own home if travel to the centre was not possible (TILDA, 2020).

Within each household all those household members eligible for the study were invited to take part (TILDA, 2020). The participants completed a Computer Aided Personal Interview (CAPI) in their own home, which contained questions on health, wellbeing, family, and finances (TILDA, 2020). At the first wave of data collection participants were invited to complete a health assessment at a dedicated centre in Dublin or Cork or to complete a modified reduced assessment in their home were travel to such a centre was not possible (TILDA, 2020). The health assessment was repeated at wave three.

Each participant was assigned a unique identifier (ID) in addition to a household identifier (household ID) and geographic cluster identified (cluster) (TILDA, 2020). All respondents within the same household had the same household ID. The individual identifier for each participant comprised of this household ID with an additional number appended to distinguish them from other participants within the same household (TILDA, 2020).

2.5.3.1 Complex survey design

In order to ensure that the sample remained representative of the Irish population survey weights were applied to correct for selection bias (TILDA, 2020). These weights were

calculated such that the participant's weight was equal to the number of individuals in the population represented in the study by that participant (TILDA, 2020). Those participants who came from groups less likely to participate were thus assigned a higher weight (TILDA, 2020). Four sets of weights were applied within the dataset. The CAPI weight is applied when the whole sample is analysed (TILDA, 2020). This weight is equal to the number of individuals in the population (determined from the 2010 Quarterly National Household Survey) represented by each of the 8175 participants who completed the CAPI interview (TILDA, 2020).

Additional weights were calculated for the self-completion questionnaire (SCQ) and the health assessment, for application in analyses using only the SCQ or health assessment sample, respectively (TILDA, 2020). These weights also incorporate the CAPI weight whilst also accounting for some subgroups to be more likely to complete the SCQ or the health assessment than others (TILDA, 2020). Further details on the generation of the weights can be reviewed in Donoghue et al., (2018), TILDA (2020) and Whelan and Savva (2013).

Two cluster variables are available in the dataset to indicate the geographic cluster (cluster) and the household (household ID) to which the participant belongs (TILDA, 2020). Geographic clusters were stratified (stratum) so that equal numbers of clusters were selected from each of the three socio-economic groups (TILDA, 2020).

2.5.4 Data collection

The study commenced data collection between October 2009 and July 2011. At the first wave of data collection a total of 8175 participants aged 50 years and over completed the study (TILDA, 2020). Additional data was collected from 329 interviews with younger spouses/partners of participants but are not included in the analysis presented here (TILDA, 2020). The second wave of data collection took place between February 2012 and March 2013. A total of 6917 of the original 8175 sample submitted data at Wave 2 (TILDA, 2020). The third wave of data collection was conducted between March 2014 and October 2015, with 6128

participants reporting data (TILDA, 2020). The fourth wave of the study was undertaken in 2016. A total of 5457 participants submitted data at Wave 4 (TILDA, 2020).

The analyses presented in this thesis utilised the anonymised publicly available data. This data has been anonymised by the research team so that no directly identifiable information such as names or addresses were released (TILDA, 2020). As a consequence, some variables available in the publicly available data have been recoded to ensure this anonymity is maintained (TILDA, 2020). Other potentially identifiable data was either top-coded, grouped or dropped for any data which on its own, or in combination with other publicly available data could result in identification of a participant (TILDA, 2020). Top and bottom coding was performed on those variables with extreme values occurring at either end of the scale. Any respondents who answered over or below the threshold value were grouped together to form a new category (TILDA, 2020).

2.5.4.1 Sample demographics

At Wave 1 the TILDA sample comprised of 8175 participants ranging in age from 50 to 80 years[2]. Approximately 85% of participants at Wave 1 reported at least one diagnosed morbidity. Further details regarding the sample characteristics can be observed in Table 2-7.

Table 2-7: Sample characteristics for TILDA cohort at Wave 1

Characteristic		***n (%)***
Age, years (*M, SD)*		63.53 (9.16)
Sex		
	Male	3744 (45.8)
	Female	4431 (54.2)
Marital status		
	Married	5638 (69)
	Never married	791 (9.7)
	Separated/divorced	551 (6.7)

[2] As per data anonymisation techniques those individuals aged 80 years and over were banded together and reported as aged 80 years.

Widowed	1195 (14.6)
Education level	
No education/primary level	2504 (30.6)
Secondary level	3263 (39.9)
Third/higher level	2404 (29.4)
Household location	
Dublin city/county	1936 (23.7)
Another town/city	2311 (28.3)
Rural area	3916 (47.9)
Employment status	
Employed	2934 (35.9)
Retired	3046 (37.3)
Other	2195 (26.9)
Comorbidity level	
None	1210 (14.8)
1	1720 (21.0)
2	1699 (20.8)
≥3	3546 (43.4)

2.5.4.2 Measures

Measures included in the analysis of the TILDA dataset included the creation of an adapted Frailty Index (Appendix D) based upon the index utilised previously by Roe, Norman, Wren, Browne and O'Halloran (2017) in the TILDA cohort. Depression, anxiety, and cognition were measured using the Center for Epidemiologic Studies Depression (CESD-8: Radloff, 1977), Hospital Anxiety and Depression Scale- Anxiety (HADS-A: Zigmond & Snaith, 1983) and Mini Mental State Examination (MMSE; Folstein, Folstein & McHugh, 1975) questionnaires, respectively. Further details on the measures are outlined in Chapter 7.

2.5.5 Ethical approval

Ethical approval for data collection was granted by the Trinity College Research Ethics Committee (TILDA, 2020). TILDA is funded by the Department of Health and Children, Irish Life and The Atlantic Philanthropies (TILDA, 2020). Ethical approval for the secondary data analysis of TILDA data was included in the original overall ethical approval of TILDA. Ethical approval for secondary data analysis conducted in this thesis was granted by the School of Psychology Filter Committee (Appendix E).

2.5.6 Data access

Data access was granted following an application to the Irish Social Science Data Archive (ISSDA) for the publicly available data. Four data files representing each wave of data collection were obtained and merged to form one dataset. The following file versions were used for the present thesis:

- Wave 1 version 1.9 (TILDA, 2019)
- Wave 2 version 2.4 (TILDA, 2019)
- Wave 3 version 3.3 (TILDA, 2019)
- Wave 4 version 4.1 (TILDA, 2019)

2.5.7 Attrition

Attrition is a challenge in all longitudinal assessments, be it temporary or permanent. However, attrition within studies of older people is even more challenging due to the increased likelihood that older adults have in experiencing health and functional problems, thus impacting upon data collection (Hardy, Allore & Studenski, 2009). Longitudinal studies of older adults can be impacted by loss to follow-up or dropout due to the increased likelihood of illness, disability, cognitive impairment, and institutionalisation (Di Bari, Williamson & Pahor, 1999). Hardy et al., (2009) argue that plans should be developed to minimise the possibility of

missing data at each phase of the research and also suggest that data collection can be adapted to meet the needs of the respondent.

Several cohort maintenance strategies were adopted in order to limit the degree of attrition that occurred in as much as was possible. Questionnaires were designed such that information from previous waves was fed forward into subsequent waves, limiting the to need repeat the same questions at each wave (Donoghue, Foley & Kenny, 2017). Accordingly, participants were asked to clarify any change in circumstances since the last wave (Donoghue et al., 2017). Proxy interviews were conducted if a participant was unable to complete the interview due to impairment and had consented to proxy-interviews in the preceding wave (Donoghue et al., 2017). End of life interviews were conducted where participants had died (Donoghue et al., 2017). Modified home-based health assessments were conducted if participants were unable or unwilling to travel to the health assessment centre (Donoghue et al., 2017). The large sample size recruited at Wave 1 has meant that a sample of considerable size remains by Wave 4. Thus, it could be argued that every effort has been made by the TILDA research team to ensure that the recommendations of Hardy and colleagues (2009) were implemented in as much as possible.

2.6 Overview of analytic strategy

This thesis aims to examine healthcare utilisation by older adults more broadly and also to determine if pharmacist intervention to improve prescribing appropriateness influences healthcare resource usage and outcomes. Sample characteristics of the IC and CH datasets have been compared thus far, however, analysis of the MOOP datasets is conducted separately to reflect the qualitative difference in the populations and in the MOOP models delivered.

Chapter 3 examines a cohort of older adults who were admitted to IC and who received the pharmacist case management model in operation in this care setting. This chapter

seeks to examine healthcare resource usage following improvements in prescribing appropriateness achieved by the case management model. Multivariate linear regression, logistic regression, Poisson regression and Kaplan-Meier survival analysis techniques will be reported. Chapter 4 will examine similar objectives within a CH context. Chapter 5 seeks to explore the associations between improvements in MAI score for medication classifications frequently prescribed inappropriately and subsequent healthcare utilisation. Descriptive statistics and chi-square tests for differences are primarily used within Chapter 5.

Chapter 6 seeks to examine trends in healthcare utilisation more broadly by adopting latent variable modelling techniques to identify heterogeneity in healthcare utilisation. Latent class analysis (LCA) is first conducted cross-sectionally using the first three waves of the TILDA study. A latent transition analysis (LTA) is then conducted to serve as a foundation for further analysis in Chapter 8, where covariates are incorporated into the analysis to examine variation in healthcare utilisation. Relevant covariates for inclusion in this analysis are examined in further detail in Chapter 7, where change over time in these covariates are also explored.

2.7 Conclusion

The present chapter has served to provide a foundation for subsequent empirical chapters by providing a description of the data samples, evaluated models of care and measures that are used in the thesis. Subsequent chapters will only provide a brief description of the relevant data set used and will rather focus on the specific analytical approaches that were taken. The reader will be referred back to this chapter or other relevant sources (e.g. Donoghue et al., 2018; Kenny et al., 2010; McKee et al., 2016; Miller et al., 2017a; Miller et al., 2017b, Miller et al., 2016; Miller, 2018; Whelan & Savva, 2013), where appropriate. Specific variables that are manipulated within the analyses will be detailed in subsequent chapters. Additionally, the specific analyses undertaken will be described in greater depth in the relevant empirical chapters.

3 Healthcare utilisation following pharmacist case management of older adults in Intermediate Care in Northern Ireland

3.1 Chapter overview

This chapter begins by examining the literature surrounding inappropriate prescribing in older people within intermediate care. Following this, the chapter examines the baseline prevalence of inappropriate prescribing within this care context in NI and characterises the nature of interventions conducted by the MOOP pharmacists before evaluating the success of pharmacist involvement in IC in modifying this inappropriate prescribing. Variation in the degree of change in MAI score from admission to discharge will be elucidated before variability in healthcare resource usage is examined as a function of MAI score change.

3.2 Introduction

3.2.1 Intermediate care

Intermediate care (IC) can be defined as "healthcare occurring somewhere between traditional primary (community) and secondary (hospital) care settings" (Woodford & George, 2010, p. 119). It has been suggested that 25% of older people have additional care needs in the post-acute period (Young, Forster & Green, 2002). Smith and colleagues (2014) specifically cite the development of intermediate care services as a vital component of coping with the demands placed upon the hospital sector of the NHS. Melis, Parker and van Eijken (2004) argue that intermediate care in the United Kingdom developed as a result of a shift in policy as opposed to scientific evidence regarding its effectiveness. Accordingly, it has been argued that intermediate care has developed as "policy before evidence" (Lee et al., 2014, p. 267; Vetter, 2005). The increased demand for inpatient beds, an ageing population and workforce changes have all contributed to the development of IC (Steiner, 2001). Posited to sit in the 'space between' hospital and home, intermediate care was proposed as a means of freeing up hospital bed capacity, encouraging independence of older people and preventing unwanted

hospital admissions (Melis et al., 2004). In England, the development of intermediate care services has been largely at the discretion of local commissioners, and thus has been largely influenced by local history and the availability of care homes (Williams et al., 2018). Furthermore, there was limited evidence regarding intermediate care to help guide commissioners with decisions regarding IC development within their area (Woodford & George, 2010). As a result, intermediate care developed at the behest of local policymakers resulting in markedly different models of intermediate care.

Despite a call to action from the National Service Framework for Older People (DOH, 2001), and a series of objectives to be achieved, no clear definition of what the ideal model of intermediate care should be was put forward at the time (Melis et al.,2004). As such it is imperative that we are explicit in what we mean when we refer to intermediate care. Even as far back as 20 years ago numerous definitions for intermediate care existed within the literature (Steiner, 2001). This lack of consensus on a definition of intermediate care has limited our understanding of how effective a care model it is (Melis et al., 2004). Rather than being clearly defined intermediate care has come to mean care that is 'in between' and without a clear definition its potential may not truly be recognised. In general, IC occupies the space between acute and community care, facilitating rehabilitation following discharge from acute care, as well as step-up care to prevent an acute care admission.

3.2.1.1 The potential within intermediate care

Increasing demands for acute care beds, in conjunction with specialisation of hospital departments has resulted in a reduction in acute care length of stay, something which is not always suitable for older people who may require a more comprehensive period of rehabilitation (Bakken et al., 2012). Among older people, acute hospitalisation is associated with a decline in functional status, the recovery of which has been found to occur at a much slower rate than recovery from the acute illness itself (Hirsch et al., 1990). The very old, those

aged 90 years and older, are less likely to regain function lost before admission to acute care and are more likely to develop new functional deficits whilst in acute care (Covinsky et al., 2003). A high proportion of those older people discharged from acute care are at risk for increased dependency and institutionalisation if insufficient opportunity for rehabilitation is available (Abrahamsen et al., 2014). By optimising the 'space between' hospital and home that is intermediate care, better outcomes for older people may be achieved.

Intermediate care is distinguished from long-term residential care with respect to the duration that the person is engaged with the service. Intermediate care is a time-limited rehabilitative service with the primary aim of facilitating the person to successfully transition to independence at home. There will of course be some instances whereby an individual may not safely return to their own home and thus may transition into longer-term residential care. So, whilst there is a clear distinction between the two contexts there is a trajectory that may exist for some individuals comprised of a transfer from hospital to intermediate care and then finally into residential care.

3.2.1.2 Intermediate care provision in Northern Ireland

In 2005, the DHSSPSNI set out a high-level definition of intermediate care as "a range of integrated services to prevent unnecessary hospital admission, promote faster recovery from illness, support timely discharge and maximise independent living" (DHSSPSNI, 2005, p. 3). Thus, within Northern Ireland, intermediate care developed with the aim of creating a responsive, integrated primary and community care network to promote independent living among older people and reduce dependency on acute hospitals (DHSSPSNI, 2005). It was further aimed that the service would provide a person-centred approach with the development of an individualised care plan delivered using a multidisciplinary team approach. At the outset, it was deemed that such services should be targeted towards those who were at risk of inappropriate admission to acute care, long-term residential care, and unnecessarily

prolonged hospital admissions. Based upon such prioritisation criteria it is highly evident that intermediate care in Northern Ireland would become a key setting for delivery of care to older people.

Provision of intermediate care across Northern Ireland varies somewhat across the five geographical Health and Social Care Trusts (HSCTs). Care is provided in non-acute community hospitals, in the person's own home or in some cases via a short-term care home admission. Within these types of settings, the care is provided via nursing staff and allied health professionals such as occupational therapists and physiotherapists. In the case of non-acute community hospitals medical input is provided by visiting clinicians, usually general practitioners, and not via an on-site medical team.

3.2.2 Inappropriate prescribing

Inappropriate prescribing is the use of an unsuitable medication, where the risk outweighs the clinical benefits for the patient, particularly when safer alternatives exist (Beers et al., 1991; Gallagher et al., 2011; Spinewine, Schmader, et al., 2007). It encompasses a broad range of poor prescribing processes including overprescribing, underprescribing and misprescribing. Overprescribing is considered to be the use of medication in the absence of a clinical indication. Underprescribing occurs when the individual does not receive necessary pharmacotherapy when clinically indicated and can be considered to be a failure to adequately manage the underlying condition. Misprescribing is an umbrella term to describe a range of suboptimal practices including the use of an incorrect dosage, or duration of therapy, or the use of medication when drug-drug interactions are likely. Assessment of inappropriate prescribing has largely focused on older age groups due to the high levels of medication consumption in those aged 65 years and older. Inappropriate prescribing has been shown to be highly prevalent among older people with estimates ranging from 20% up to as much as

71% (Cahir, Moriarty, et al., 2014; Hudhra et al., 2016; Moriarty, Bennett, et al., 2015; Recoche et al., 2017).

3.2.2.1 Assessing inappropriate prescribing

As previously discussed in Chapter 1, several instruments have been developed aimed at detecting inappropriate prescribing which, broadly speaking, may be dichotomised into explicit and implicit tools. Explicit tools consist of lists of medications and/or clinical scenarios where their use is considered inappropriate. Generally developed by expert consensus there has been an explosion in the number of explicit tools in operation, with many reflective of the specific availability of medicines in a particular country (Kaufmann et al., 2014). Implicit tools on the other hand provide some flexibility by encouraging the clinician to apply some experience-based judgement thus providing more scope for patient-centred care (Shelton et al., 2000).

The application of different explicit screening tools within the same population has been shown to result in varying estimates of inappropriate prescribing (Cahir, Moriarty, et al., 2014; Hudhra et al., 2016; Moriarty, Bennett, et al., 2015). A particular limitation of explicit tools is that they require continual revision in order to incorporate advances in clinical knowledge. The 2014 version of STOPP (O'Mahony et al., 2015) was found to detect inappropriate prescribing in 63% of individuals in comparison with 35% detected with the 2008 (Gallagher et al., 2008) version (Hudra et al., 2016). The greater number of indicators included in the revised version of STOPP has highlighted the need for screening tools that are sufficiently robust to advances in clinical knowledge.

The MAI (Hanlon et al., 1992), which quantifies prescribing appropriateness through its ten-item questionnaire structure, is superior to explicit lists as it is not subject to continual revision. In fact, MAI can be used in conjunction with explicit lists to quantify the severity of inappropriate prescribing in a given individual. An overall patient score can be calculated by

summating individual drug MAI scores. In doing so it provides a more holistic sense of the problem for the individual.

As our clinical knowledge base grows the focus of our attention may shift, thus it is imperative that we utilise a tool that is flexible and still retains utility for use in the field. Furthermore, if we are to truly understand inappropriate prescribing in older people, and to develop suitable interventions we need to understand not just how prevalent the problem is but also its severity. Only then can we make real inroads in reducing medication related harm for older people.

3.2.2.2 Inappropriate prescribing within the wider context of healthcare provision

Inappropriate prescribing is particularly challenging for both the patient and the healthcare system as it is associated with several negative outcomes. For the patient, there is an increased risk of experiencing an adverse drug event (Cahir, Bennett, et al., 2014) and an increased risk of hospitalisation (Hyttinen et al., 2016; Moriarty et al., 2014). Every point of contact that a patient has with the health service provides an opportunity for intervention, including better rationalisation of drug therapies. Medicines optimisation has been defined as "a person-centred approach to safe and effective medicine use to ensure that people obtain the best possible outcomes from their medicines" (National Institute for Health and Care Excellence, 2015, p. 7). Within the acute care setting an opportunity exists for hospital pharmacists to review patients' medications and make recommendations to the medical team as to how these medications may be optimised.

However, the health system landscape has changed considerably over the last number of years. The number of adults aged 75 years and older being admitted into acute hospitals in the UK continues to rise and is largely attributed to the rise in the number of people living with long-term conditions (Wilson, Buck & Ham, 2005). Approximately one third of emergency admissions to NHS hospital beds among those aged 65 years and older are associated with

chronic conditions (Hutt et al., 2004). Furthermore, those with multiple chronic conditions (≥ 4 conditions) are 99 times more likely to be hospitalised for adverse events compared with those without chronic conditions (Wolff et al., 2002). Woodford and George (2010) argue that this rise in demand has not been met with a commensurate increase in bed capacity, thereby resulting in a reduction in hospital length of stay.

There is a concern that patients are now discharged earlier from acute care with evidence showing that mean length of hospital stay has reduced, and the number of readmissions has increased (Godden et al., 2009). A reduction in length of hospital stay may also pose several challenges for medicines optimisation. It is often the case that an accurate list of the patient's medications may not have been collated in that time, a process known as medication reconciliation. As such, potential drug related problems may not have been identified and thus not rectified prior to discharge. Furthermore, in the absence of medicines reconciliation having taken place, acute care setting prescribers may prescribe additional medications for the patient that are incompatible with their existing regimen, creating the potential for adverse events post-discharge that may result in a readmission to acute care. The demand for earlier discharge from acute care services has largely driven the development of newer, complementary models of care, including intermediate care.

Acute hospitalisation can itself be a driver for inappropriate prescribing. Within the Irish context it has been shown that hospital admission increases the likelihood of receiving at least one potentially inappropriate medication by 49% (Peréz et al., 2018). Furthermore, those who were admitted to hospital were found to have a 72% increased risk of having at least one potentially inappropriate medication at discharge, compared with before admission. In Australia, estimates of prevalence of inappropriate prescribing follow hospital discharge have been shown to vary from 12-42% (Chang, Kowalksi, Sorich & Alderman, 2017; Runganga, Peel & Hubbard, 2014). Furthermore, very few inappropriate medications are likely to be

discontinued within hospital (Scott et al., 2018), supporting the need for appropriate medication reviews in the post-discharge period. Edey et al., (2018) argue that many barriers to deprescribing exist within the hospital setting, including the clinician's preoccupation with the acute illness, a lack of time for follow up, and lack of interdisciplinary communication. Often, the factors directly contributing to the admission diagnosis are addressed whereas medication related issues are left for primary care physicians to respond to (Edey et al., 2018).

3.2.2.3 Inappropriate prescribing in intermediate care

Our understanding of inappropriate prescribing in intermediate care is limited by the paucity of research conducted in this setting. One prevalence study, conducted in an intermediate care nursing unit in Norway, identified inappropriate prescribing in 26% of patients at admission and this increased to 33% of patients at discharge (Bakken et al., 2012). More recently a small study conducted in intermediate care in Northern Ireland (NI) (N = 74) reported that inappropriate prescribing was highly prevalent (Millar, 2016). Using the STOPP/START criteria it was found that approximately 72% of patients were prescribed at least one inappropriate medication on admission into intermediate care and that 73% of patients had at least one inappropriate medication at discharge (Millar, 2016). Medications for the central nervous system were reported to be the classification of medication most frequently prescribed inappropriately. Similarly, potential prescribing omissions were identified in 61% of patients at admission and 50% of patients at discharge.

High prevalence of inappropriate prescribing in intermediate care is not surprising given the historical delivery of pharmacy services within this context. Traditionally, there has been an absence of clinical pharmacy services to intermediate care facilities in NI. Rather, a 'supply only' function would have been served. In response to a call for better integration of primary and secondary care services for older people in NI, as outlined in the 'Transforming Your Care' Compton Review (DHSSPSNI, 2011a), clinical pharmacy services began to be

introduced into intermediate care in Northern Ireland. A novel care pathway providing pharmacy services within intermediate care was piloted in the Western Health and Social Care Trust (WHSCT) in 2012-2013 with 12-month follow-up (Miller et al., 2016).

3.2.3 Pharmacy services across the primary-secondary care interface

Community pharmacies are responsible for pharmacy service provision directly to individuals residing within the community. Furthermore, many community pharmacies may be responsible for the supply of medication to residential care settings. However, in this instance the service is largely one of supply only, as decisions regarding pharmacotherapy for the individual predominately lies with that of the GP, although non-medical prescribers also contribute to care.

Within secondary care, clinical pharmacy services have developed to such an extent that specialist pharmacy roles have been developed across a diverse range of specialties including antimicrobial, renal, paediatrics, oncology, geriatrics etc. The role of the pharmacist in these specialist areas allows for greater opportunity for multidisciplinary work with other members of the healthcare team. As a consequence of these expanded roles pharmacists in secondary care are often involved in making recommendations for treatment optimisation to the multidisciplinary team.

A critical aspect in the pharmaceutical care of patients in secondary care is the collation of an accurate list on prescribed medications upon admission, often referred to as medication reconciliation. It is a fundamental aspect of ensuring appropriate pharmacotherapy and avoidance of medication related harm. In the absence of medicines reconciliation inappropriate decisions regarding patient care can occur and may result in medication related harm. Similarly, at the point of discharge from secondary care a further potential for harm exists in relation to the communication of any medication related changes to those responsible for the care of the patient in primary care.

Transitions of care have thus been recognised as a key point within the healthcare system during which medication related harm can occur, necessitating the need for some element of service provision to 'mind the gap'. In particular, discharge from hospital poses challenges for communication of medication related changes. Healthcare professionals report that communication of information between care settings is often sub-optimal (Sargent et al., 2007), increasing the risk for ADEs. It has been estimated that only one-fifth of changes to medication made during a hospital admission are explained in discharge summaries (Belleli, Naccarella & PiIrotta, 2013). Furthermore, the practice of handwritten communication persists, with illegible writing and the omission of medication related information a common occurrence (Belleli et al., 2013). It has been found that three in five hospital discharge summaries prepared without pharmacist involvement contain at least one medication error (Tong et al., 2017).

Integrated Medicines Management (IMM) is a collaborative programme that seeks to address medicines management issues across the primary-secondary care interface in Northern Ireland. It is initiated in secondary care and begins with the collation of an accurate drug history from available sources (Scullin et al., 2007). During this hospital admission the patient is monitored by the pharmacist and appropriate patient education is provided, where necessary. In preparation for discharge the IMM pharmacist prepares a discharge prescription and communicates the details of any changes with the patient's GP and community pharmacist. The focus of this service is to ensure that patient safety is not compromised during transitions of care.

However, whilst IMM has been shown to be a valuable service, resulting in a reduction in hospital length of stay and readmissions (Scullin et al., 2007; Scullin et al., 2011), a possibility remains for medication related issues to persist beyond hospital discharge. A reduced length of stay in secondary care may result in a patient transitioning into intermediate care or a care

home that may have still have some unmet pharmaceutical care needs. Furthermore, IMM is not universal across all hospital wards, with only approximately 50% of wards providing IMM services. As such, there are gaps within the acute care setting in Northern Ireland where pharmacy have no input other than to supply medications. Case management proffers an opportunity to improve such communication through coordination of care.

3.2.4 Pharmacist case management in intermediate care

Despite the important role that intermediate care plays in responding to the needs of the older population, and their vulnerability to medication related harm, pharmacy services have not routinely been integrated into this care setting. Traditionally pharmaceutical care services within intermediate care have predominately been limited to medication supply and reconciliation services, with very little clinical pharmacy services having been developed (Millar, 2016). Therefore, it is not surprising that inappropriate prescribing has been found to be highly prevalent among intermediate care patients (Millar, 2016).

The MOOP case management models in intermediate care (refer to Chapter 2) begins with an initial patient assessment on admission into IC. Medications are reviewed by the MOOP pharmacists using MAI, with scoring of each medication influencing the interventions conducted to redress this inappropriate prescribing. MAI scores are recalculated on discharge and case management continues for approximately 30 days. Healthcare usage in the form of unplanned hospital readmissions and ED visits not leading to a readmission are monitored for 90 days following IC discharge.

The development of this care model has expanded the pharmacy service within IC beyond that of a ‘supply only’ model to one focused on improving patient outcomes. In addition to significant improvements in prescribing appropriateness, the model was found to make an estimated annual drug cost saving of £68,000 (Miller et al., 2016). Pharmacotherapy interventions to reduce inappropriate prescribing in intermediate care have not received as

much research attention when compared with other settings (Millar, 2016). In particular, how the reduction in inappropriate prescribing relates to later healthcare resource usage has also not been fully elucidated. If such an intervention were to improve the outcomes of the individual patient following discharge, this could result in greater numbers of older people returning to their own homes and ward off transfer into a longer-term care home setting.

3.3 Objectives

- Describe the prevalence of inappropriate prescribing in Intermediate Care settings in Northern Ireland, as assessed using MAI
- Calculate the change in total MAI score from admission into and discharge from IC following pharmacist intervention
- Characterise the nature of interventions conducted by the MOOP pharmacists in this care setting
- Establish the proportion of variability in MAI score change that is explained by a number of demographic and medication related factors
- Examine variability in healthcare resource usage and outcomes that is explained by changes in total MAI score, as well as examining the patient level covariates associated with this variability

3.4 Method

3.4.1 Study population

This study involved secondary data analysis of cross-sectional data collected by the MOOP team in IC, between 2015 and 2016. Further detail on the sample characteristics and data collection can be observed in Chapter 2. The IC sample comprised of 532 participants who ranged in age from 65 to 99 years (M = 82, SD = 7.6 years).

3.4.2 Design and variables

The study involved secondary data analysis of data previously collected by the MOOP pharmacists in NHSCT and WHSCT. As described in Chapter 2 this data collection adopted a prospective design, with data captured by the MOOP pharmacists upon admission into IC (baseline) and at discharge. Further details regarding data collection can be found in Chapter 2. Demographic information such as age, sex and residential status were examined in the present study. In addition, the following variables reflecting the clinical status of IC participants were also considered:

- **Independence**: this related to how independent participants were with respect to medicines management. Four dummy variables were created such that ***indp1*** were those who were completely independent; ***indp2*** were those who received some assistance or prompting for medicines management; ***indp3*** were those who received informal assistance from a relative/carer/friend; ***indp4*** were those who received a formal assistance package.
- **Acute inpatient**: this binary variable was created using information from the '*origin'* variable. The '*origin'* variable outlined all sources of admissions into intermediate care. All those who were categorised as being admitted into intermediate care from acute care were coded as '*yes'*. Those who were admitted into intermediate care following a GP step up request, via the WHSCT Older Persons Assessment and Liaison (OPAL) and Rapid Response teams were coded as *'no'*.
- **Number of acute admissions in previous 12 months**: this continuous variable indicated the number of acute care admissions experienced by participants in the 12-month period prior to the index admission into intermediate care. This variable was included within regression analyses to control for previous healthcare resource utilisation.

- **Origin**: this binary variable was recoded from the original 'type of residence' variable such that 0 was *'private nursing home, residential home, supported living accommodation, or other'* and 1 was '*own home*'.

3.4.2.1 Clinical history information

Details for up to ten previous medical history diagnoses were captured within the dataset. This information was coded according to ICD-10 criteria (WHO, 1992). Frequency counts for each previous medical history endorsed were completed using IBM SPSS Statistics for Windows 24 (IBM Corp., 2016) and consolidated using Microsoft Excel. Binary variables were computed for the most frequently endorsed medical histories. These binary variables were then aggregated into higher order groups of similar diagnosis codes to ensure that no variable contained <5% of the sample population. The higher-order diagnoses examined within intermediate care can be observed in Table 3-1.

Table 3-1: Aggregated previous medical histories examined in the IC sample

Higher order variable	Diagnosis subtypes
Fracture	Fractured neck of femur
	Fracture
	Fractured pubic ramus
	Fractured humerus
	Fractured arm
	Multiple fractures
	Fractured hip
	Fractured lumbar vertebrae
Anaemia	Iron deficiency anaemia
Stroke	Cerebrovascular accident
	Cerebral infarct
	Transient ischaemic attack
	Stroke non-specified
Acute myocardial infarction	Acute myocardial infarction
Cognitive impairment	Cognitive impairment
	Acute on chronic with Alzheimer's background
	Unspecified dementia
	Vascular dementia
Falls	Falls

	Unspecified falls
	Increased frequency of falls
	Other fall from one level to another
Urinary tract infection	Urinary tract infection
Heart failure	Heart failure
Chronic obstructive pulmonary disease (COPD)	Other COPD
Pneumonia	Bacterial pneumonia not elsewhere specified
	Pneumonia, organism unspecified
	Hospital acquired pneumonia
Essential primary hypertension	Essential primary hypertension
Lower respiratory tract infection (LRTI)	Bacterial LRTI
	Unspecified acute LRTI
Osteoarthritis	Osteoarthritis
Renal failure	Acute renal failure
	Chronic renal failure
Atrial fibrillation and flutter	Atrial fibrillation and flutter
Type II diabetes	Type II diabetes
	Non-insulin dependent diabetes
Hip replacement	Hip replacement
Chronic ischemic heart disease	Chronic ischemic heart disease
Diverticular disease of the intestine	Diverticular disease of the intestine
Malignancy	Malignant neoplasm of bone
	Malignant neoplasm of brain
	Malignant neoplasm of rectosigmoid junction
	Malignant neoplasm of stomach
	Multiple myeloma and malignant plasma cell neoplasms
	Other skin
	Malignant neoplasm of colon
	Malignant neoplasm of gallbladder
	Malignant neoplasm of bronchus/lung
	Malignant neoplasm of breast
	Malignant neoplasm of kidney except renal pelvis
	Other and unspecified types of non-Hodgkin's lymphoma
	Basal cell carcinoma
	Follicular lymphoma
	Follicular nodular non-Hodgkin's lymphoma
	Hodgkin's disease
	Lung cancer with bony metastases
Osteoporosis	Osteoporosis with fracture
	Osteoporosis without fracture
Hypothyroidism	Hypothyroidism
Depression with or without anxiety	Depression with anxiety

	Depressive episode
Chronic kidney disease	Chronic kidney disease
Gout	Gout
Hypercholesterolaemia	Hypercholesterolaemia

3.4.2.2 Healthcare utilisation outcome variables

Several binary variables relating unplanned hospital readmissions were available within the intermediate care dataset. These included '*unplanned readmission within 30 days*', '*unplanned readmission within 31-90 days'* and *'unplanned readmission within 90 days'*. Several continuous variables were also available including *'number of readmissions within 30 days'*, *'number of readmissions within 31-90 days'*, '*total number of readmissions within 90 days'*, '*length of stay on first unplanned readmission'* and '*time to readmission'.*

These outcome variables were recoded to address data entry errors and to ensure that participants who died during their intermediate care admission were captured as 'non-applicable' on outcome variables. An examination of the '*total number of readmissions within 90 days'* variable revealed data entry errors for five cases (8272, 8263, 8159, 8257, 8017). Thus, a new variable '*recoded total number of readmissions within 90 days'* was computed by summating the values from '*number of readmissions within 30 days'* and the values *'number of readmissions within 31-90 days'* variables. Details regarding recoding of information to address data entry errors are as follows:

- **r_read30**: binary variable (Y=1, N=0) recoded from the original binary '*unplanned readmission within 30 days of intermediate care discharge'* variable such that those who died during the index IC admission were recoded as 8888 (non-applicable).
- **r_read90**: binary variable (Y=1, N=0) recoded from the original binary '*unplanned readmission within 31-90 days of intermediate care discharge'* variable such that those who died during the index IC admission were recoded as 8888 (non-applicable).

- **r_adm90**: binary variable (Y=1, N=0), representing readmission between 0 and 90 days of IC discharge, was computed using information from *'r_read30'* and '*r_read90'*. If *'r_read30'* **OR** *'r_read90'* were labelled as *'yes'* then **r_adm90** was coded as 1. Those who died during IC admission were labelled as 8888 (non-applicable).
- **r_admboth**: binary variable (Y=1, N=0) computed using information from *'r_read30'* and '*r_read90',* such that if *'r_read30'* **AND** *'r_read90'* were both labelled as *'yes'* then **r_admboth** was coded as 1. Those who died during IC admission were labelled as 8888 (non-applicable).
- **r_LOSread**: this continuous variable was recoded from the original '*length of stay on first readmission'* such that those who died during IC admission were labelled as 8888 (non-applicable). All other missing values were labelled as 9999.
- **r_TTread**: this continuous variable was recoded from the original '*time to first unplanned readmission'* variable such that those who died during IC admission were labelled as 8888 (non-applicable). All other missing values were labelled as 9999.
- **r_Died90**: Information on death during the intervention was captured on either the '*died during intermediate care admission'* or *'died within 90 days of intermediate care discharge'* variables. It was noted that two participants (8001 and 8062) who died during the intermediate care admission were also listed on the 90-day variable. These two cases were considered as deaths during intermediate care admission as all subsequent variable information had been captured as non-applicable for these participants. Thus, the 'died90' variable was recoded to **r_Died90** such that if '*died within 90 days of intermediate care discharge'* was *'yes'* then **r_Died90** was coded as 1; 'no' was coded as 0. If 'died during intermediate care admission' was 'yes' then **r_Died90** was coded as 8888 (non-applicable).

3.4.3 Data analyses

Demographic and clinical characteristics of participants are expressed in terms of counts, mean (with standard deviation), median and proportions, as appropriate. Descriptive statistics were completed using IBM SPSS Statistics for Windows 24 (IBM Corp., 2016). Frequencies of endorsement for previous medical histories and frequency of prescribing in each BNF chapter subclassification were consolidated using Microsoft Excel for efficiency in tabulation.

Prevalence of inappropriate prescribing at baseline was examined using participant Total MAI score. Kolmogorov-Smirnov and Shapiro- Wilks tests were conducted to examine the distribution of Total MAI score at baseline and following case management completion. Tests of normality indicated that participant Total MAI score at both time points were non-normally distributed. Differences in mean Total MAI score at baseline were examined using Wilcoxon-Signed rank tests for continuous variables and Chi-square tests of independence for categorical variables. Total MAI score at baseline was categorised according to the following: 0; 1-18; 19-36; 37-54; 55-72; >72 categories to examine the proportion of participants who had an increasing severity of inappropriate prescribing. Chi-square tests of independence were conducted to examine differences between categorical demographic variables and MAI baseline category. The change in Total MAI score between both time points was examined using Wilcoxon-Signed Rank test.

Linear regression analyses were used to determine the association between demographic and clinical variables and MAI total score change during the intervention. Multivariate regression analyses were conducted using Mplus 8.1 (Muthén & Muthén, 1998-2018), using the maximum likelihood robust estimator (MLR) to account for multivariate non-normality. This estimator provides a robust estimation of standard errors whilst accounting for non-normality of outcomes and non-independence of observations. These robust standard

errors are computed using a sandwich estimator (Muthén & Muthén, 1998-2016). Preliminary regression analyses in SPSS indicated that the data violated the assumption of homoscedasticity, necessitating the requirement for more robust estimation methods. Several demographic and clinical variables were entered into the predictive model. The regression coefficients, associated significance values and R^2 were examined for each predictive model.

Binary healthcare utilisation outcome variables were examined using multivariate logistic regression analyses completed with Mplus 8.1 (Muthén & Muthén, 1998-2018), using the maximum likelihood robust (MLR) estimator to account for multivariate non-normality. Poisson regression analyses were completed for count outcome variables using the robust estimator of the Generalized function within IBM SPSS Statistics for Windows 24 (IMB Corp., 2016). Survival analyses were conducted for *'time to readmission'* outcome variables using the Kaplan Meier function within IBM SPSS Statistics for Windows 24 (IMB Corp., 2016). Multivariate linear regression analyses were conducted for *'length of stay on first unplanned readmission'* variables using Mplus 8.1 (Muthén & Muthén, 1998-2018), using the MLR estimator. Regression coefficients, odds ratios and associated confidence intervals, significance values and model fit statistics are reported for each predictive model.

3.5 Results

3.5.1 Clinical history and care context

The majority of IC participants entered intermediate care via an acute care hospital (*n* = 462). Additional admittances from acute care were made within WHSCT via specialist teams, including the Rapid Access team (*n* = 1) and the OPAL team in the ED (*n* = 7). A small number of participants who entered IC were recorded as entering via an 'other' acute care location, for example an acute care hospital outside of the relevant HSCT (*n* = 5). A total of 57 participants were admitted to IC following a GP step up request.

Prior to entering IC, the majority of participants resided in their own home (*n* = 484). Twenty-two resided in supported living accommodation, 14 resided in a private nursing home and 11 resided in a residential home. Two-thirds of the IC sample had an intermediate care length of stay of more than two weeks but less than two months. A small proportion of participants had an intermediate care length of stay in excess of three months. Further detail on intermediate care length of stay can be observed in Table 3-2.

Table 3-2: Frequencies for category of length of stay in IC (N = 498)

Length of stay in intermediate care	***n* (%)**
0-7 days	16 (3.0)
8-14 days	58 (10.9)
15-28 days	177 (33.3)
29-56 days	174 (32.7)
57-84 days	50 (9.4)
>84 days	23 (4.3)

Note. Information regarding intermediate care length of stay missing for 34 participants.

Of the participants who transitioned into intermediate care from an acute care setting, almost three-quarters (71.2%) experienced an acute care length of stay of up to three weeks. The most frequently endorsed length of stay in acute care was between eight and 14 days. Just over one-tenth of those who transitioned into intermediate care from acute care had experienced an acute care length of stay greater than one month (Table 3-3).

Table 3-3: Frequencies for category of acute care length of stay for those IC participants admitted from acute care (N = 475)

Length of stay in acute care	***n* (%)**
0-7 days	134 (25.2)
8-14 days	171 (32.1)

15-21 days	74 (13.9)
22-28 days	37 (7.0)
>28 days	59 (11.1)

3.5.2 Medicines management

The majority of IC participants were completely independent with respect to managing their medicines at home (*n* = 286). A total of 166 participants received some form of assistance with managing their medicines from an informal carer, relative or friend. Fifty-seven participants received a formal assistance package. Eleven participants required some assistance with managing their medicines at home, whilst a further seven required some prompting. Two-fifths of the sample (*n* = 213) used a compliance aid to assist with medicines management, with the majority of these being filled by their community pharmacist (*n* = 180). Family carers filled the compliance aid for 26 participants, whilst seven took personal responsibility for filling their compliance aid. A further 29 IC participants used another unspecified compliance solution that was not a monitored dosage system.

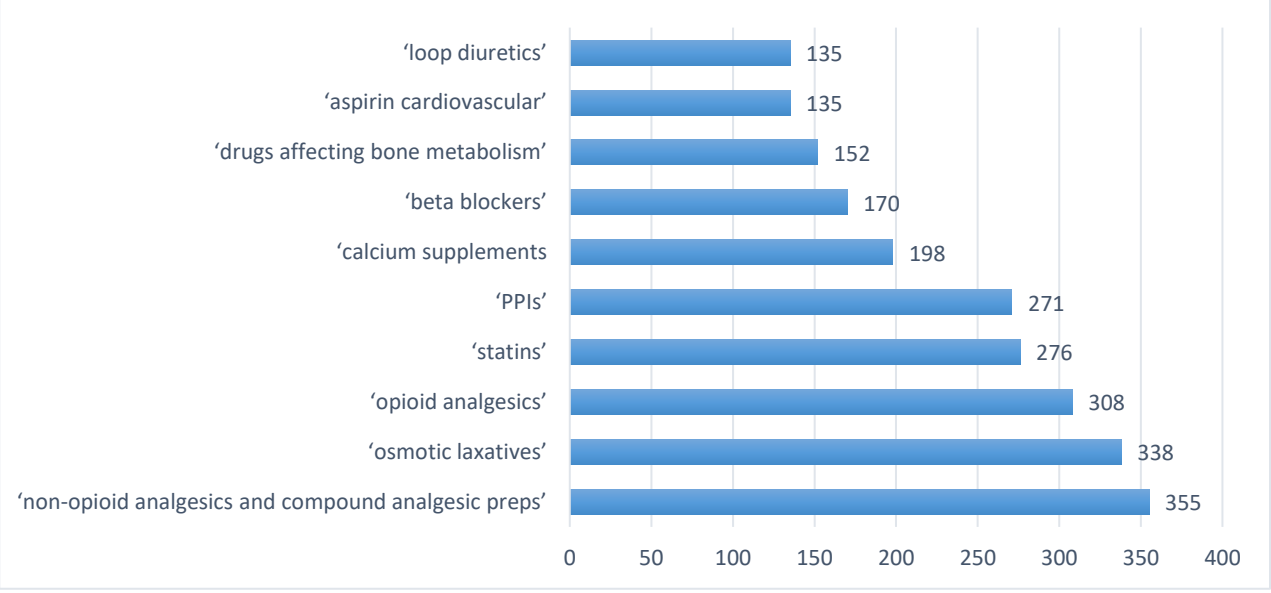

Figure 3-1: Top 10 most frequently endorsed medications in the IC sample by BNF subclassification (N = 532)

An examination of BNF chapter subclassifications revealed that 'non-opioid analgesics and compound analgesic preparations' was the most frequently endorsed subclassification for IC participants (Figure 3-1).

3.5.3 Prescribing appropriateness at baseline

A large proportion of IC participants (89.5%) had some degree of inappropriate prescribing upon admission into IC. Total MAI scores at admission ranged from 0 to 63 (*M* = 15.51, *SD* = 11.88). Baseline total MAI score categories can be observed in Table 3-4.

Table 3-4: Frequencies for category of total MAI score at baseline (N = 532)

Baseline total MAI category	n (%)
0	56 (10.5)
1-18	293 (55.1)
19-36	155 (29.1)
37-54	25 (4.7)
55-72	3 (0.6)

The Mann-Whitney test of differences indicated that the mean ranks for baseline total MAI score was significantly higher for participants who were in the NHSCT (*Mdn* = 16) than for participants in the WHSCT (*Mdn* = 13), *U* = 29092.0, *p* =.006, *r* = .12. No significant difference was observed in the mean ranks of baseline MAI total scores for males (*Mdn* = 13) and females (*Mdn* = 15, *U* = 28648.5, *p* = .078). Similarly, no significant difference was observed in the mean ranks of baseline MAI total scores between those who had previously been an acute inpatient (*Mdn* = 14) and those that were not (*Mdn* = 16, *U* = 13383, *p* = .155). Furthermore, there was no difference in baseline total MAI scores for those who were ordinarily resident in their own home (*Mdn* = 14) compared with those who were not (*Mdn* = 10.5, *U* = 10747, *p* = .392).

A chi-square test of independence was conducted to examine the relationship between HSCT trust and MAI total score category at baseline. A statistically significant weak association was observed, $X^2(4, N = 532) = 12.75$, $p = .013$, Cramer's V = .16. Chi-square tests of independence to examine the association between baseline MAI total score category and intermediate care length of stay; polypharmacy category; and age category could not be conducted as an assumption underlying the application of this test, that <20% of cells have an expected count less than 5, was violated in all instances. Results of a Spearman correlation indicated that there was a significant positive association between the number of prescribed medications at baseline and baseline total MAI score $r_s = .419$, $p < .001$.

3.5.4 Case management intervention

In the IC sample the number of clinical interventions conducted by the case management pharmacists ranged from 0 to 12 ($M = 4.48$, $SD = 2.56$). Details for a total of 2377 interventions recorded within the IC dataset can be observed in Figure 2-7 (Chapter 2). Information regarding the classification of intervention type was missing for four interventions in the IC dataset. The most prevalent interventions were medication stopped (77.3%), dosage change (54.9%) and medication started (50.2%) (refer to Chapter 2, Table 2-5). A total of 948 medication cessations, 432 medication initiations and 435 dosage changes were recorded for the cohort (refer to Chapter 2, Figure 2-7).

3.5.5 Prescribing appropriateness following case management pharmacist intervention

The majority of IC participants (83.6%) experienced a change in total MAI score from baseline ($N = 497$). On average, participant total MAI score reduced by 15.41 points ($SD = 11.76$, range 0-63). Upon discharge participants were found to be prescribed an average of 9.68 medications ($SD = 4.02$, range = 0-23, $N = 493$). A significant weak Spearman's rho

correlation was observed between number of prescribed medications and total MAI score at discharge (r_s = .091, p = .043).

Table 3-5: Means and standard deviations for number of medications and total MAI score at both time points in IC

	Time 1: Admission		**Time 2: Discharge**	
	N	*M (SD)*	*N*	*M (SD)*
Number of medications	532	10.68 (4.14)	493	9.68 (4.02)
MAI total score	532	15.51 (11.88)	497	0.41 (1.84)

Note. MAI total score missing for 35 IC participants at Time 2

A Wilcoxon sign-rank test showed that pharmacist intervention significantly reduced MAI total scores from admission (*Mdn* = 14) to discharge from intermediate care (*Mdn* = 0) (Z = -18.28, p < .001). Furthermore, the number of medications prescribed for intermediate care participants was also significantly reduced (Z = -8.30, p < .001). Median numbers of medications changed from 10 to 9 following pharmacist intervention.

3.5.6 Explaining variability in MAI score change

Linear regression was conducted to predict MAI score change in intermediate care with demographic, clinical history, and pharmacist intervention variables as independent variables. The model explained 44.2% of the variance in MAI score change. Age, sex, and ordinary residence status were not significant predictors of MAI score change. Participant's health and social care trust (HSCT) was a significant predictor of variability in MAI score change (ß = .191, p < .001). Participants in the Northern HSCT experienced a greater reduction in MAI score compared with their counterparts in WHSCT. These participants were found to have higher MAI total scores at baseline. Length of stay in IC was a statistically significant weak predictor of MAI score change (ß = .087, p = .029).

Several interventions conducted by the case management pharmacists explained variance in MAI score change. The change in the number of prescribed medications from baseline to completion of the intervention was the strongest predictor (ß = .584, p < .001). Having the dose of at least one medication changed also explained variability in MAI score change (ß = .206, p < .01). Providing a medicines information intervention was a significant negative predictor of MAI score change (ß = -.080, p =.001) with those participants who experienced a medicines information intervention experiencing a smaller MAI score change. Addressing Kardex issues was also as significant weak predictor of MAI score change in intermediate care.

Table 3-6: Linear regression model with MAI score change as the dependent variable for IC (N = 442)

Predictor	**Unstandardised estimate**	**Standardised estimate**	***p***
Demographics			
Age	-.007	-.004	.905
Sex	1.601	.064	.059
HSC Trust	4.451	.191	<.001**
Original residence (ref other): *own home*	1.303	.032	.317
Clinical history			
Number of hospital admissions in previous 12 months	.257	.031	.320
Length of stay in acute care	.023	.028	.491
Length of stay in intermediate care	.043	.087	.029*
Pharmacist intervention			
Change in number of prescribed medications	2.805	.584	<.001**
Blood tests completed	-.038	-.001	.981
Medicines information	-5.948	-.080	.001*
Medication dosage change	4.813	.206	<.001**
Referral to another healthcare professional	.051	.002	.969
Kardex issue addressed	1.916	.079	.032*
Education	1.237	.033	.347
Other	.885	.020	.488

Note. * p < .05; ** p < .001

3.5.7 Explaining variability in healthcare resource utilisation

Baseline healthcare resource utilisation

The number of unplanned hospital admissions in the 12 months prior to the index IC admission ranged from 0 to 11 (*M* = 0.90, *SD* = 1.49). Just over half of IC participants (55.8%) did not experience an unplanned hospital admission in the 12 months prior to the index IC admission. Approximately one fifth (22.4%) of the sample experienced just one unplanned hospital admission, 11.7% experienced two unplanned hospital admissions and 4.7% experienced three unplanned hospital admissions in the preceding 12 months. The remainder (5.5%) experienced between four and 11 unplanned hospital admissions. No significant correlation was observed between MAI total score at baseline and the number of unplanned hospital admissions experienced by IC participants in the preceding 12 months (r = .043, p = .328).

Post-intervention healthcare utilisation

A total of 115 IC participants experienced an unplanned hospital readmission within 90 days of discharge from intermediate care, with a greater number of participants experiencing this readmission between 31 and 90 days of discharge from intermediate care.

Table 3-7: Counts for hospital readmission for IC participants (N = 532)

	< 30 days	**31-90 days**	**Both time periods**	**0-90 days**
No	448	430	482	396
Yes	63	81	29	115
N/a	21	21	21	21

Note. N/a = non-applicable; participants who died prior to discharge from intermediate care

The duration of these unplanned readmissions by IC participants ranged between 1 and 76 days (*M* = 13.85, *SD* = 15.30, *n* = 101), with time to readmission found to range

between 1 and 89 days (*M* = 33.56, *SD* = 25.71, *n* = 113). On average IC participants experienced 0.34 readmissions (SD = 0.67, range 0-5, n = 432) within 90 days of IC discharge.

Predicting unplanned hospital admission

The degree of MAI total score change was not significantly associated with likelihood of experiencing a hospital readmission for IC participants, in either the 30-day or 31-90-day period (Table 3-8). Patient education was the only intervention type found to be associated with a reduced likelihood of hospital readmission within 30 days (OR = 0.15, 95% CI 0.03, 0.71, $p < .001$). None of the clinical intervention types were significantly associated with likelihood of unplanned readmission within 31-90 days of IC discharge.

Table 3-8: Multivariate logistic regression of likelihood of hospital readmission <30 days and 31- 90 days for IC participants (N = 483)

	< 30 days		**31-90 days**	
Variables	**OR (95% CI)**	***p***	**OR (95% CI)**	***p***
MAI score difference	1.01 (0.98, 1.04)	.470	1.01 (0.98, 1.04)	.432
Age	0.96 (0.91, 1.01)	.082	1.01 (0.97, 1.05)	.652
Sex (reference: male)				
Female	**2.37 (1.04, 5.39)**	**.040**	0.98 (0.53, 1.82)	.939
Medicines management (reference: formal assistance)				
Completely independent	**9.21 (1.33, 63.79)**	**.025**	1.63 (0.52, 5.07)	.401
Some assistance/prompting	**11.41 (1.04, 125.61)**	**.047**	2.18 (0.40, 12.01)	.370
Informal assistance from relative/friend/carer	5.07 (0.72, 35.87)	.104	1.00 (0.31, 3.30)	.999
IC length of stay (days)	0.99 (0.98, 1.01)	.332	1.00 (0.99, 1.01)	.835
HSC trust (reference: W HSCT)				
Northern HSCT	0.95 (0.36, 2.53)	.922	0.79 (0.36, 1.73)	.553
Acute care inpatient (ref: no)	**0.33 (0.12, 0.94)**	**.038**	1.12 (0.47, 2.71)	.798
Number of acute admissions in the previous 12 months	**1.37 (1.12, 1.68)**	**.002**	**1.37 (1.14, 1.65)**	**.001**
Original residence (ref: other)				
Own home	0.99 (0.19, 5.07)	.988	0.60 (0.20, 1.74)	.344
Medication stopped	0.96 (0.40, 2.29)	.929	0.65 (0.32, 1.32)	.238
Medication initiated	1.80 (0.85, 3.84)	.126	1.14 (0.63, 2.07)	.671
Blood tests requested	0.64 (0.20, 2.09)	.643	2.78 (1.27, 6.07)	.010

Medicines information service	**33.34 (5.67, 195.85)**	**<.001**	1.07 (0.20, 5.78)	.942
Dose changed	1.04 (0.51, 2.14)	.915	0.61 (0.34, 1.09)	.093
Referred to another HCP	0.66 (0.24, 1.81)	.418	0.82 (0.35, 1.90)	.645
Kardex issue addressed	0.99 (0.47, 2.08)	.968	1.07 (0.59, 1.95)	.823
Education	**0.15 (0.03, 0.71)**	**.016**	1.15 (0.46, 2.88)	.769
Other intervention	**4.32 (1.60, 11.68)**	**.004**	1.22 (0.49, 3.04)	.676
Fracture	0.72 (0.34, 1.54)	.397	**0.34 (0.18, 0.64)**	**.001**
Anaemia	2.38 (0.57, 9.99)	.236	0.46 (0.12, 1.79)	.261
Acute myocardial infarction	1.50 (0.49, 4.60)	.480	1.25 (0.49, 3.22)	.641
Stroke	0.61(0.24, 1.56)	.305	0.54 (0.26, 1.14)	.108
Cognitive impairment	2.52 (0.87, 7.28)	.087	1.29 (0.51, 3.28)	.590
Falls	0.71 (0.27, 1.86)	.484	0.85 (0.41, 1.79)	.675
Urinary tract infection	4.12 (1.51, 11.24)	.006	1.40 (0.55, 3.58)	.481
Heart failure	1.54 (0.56, 4.28)	.406	0.64 (0.26, 1.53)	.314
COPD	0.73 (0.28, 1.94)	.530	1.00 (0.46, 2.18)	.997
Pneumonia	2.75 (0.96, 7.89)	.061	1.08 (0.45, 2.62)	.862
Hypertension	0.58 (0.28, 1.23)	.154	1.01 (0.56, 1.84)	.970
LRTI	**3.64 (1.05, 12.55)**	**.041**	1.45 (0.47, 4.52)	.520
Osteoarthritis	0.93 (0.33, 2.65)	.888	0.80 (0.35, 1.82)	.591
Renal failure	0.78 (0.28, 2.16)	.635	1.70 (0.80, 3.65)	.170
Atrial fibrillation and flutter	1.52 (0.68, 3.39)	.306	1.31 (0.68, 2.54)	.426
Type 2 diabetes mellitus	1.32 (0.57, 3.05)	.522	1.52 (0.79, 2.94)	.211
Hip replacement	0.94 (0.24, 3.72)	.932	0.95 (0.34, 2.62)	.914
Ischaemic heart disease	0.50 (0.18, 1.43)	.198	0.92 (0.42, 2.01)	.824
Diverticular disease	0.42 (0.07, 2.35)	.321	0.54 (0.17, 1.77)	.311
Malignancy	0.36 (0.07, 1.87)	.226	1.32 (0.45, 3.83)	.611
Osteoporosis	0.82 (0.28, 2.40)	.717	1.30 (0.55, 3.06)	.548
Hypothyroidism	0.82 (0.31, 2.19)	.687	0.41 (0.16, 1.09)	.074
Depression	1.41 (0.38, 5.14)	.607	1.01 (0.35, 2.95)	.986
Chronic kidney disease	3.16 (0.89, 11.15)	.074	1.25 (0.42, 3.71)	.687
Hypercholesterolaemia	0.86 (0.28, 2.57)	.780	1.31 (0.55, 3.14)	.541

Note. HCP = healthcare professional; LRTI: lower respiratory tract infection

Those who had previously been an acute care inpatient were significantly less likely to have experienced a readmission within 30 days of discharge from intermediate care, compared with those who entered IC following a GP step up request. The greatest significant predictor of likelihood of readmission in both monitoring periods was the number of acute care admissions in the preceding 12-month period; each additional acute care admission in the preceding 12 months increased the risk for readmission 1.37-fold. Those with a previous medical history of a

fracture were significantly less likely to experience an unplanned hospital readmission between 31- and 90-days following IC discharge.

When readmissions were aggregated (0 to 90 days following IC discharge) the number of hospital admissions in the 12 months prior to the index admission remained a significant predictor of increased likelihood for readmission (Table 3-9). Each additional admission in the preceding 12 months increased the risk for readmission 1.44-fold (95% CI 1.18, 1.74). Neither the degree of total MAI score change, nor the clinical intervention types were associated with risk of hospital readmission in the 90 days following IC discharge.

Table 3-9: Multivariate logistic regression of predictors of hospital readmission within 90 days for IC participants (N = 483)

Variables	***OR (95% CI)***	***p***
MAI score difference	1.01 (0.99, 1.04)	.340
Age	0.97 (0.94, 1.01)	.150
Sex	1.51 (0.84, 2.72)	.166
Medicines management (ref: formal assistance package)		
Completely independent	1.87 (0.66, 5.32)	.240
Some assistance or prompting	2.37 (0.50, 11.20)	.277
Informal assistance from relative/friend/carer	1.23 (0.42, 3.63)	.707
Intermediate care length of stay (days)	1.00 (0.99, 1.01)	.654
HSC trust (ref: Western HSCT)	0.68 (0.34, 1.38)	.285
Acute inpatient (ref: no)	0.65 (0.30, 1.43)	.284
Number of hospital admissions in previous 12 months	**1.44 (1.18, 1.74)**	**<.001**
Original residence (ref: other)	0.57 (0.21, 1.56)	.277
Medication stopped	0.83 (0.44, 1.60)	.586
Medication initiated	1.35 (0.78, 2.34)	.280
Blood tests requested	1.68 (0.77, 3.66)	.194
Medicines information service	4.15 (0.90, 19.07)	.068
Dose changed	0.71 (0.42, 1.21)	.207
Referred to another HCP	0.69 (0.32, 1.49)	.350
Kardex issue addressed	1.06 (0.62, 1.82)	.835

Education	0.60 (0.25, 1.46)	.256
Other intervention	2.01 (0.90, 4.50)	.090
Fracture	**0.39 (0.22, 0.68)**	**.001**
Anaemia	0.74 (0.23, 2.40)	.619
Acute myocardial infarction	1.18 (0.49, 2.83)	.719
Stroke	0.51 (0.26, 1.01)	.053
Cognitive impairment	1.19 (0.52, 2.73)	.684
Falls	0.68 (0.34, 1.33)	.258
Urinary tract infection	**2.41 (1.06, 5.46)**	**.035**
Heart failure	0.98 (0.45, 2.16)	.962
COPD	0.88 (0.43, 1.81)	.737
Pneumonia	1.21 (0.52, 2.81)	.661
Hypertension	0.79 (0.46, 1.34)	.376
Lower respiratory tract infection	2.74 (0.99, 7.52)	.051
Osteoarthritis	0.83 (0.39, 1.75)	.620
Renal failure	1.17 (0.57, 2.40)	.670
Atrial fibrillation and flutter	1.50 (0.82, 2.74)	.188
Type 2 diabetes mellitus	1.50 (0.82, 2.74)	.188
Hip replacement	0.73 (0.27, 1.97)	.733
Ischaemic heart disease	0.72 (0.34, 1.51)	.717
Diverticular disease	0.46 (0.15, 1.35)	.156
Malignancy	0.93 (0.34, 2.53)	.880
Osteoporosis	1.36 (0.64, 2.90)	.428
Hypothyroidism	0.51 (0.22, 1.14)	.101
Depression	1.80 (0.70, 4.62)	.219
Chronic kidney disease	1.48 (0.56, 3.94)	.433
Hypercholesterolaemia	1.09 (0.49, 2.40)	.836

Participants who had previously had a fracture were significantly less likely to be readmitted within 90 days of IC discharge compared with those participants who did not have a previous fracture. A previous medical history of at least one urinary tract infection was

associated with a significantly increased likelihood of readmission within 90 days of IC discharge.

No significant predictive relationship was observed between MAI score change and the number of unplanned hospital admissions within 30 days of IC discharge (Table 3-10). Females were found to have almost twice the number of unplanned hospital admissions (OR = 1.83, 95% CI 1.03, 3.26) compared with males. Each additional hospital admission in the 12 months preceding the index admission resulted in 1.2 times more readmissions within 30 days of IC discharge (95% CI 1.04, 1.40).

Table 3-10: Poisson regression of number of readmissions within 30 days of discharge from IC (N = 424).

Variables	***Estimate***	***SE***	***OR (95% CI)***	***p***
MAI difference	.003	.013	1.00 (0.98, 1.03)	.801
Age	-.020	.018	0.98 (0.95, 1.02)	.257
Sex (ref: male)				
Female	**.604**	**.295**	**1.83 (1.03, 3.26)**	**.041**
Medicines management (ref: independent)				
Some assistance or prompting	.455	.703	1.58 (0.40, 6.25)	.517
Informal assistance from relative/friend/carer	-.363	.306	0.70 (0.38, 1.27)	.235
Formal assistance package	**-1.56**	**.668**	**0.21 (0.06, 0.78)**	**.019**
Intermediate care length of stay (days)	-.006	.007	0.99 (0.98, 1.01)	.375
Trust (ref: WHSCT)				
NHSCT	.383	.443	1.47 (0.62, 3.49)	.388
Acute inpatient (ref: no)	-.648	.354	0.52 (0.26, 1.05)	.067
Number of hospital admissions in previous 12 months	**.189**	**.075**	**1.21 (1.04, 1.40)**	**.012**
Original residence (ref: other)				
Own home	-.110	.535	0.90 (0.31, 2.56)	.837
Medication stopped	.000	.278	1.00 (0.58, 1.72)	.999
Medication initiated	.336	.279	1.40 (0.81, 2.42)	.229
Blood tests requested	-.286	.434	0.75 (0.32, 1.76)	.511
Medicines information	**1.938**	**.523**	**6.95 (2.49, 19.35)**	**<.001**
Dose changed	.076	.298	1.08 (0.60, 1.94)	.567
Referred to another HCP	-.194	.339	0.82 (0.42, 1.60)	.567
Kardex issue addressed	-.042	.274	0.96 (0.56, 1.64)	.878

Education	**-1.372**	**.511**	**0.25 (0.09, 0.69)**	**.007**
Other intervention	**.856**	**.325**	**2.35 (1.25, 4.45)**	**.008**
Fracture	-.312	.309	0.73 (0.40, 1.34)	.312
Anaemia	.348	.550	1.42 (0.48, 4.16)	.527
Acute myocardial infarction	.357	.449	1.43 (0.59, 3.45)	.427
Stroke	-.358	.373	0.70 (0.34, 1.45)	.337
Cognitive impairment	**.818**	**.342**	**2.27 (1.16, 4.43)**	**.017**
Falls	-.288	.380	0.75 (0.36, 1.58)	.488
Urinary tract infection	**.885**	**.350**	**2.42 (1.22, 4.81)**	**.012**
Heart failure	.648	.482	1.91 (0.74, 4.92)	.179
COPD	-.278	.359	0.76 (0.38, 1.53)	.438
Pneumonia	.712	.373	2.04 (0.98, 4.23)	.056
Hypertension	-.350	.273	0.70 (0.41, 1.20)	.198
Lower respiratory tract infection	**.832**	**.407**	**2.30 (1.04, 5.10)**	**.041**
Osteoarthritis	.203	.486	1.23 (0.47, 3.18)	.174
Renal failure	-.444	.375	0.64 (0.31, 1.34)	.236
Atrial fibrillation and flutter	.342	.306	1.41 (0.77, 2.57)	.264
Type 2 diabetes mellitus	.204	.297	1.23 (0.69, 2.19)	.493
Hip replacement	-.037	.626	0.96 (0.28, 3.29)	.953
Ischaemic heart disease	-.505	.355	0.60 (0.30, 1.21)	.155
Diverticular disease	-.751	.603	0.47 (0.15, 1.54)	.213
Malignancy	-.785	.620	0.46 (0.14, 1.54)	.205
Osteoporosis	-.144	.366	0.87 (0.42, 1.77)	.694
Hypothyroidism	-.161	.413	0.85 (0.38, 1.91)	.697
Depression	.166	.479	1.18 (0.46, 3.02)	.730
Chronic kidney disease	.557	.503	1.75 (0.65, 4.68)	.268
Hypercholesterolaemia	.316	.505	1.37 (0.51, 3.69)	.532

A formal assistance package for medicines management was found to result in significantly fewer unplanned readmissions within 30 days of IC discharge compared with those who were completely independent with respect to medicines management. Patient education resulted in significantly fewer unplanned readmissions (OR = 0.25, 95% CI 0.09, 0.69, p = .007). A medicines information intervention resulted in almost seven times more readmissions (OR = 6.95, 95% CI, 2.49, 0.69, p < .001) within 30 days of IC discharge. Those

who received at least one intervention categorised as 'other' experienced twice the number of unplanned admissions within 30 days of IC discharge than those who did not receive this intervention type (OR = 2.35, 95% CI 1.25, 4.45, *p* = .008).

Several previous medical history variables exhibited significant associations with the number of unplanned hospital admissions within 30 days of IC discharge. Those with cognitive impairment experienced over twice the number of readmissions compared with those with no diagnosis of cognitive impairment (OR = 2.27, 95% CI 1.16, 4.43, p = .017). Those IC participants with a previous medical history of experiencing a urinary tract infection (UTI) were also found to have twice the number of unplanned hospital readmissions. Similarly, those who had previously been diagnosed with a lower respiratory tract infection (LRTI) also experienced over twice the number of unplanned hospital admissions within 30 days of IC discharge in comparison with those with no previous medical history of a LRTI.

No significant association was observed between the degree of MAI score change and the number of unplanned readmissions within 31-90 days of discharge from intermediate care (Table 3-11). However, having had at least one medication dose changed was found to significantly reduce the number of readmissions (OR = 0.60, 95% CI 0.36, 0.98, p = .042). Each additional hospital admission in the 12-month period prior to the index admission increased the number of unplanned hospital admissions in the 31 to 90-day post-IC discharge period 1.31-fold (95% CI 1.17, 1.48).

Table 3-11: Poisson regression of count of number of readmissions within 31-90 days of IC discharge (N = 414)

Variables	***Estimate***	***SE***	***OR (95% CI)***	***p***
MAI difference	-.001	.015	1.00 (0.97, 1.03)	.966
Age	.015	.016	1.02 (0.98, 1.05)	.366
Sex (ref: male)				
Female	-.055	.262	0.95 (0.57, 1.58)	.835
Medicines management (ref: independent)				
Some assistance or prompting	.453	.690	1.57 (0.41, 6.08)	.512

Informal assistance from relative/friend/carer	-.079	.273	0.92 (0.54, 1.58)	.771
Formal assistance package	-.529	.520	0.60 (0.21, 1.63)	.309
Intermediate care length of stay (days)	.006	.005	1.01 (0.99, 1.02)	.215
HSC Trust (ref: WHSCT)				
NHSCT	.074	.353	1.08 (0.54, 2.15)	.834
Acute inpatient (ref: no)	.071	.354	1.07 (0.54, 2.15)	.841
Number of hospital admissions in previous 12 months	**.273**	**.060**	**1.31 (1.17, 1.48)**	**<.001**
Original residence (ref: other)				
Own home	-.418	.481	0.66 (0.26, 1.69)	.386
Medication stopped	.050	.311	1.05 (0.57, 1.93)	.871
Medication initiated	.388	.258	1.47 (0.89, 2.45)	.133
Blood tests requested	.494	.299	1.64 (0.91, 2.95)	.099
Medicines information	-.989	.993	0.37 (0.05, 2.61)	.319
Dose changed	**-.520**	**.255**	**0.60 (0.36, 0.98)**	**.042**
Referred to another HCP	-.133	.432	0.88 (0.38, 2.04)	.758
Kardex issue addressed	.341	.284	1.41 (0.81, 2.45)	.229
Education	.351	.446	1.42 (0.59, 3.40)	.431
Other intervention	.049	.441	1.05 (0.44, 2.49)	.911
Fracture	**-1.08**	**.297**	**0.34 (0.19, 0.61)**	**<.001**
Anaemia	-1.11	.749	0.33 (0.08, 1.43)	.138
Acute myocardial infarction	.411	.388	1.51 (0.71, 3.23)	.290
Stroke	**-.632**	**.279**	**0.53 (0.31, 0.92)**	**.024**
Cognitive impairment	.491	.416	1.63 (0.72, 3.69)	.239
Falls	-.173	.317	0.84 (0.45, 1.57)	.584
Urinary tract infection	-.024	.426	0.98 (0.42, 2.25)	.995
Heart failure	.104	.367	1.11 (0.54, 2.28)	.777
COPD	-.086	.326	0.92 (0.49, 1.74)	.792
Pneumonia	-.377	.403	0.69 (0.31, 1.51)	.349
Hypertension	.331	.240	1.39 (0.87, 2.23)	.168
Lower respiratory tract infection	-.059	.432	0.94 (0.40, 2.20)	.891
Osteoarthritis	-.283	.348	0.75 (0.38, 1.49)	.416
Renal failure	**.643**	**.318**	**1.90 (1.02, 3.55)**	**.043**
Atrial fibrillation and flutter	.281	.270	1.33 (0.78, 2.25)	.298
Type 2 diabetes mellitus	.172	.316	1.19 (0.64, 2.21)	.587
Hip replacement	-.056	.488	0.95 (0.36, 2.46)	.908
Ischaemic heart disease	-.187	.295	0.83 (0.47, 1.48)	.526

Diverticular disease	-.358	.438	0.70 (0.30, 1.65)	.414
Malignancy	.322	.419	1.38 (0.61, 3.14)	.442
Osteoporosis	.504	.371	1.66 (0.80, 3.42)	.174
Hypothyroidism	**-1.00**	**.428**	**0.37 (0.16, 0.85)**	**.019**
Depression	-.449	.458	0.64 (0.26, 1.57)	.327
Chronic kidney disease	-.105	.441	0.90 (0.38, 2.14)	.813
Hypercholesterolaemia	.707	.395	2.03 (0.94, 4.40)	.074

A previous medical history of a fracture resulted in significantly fewer unplanned readmissions in the 31 to 90-day period (OR = 0.34, 95% CI 0.19, 0.61, $p < .001$). Those who had a stroke or had been previously diagnosed with hypothyroidism were also found to have significantly fewer readmissions during this time period. Renal failure increased the number of readmissions within 31-90 days of IC discharge 1.9-fold.

Magnitude of MAI total score change was not significantly associated with the number of unplanned readmissions within 90 days of IC discharge (Table 3-12). When readmissions in both time periods were aggregated none of the clinical intervention types predicted the number of unplanned admissions in the three months following IC discharge. Baseline levels of hospitalisation were again found to positively predict the number of unplanned readmissions in the monitoring period. Each additional previous admission increased the number of unplanned readmissions 1.24-fold (95% CI 1.13, 1.37). When readmissions information was aggregated only a previous medical history of fracture or hypothyroidism significantly predicted number of unplanned readmissions. No significant association was observed for stroke or cognitive impairment.

Table 3-12: Poisson regression of count of number of readmissions within 90 days of IC discharge (N = 424)

Variables	***Estimate***	***SE***	***OR (95% CI)***	***P***
MAI score difference	.001	.011	1.00 (0.98, 1.02)	.896
Age	-.001	.013	1.00 (0.98, 1.02)	.949

Sex (ref: male)				
Female	.228	.196	1.26 (0.86, 1.85)	.245
Medicines management (ref: independent)				
Some assistance or prompting	.259	.466	1.30 (0.52, 3.23)	.578
Informal assistance from relative/friend/carer	-.175	.214	0.84 (0.55, 1.28)	.411
Formal assistance package	-.792	.404	0.45 (0.21, 1.00)	.050
Intermediate care length of stay (days)	.002	.004	1.00 (0.99, 1.01)	.664
Trust (ref: WHSCT)				
NHSCT	.127	.292	1.14 (0.64, 2.01)	.664
Acute inpatient (ref: no)	-.194	.275	0.82 (0.48, 1.41)	.479
Number of hospital admissions in previous 12 months	**.215**	**.049**	**1.24 (1.13, 1.37)**	**< .001**
Original residence (ref: other)				
Own home	-.186	.368	0.83 (0.40, 1.71)	.613
Medication stopped	.051	.218	1.05 (0.69, 1.61)	.816
Medication initiated	.345	.203	1.41 (0.95, 2.10)	.088
Blood tests requested	.197	.265	1.22 (0.73, 2.05)	.456
Medicines information	.457	.504	1.58 (0.59, 4.24)	.364
Dose changed	-.237	.202	0.79 (0.53, 1.17)	.239
Referred to another HCP	-.172	.302	0.84 (0.47, 1.52)	.568
Kardex issue addressed	.179	.217	1.20 (0.78, 1.83)	.409
Education	-.358	.358	0.70 (0.35, 1.41)	.317
Other intervention	.427	.291	1.53 (0.87, 2.71)	.142
Fracture	**-.779**	**.233**	**0.46 (0.29, 0.73)**	**.001**
Anaemia	-.282	.379	0.76 (0.36, 1.59)	.457
Acute myocardial infarction	.439	.313	1.55 (0.84, 2.87)	.161
Stroke	-.496	.254	0.61 (0.37, 1.00)	.051
Cognitive impairment	.565	.320	1.76 (0.94, 3.30)	.077
Falls	-.176	.255	0.84 (0.51, 1.38)	.489
Urinary tract information	.418	.254	1.52 (0.92, 2.50)	.099
Heart failure	.308	.343	1.36 (0.70, 2.66)	.369
COPD	-.163	.247	0.85 (0.52, 1.38)	.509
Pneumonia	.003	.257	1.00 (0.61, 1.66)	.990
Hypertension	.112	.191	1.12 (0.77, 1.63)	.557
Lower respiratory tract infection	.305	.327	1.36 (0.72, 2.58)	.351
Osteoarthritis	-.093	.328	0.91 (0.48, 1.73)	.776
Renal failure	.235	.281	1.27 (0.73, 2.19)	.402
Atrial fibrillation and flutter	.288	.225	1.33 (0.86, 2.08)	.202

Type 2 diabetes mellitus	.204	.234	1.23 (0.78, 1.94)	.383
Hip replacement	-.079	.428	0.92 (0.40, 2.14)	.854
Ischaemic heart disease	-.245	.244	0.78 (0.49, 1.26)	.316
Diverticular disease	-.387	.422	0.68 (0.30, 1.55)	.359
Malignancy	-.008	.368	0.99 (0.48, 2.04)	.983
Osteoporosis	.320	.309	1.38 (0.75, 2.52)	.300
Hypothyroidism	**-.685**	**.329**	**0.50 (0.26, 0.96)**	**.038**
Depression	-.145	.337	0.87 (0.45, 1.67)	.666
Chronic kidney disease	.139	.364	1.15 (0.56, 2.34)	.702
Hypercholesterolaemia	.487	.365	1.63 (0.80, 3.32)	.182

The survival distributions for time to first readmission (days) for IC participants can be observed in Figure 3-2. A log-rank test of differences indicated that the survival distributions for those who had experienced a change in total MAI score (*Mdn* = 25) and those who did not (*Mdn* = 28) were not statistically significantly different, X^2 (1) = .468, *p* = .494.

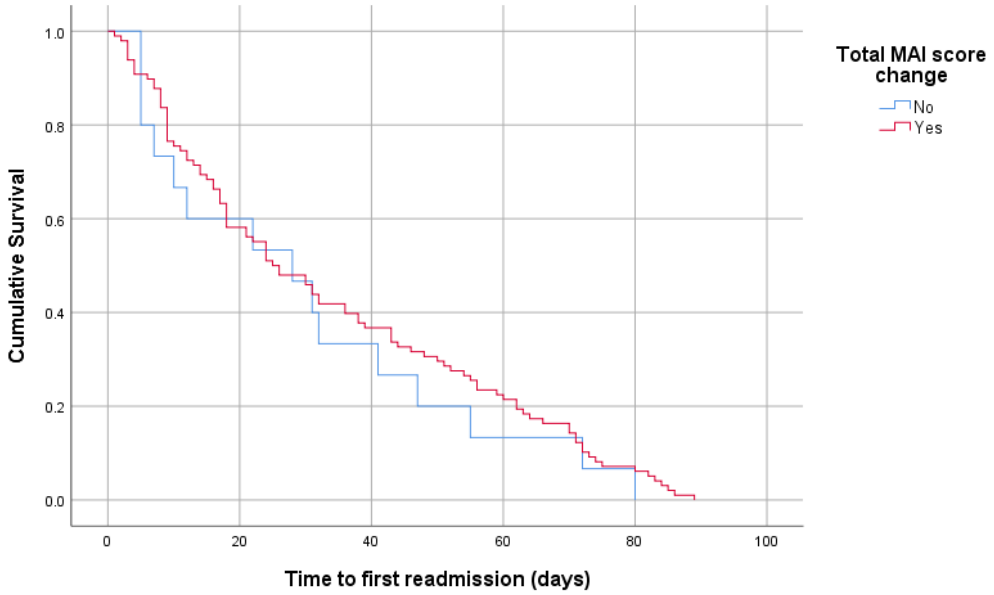

Figure 3-2: Kaplan-Meier survival plot for time to readmission for intermediate care participants (N = 113)

The degree of change in total MAI score was not a significant predictor of length of stay during the first unplanned hospital admission for IC participants (Table 3-13). A dosage

adjustment for at least one medication was associated with a reduced length of stay on readmission (*ß* = -.181, *p* = .015). A diagnosis of heart failure or previous medical history of an acute myocardial infarction was associated with a longer duration of admission. Previous medical history of pneumonia or a lower respiratory tract infection was associated with a shorter admission.

Table 3-13: Predictors of length of stay (days) on first readmission for IC participants (N = 97)

Variables	**Unstandardised Estimate**	**Standardised Estimate**	**Standard Error**	***p***
MAI score difference	.059	.050	.096	.603
Age	.078	.040	.106	.705
Sex (ref: male)				
Female	4.454	.143	.122	.242
Medicines management (ref: formal assistance package)				
Completely independent	-6.099	-.205	.298	.492
Some assistance or prompting	-7.812	-.106	.112	.346
Informal assistance from relative/friend/carer	-2.199	-.069	.270	.800
Intermediate care length of stay (days)		-.001	.070	.986
HSC trust (ref: Western HSCT)				
Northern HSCT	-4.379	-.149	.128	.243
Acute care inpatient (ref: no)	-1.430	-.033	.105	.751
Number of acute admissions in the previous 12 months	-.174	-.025	.084	.761
Original residence (ref: other)				
Own home	-14.033	-.290	.155	.060
Had a medication stopped	-1.409	-.039	.096	.681
Had a medication initiated	2.778	.094	.116	.417
Blood tests requested	-1.237	-.029	.098	.769
Medicines information service	7.372	.121	.068	.075
Dose changed	**-5.334**	**-.181**	**.075**	**.015**
Referred to another HCP	2.913	.072	.090	.424
Kardex issue addressed	-.074	-.002	.086	.978
Education	-6.143	-.121	.083	.143

Other intervention	1.130	.024	.087	.779
Fracture	-6.091	-.184	.109	.093
Anaemia	-3.734	-.056	.073	.444
Acute myocardial infarction	**14.205**	**.318**	**.120**	**.008**
Stroke	-.262	-.006	.088	.943
Cognitive impairment	-2.563	-.051	.118	.669
Falls	1.506	.037	.107	.728
Urinary tract infection	2.668	.067	.109	.536
Heart failure	**11.807**	**.312**	**.130**	**.017**
COPD	5.557	.156	.094	.097
Pneumonia	**-6.620**	**-.137**	**.066**	**.037**
Hypertension	-1.621	-.055	.125	.661
Lower respiratory tract infection	**-9.623**	**-.180**	**.083**	**.031**
Osteoarthritis	6.569	.136	.085	.109
Renal failure	8.494	.229	.122	.059
Atrial fibrillation and flutter	-1.757	-.052	.104	.616
Type 2 diabetes mellitus	-5.996	-.183	.122	.133
Hip replacement	-1.083	-.016	.073	.824
Ischaemic heart disease	-1.989	-.049	.121	.686
Diverticular disease	-12.777	-.192	.099	.051
Malignancy	2.845	.047	.090	.603
Osteoporosis	5.161	.123	.076	.104
Hypothyroidism	3.086	.064	.091	.484
Depression	-4.721	-.093	.110	.396
Chronic kidney disease	4.002	.093	.117	.428
Hypercholesterolaemia	.782	.017	.085	.843

3.5.8 Death

A total of 40 IC participants died during data collection. Twenty-one participants died during the index admission in intermediate care. Nineteen participants died during the 90-day monitoring period, six of whom died during an unplanned hospital readmission. No significant predictive models of likelihood of death within 90 days of IC discharge could be identified.

3.6 Discussion

The present study sought to examine inappropriate prescribing within intermediate care in Northern Ireland, as well as to determine the effectiveness of a pharmacist case management model developed within the NHSCT and WHSCT at reducing this inappropriate prescribing. Previous studies have indicated that inappropriate prescribing is prevalent within this type of care setting (Bakken et al., 2012; Millar, 2016; Miller et al., 2016).

The majority of IC participants (89.5%) experienced some degree of inappropriate prescribing, lending support to the need for pharmaceutical care services within intermediate care settings beyond the traditional 'supply only' function. Millar (2016) previously examined inappropriate prescribing among IC facilities in Northern Ireland using the STOPP/START criteria. It was found that 72% of patients had at least one inappropriate medication on admission, with 74% prescribed at least one inappropriate medication on discharge. Prescribing omissions were also highly prevalent, with 61% of patients having at least one potential prescribing omission on admission and 50% having at least one prescribing omission on discharge from intermediate care. Such findings highlight the requirement for clinical pharmacy services within intermediate care. The present study found that not only was inappropriate prescribing still highly prevalent in intermediate care facilities in Northern Ireland, but that the inclusion of a clinical pharmacist conducting person-centred medication reviews, aimed at addressed such poor prescribing practices, resulted in a significant reduction in suboptimal prescribing.

Few studies that have examined inappropriate prescribing using MAI have provided any insight into the patient and environmental factors that are associated with high MAI scores. In the present study, no age or sex differences were observed in severity of inappropriate prescribing at baseline, for intermediate care participants. International evidence would suggest that inappropriate prescribing is more prevalent among females.

Jiron and colleagues (2016) previously found that females in the US had a 12% increased risk of being prescribed an inappropriate medicine when using the 2012 Beers' Criteria as a screening tool. Using the same screening tool, Morgan, and colleagues (2016) found that Canadian females aged ≥ 65 years had 23% increased risk for receiving at least one potentially inappropriate medicine. An increased prevalence of inappropriate prescribing among Swedish females aged ≥ 60 years was also reported by Sköldunger, Fastbomm Wimo, Fraiglioni and Johnell (2015). Similarly, Morin et al., (2015) found in large sample of 1.3 million Swedish people aged ≥ 65 years that females were more likely to be exposed to inappropriate prescribing, irrespective of what screening tool was used to detect this suboptimal prescribing.

Within the Northern Irish context, Bradley, and colleagues (2012) found that inappropriate prescribing, assessed using 28 STOPP indicators, was more likely to occur in females (OR 1.26, 95% CI 1.23-1.29), after adjusting for age and polypharmacy. In contrast, a study in the UK context, using 52 STOPP indicators, found that exposure to an inappropriate medication was less likely for females (OR 0.9, 95% CI 0.9-0.9) (Bradley et al., 2014). It has been suggested that prescribing omissions, the absence of a clinically indicated medication, may be more prevalent in males (Galvin et al., 2014),

It is not surprising that a significant moderate positive correlation was observed between the number of prescribed medications and baseline MAI total score in intermediate care. A significant association between the number of prescribed medications and the likelihood of exposure to inappropriate prescribing has also been reported internationally using a variety of inappropriate prescribing screening tools (Hudhra et al., 2016; Jiron et al., 2016; Morin et al., 2015). This association has been reported in a number of patient contexts including at hospital discharge (Hudhra et al., 2016), among community dwelling individuals (Galvin et al., 2014), and among those older people presenting to hospital following a fall (McMahon et al., 2014).

In the UK, Bradley et al., (2014) examined a cohort of over 1 million participants aged ≥ 70 years in the UK Clinical Practice Research Datalink and found those who were prescribed ≥ 4 medications were 18 times more likely to be exposed to an inappropriate medication compared with those prescribed 0-3 medications, when adjusted for age, gender and morbidity. This study was conducted using 52 out of 65 STOPP criteria. When assessed in Northern Ireland using a smaller subset of STOPP (28 indicators), a significant association between polypharmacy (operationalised as ≥ 4 medications) and inappropriate prescribing was found. A linear trend between increasing levels of polypharmacy and likelihood of inappropriate prescribing was observed, with those who received seven medications five times more likely to be exposed to inappropriate prescribing compared with those who received 0-3 medications.

Pharmacist case management services to intermediate care settings was shown to result in significant improvement in prescribing appropriateness, with a large proportion of participants (>80%) showing a reduction in total MAI score of at least one point. Participant MAI total score reduced by an average of 15 points for IC participants, resulting in an almost negligible score of 0.41 at discharge from IC.

A number of pharmacist intervention studies have examined inappropriate prescribing using the MAI. Hanlon et al., (1996) have previously shown that pharmaceutical care for older patients (≥ 65 years) in primary care significantly reduces MAI scores, and that this reduction is sustainable at 12 months. The inclusion of a specialist clinical pharmacist to an inpatient geriatric evaluation unit, to provide pharmaceutical care from the point of admission to discharge, also resulted in an increased likelihood for MAI score reduction (OR = 9.1, 95% CI 4.2-21.6) compared with control (Spinewine, Swine, et al., 2007). Chiu et al., (2018) reported that pharmacist intervention in a geriatric unit of Hong Kong hospital resulted in a significant reduction in MAI scores for the intervention group compared with normal care. The present

findings extend those of previous studies by reporting evidence that pharmacist case management also results in a significant reduction in MAI scores in additional care settings such as intermediate care.

Gillespie and colleagues (2013) conducted an RCT to examine the influence of an enhanced pharmacy service through the addition of a clinical pharmacist to the care team, in comparison with a control group where no pharmacist was involved in patient care. The intervention comprised of initial medication reconciliation, medication review, communication of drug-related problems to the physician, patient education, communication of the treatment plan to primary care and follow-up phone calls to the patient following discharge. As such their intervention bore some resemblance to that delivered by the case management pharmacists in the present study. The intervention reported by Gillespie et al., (2013) was standardised, but the medication review component did not involve the consistent use of any particular instrument. Retrospective assessments of prescribing appropriateness were made using STOPP, START and MAI. Between admission and discharge, MAI scores were found to improve in 60% of intervention participants compared with 11% of control group participants.

In the present study, higher rates of improvement were reported in IC (approx. 80%) and may be as a consequence of the medication review component being structured around MAI. The MAI considers appropriateness of prescribing across 10 domains and its structured format can be used to guide subsequent pharmaceutical care plans. Within the Northern Irish context, Burnett and colleagues (2009) also found that incorporating assessments of prescribing appropriateness using MAI within the framework of Integrated Medicines Management led to a significant reduction in inappropriate prescribing when compared with standard pharmaceutical care.

By examining the intervention types enacted by the case management pharmacists in the present study we have a clearer understanding of what may be a driver of MAI score

reduction, namely medication cessation, dosage changes and the alteration of Kardex related issues. There is evidence to suggest that providing medicines information to the clinical team is a somewhat passive strategy that limits the degree of MAI score change that may occur with other intervention types.

We must also move beyond assuming that existing therapy has already been optimised in earlier care settings. A high proportion of those in intermediate care required some adjustment to their pharmacotherapy, which is notable given that for the most part this cohort had recently experienced an acute care admission. Kardex issues were frequently addressed in the IC sample which may point towards the persistence of medication-related problems following discharge from acute care. It has been reported that over 90% of patients have at least one medication-related problem following discharge from acute care (Basger, Moles & Chen, 2015; Ellitt, Engblom, Aslani, Westerlund & Chen, 2010). Integrated Medicines Management as an initiative to improve communication across the primary-secondary care interface has been shown to result in improved prescribing appropriateness (Burnett et al., 2009).

Most of the clinical interventions conducted by the case management pharmacists in the present study were self-rated to be clinically significant and resulted in an improvement in the care of the patient. Eadon (1992) in proposing the rating criteria used in the present study found that ratings of clinical significance did not differ between the pharmacist's scores and those of three physicians. Vo et al., (2016) conducted a systematic review of tools used to assess potential significance of pharmacist interventions. All 133 tools identified were assessed for quality by the review authors based upon a framework that included setting, sampling, quality, and number of raters, rating method, reliability, and risk of bias. As part of their assessment Vo and colleagues concluded that the Eadon criteria were of high quality. A previous study conducted examining pharmacist case management in intermediate care in

Northern Ireland found that 84% of interventions were self-graded as Eadon 4 and above (Miller et al., 2016). In this study a sample of ten of these gradings were independently reviewed by four consultant geriatricians for consistency. Reliability analysis indicated an excellent level of consistency between the ratings (Cronbach's alpha coefficient 0.909), indicating that pharmacist self-ratings were congruent with that of consultant geriatricians.

When considering the proportion of variability in MAI score change explained by a number of demographic and intervention variables, the change in the number of prescribed medications was the strongest predictor of MAI score change for IC participants. The greater the reduction in the number of medications prescribed at discharge, compared with at admission, the greater the difference in MAI score between both time points. For each discontinued medication, a MAI score reduction of 0.584 points was observed.

A change in medication dosage was also a significant predictor of MAI score change for IC participants, indicating that inappropriate dosages contributed to MAI score calculation at baseline and highlighting the requirement for prescribers to be cognisant of the need for reduced medication doses for some older people. The location of the intermediate care site was also a significant predictor of MAI score change within intermediate care with those in the Northern HSCT experiencing a greater change in total MAI score. This finding is not surprising considering baseline total MAI scores for were higher for NHSCT intermediate care participants compared with WHSCT participants.

A longer duration of stay in intermediate care also facilitated a greater reduction in MAI score change. Within Northern Ireland the goal of intermediate care is to prevent unnecessary hospital admission, promote recovery and support independent living. There is considerable debate as to the effectiveness of intermediate care as a model, owed largely to the varied conceptualisations of intermediate care in existence (Steiner, 2001; Melis et al., 2004). These varied models have prevented firm conclusions from being drawn regarding the

effectiveness of intermediate care from preventing unnecessary hospital admission. Nevertheless, the present study indicates that improvements in prescribing appropriateness can be achieved for each additional day spent in intermediate care and given the relationship between inappropriate prescribing and adverse events, this is not a trivial finding.

Additional clinical interventions explained variability in MAI score change, with having experienced at least one medication dosage change the second most significant predictor. Furthermore, having at least one Kardex issue addressed by the case management pharmacist was also a significant weak predictor of MAI score reduction. In contrast, merely providing a medicines information service to the clinical team was a significant negative predictor of MAI score change, indicating that the provision of clinical information was insufficient to improve medication appropriateness, and highlighting the importance of active interventions on the part of the pharmacist.

Medication dosage and Kardex instructions may not have been contributing to baseline MAI scores in the first instance to the same level that the mere presence of a particular medication may have been. The MAI is a weighted questionnaire whereby the greatest weighting of 3 points is given to the use of a medication in the absence of a clinical indication. In terms of score calculation, a lack of indication would provide the same MAI score for a medication (3) as would the combination of an incorrect dosage (2) and inappropriate duration (1). In the development of the MAI weighting system Samsa and colleagues (1994) acknowledge that interpretation of MAI scores must also be considered in light of the individual item weightings.

Overall, the magnitude of total MAI score improvement did not reduce healthcare resource utilisation. Despite a significant reduction in MAI total score, the magnitude of MAI score change did not predict the likelihood of experiencing a hospital readmission for IC participants. Furthermore, MAI score change was not predictive of time to readmission, with

no significant difference observed between those who experienced a change in total MAI score and those who did not.

Similar findings have previously been reported by Chiu et al., (2018) following a prospective controlled study within a geriatric hospital unit setting. Two hundred and twelve participants were randomly allocated to receive usual care or pharmacist intervention. The intervention comprised of medication reconciliation, a medication review guided by MAI, and patient counselling. A significant reduction in MAI score was observed in the intervention group when compared with control. However, this reduction was not predictive of duration of inpatient stay or of inpatient mortality. Furthermore, no significant differences were observed in the number of ED attendances or mortality within one or three months of hospital discharge. In contrast, a previous systematic review and meta-analysis has suggested that pharmacist-led medication reconciliation services were associated with significant reductions in hospital readmissions (19%), ED visits (28%) and ADE-related hospitalisations (67%) (Mekonnen, McLachlan & Brien, 2016).

In contrast to the present study, Chiu, and colleagues (2018) noted a significant reduction in the number of unplanned hospital admissions within one month, but not within three months of discharge following the index admission. It is not apparent whether the participants examined by Chiu and colleagues received any formal post-discharge care such as intermediate care. It is possible that differences in outcomes between the present study and the findings of Chiu and colleagues relates to the rehabilitative function of intermediate care, which may have served to reduce the likelihood for readmission for all participants irrespective of the degree of MAI score change observed.

There is some evidence to suggest that intermediate care may be functioning effectively as a post-discharge care setting within NI. It was observed that those who entered IC from acute care were less likely to be readmitted to hospital within 30 days compared with

those who entered IC via another pathway, such as following a GP step-up request. Such a finding underscores the importance of intermediate care to encourage more clinical stability for older people. The high prevalence of inappropriate prescribing observed here and in the findings of Millar (2016) further emphasises the need for clinical pharmacist input in this care setting.

Whilst the significant reduction in MAI score was not associated with a reduction in readmission potential for IC participants, pharmacist intervention showed some significant relationships with healthcare outcomes in this cohort. Those IC participants who received at least one education intervention had a reduced likelihood of hospital readmission, and a reduced number of hospital readmissions within 30 days of IC discharge, compared with those who did not receive this intervention type.

Studies examining the impact of patient education by pharmacists on readmissions rates show mixed results. Bach, Peasah and Barber (2018) conducted a systematic review to examine the effectiveness of several pharmacist interventions on reducing hospital readmissions. Many of the studies reviewed focused on post-discharge patient education, either alone or in combination with medication reconciliation before discharge. Five of the education intervention studies included in the review were conducted among older populations, with two showing a reduction in readmissions (Al-Rashed, Wright, Roebuck, Sunter & Chrystyn, 2002; Briggs et al., 2015), two showing no impact (Krska et al., 2001; Nazareth et al., 2001) and one reported evidence of an increase in readmissions (Holland et al., 2005). In the present study, patient education was an important factor, over and above improvements in prescribing appropriateness, highlighting that pharmacist interventions should not solely focus on a metric, such as MAI, but also on the qualitative nature of the intervention type.

Those IC participants who experienced at least one medication dosage change were found to spend five fewer days in acute care on readmission compared with those who did not have any medication dosage changes. Such a finding highlights the need to consider more than merely stopping existing medicines or starting new medicines, as advocated by explicit criteria such as STOPP and START. Optimising existing therapy whilst offsetting potential harm can be achieved through dosage reduction and MAI provides a metric within which this can be captured.

Several pharmacist interventions within IC were found to be associated with increases in readmissions within the 30-day post-discharge period. Those IC participants who received a 'medicines information' or 'other' intervention had significantly greater numbers of readmissions during this period. It could be argued that such intervention types may be too passive to have a real clinical impact for the patient. For example, providing a medicines information service to the prescriber may perhaps infer the continuation of a medication that may have not been entirely appropriate and thus may suggest the maintenance of a status quo for the patient.

There is some evidence that targeted post-discharge follow up can be associated with increases in healthcare utilisation, and that this may indicate better chronic disease management. Rosstad et al., (2017) examined a new generic care pathway in Norway in comparison to a normal care control. The novel care pathway comprised of pre-discharge planning and coordination of care between the general hospital and primary care, with GP visits to support where required. During the 12-month follow up period it was found that those in the intervention group had more GP visits, with the authors hypothesising that GPs were taking an active role in the management of patients following acute care discharge. In the present study utilisation of primary care services by IC participants was not available, and the primary outcome recorded for this cohort was unplanned hospital readmission. Increases in

the number of readmissions within 30 days of IC discharge could not be seen to be a marker of increased primary care physician engagement but rather some element of clinical deterioration that required an acute care admission.

Throughout the analyses presented here it was observed that previous levels of healthcare resource utilisation were a significant predictor in a large proportion of the analyses. The number of hospital admissions in the 12-month period prior to the index intermediate care admission was a consistent predictor of likelihood for readmission in all periods, and of numbers of readmissions and thus may serve as a marker of the relative clinical instability of some IC participants.

It has been argued that intermediate care has been developed as a policy initiative, to ease pressures within other structures of the health service. Notwithstanding these arguments of its empirical origins and the challenges posed by various definitions of what intermediate care is, a universal theme is that this care setting should provide an opportunity for recovery and re-enablement of the patient with prolonged care needs following an acute care admission. This recovery should facilitate the patient to return to their preferred destination and in an effective intermediate care model they should not experience an avoidable hospital readmission.

Within the present study those IC participants who had a previous medical history of a fracture exhibited a lower likelihood of readmission and fewer admissions within 90 days. Those with a clinical history of a stroke had fewer numbers of readmissions within the 31-90-day period. These findings must be interpreted cautiously, as no information regarding the recency of diagnoses was available. Similarly, the primary diagnosis on admission to intermediate care was also not available. That said, common reasons for admission into intermediate care include fracture and stroke rehabilitation. Thus, if such were the case for intermediate care participants in the present study, this would suggest that intermediate care

is performing effectively within Northern Ireland, as reduced risk for readmission was observed with these diagnoses.

Notably, those IC participants who had previously been diagnosed with cognitive impairment had significantly greater numbers of readmissions < 30 days, compared with those with no such diagnosis. Such a finding supports the existing literature that those older people living with dementia are at greater risk of an acute care admission. A systematic review by Toot et al., (2013) concluded that people with dementia had an increased risk of hospital admission compared with people without dementia. In particular, the likelihood for admission due to orthopaedic (Nourhashemi et al., 2001; Natalwala et al., 2008; Malone et al., 2009; Tuppin et al., 2009), respiratory (Carter & Porell, 2005; Natalwala et al., 2008; Sampson et al., 2009; Tuppin et al., 2009) and urological (Carter & Porell, 2005; Natalwala et al., 2008; Sampson et al., 2009; Tuppin et al., 2009) crises was greater among people with dementia compared with those without.

Several methodological limitations must be considered when interpreting the present study's findings. Information pertaining to previous medical history did not indicate whether the various diagnoses were currently clinically relevant. The recency of diagnoses such as falls, fractures, or infective episodes could not be ascertained, limiting the inferences that may be drawn regarding the influence of morbidity on healthcare utilisation and outcomes. The absence of a matched control group prevents an assessment of the effectiveness of pharmacist case management in comparison with usual care. This is further compounded by the high proportion of participants who experienced a change in total MAI score. Maintaining adequate statistical power to examine outcomes such as healthcare resource usage in the post-intervention period is a challenge when most participants have experienced some degree of MAI score change.

Several limitations also relate to the use of the MAI. The implicit nature of the MAI means that the impact of clinical experience on the calculation of MAI scores cannot be eliminated. The possibility remains that regional differences in baseline MAI score may occur because of inter-individual differences among the case management pharmacists. Future research should seek to examine the impact of pharmacist experience, as well as investigating regional differences using multi-level modelling. The scoring process of the MAI is somewhat time consuming to apply. It has been estimated that it can take up to ten minutes to calculate the MAI score for one medication alone (Hanlon et al., 1992). Thus, within the context of the considerable polypharmacy evident within the present sample it could take up to 100 minutes to determine MAI scores for the patient who is prescribed ten medications. Luo, Scullin, Mullan, Scott and McElnay (2011) previously conducted a comparison of several tools to assess inappropriate prescribing and concluded that while the MAI was in their experience the most comprehensive tool to apply it also was the most time consuming. Furthermore, the weighting of MAI indictors was developed based on clinical relevance and does not account for what the patient may place importance upon.

3.7 Conclusion

In the present study it has been shown that inappropriate prescribing is highly prevalent among those aged ≥ 65 years who are cared for within IC in NI. No differences in baseline severity of MAI score was observed for age or sex. Regional differences in baseline severity of prescribing inappropriateness was observed, which may warrant further examination in future studies.

The majority of interventions delivered by the case management pharmacist were self-rated to be clinically significant and resulting in improvements in the standard of care, with the most common interventions including medication discontinuation and dosage adjustment.

Pharmacist intervention was found to significantly improve appropriateness of pharmacotherapy, lending support to earlier pilot work and highlighting the need for continued involvement of clinical pharmacists in these contexts. Furthermore, the successful delivery of the care model was maintained when delivered by case management pharmacists who are supported and mentored by a consultant pharmacist.

The present study also extends work conducted previously within IC in NI by examining the relationship between improved prescribing appropriateness and subsequent healthcare resource usage. The present study has shown that improvement in prescribing appropriateness, as indicated by the degree of change in total MAI score, was not significantly associated with a reduction in healthcare resource usage. Individual pharmacist intervention types such as patient education and medication dosage adjustments did show significant benefits in terms of reduced resource usage. Several medical diagnoses showed significant relationships with increased healthcare resource usage including cognitive impairment, urinary tract infections, renal failure, and heart failure. Associations between reduced healthcare utilisation and previous medical history of stroke and fracture provide some tentative evidence that intermediate care is performing as an effective rehabilitative space in Northern Ireland.

Furthermore, previous healthcare resource usage was a dominant predictor of healthcare utilisation which underscores the high level of clinical need among those patients who access IC in NI. Despite clear evidence that significant improvements in prescribing were achieved via case management approaches, multivariate analyses indicated that several patient level factors contribute to increased healthcare resource usage. The natural clinical course of some of these patient level factors is not always directly modifiable by the clinical pharmacist.

Hospital admissions and healthcare resource usage is multifactorial. The multimorbid patient provides a level of complexity that is further augmented with older age, increased

levels of dependency and the impact that transitions of care have upon the older person. It could be argued that for the comorbid older person with a history of previous healthcare resource usage the goal of intervention may be to achieve a ‘steady state’ as opposed to absolute reductions in healthcare usage. With hospital readmission associated with considerable functional deficits a pharmacist case management intervention that is not related to an increase in readmissions may be considered an achievement.

4 Healthcare utilisation following pharmacist case management of older adults in Care Homes in Northern Ireland

4.1 Chapter overview

This chapter begins by building on the literature discussed in the previous chapter (Chapter 3) through a discussion of inappropriate prescribing specifically within the context of care homes. The reader is reminded of the case management model developed for care homes in Northern Ireland (previously introduced in Chapter 2: Methodology). The effectiveness of this case management model is then examined in two ways. First, the degree of change in inappropriate prescribing, as assessed using MAI, from baseline to post-intervention is examined. Secondly, the proportion of variability in healthcare resource usage that is explained by changes in patient total MAI score is examined.

4.2 Introduction

Discharge from secondary care may result in admission into long term residential care for some older people. Inappropriate prescribing is also a particular concern in this care setting. Estimates of inappropriate prescribing in care home settings are wide ranging from 27-88% (Anrys et al., 2018; Cool et al., 2014; Elseviers, Vander Stichele & Van Bortel, 2014; Heppenstall et al., 2016; Lau, Kasper, Potter & Lyles, 2004; Ryan et al., 2013). The variance in prevalence estimates may be related to the use of different screening tools or may relate to differences in healthcare contexts in different jurisdictions, for example in medication reimbursement and availability. Morin, Laroche, Texier and Johnell (2016), in their systematic review, found that pooled prevalence estimates for European studies was higher at 49% in comparison with 26.8% in the US. Thus, drawing inferences from the international literature may do little to inform of the incidence of the problem within the Northern Irish setting.

Northern Ireland has a long history of integrated health and social care since the HPSS (NI) Order in 1973, which originally provided for the establishment of four Health and Social

Services Boards responsible for the provision of services (Bengoa, Stout, Scott, McAlinden & Taylor, 2016). In 2007, five new integrated Trusts, five Local Commissioning Groups, a smaller Health and Social Care Board and the Public Health Agency were established, with the Health and Social Care Board responsible for the commissioning of services (Bengoa et al., 2016). However, it has been reported that funding for social care has not been commensurate with health care funding and has not adapted in line with the increasing demand for services due to an ageing demographic (Dowds, McParland, Devine & Gray, 2012). Northern Ireland has the fastest growing ageing population within the United Kingdom (DHSSPSNI, 2011a). The Appleby Report (2011) identified that Northern Ireland has an additional 9% need in comparison to England and that a potential £1 billion gap in funding would have to be addressed. It is estimated that 62% of total spending on adult social care services in Northern Ireland is spent on older people's care (Bengoa et al., 2016). In fact, 42% of HSC finances are spent on those aged over 65 years despite only occupying 14% of the population (Bengoa et al., 2016).

The availability of healthcare services in Northern Ireland is limited by its ability to meet the demand placed upon services. Approximately two-thirds of acute hospital beds are occupied by those aged over 65 years (Bengoa et al., 2016) and approximately 9670 people aged over 65 years live in residential care or nursing homes (Bengoa et al., 2016). An increase in demand creates additional pressures at both admission and discharge points. Between 2010/11 and 2013/14 the number of hospital admissions increased by 48,000 and the number of outpatient appointments increased by 121,000 (DHSSPSNI, 2011a). Furthermore, based upon population projections it is estimated that by 2037 an additional 20,101 care packages will be required compared to 2016, which is an increase of 68% (Bengoa et al., 2016).

The TYC report (DHSSPSNI, 2011a) sought to reset the balance of care within Northern Ireland to provide more community and home care services for those living with comorbidity, reducing the need for hospital-based interventions. The Commissioner for Older People

Northern Ireland (COPNI; 2017) argue that categorising long-term care as social care and not health care is a move towards shifting responsibility for cost of such services and an attempt to encourage people to make provisions for their own long-term care. Entry into a care home environment usually occurs at the point where the individual cannot safely live at home due to increased functional dependency. In many instances this transition occurs at a point of crisis and as such the choice of care is often limited by the availability of places (COPNI, 2017).

There are 483 registered care homes in Northern Ireland comprised of 248 nursing homes and 235 residential care homes (Health and Social Care Board Northern Ireland: HSCBNI, 2020a). The majority of these are independently owned with only five statutory nursing homes and 43 statutory residential homes on the register (HSCBNI, 2020a). A distinction is drawn between residential care and nursing home care. Residential care is comprised of residential accommodation with board and personal care provided for those in need of personal care. Nursing homes provide additional nursing care and some homes are registered to provide both residential and nursing care (HSCBNI, 2020a). Each HSCT has a capped amount for which it pays for residential care and if the selected care home charges more than this capped amount, the difference is paid for by the individual or their family (COPNI, 2017).

The Care Standards for Nursing Homes sets out the criteria for registration and inspection of nursing homes as per the Nursing Homes Regulations (Northern Ireland) 2005 (DHSSPS, 2015). These standards set the benchmark for care provision within the region with the aim of ensuring consistency of care irrespective of whether care is provided within the voluntary, independent, or statutory sector. There are 48 care standards in total and are categorised in relation to a number of key areas: before admission, quality of life, quality of care, quality of management, quality of the physical environment (DHSSPSNI, 2015). Whilst four of the 48 standards relate to medicines, they do not consider the wider aspects of

pharmaceutical care. Rather the standards only consider more logistical aspects such as medicines management, records, storage, and controlled drugs (DHSSPS, 2015). Thus, there is an argument that there is room for improvement with respect to medicines optimisation within this care context.

In addition to TYC (DHSSPSNI, 2011a), the 2016 publication of 'Systems not structures: changing health and social care' Expert Panel Report chaired by Prof. Bengoa made additional recommendations for service provision within NI (Bengoa et al., 2016). The Bengoa Report set out several key aims with respect to transformation of health and social care in NI. It advocated a move towards a proactive model, based on the needs of chronic patients, and that worked to 'cure, care, and prevent illness' (Bengoa et al., 2016, p. 39). It also encouraged a move towards active patient participation in self-management and the development of continuity of care that provided services in the right place for patients (Bengoa et al., 2016). In order to achieve this a move towards a multidisciplinary approach to primary care provision and away from a GP-led model of care was proposed. Thus, these two seminal reports set out a clear mandate for health and social care provision in Northern Ireland to adapt in order to fulfil the needs of the population it served.

Further adaptation is required going into the future. As the Northern Irish population ages dementia will become a larger public health consideration, with numbers set to rise to 60,000 by 2051 (DHSSPSNI, 2011b). This will demand a health and social care system that is responsive to the complex needs of older people who are likely to also be living with considerable multimorbidity. Safe, effective, person-centred care has been identified as a core value in the Dementia Strategy (DHSSPSNI, 2011b) and is an aspect that must be considered with respect to pharmaceutical care needs of the person living with dementia in a care home. Traditionally, access to pharmaceutical care is limited within care homes, as care home residents often do not have direct access to a pharmacist. Thus, it can be argued that residents

do not have the same opportunity as their community-dwelling counterparts to raise any concerns that they may be having with their medications.

Chapter 1 and 2 outlined the challenges with prescribing for older people, the particular problem of inappropriate prescribing and the higher prevalence of inappropriate prescribing in care homes. Those care home residents with polypharmacy, history of falls and a neuropsychiatric disorder are more likely to receive inappropriate prescribing (Anrys et al., 2018). High rates of inappropriate prescribing have been reported for people with dementia (PWD) (Hukins, Macleod & Boland, 2019; Parsons et al., 2012). Concerns have been raised regarding the use of psychotropic medications to control the behavioural and psychological symptoms of dementia (BPSD) in care home settings (Barry et al., 2015; Patterson et al., 2007; Renom-Giuteras et al., 2018). Psychotropic medications are those which can alter the mind, emotions, and behaviour and thus their use in BPSD may be considered a form of chemical restraint.

In NI, the prevalence of psychotropic medication is higher among care home residents compared with community dwelling individuals (Maguire et al., 2013). An examination of administrative claims information found that the longitudinal increase in prescribing of psychotropic medication for those moving into a care home was greater than that seen in community-dwelling individuals over the same time period (Maguire et al., 2013). In fact, psychotropic prescribing increased sharply following admission into a care home (Maguire et al., 2013). However, such a practice may not be as insidious as it sounds. Maguire and colleagues (2013) make the compelling argument that much of the inappropriate prescribing in care homes may be a continuation of the prescribing culture within primary care prior to admission, given that the patients' GP remains the main prescriber to the individual whilst they are in a care home. There is evidence to suggest that suboptimal management of repeat prescriptions exists in Northern Ireland (McGavock, Wilson-Davis & Connolly, 1999).

Transition into long-term care is associated with a change in prescribing practices (Maguire, et al., 2013), and in many cases inappropriate pharmacotherapy is initiated, often in response to BPSD (Cornegé-Blokland, Kleijer, Hertogh & var Marum, 2012). The initiation of inappropriate medications in this care context may increase the risk for medication related harm, and thus subsequent interaction with healthcare services. There is also a concern that older care home residents may be presenting to Emergency Departments unnecessarily, with lack of access to primary care services cited as a contributory factor (Lemoyne et al., 2019).

Clinical pharmacy services have shown positive impacts on healthcare outcomes within hospital and care home settings. Pharmacist-led interventions and medication reviews conducted in the general hospital inpatient population have shown reductions in emergency department visits and hospital readmissions (Christensen & Lundh, 2016; Ravn-Nielson et al., 2018). For older people specifically, pharmacist-led interventions within the hospital context have been shown to reduce the hospital length of stay (Scullin et al., 2007; Scullin et al., 2011), emergency department visits and drug-related readmissions (Gillespie et al., 2013). Within the care home setting pharmacist intervention has been shown to result in a reduction in falls (Zermansky et al., 2006) and in the prescribing of psychoactive medications (Schmidt et al., 1998).

The MOOP care home model (refer to Chapter 2, Figure 2-2) was developed in the NHSCT and also reported similar improvements in prescribing appropriateness and annual drug cost savings as those delivered by the intermediate care model (McKee et al., 2016). Furthermore, a reduction in inappropriate attendances to ED were also noted. In the original development of the care home model outreach visits to care homes were conducted in conjunction with a consultant geriatrician. The model was found to be equally effective when delivered by pharmacists alone in comparison with the more human resource heavy collaboration with a consultant geriatrician (McKee et al., 2016; Miller, 2018). As a

consequence, the service evolved to one that was led by the pharmacist but included a facility for referral to a geriatrician when it was deemed medically necessary.

The replication of the care home model within the WHSCT allowed for the opportunity to examine alternative models of communication with GPs. The original model developed in the NHSCT communicated clinical interventions and recommendations to GPs via letter. In addition to these letters of recommendation, the case management pharmacists within the WHSCT used teleconferencing and had direct access to the GP's computer system to communicate clinical interventions. As the pharmacist case management models embed across Northern Ireland there is a need to develop a greater understanding of the nature and extent of inappropriate prescribing among older people in care homes.

As previously outlined in Chapter 3, pharmacist case management significantly improved prescribing appropriateness in intermediate care, where pharmacist interventions were associated with a reduced likelihood of hospital readmission. The continual development of clinical pharmacy services for older people is warranted in light of the high prevalence of inappropriate prescribing identified. Given that inappropriate prescribing is known to be highly prevalent in care homes internationally, there is a clear need to understand the extent of the problem within the Northern Irish care home context. Furthermore, the associations between suboptimal prescribing and increased healthcare resource utilisation highlight the opportunity to identify if improvements in prescribing relate to reduced healthcare resource usage by care home residents. A reduction in hospital admissions and readmissions will provide for better capacity within the health service whilst avoiding the potential for decrements in physical functioning for the older person.

4.3 Objectives

- Describe the prevalence of inappropriate prescribing in Care Home settings in Northern Ireland, as assessed using MAI scores.
- Calculate the change in total MAI scores from baseline to completion of pharmacist case management.
- Establish the proportion of variability in MAI score change that is explained by a number of demographic and medication related factors.
- Examine the proportion of variability in healthcare resource usage that is explained by total MAI score change and examine the patient-level covariates that are associated with this

4.4 Methods

4.4.1 Study population

This study involved secondary data analysis of cross-sectional data collected by the MOOP pharmacists from 32 care homes in the Northern and Western HSCTs, between 2015 and 2016. The CH sample comprised of 1095 individuals ranging in age from 65 to 102 years (*M* = 84, *SD* = 7.5). The sample characteristics can be observed in Table 2-1 in Chapter 2.

4.4.2 Design and variables

Similar to the design previously reported in Chapter 3, the present study involved secondary data analysis of data collected by the MOOP pharmacists in NHSCT and WHSCT. Initial data collection adopted a prospective design, with data captured by the clinical pharmacists at baseline and throughout the case management intervention. The prospective nature of data collection facilitated the determination of prevalence of inappropriate prescribing at baselines, as well as an assessment of how this prescribing changed during the course of the intervention. Data collection in the Care Homes (CH) sample was collected at the

point of first contact with the participant (baseline) and at the completion of the patient-specific pharmaceutical care plan. Data were collected from 32 homes across both HSCTs. The breakdown of homes for each HSCT is as follows: WHSCT Southern Sector: nine homes; WHSCT Northern Sector: 10 homes; NHSCT: 13 homes. Further details regarding data collection can be found in Chapter 2.

Demographic characteristics such as age, sex, bed type, and care home length of stay were examined in the present study. Additional demographic variables were also included to allow for a greater depth of patient-level analysis. The following variables were also considered:

- **Baseline origin:** this binary variable outlined the source of admission into the care home. Those who were admitted into the care home from their own home were coded as '0'. Those who were admitted into CH from acute care were coded '1'.
- **Direct access to GP's computer system:** this binary variable was created using information from the *'approach'* variable, which provided information on the communication method used to relay changes to the participant's medications by the CH MOOP pharmacist. In the WHSCT a novel method of communication was being trialled where the CH MOOP pharmacist had direct real time access to the GP's computer system and could directly enact changes to the medication record. This modification was done so that comparisons could be made with the previous communication methods conducted in NHSCT including a letter to the GP (with/without telephone follow up) or teleconference with GP. Where direct access was available this was coded as *'yes=1'* and where it was not available this was coded *'no=0'*.

- **Received ACP:** this binary variable (Y=1, N=0) reflected whether the participant had received advanced care planning.
- **Previously received IMM:** this binary variable (Y=1, N=0) reflected whether the participant had received Integrated Medicines Management during their last inpatient admission to acute care.

Clinical history information

Details for up to ten previous medical diagnoses, coded according to ICD-10 criteria (WHO, 1992), were captured within the original dataset. Frequency counts for each of the ten medical history variables were completed using IBM SPSS Statistics for Windows 24 (IBM Corp., 2016) and consolidated using Microsoft Excel, for efficiency in tabulation. Binary variables (yes/no) were computed for the most frequently endorsed medical histories. These binary variables were then aggregated into higher order groups of similar diagnosis codes to ensure that no variable contained <5% of the sample population. The higher-order diagnoses examined Table 4-1.

Table 4-1: Aggregated previous medical histories examined in the CH sample

Higher order variable	Diagnosis subtypes
Fracture	Fractured neck of femur
	Fracture
	Fractured pubic ramus
	Fractured humerus
	Fractured arm
	Multiple fractures
	Fractured hip
	Fractured lumbar vertebrae
	Fractured ribs
Angina pectoris	Angina pectoris
Parkinson's disease	Parkinson's disease
Senile cataract	Senile cataract
Anaemia	Iron deficiency anaemia
	Vitamin b12 deficiency anaemia
	Other anaemias

	Megaloblastic anaemia
	Normochromic anaemia
	Deficiency of another b group vitamin
	Normocytic anaemia
Stroke	Cerebrovascular accident
	Cerebral infarct
	Subarachnoid haemorrhage
	Intracerebral haemorrhage
	Other cerebrovascular diseases
	Cerebral aneurysm
	Transient ischaemic attack and related syndromes
	Stroke non-specified
Acute myocardial infarction	Acute myocardial infarction
Cognitive impairment	Cognitive impairment
	Acute on chronic with Alzheimer's background
	Unspecified dementia
	Vascular dementia
	Memory loss
	Alzheimer's disease
	Acute confusion
	Age related memory loss
Falls	Falls
	Fall involving other furniture
	Increased frequency of falls
Urinary tract infection	Urinary tract infection??
	Recurrent urinary tract infection
Heart failure	Heart failure
Chronic obstructive pulmonary disease (COPD)	Other COPD
Gastric	Duodenal ulcer
	GORD
	Gastric ulcer
	Gastritis and duodenitis
	Peptic ulcer unspecified site
Essential primary hypertension	Essential primary hypertension
Osteoarthritis	Osteoarthritis
Renal failure	Acute renal failure
	Chronic renal failure
Atrial fibrillation and flutter	Atrial fibrillation and flutter
Diabetes	Type II diabetes
	Non-insulin dependent diabetes
	Type I diabetes
	Insulin dependent diabetes

Chronic ischemic heart disease	Chronic ischemic heart disease
Diverticular disease of the intestine	Diverticular disease of the intestine
Malignancy	Malignant neoplasm of stomach
	Multiple myeloma and malignant plasma cell neoplasms
	Malignant neoplasm of colon
	Malignant neoplasm of bronchus and lung
	Malignant neoplasm of breast
	Malignant neoplasm of kidney except renal pelvis
	Basal cell carcinoma
	Lung cancer with bony metastases
	Myeloid leukaemia
	Myelodysplastic disorders
	Malignant meninges uncertain
	Malignant uncertain oral cavity
	Malignant neoplasm of thyroid
	Malignant neoplasm of spinal cord
	Malignant neoplasm of ovary
	Malignant neoplasm of oesophagus
	Malignant neoplasm of the lip
	Malignant neoplasms immunoproliferative disorders
	Metastatic breast cancer
	Malignant neoplasm of prostate
	Malignant neoplasm of bladder
	Basal cell carcinoma
	Squamous cell papilloma
	Malignant neoplasm of pancreas
	Carcinoma in situ of skin
	Diffuse non-Hodgkin’s
	Malignant neoplasm of skin
	Malignant neoplasm of cervix
	Malignant neoplasm of vagina
	Other and unspecified types of non-Hodgkin’s
	Carcinoma in situ in oral cavity
Osteoporosis	Osteoporosis with fracture
	Osteoporosis without fracture
Hypothyroidism	
Depression	Depression with anxiety
	Recurrent depressive episode
	Depressive episode
	Bipolar affective disorder

	Other mood disorder
	Unspecified mood/affective disorder
Chronic kidney disease	
Hypertensive heart disease	
Hypercholesterolaemia	

Healthcare utilisation outcome variables

A total of fifteen outcome variables available within the care homes data were examined in the present study. Count variables included:

- Number of GP call outs within 30 days
- Number of GP call outs within 90 days
- Number of OOH GP visits within 30 days
- Number of OOH GP visits within 90 days
- Number of ED visits not leading to an admission within 30 days
- Number of ED visits not leading to an admission within 90 days
- Number of unplanned hospital admissions within 90 days

Binary variables were as follows:

- Died within 30 days (No = 0, Yes = 1)
- Died within 90 days (No = 0, Yes = 1)
- Died between 31 and 90 days (No = 0, Yes = 1)
- Unplanned hospital admission within 30 days (No = 0, Yes = 1)
- Unplanned hospital admission between 31 and 90 days (No = 0, Yes = 1)
- Unplanned hospital admission within 90 days (No = 0, Yes = 1)

Continuous outcome variables included:

- Length of stay on first unplanned hospital readmission (days)
- Time to first unplanned readmission (days)

4.4.3 Data analyses

Demographic and clinical characteristics are expressed in terms of mean (with standard deviation), median and proportions, as appropriate. Descriptive statistics were completed using IBM SPSS Statistics for Windows 24 (IBM Corp., 2016). Frequencies of endorsement for prescribing in each BNF chapter subclassification and endorsement of previous medical history diagnoses were consolidated using Microsoft Excel for efficiency in tabulation.

Prevalence of inappropriate prescribing at baseline was examined using participant Total MAI score. Kolmogorov-Smirnov and Shapiro- Wilks tests were conducted to examine the distribution of Total MAI score at baseline and following case management completion. Tests of normality indicated that participant Total MAI score at both time points were non-normally distributed. Differences in mean Total MAI score at baseline were examined using Wilcoxon-Signed rank tests for continuous variables and Chi square tests of independence for categorical variables. Total MAI score at baseline was categorised according to the following: 0; 1-18; 19-36; 37-54; 55-72; >72 categories to examine the proportion of participants who had an increasing severity of inappropriate prescribing. Chi square tests of independence were conducted to examine differences between categorical demographic variables and MAI baseline category. The change in Total MAI score between both time points was examined using Wilcoxon-Signed Rank test.

Linear regression analyses were used to determine the association between demographic and clinical variables and MAI total score change during the intervention. Multivariate regression analyses were conducted using Mplus 8.1 (Muthén & Muthén, 1998-2018), using the maximum likelihood robust estimator (MLR) to account for multivariate non-normality. This estimator provides a robust estimation of standard errors whilst accounting for non-normality of outcomes and non-independence of observations. These robust standard

errors are computed using a sandwich estimator (Muthén & Muthén, 1998-2017). Preliminary regression analyses in SPSS indicated that the data violated the assumption of homoscedasticity, necessitating the requirement for more robust estimation methods. Several demographic and clinical variables were entered into the predictive model. The regression coefficients, associated significance values and R^2 were examined for each predictive model.

Multivariate logistic regression analyses were completed for binary healthcare utilisation outcome variables using Mplus 8.1 (Muthén & Muthén, 1998-2018), using the maximum likelihood robust (MLR) estimator to account for multivariate non-normality. Poisson regression analyses were completed for count outcome variables using the robust estimator of the Generalized function within IBM SPSS Statistics for Windows 24 (IMB Corp., 2016). Survival analyses were conducted for *'time to readmission'* outcome variables using the Kaplan Meier function within IBM SPSS Statistics for Windows 24 (IMB Corp., 2016). Multivariate linear regression analyses were conducted for *'length of stay on first unplanned readmission'* variables using Mplus 8.1 (Muthén & Muthén, 1998-2018), using the MLR estimator. Regression coefficients, odds ratios and associated confidence intervals, significance values and model fit statistics are reported for each predictive model.

4.5 Results

4.5.1 Care context

The majority of CH participants occupied a 'general nursing' bed (*n* = 695). Approximately one quarter of the sample occupied an 'elderly mentally impaired (EMI) bed' (*n* = 283), with the remainder occupying a 'residential' bed (*n* = 117). Over half of CH participants (60.5%) entered the care home setting from their own home, with the remainder transitioning into their care home following hospital discharge. Almost half of care home participants had been resident in their care home for over two years when assessed by the case management pharmacists at baseline. Frequencies for length of residence categories for CH participants can

be observed in Table 4-2. Almost all CH participants (98.3%) were permanent residents within their care home. The remainder (1.7%) were resident on a short-stay or respite basis.

Table 4-2: Frequencies for category of residence duration for CH participants (N = 1095)

Length of residence	***n* (%)**
<4 weeks	16 (1.5)
4-12 weeks	58 (5.3)
3-6 months	88 (8.0)
6-12 months	159 (14.5%)
1-2 years	247 (22.6)
>2 years	527 (48.1)

4.5.2 Medicines management

A total of 3936 nervous system medications were prescribed for CH participants, with 1067 participants prescribed at least one medication for the nervous system. The most frequently endorsed BNF chapter classification was for medications for the nervous system (refer to Chapter 2, Figure 2-4). The most frequently endorsed BNF chapter subclassification was 'osmotic laxatives' (Figure 4-1).

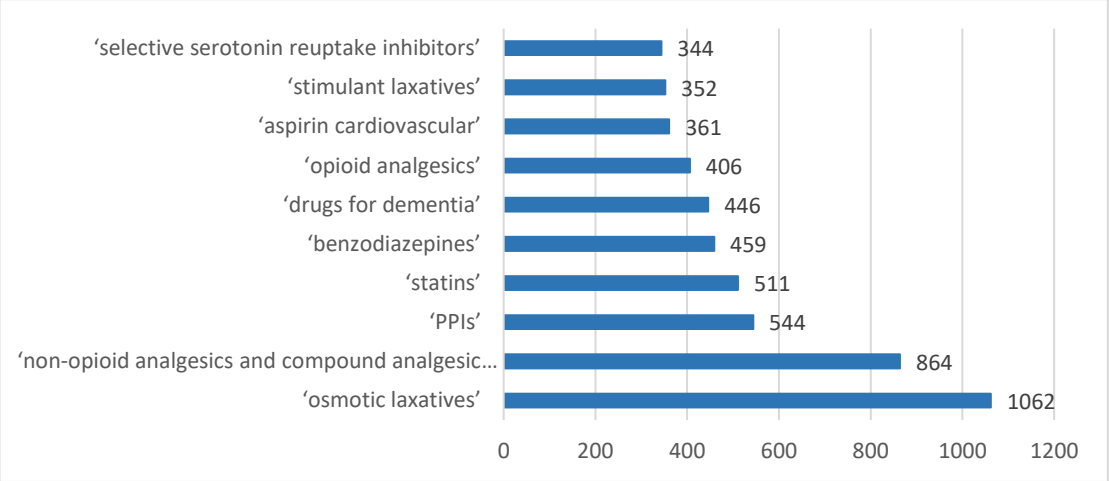

Figure 4-1: Top 10 most frequently endorsed medications in the CH sample by BNF subclassification (N = 1095)

Higher mean numbers of medications were prescribed for participants in the CH sample (*M* = 12.08, *SD* = 4.75, range 1-32) compared with the IC sample (refer to Chapter 3: *M* = 10.68, *SD* = 4.14, range 1-24). Frequency of polypharmacy in CH can be observed in Table 2-2 (refer to Chapter 2). The most frequently endorsed polypharmacy category for CH participants was 11-15 medicines.

A total of 348 CH participants had previously received Integrated Medicines Management services whilst in acute care. A total of 235 CH participants had received some form of advanced care planning. At baseline, a total of 31 CH participants had been identified as high risk and referred to a consultant geriatrician for medical input. Fifty-nine participants were identified as requiring consultant pharmacist input by the case management pharmacist. For the CH participants the method of communication of medication related changes adopted by the case management pharmacists included a letter to the GP (*n* = 578), telephone conference with the GP (*n* = 3), a letter and follow up telephone call (*n* = 92) and real time access to the GP's computer system (*n* = 422).

4.5.3 Prescribing appropriateness at baseline

The mean total MAI score at baseline was 14.87 (*SD* = 13.11), with 84.1% of CH participants reporting some degree of inappropriate prescribing at baseline. Frequencies of endorsement for total MAI score ranges can be observed in Table 4-1.

Table 4-3: Frequencies for category of total MAI score at baseline for CH (N = 1088)

Baseline total MAI category	n (%)
0	174 (15.9)
1-18	575 (52.5)
19-36	257 (23.5)
37-54	69 (6.3)

55-72	12 (1.1)
>72	1 (0.1)

The Mann-Whitney test of differences indicated that the mean rank of baseline MAI total scores was significantly higher for WHCST (*Mdn* = 14) participants compared with the NHSCT participants (*Mdn* = 9), *U* = 114020, *p* < .001, *r* = .20. The mean rank of baseline MAI total scores was also significantly higher for those participants for whom the case management pharmacist had direct access to the GP's computer system (*Mdn* = 16) compared with those where such access was not available (*Mdn* = 9), *U* = 93208.5, *p* < .001, *r* = .28. No significant difference was observed in the mean ranks of baseline MAI total scores for males (*Mdn* = 12) and females (*Mdn* = 13), *U* = 116902.5, *p* = .204.

A statistically significant weak association was observed between HSCT trust and MAI total score category at baseline, $X^2(5, N = 1088) = 44.07$, *p* < .001, Cramer's V = .20. A MAI baseline total score of 0 was more frequently observed for NHSCT participants. A MAI total score category of 37-54 was more frequently observed for WHSCT participants. A chi-square test of independence also revealed a significant weak to moderate association between direct access to the patient's GP's computer system and category of MAI total score at baseline, $X^2(5, N = 1088) = 92.04$, *p* < .001, Cramer's V = .28. A MAI total score of 0 at baseline was more frequently observed for those where no direct access was available. MAI total score categories of 19-36, 37-54 and 55-72 were more frequently observed for those participants where direct access was available.

A significant weak association was observed between care home length of stay category and baseline MAI total score category, $X^2(15, N = 1088) = 42.26$, *p* < .001, Cramer's V = .11. Participants who had resided in a care home for less than six months were more frequently found to have a baseline category of 0. Those who had resided in a care home for

more than two years were more frequently found to have a baseline MAI total score in the range of 37 to 54. No significant association was observed for bed type and baseline MAI total score category, $X^2(10, N = 1088) = 14.10$, $p = .173$. Similarly, no significant association was observed between age category and baseline MAI total score category, $X_2(20, N = 1088) = 18.59$, $p = .549$.

A significant weak to moderate association was observed between polypharmacy category and baseline MAI total score category, $X^2(20, N = 1088) = 362.04$, $p < .001$, Cramer's V = .29. A baseline MAI score of 0 was more frequently observed for those prescribed between 0 and 5 medications. Those who were prescribed 6-10 medications were more frequently observed to have MAI total scores of both 0 and 1-18 categories. Baseline total MAI scores of 19-36 were more frequently observed for those prescribed between 11 and 15 medications. Those who were prescribed 16-20 medications were more frequently found to have baseline MAI total scores in the range of 19-36 and 37-54. Those who were prescribed more than 20 medications at baseline were more frequently found to have a MAI total score category of 55-72. Results of a Spearman correlation indicated that there was a significant positive association between the number of prescribed medications at baseline and baseline total MAI score $r_s = .538$, $p < .001$.

4.5.4 Case management intervention

In the CH sample the number of clinical interventions recorded at baseline ranged from 0 to 12 ($M = 2.68$, $SD = 1.99$) with details relating to 2903 clinical interventions recorded at baseline. The frequency of participants who endorsed a minimum count of one for each clinical intervention type can be observed in Table 2-5 (refer to Chapter 2). The most frequently endorsed intervention was medication cessation (refer to Figure 2-7, Chapter 2), with 75% CH participants having had at least one medication stopped.

4.5.5 Prescribing appropriateness following pharmacist case management

The majority of CH participants (82%) experienced a change in total MAI score from baseline (*N* = 1088). On average, CH participant total MAI score reduced by 14.17 points (*SD* = 12.50, range 0-71) following pharmacist intervention. A Wilcoxon sign-rank test showed that CH participants experienced a statistically significant reduction in MAI total scores from the initial baseline assessment to the completion of the pharmaceutical care plan (*Z*= -25.97, *p* < .001).

Table 4-4: Means and standard deviations for total MAI score at both time points for CH sample (N = 1088)

	Time 1 Baseline		**Time 2 Case management completion**	
MAI total score	1088	14.87 (13.11)	1088	0.70 (2.04)

Note. MAI total score missing for 7 CH participants at Time 2

4.5.6 Explaining variability in MAI score change

Linear regression was conducted to predict MAI score change in the care home setting with demographic, clinical history, and pharmacist intervention variables as independent variables. The model explained 51% of the variance in MAI score change. Age, sex, and baseline origin were not significant predictors of MAI score change in the care homes sample. As the WHSCT was investigating the impact of a novel method of communicating suggested interventions to care home resident's prescriber, namely direct access to the GP's computer system, it was not possible to examine both 'HSCT' and 'GP direct access' in the same predictive model. The inclusion of 'GP direct access' resulted in a significant contribution to explaining variability in MAI score change (*ß* = .187, *p* < .001).

Those who occupied a residential bed experienced a smaller MAI score change compared with those who occupied an EMI bed. No effect was observed for those occupying a general nursing bed. Those who were residing in their care home < 6 months and 6-12 months experienced a smaller MAI score change compared with the reference category, which was care home residence >2 years. No difference was observed for those CH participants who were resident between 1 and 2 years. Having received IMM during the previous acute care admission was associated with a smaller MAI score change. The number of prescribed medications at baseline was the strongest predictor of MAI score change (*ß* = .400, *p* < .001). Of the clinical interventions conducted by the case management pharmacists only medication discontinuation was a significant predictor of MAI score change (*ß* = .358, *p* < .001).

Table 4-5: Linear regression model with MAI score change as the dependent variable for CH (N = 1085)

Predictor	**Unstandardised estimate**	**Standardised estimate**	***p***
Demographics			
Age	.028	.017	.446
Sex	-.987	-.036	.090
Baseline origin	-.630	-.025	.267
Direct access to GP's computer system	4.819	.187	<.001**
Bed type: elderly mentally impaired *(reference)*		-	-
General nursing	.647	.025	.311
Residential	-2.373	-.059	.007*
Clinical history			
Care home length of stay: >2 years *(reference)*		-	-
Care home length of stay: <6 months	-1.679	-.047	.036*
6 months – 1 year	-1.698	-.048	.027*
1-2 years	-1.197	-.040	.077
No. of acute care admissions in previous 12 months	.037	.003	.903

Received ACP	.184	.006	.831
Previously received IMM	-2.449	-.091	.001**
Baseline number of medications	1.059	.400	<.001**
Pharmacist intervention			
Medication stopped	10.518	.358	<.001**
Medication started	.527	.013	.571
Blood tests completed	.701	.019	.423
Medicines information	-1.469	-.034	.051
Medication dosage change	.851	.032	.199
Referral to another healthcare professional	1.058	.020	.430
Kardex issue addressed	1.567	.031	.154
Other	-.722	-.008	.708

Note. *= p < .05; ** p < .001; ACP = advanced care planning; IMM= integrated medicines management

4.5.7 Explaining variation in healthcare resources usage

Baseline (pre-intervention) healthcare resource utilisation

The number of unplanned hospital admissions in the 12 months prior to pharmacist intervention ranged from 0 to 11 (*M* = 0.66, *SD* = 1.12). Almost two-thirds of CH participants (62.3%) did not experience an unplanned hospital admission in the previous 12 months. Almost one-quarter (23.2%) experienced one unplanned hospital admission, 8.2% experienced two unplanned admissions and 3.9% experienced three unplanned hospital admissions in the preceding 12 months. The remainder of CH participants (2.4%) experienced between four and 11 hospital admissions. No significant correlation was observed between MAI total score at baseline and the number of unplanned hospital admissions in the preceding 12 months (*r* = -.045, *p* = .136). The average length of time since the last unplanned hospital admission was 21.54 weeks (*SD* = 15.48, range 0-52, *n* = 445). Additional healthcare utilisation information at baseline was available for CH participants (Table 4-6).

Table.4-6: Descriptive statistics for pre-intervention healthcare resource utilisation by CH participants (N = 1089-1095)

	n	*M (SD)*	Range
GP call outs previous 30 days	1091	0.27 (0.58)	0-4
GP call outs previous 90 days	1089	0.66 (1.18)	0-12
Out of hours GP call outs previous 30 days	1095	0.15 (0.45)	0-5
Out of hours GP call outs previous 90 days	1095	0.42 (0.86)	0-7
ED presentation previous 30 days	1091	0.07 (0.32)	0-6
ED presentation previous 90 days	1091	0.18 (0.54)	0-6
Unplanned hospital admissions previous 30 days	1095	0.08 (0.30)	0-2
Unplanned hospital admissions previous 90 days	1094	0.18 (0.48)	0-4

Hospital admission post-intervention

A total of 110 CH participants experienced an unplanned hospital readmission within 90 days of case management pharmacist review (Table 4-7). The duration of the first unplanned hospital readmission ranged between 1 and 95 days (*M* = 8.79, *SD* = 11.68, *n* = 110), with time to readmission found to range from 0 and 89 days (*M* = 42, *SD* = 25.22, *n* = 109). The number of unplanned hospital readmissions within 90 days ranged from 0 and 3 (*M* = 0.13*, SD* = 0.39*, n* = 1004).

Table 4-7: Counts for hospital readmission for care home participants (N = 1095)

	< 30 days	**31-90 days**	**Both time periods**	**0-90 days**
No	999	941	1079	894
Yes	45	81	16	110
Non-applicable	34	57	-	51
Missing	17	16	-	40

Note. Twenty-two CH participants died prior to completion of pharmacist review

Likelihood of unplanned hospital readmission for CH participants can be observed in Table 4-8. In order to obtain model identification for likelihood of readmission within the 30-day period a reduced model was specified. The number of admissions to acute care in the preceding 12 months was the only significant predictor of likelihood of an unplanned admission within 30 days of pharmacist intervention. Each additional previous admission increased the likelihood of an unplanned admission by 38%. Likelihood of admission in each time period was significantly predicted by previous patterns of hospital admissions.

A care home length of stay of 1-2 years was significantly associated with a reduced likelihood of unplanned hospital admission in the 31-90 day when compared to a care home length of stay of <6 months. Those who occupied an EMI bed had increased odds of an unplanned admission within the 31-90-day period, compared with those who occupied a general nursing bed. Males had a significantly increased odds of readmission in the 0-90-day period post-intervention (OR = 1.75, 95% CI 1.07, 2.88, *p* = .027). Those CH participants with a previous medical history of diabetes were also an increased risk of an unplanned hospital admission in the three-month period following pharmacist intervention.

Table 4-8: Multivariate logistic regression for predictors of unplanned hospital readmission for CH participants

	***N* = 999** **< 30 days**		***N* = 974** **31-90 days**		***N* = 957** **< 90 days**	
Variables	**Odds ratio (95% CI)**	***p***	**Odds ratio (95% CI)**	***p***	**Odds ratio (95% CI)**	***p***
MAI difference	1.02 (0.99, 1.05)	.285	0.99 (.96, 1.02)	.378	1.00 (0.98, 1.03)	.776
Age	1.01 (0.97, 1.05)	.734	1.04 (1.00, 1.08)	.052	1.02 (0.99, 1.06)	.183
Sex (*ref: female*)						
Male	1.43 (0.74, 2.76)	.291	1.64 (0.93, 2.89)	.091	**1.75 (1.07, 2.88)**	**.027**
Bed type (*ref: general*)						
Residential bed	2.17 (0.95, 4.93)	.065	1.35 (0.62, 2.92)	.446	1.53 (0.79, 2.97)	.211
EMI bed	0.80 (0.35, 1.85)	.608	**2.11 (1.12, 3.94)**	**.020**	1.51 (0.87, 2.64)	.146
Care home length of stay (*ref: < 6mths*)						
6-12 months	-	-	1.07 (0.48, 2.39)	.879	0.98 (0.47, 2.07)	.983
1-2 years	-	-	**0.30 (0.18, 0.76)**	**.011**	0.46 (0.22, 1.01)	.054

>2 years	-	-	0.61 (0.29, 1.29)	.195	0.72 (0.37, 1.41)	.336
Baseline origin (*ref: home)*						
Hospital	-	-	1.18 (0.68, 2.04)	.563	1.07 (0.67, 1.73)	.774
Received ACP	-	-	0.51 (0.24, 1.08)	.079	0.66 (0.35, 1.26)	.204
Received IMM	-	-	0.83 (0.45, 1.53)	.549	1.23 (0.72, 2.09)	.445
Access to GP computer	-	-	1.29 (0.64, 2.60)	.483	1.27 (0.67, 2.40)	.461
Number of admissions in 12 months	**1.38 (1.14, 1.67)**	**.001**	**1.30 (1.07, 1.59)**	**.009**	**1.27 (1.06, 1.53)**	**.011**
Medication stopped	0.67 (0.27, 1.65)	.385	1.05 (0.50, 2.24)	.894	0.69 (0.36, 1.32)	.266
Medication initiated	2.20 (0.98, 4.97)	.058	2.04 (0.99, 4.19)	.052	**2.28 (1.24, 4.20)**	**.008**
Blood tests requested	0.88 (0.34, 2.29)	.798	0.75 (0.34, 1.68)	.488	0.78 (0.38, 1.59)	.496
Dose changed	1.25 (0.64, 2.44)	.518	1.14 (0.67, 1.99)	.638	1.27 (0.79, 2.05)	.327
Referred to another HCP	2.10 (0.78, 5.65)	.141	1.58 (0.62, 3.99)	.337	1.58 (0.70, 3.55)	.268
Kardex issue addressed	0.89 (0.25, 3.10)	.848	0.75 (0.24, 2.41)	.633	0.64 (0.23, 1.81)	.402
Medicines information	1.78 (0.68, 4.65)	.239	0.92 (0.38, 2.24)	.858	0.70 (0.30, 1.64)	.408
Other intervention	2.56 (0.54, 12.28)	.235	2.40 (0.60, 9.71)	.218	1.98 (0.51, 7.68)	.326
Fall	-	-	1.22 (0.57, 2.59)	.611	0.99 (0.49, 2.00)	.973
Essential primary hypertension	-	-	0.77 (0.41, 1.45)	.417	0.77 (0.44, 1.33)	.346
Diverticular disease	-	-	0.54 (0.17, 1.67)	.284	1.09 (0.49, 2.43)	.839
CKD	-	-	1.86 (0.91, 3.78)	.088	1.48 (0.78, 2.79)	.228
Cognitive impairment	-	-	0.68 (0.39, 1.19)	.171	0.97 (0.60, 1.58)	.908
Atrial fibrillation/flutter	-	-	1.23 (0.63, 2.37)	.544	1.17 (0.65, 2.11)	.592
Osteoarthritis	-	-	0.41 (0.15, 1.07)	.068	0.49 (0.22, 1.08)	.076
IHD	-	-	1.11 (0.54, 2.31)	.775	0.88 (0.46, 1.69)	.669
Heart failure	-	-	1.33 (0.65, 2.76)	.439	1.37 (0.73, 2.59)	.331
Hypercholesterolaemia	-	-	1.16 (0.50, 2.67)	.736	1.31 (0.65, 2.65)	.455
Other COPD	-	-	2.00 (0.97, 4.13)	.061	1.80 (0.95, 3.42)	.072
Acute MI	-	-	1.15 (0.49, 2.66)	.750	0.92 (0.42, 2.02)	.837
Osteoporosis	-	-	0.93 (0.43, 2.01)	.855	1.08 (0.56, 2.09)	.820
Hypothyroidism	-	-	1.43 (0.71, 2.88)	.319	1.47 (0.79, 2.71)	.223
Diabetes	-	-	1.52 (0.84, 2.76)	.166	**1.71 (1.02, 2.86)**	**.041**
HHD	-	-	0.69 (0.29, 1.64)	.407	0.74 (0.36, 1.53)	.413
Renal failure	-	-	0.86 (0.34, 2.20)	.760	1.26 (0.59, 2.73)	.549
Stroke	-	-	1.32 (0.76, 2.28)	.331	1.51 (0.94, 2.42)	.090
Parkinson's disease	-	-	0.23 (0.03, 1.77)	.159	0.28 (0.06, 1.24)	.093
Senile cataract	-	-	0.54 (0.15, 1.99)	.356	0.77 (0.27, 2.16)	.614
Gastric	-	-	1.25 (0.51, 3.06)	.632	1.48 (0.70, 3.11)	.305
Angina pectoris	-	-	**2.31 (1.02, 5.24)**	**.045**	1.67 (0.77, 3.63)	.195

Depression	-	-	0.81 (0.40, 1.62)	.547	0.77 (0.42, 1.42)	.403
Malignancy	-	-	0.96 (0.44, 2.09)	.925	1.26 (0.65, 2.43)	.489

Note. EMI = elderly mentally impaired; ACP = advanced care planning; IMM = integrated medicines management; CKD = chronic kidney disease; IHD= ischemic heart disease; COPD = chronic obstructive pulmonary disease; HHD = hypertensive heart disease; anaemia removed to allow for model identification; - = parameter removed to allow for model identification

Time to readmission

The survival distributions for time to first readmission (days) for CH participants can be observed in Figure 4-2. A log-rank test of differences indicated that the survival distributions for those who had experienced a change in total MAI score (*Mdn* = 42) and those who did not (*Mdn* = 34) were not statistically significantly different, X^2 (1) = .247, *p* = .619.

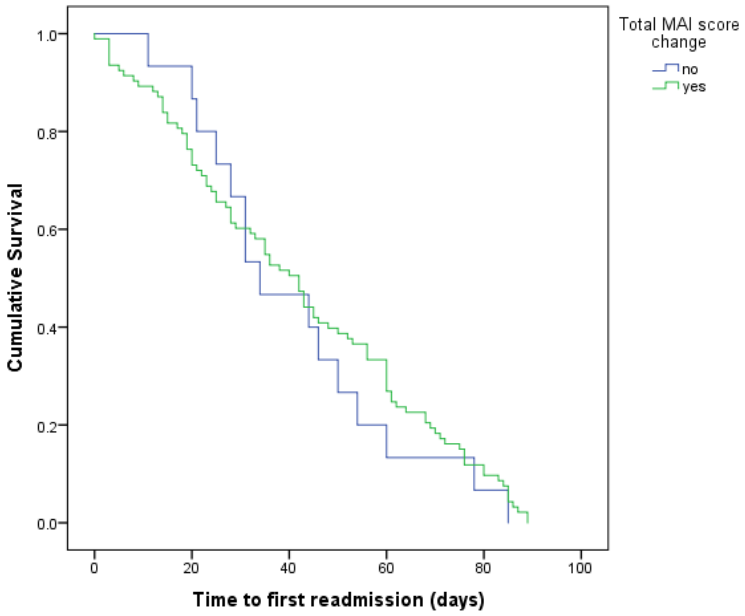

Figure 4-2: Kaplan-Meier survival plot for time to readmission for care home participants (N = 108)

Length of stay on first readmission

Change in participant total MAI score was significantly associated with a reduction in length of stay on the first unplanned readmission following pharmacist intervention (ß = -.265, p = .016). For each unit reduction in total MAI score a reduction in length of stay of 0.24 days was observed. Those who occupied a residential bed (ß = .224, *p* = .017) had a longer duration

of readmission in comparison with those who occupied a general nursing bed. Care home length of stays between 1-2 years and >2 years were also found to be significantly associated with longer readmissions than for those CH participants who had a length of stay of <6 months. The number of previous hospital admissions had no significant relationship with the duration of unplanned hospital admission following pharmacist case management (ß = .089, p = .323).

Table 4-9: Multivariate linear regression of predictors of length of stay (days) during first unplanned readmission for CH participants (N = 104)

Variables	**Unstandardised estimate**	**Standardised estimate**	**Standard error**	***p***
MAI score change	**-.243**	**-.265**	**.111**	**.016**
Age	.150	.090	.088	.304
Sex (ref: female)				
Male	.557	.023	.085	.786
Bed type (ref: *general nursing bed*)				
Residential bed	**7.223**	**.224**	**.094**	**.017**
EMI bed	4.408	.164	.090	.069
Care home length of stay (ref: *<6 months*)				
6-12 months	.551	.019	.088	.833
1-2 years	**11.156**	**.338**	**.123**	**.006**
>2 years	**6.142**	**.256**	**.113**	**.023**
Baseline origin (*ref: own home*)				
Hospital	.947	.040	.082	.629
Received ACP	5.636	.193	.115	.094
Received IMM	5.015	.208	.114	.068
Direct access to GP computer system	5.082	.213	.123	.083
Number of admissions in the previous 12 months	.764	.089	.090	.323
Medication stopped	**5.508**	**.200**	**.075**	**.007**
Medication initiated	-1.984	-.066	.094	.486
Blood tests requested	4.048	-.113	.108	.299
Dose changed	.361	.015	.075	.844
Referred to another HCP	2.234	.058	.107	.591
Kardex issue addressed	2.948	.053	.070	.447
Medicines information	-9.097	-.204	.110	.064

Other intervention	**-17.562**	**-.247**	**.096**	**.010**
Fall	**-12.190**	**-.327**	**.121**	**.007**
Essential primary hypertension	2.203	.081	.100	.418
Diverticular disease	-.132	-.003	.106	.977
CKD	**6.543**	**.217**	**.104**	**.037**
Cognitive impairment	2.791	.117	.077	.130
Atrial fibrillation/flutter	-5.337	-.189	.100	.080
Osteoarthritis	2.000	.045	.077	.563
IHD	.666	.020	.109	.857
Heart failure	-1.532	-.050	.098	.612
Hypercholesterolaemia	.119	.003	.112	.976
Other COPD	-3.753	-.122	.077	.115
Acute MI	.201	.005	.075	.947
Osteoporosis	1.897	.058	.071	.420
Hypothyroidism	.987	.031	.097	.746
Diabetes	.751	.030	.088	.737
Hypertensive heart disease	-1.635	-.051	.097	.599
Renal failure	-2.850	-.077	.090	.394
Stroke	1.730	.071	.087	.418
Parkinson's disease	1.276	.015	.094	.875
Senile cataract	15.186	.273	.182	.134
Gastric	-1.751	-.045	.078	.560
Angina pectoris	4.651	.120	.120	.317
Depression	.428	.013	.068	.848
Malignancy	-2.199	-.065	.083	.435

Improvements in MAI total score was predictive of a decreased length of stay on first unplanned admission (*ß* = -.265, *p* = .016). Each unit reduction in MAI total score was associated with a reduction in admission duration of 0.24 days. Those CH participants who had at least one medication discontinued had a significantly longer duration of admission than those participants who did not have a medication stopped (*ß* = .200, *p* = .007). Having received a pharmacist intervention considered as 'other' was associated with a significantly shorter length of stay on readmission (*ß* = -.247, *p* = .010). Participants who had a previous medical history of a fall were also found to have a significantly shorter admission compared with those

CH participants who had no previous medical history of a fall (*ß* = -.327, *p* = .007). Those with chronic kidney disease had a longer duration of readmission (*ß* = .217, *p* =.037).

Additional healthcare resource utilisation

Information relating to additional healthcare resources was available for CH participants including GP call outs to the care home, out of hours GP call outs and ED presentations not leading to a hospital readmission was also recorded. Significant reductions in numbers of GP visits (*t* = 3.968, *p* < .001, *n* = 996), as well as out-of-hours GP visits (*t* = 4.126, *p* < .001, *n* = 1004) within 90 days of pharmacist intervention were observed. Significant reductions in ED visits in both periods were also observed.

Table 4-10: Descriptive statistics, t values and associated significance values for pre- and post-intervention comparison of healthcare resource usage by care home residents

	n	***M (SD)*** **Pre**	***M (SD)*** **Post**	***t***	***P***
GP call outs 30 days	1050	.26 (.56)	.22 (.55)	1.631	.103
GP call outs 90 days	996	.63 (1.14)	.47 (.84)	3.968	<.001**
Out of hours GP call outs 30 days	1055	.14 (.45)	.15 (.44)	-.367	.714
Out of hours GP call outs 90 days	1004	.41 (.86)	.28 (.69)	4.126	<.001**
ED presentation 30 days	1050	.07 (.32)	.04 (.21)	2.141	.033*
ED presentation 90 days	995	.16 (.52)	.12 (.36)	2.342	.019*

Note. *= p < .05; ** p < .001

Each additional unit reduction in MAI score was associated with a 1.02-fold increase in the number of GP call outs to the care home within 30 days of intervention (Table 4-11). However, this effect was not observed during the 90-day monitoring period. Integrated medicines management (IMM) resulted in significantly fewer care home GP call outs within 30-

days and 90-days of pharmacist intervention. Baseline levels of healthcare utilisation significantly predicted the number of GP call outs within both time periods. Each GP call out in the 30 days before first contact with the case management pharmacist increased the number of subsequent GP call outs by 54%. Similarly, within the 90-day period it was observed that each GP call out in the 90 days prior to pharmacist intervention increased the number of GP call outs within 90 days by 18%.

Table 4-11: Multivariate Poisson regression of predictors of number of GP call outs <30 and< 90 days for CH participants

	***N* = 999**		***N* = 947**	
	<30 days		***<90 days***	
Variables	***Odds ratio (95% CI)***	***p***	***Odds ratio (95% CI)***	***P***
MAI difference	**1.02 (1.01, 1.03)**	**.002**	1.01 (1.00, 1.02)	.007
Age	0.99 (0.97, 1.01)	.250	1.00 (0.99, 1.02)	.838
Sex (*ref: female*)				
Male	1.36 (0.97, 1.91)	.077	**1.30 (1.01, 1.68)**	**.046**
Bed type (*ref: general nursing*)				
Residential	**1.57 (1.02, 2.44)**	**.043**	1.33 (0.93, 1.88)	.115
Elderly mentally impaired	0.80 (0.51, 1.26)	.340	0.93 (0.67, 1.28)	.643
Care home length of stay (*ref: <6 months*)				
6-12 months	1.12 (0.63, 2.01)	.697	0.96 (0.65, 1.41)	.832
1-2 years	0.80 (0.47, 1.37)	.421	**0.64 (0.44, 0.92)**	**.017**
>2 years	0.89 (0.55, 1.44)	.622	0.82 (0.59, 1.13)	.213
Baseline origin (*ref: own home*)				
Hospital	1.20 (0.86, 1.67)	.295	1.02 (0.80, 1.30)	.886
Received ACP	1.51 (0.96, 2.73)	.072	1.29 (0.90, 1.85)	.162
Received IMM	**0.66 (0.44, 0.98)**	**.041**	**0.74 (0.55, 0.98)**	**.039**
Direct access to GP computer system	0.71 (0.49, 1.04)	.077	0.77 (0.57, 1.05)	.097
Number of acute admissions in previous 12 months	**1.14 (1.02, 1.27)**	**.023**	**1.17 (1.08, 1.27)**	**<.001**
Number of GP call outs (previous 30 days)	**1.54 (1.28, 1.84)**	**<.001**	-	-
Number of GP call outs (previous 90 days)	-	-	**1.18 (1.12, 1.26)**	**<.001**
Medication stopped	0.79 (0.51, 1.24)	.309	0.99 (0.72, 1.35)	.939
Medication initiated	0.93 (0.55, 1.55)	.767	1.11 (0.76, 1.62)	.593
Blood tests requested	0.60 (0.35, 1.02)	.058	0.76 (0.53, 1.09)	.134

Dose changed	1.00 (0.73, 1.26)	.976	0.99 (0.78, 1.25)	.931
Referred to another HCP	1.36 (0.78, 2.36)	.280	1.22 (0.82, 1.83)	.328
Kardex issue addressed	1.18 (0.70, 2.01)	.537	0.94 (0.62, 1.43)	.777
Medicines information	1.03 (0.63, 1.69)	.896	0.93 (0.64, 1.34)	.682
Other intervention	1.40 (0.60, 3.25)	.434	1.31 (0.67, 2.55)	.429
Fracture	-	-		
Fall	**1.56 (1.09, 2.25)**	**.017**	**1.62 (1.25, 2.10)**	**<.001**
Essential primary hypertension	0.92 (0.63, 1.35)	.675	0.76 (0.56, 1.02)	.065
Diverticular disease	1.57 (0.97, 2.54)	.064	**1.46 (1.06, 2.02)**	**.022**
CKD	**1.79 (1.21, 2.63)**	**.003**	**1.41 (1.03, 1.94)**	**.034**
Cognitive impairment	0.92 (0.65, 1.30)	.637	1.04 (0.80, 1.35)	.776
Atrial fibrillation/flutter	1.07 (0.73, 1.57)	.721	1.04 (0.76, 1.42)	.807
Osteoarthritis	0.71 (0.45, 1.14)	.159	0.91 (0.66, 1.27)	.589
IHD	1.20 (0.79, 1.83)	.398	1.00 (0.72, 1.40)	.997
Heart failure	1.13 (0.73, 1.74)	.594	1.06 (0.74, 1.51)	.739
Hypercholesterolaemia	0.70 (0.43, 1.14)	.156	0.76 (0.52, 1.10)	.140
Other COPD	0.99 (0.65, 1.51)	.948	1.08 (0.76, 1.53)	.661
Acute MI	0.96 (0.59, 1.57)	.873	0.80 (0.54, 1.20)	.276
Osteoporosis	**1.60 (1.08, 2.38)**	**.020**	**1.40 (1.05, 1.87)**	**.022**
Hypothyroidism	0.93 (0.62, 1.41)	.742	1.11 (0.82, 1.50)	.510
Diabetes	0.94 (0.66, 1.32)	.703	1.07 (0.82, 1.39)	.613
Hypertensive heart disease	0.84 (0.48, 1.47)	.550	1.11 (0.73, 1.67)	.632
Renal failure	0.78 (0.45, 1.35)	.371	0.82 (0.53, 1.28)	.386
Stroke	1.08 (0.78, 1.51)	.639	1.07 (0.83, 1.39)	.615
Anaemia	0.58 (0.31, 1.08)	.085	1.02 (0.69, 1.50)	.921
Parkinson's disease	0.60 (0.34, 1.07)	.086	0.74 (0.48, 1.14)	.177
Senile cataract	1.31 (0.78, 2.20)	.301	1.07 (0.69, 1.67)	.751
Gastric	1.30 (0.70, 2.39)	.410	0.87 (0.53, 1.42)	.579
Angina pectoris	1.19 (0.73, 1.96)	.489	1.02 (0.70, 1.50)	.917
Depression	0.91 (0.60, 1.38)	.672	0.95 (0.72, 1.26)	.724
Malignancy	0.67 (0.42, 1.07)	.092	0.72 (0.51, 1.02)	.062

Note. Fracture omitted as redundant parameter (all individuals had a history of fracture)

Each admission to acute care in the preceding 12 months was associated with a 14% and 17% increase in the number of GP call outs within 30 and 90 days, respectively. Those care home residents who occupied a residential bed experienced more GP call outs within 30 days, compared with those in a general nursing bed. Those with a care home length of stay between 1-2 years had significantly fewer numbers of GP call outs within 90 days in comparison with those who had been resident within the care home for 6 months or less. A previous medical

history of a fall was associated with a 56% and 62% increase in the number of GP call outs within 30 days and 90 days, respectively. Similarly, chronic kidney disease and osteoporosis were both associated with greater numbers of GP call outs in both time periods. Diverticular disease was associated with an increased number of GP call outs within the 90-day period only.

The magnitude of MAI score change was not a significant predictor of the number OOH GP visits by CH participants. Greater numbers of OOH GP call outs within 30 days were evident for those CH participants who occupied a residential bed in comparison with those who occupied a general nursing bed (Table 4-12). A care home length of stay of 1-2 years or >2 years was associated with a reduced number of OOH GP call outs within 90 days of pharmacist intervention compared with a care home length of stay of <6 months. Blood tests ordered by the case management pharmacist was associated with a significant reduction in OOH call outs during both monitoring periods. The initiation of at least one medication and those who had been referred to another healthcare professional has significantly more OOH visits within 30 days of pharmacist intervention. Baseline levels of healthcare resource utilisation variables were also significantly associated with increased numbers of OOH call outs in both time periods.

Table 4-12: Poisson regression for number of Out of Hours (OOH) GP call outs to care home participants <30 and <90 days of pharmacist intervention

	***N* = 1004**		***N* = 954**	
	<30 days		***<90 days***	
Variables	***Odds ratio (95% CI)***	***p***	***Odds ratio (95% CI)***	***P***
MAI difference	1.02 (1.00, 1.03)	.058	1.02 (1.00, 1.03)	.020
Age	1.00 (0.98, 1.03)	.991	1.01 (0.99, 1.03)	.483
Sex (*ref: female*)				
Male	0.73 (0.46, 1.16)	.181	1.09 (0.77, 1.53)	.643
Bed type *(ref: general*)				
Residential bed	**1.75 (1.06, 2.86)**	**.027**	1.22 (0.82, 1.80)	.334
EMI bed	1.11 (0.69, 1.79)	.669	1.22 (0.89, 1.68)	.219
Care home length of stay (*ref: <6 months)*				
6-12 months	1.35 (0.76, 2.40)	.305	0.88 (0.58, 1.35)	.566
1-2 years	0.63 (0.36, 1.10)	.106	**0.54 (0.36, 0.81)**	**.003**
>2 years	0.75 (0.48, 1.18)	.217	**0.57 (0.40, 0.80)**	**.001**
Baseline origin (*ref: own home*)				
Hospital	1.28 (0.88, 1.85)	.200	1.16 (0.88, 1.52)	.286
Received ACP	0.64 (0.37, 1.11)	.113	0.67 (0.45, 1.01)	.053
Received IMM	1.13 (0.70, 1.84)	.619	1.01 (0.73, 1.41)	.938
Access to GP computer system	1.06 (0.64, 1.74)	.833	1.13 (0.79, 1.61)	.506
Number of acute admissions in previous 12 months	0.97 (0.80, 1.18)	.971	1.10 (0.98, 1.22)	.110
Number of OOH call outs in previous 30 days	**1.55 (1.24, 1.95)**	**<.001**	-	-
Number of OOH call outs in previous 90 days	-	-	**1.32 (1.21, 1.44)**	**<.001**
Medication stopped	0.94 (0.55, 1.60)	.814	1.02 (0.68, 1.53)	.923
Medication initiated	**1.61 (1.03, 2.51)**	**.037**	1.20 (0.83, 1.74)	.339
Blood tests requested	**0.34 (0.18, 0.63)**	**.001**	**0.59 (0.39, 0.91)**	**.016**
Dose changed	1.28 (0.85, 1.90)	.235	1.05 (0.79, 1.40)	.725
Referred to another HCP	**1.94 (1.15, 3.27)**	**.013**	1.27 (0.91, 2.07)	.130
Kardex issue addressed	0.85 (0.40, 1.81)	.673	0.77 (0.43, 1.39)	.391
Medicines information	1.57 (0.89, 2.76)	.117	1.08 (0.66, 1.28)	.760
Other intervention	0.96 (0.24, 3.86)	.953	0.85 (0.30, 2.46)	.766
Fall	1.06 (0.65, 1.74)	.821	0.71 (0.48, 1.06)	.092
Essential primary hypertension	0.86 (0.55, 1.34)	.497	0.84 (0.59, 1.29)	.316
Diverticular disease	0.52 (0.23, 1.16)	.110	0.98 (0.65, 1.48)	.926
CKD	1.99 (0.99, 2.56)	.055	1.22 (0.83, 1.77)	.313
Cognitive impairment	1.21 (0.83, 1.77)	.330	1.19 (0.88, 1.61)	.270

Atrial fibrillation or flutter	1.21 (0.81, 1.81)	.364	1.21 (0.86, 1.71)	.270
Osteoarthritis	1.03 (0.62, 1.70)	.920	0.89 (0.56,1.42)	.625
Ischaemic heart disease	0.72 (0.43, 1.21)	.212	0.88 (0.56, 1.40)	.599
Heart failure	0.99 (0.61, 1.60)	.961	1.20 (0.80, 1.79)	.376
Hypercholesterolaemia	**0.50 (0.27, 0.94)**	**.030**	**0.59 (0.38, 0.92)**	**.020**
Other COPD	1.25 (0.78, 2.00)	.353	1.27 (0.84, 1.91)	.264
Acute MI	1.19 (0.60, 2.34)	.616	0.88 (0.58, 1.35)	.560
Osteoporosis	**1.99 (1.30, 3.04)**	**.001**	1.32 (0.95, 1.82)	.097
Hypothyroidism	1.30 (0.77, 2.19)	.327	1.22 (0.83, 1.79)	.321
Diabetes	1.21 (0.74, 1.97)	.441	1.17 (0.84, 1.61)	.357
Hypertensive heart disease	1.25 (0.72, 2.17)	.425	0.73 (0.48, 1.12)	.151
Renal failure	1.19 (0.65, 2.16)	.575	0.90 (0.58, 1.40)	.648
Stroke	1.22 (0.82, 1.82)	.322	1.24 (0.94, 1.65)	.134
Anaemia	0.77 (0.39, 1.52)	.458	1.36 (0.91, 2.03)	.140
Parkinson's disease	0.85 (0.36, 1.99)	.706	0.81 (0.45, 1.48)	.500
Senile cataract	0.45 (0.15, 1.38)	.164	0.58 (0.28, 1.22)	.153
Gastritis, ulcer or GORD	1.48 (0.88, 2.51)	.143	0.84 (0.54, 1.31)	.446
Angina pectoris	1.78 (0.91, 3.48)	.092	**1.64 (1.11, 2.42)**	**.014**
Depression	**0.60 (0.39, 0.93)**	**.023**	0.69 (0.46, 1.04)	.075
Malignancy	1.60 (1.00, 2.55)	.048	**1.62 (1.16 2.27)**	**.005**

Note. Fracture omitted as redundant parameter

Poisson regression models for ED visits which included the same predictors of interest as for GP and OOH GP call outs could not be identified within the data. The removal of previous medical history variables did not aid in model identification for either the <30 day or <90-day periods. A simplified model comprised of fewer demographic characteristics provided good fit to the sample data (Table 4-13). Those who occupied a residential bed had significantly greater numbers of ED visits within both periods, in comparison with those in a general nursing bed. Baseline levels of ED visits was only a significant predictor in the 90-day period.

Table 4-13: Poisson regression for number of ED visits for CH participants <30 and < 90 days of pharmacist intervention

Variables	***N* = 1003 <30 days**		***N* = 951 <90 days**	
	Odds ratio (95% CI)	***P***	***Odds ratio (95% CI)***	***P***
MAI difference	1.02 (0.99, 1.05)	.251	0.99 (0.97, 1.01)	.299
Age	1.02 (0.98, 1.06)	.352	1.00 (0.98, 1.03)	.771
Sex (*ref: female*)				
Male	1.46 (0.75, 2.84)	.271	0.95 (0.60, 1.50)	.835
Bed type (*ref: general*)				
Residential bed	**4.12 (2.01, 8.64)**	**<.001**	**1.92 (1.13, 3.26)**	**.016**
EMI bed	1.13 (0.48, 2.67)	.773	0.94 (0.59, 1.50)	.793
Access to GP computer system	0.62 (0.32, 1.19)	.150	0.73 (0.46, 1.14)	.161
Number of hospital admissions in previous 12 months	1.27 (1.05, 1.53)	.012	1.09 (0.96, 1.23)	.180
Number of ED visits in previous 30 days	1.25 (0.82, 1.89)	.297	-	-
Number of ED visits in previous 90 days	-	-	**1.29 (1.07, 1.56)**	**.007**
Medication stopped	0.78 (0.33, 1.83)	.569	1.21 (0.71, 2.07)	.483
Medication initiated	1.41 (0.54, 3.71)	.484	0.92 (0.46, 1.84)	.815
Blood tests requested	0.72 (0.24, 2.12)	.545	0.78 (0.38, 1.62)	.508
Dose changed	1.42 (0.73, 2.75)	.307	1.15 (0.74, 1.81)	.535
Referred to another HCP	1.04 (0.30, 3.65)	.951	0.94 (0.33, 2.62)	.898
Kardex issue addressed	0.37 (0.06, 2.43)	.303	0.32 (0.08, 1.28)	.108
Medicines information	1.69 (0.62, 4.56)	.304	0.76 (0.36, 1.60)	.471
Other intervention	4.27 (1.40, 13.00)	.011	2.61 (1.27, 5.41)	.010

4.5.8 Death

The degree of change in MAI total score was not significantly associated with likelihood of death for CH participants (Table 4-14). Similarly, none of the clinical intervention type variables had any significant predictive relationship with death. Those CH participants who had a previous medical history of a malignancy had an increased risk of death within 90 days of pharmacist intervention (OR = 3.57, 95% CI 1.77, 7.19, $p < .001$). An increased risk of

death within 90 days was observed for those with a previous medical history of chronic kidney disease, atrial fibrillation or flutter, stroke, and depression.

Table 4-14: Multivariate logistic regression for predictors of death for CH participants <90 days of pharmacist intervention (N = 1021)

Variables		**Odds ratio (95% CI)**	***P***
MAI difference		1.01 (0.98, 1.04)	.557
Age		1.03 (0.99, 1.08)	.148
Sex (*ref: female*)			
	Male	1.98 (1.06, 3.72)	.033
Bed type (ref: *general nursing bed*)			
	Residential bed	0.58 (0.19, 1.80)	.349
	EMI bed	0.53 (0.24, 1.17)	.115
Care home length of stay (*ref: <6 months*)			
	6-12 months	0.44 (0.15, 1.31)	.141
	1-2 years	0.56 (0.21, 1.49)	.242
	>2 years	0.82 (0.35, 1.94)	.654
Baseline origin (*ref: home*)			
	Hospital	1.25 (0.69, 2.27)	.466
Received ACP		**2.29 (1.08, 4.83)**	**.030**
Received IMM		1.07 (0.51, 2.22)	.862
Direct access to GP computer system		0.53 (0.22, 1.28)	.159
Number of acute admissions in previous 12 months		1.24 (0.95, 1.62)	.118
Medication stopped		0.62 (0.27, 1.40)	.249
Medication initiated		1.55 (0.64, 3.76)	.331
Blood tests requested		0.37 (0.12, 1.10)	.074
Dose changed		1.28 (0.67, 2.46)	.462
Referred to another HCP		2.08 (0.69, 6.29)	.196
Kardex issue addressed		1.79 (0.63, 5.08)	.276
Medicines information		2.08 (0.85, 5.10)	.111
Other intervention		-	-
Fall		**0.17 (0.03, 0.84)**	**.030**
Essential primary hypertension		0.84 (0.40, 1.65)	.566
Diverticular disease		0.59 (0.19, 1.84)	.363
Chronic kidney disease		**2.30 (1.09, 4.85)**	**.030**
Cognitive impairment		1.35 (0.73, 2.49)	.334
Atrial fibrillation or flutter		**2.21 (1.12, 4.38)**	**.023**

Osteoarthritis	1.78 (0.85, 3.71)	.125
Ischaemic heart disease	0.84 (0.34, 2.07)	.701
Heart failure	1.10 (0.48, 2.49)	.825
Hypercholesterolaemia	0.58 (0.19, 1.84)	.357
Other COPD	0.85 (0.32, 2.28)	.752
Acute MI	0.21 (0.03, 1.62)	.133
Osteoporosis	0.61 (0.23, 1.62)	.322
Hypothyroidism	0.92 (0.39, 2.18)	.847
Diabetes	0.64 (0.31, 1.31)	.220
Hypertensive heart disease	1.19 (0.46, 3.05)	.722
Renal failure	0.90 (0.31, 2.66)	.851
Stroke	**1.90 (1.05, 3.41)**	**.033**
Parkinson's disease	0.55 (0.12, 2.58)	.450
Senile cataract	0.64 (0.13, 3.11)	.583
Gastric	1.02 (0.37, 2.85)	.698
Angina pectoris	2.15 (0.82, 5.63)	.117
Depression	**2.34 (1.18, 4.62)**	**.014**
Malignancy	**3.57 (1.77, 7.19)**	**<.001**

Note. Other intervention not included to allow for model identification

4.6 Discussion

The present study sought to examine inappropriate prescribing within the Northern Irish care home context, to determine the effectiveness of pharmacist case management in reducing this inappropriate prescribing as well as an examination of the relationship these improvements had with subsequent healthcare usage within this cohort. Inappropriate prescribing was found to be highly prevalent (84%) within NHSCT and WHSCT care homes, when assessed using MAI, thereby extending the international literature that indicates care homes as a critical location to focus medicines optimisation efforts (Anrys et al., 2018; Cool et al., 2014; Elseviers et al., 2014; Heppenstall et al., 2016; Maguire et al., 2013; McKee et al., 2016; Lau et al., 2004; Ryan et al., 2013).

When comparing the prevalence of inappropriate prescribing in care homes in the present study to published studies it is somewhat challenging to draw direct comparisons, given the wide variety of screening tools reported within the literature. Reported prevalence estimates are wide ranging, reporting values from 27-88% (Anrys et al., 2018; Cool et al., 2014; Elseviers et al., 2014; Heppenstall et al., 2016; Lau et al., 2004; Ryan et al., 2013). Furthermore, a recent systematic review has suggested that point prevalence estimates are higher in European contexts (49%) compared with North America (27%) (Morin et al., 2016). Morin and colleagues (2015) compared the performance of five different sets of criteria used to detect inappropriate prescribing among a sample of over 1.3 million Swedish people aged ≥ 65 years. Prevalence estimates ranged from 16-24 % dependent on the screening tool applied. Those who were resident in a nursing home were more likely to be exposed to inappropriate prescribing irrespective of which screening tool that was applied to the sample data. Nevertheless, despite the challenges in making direct comparisons across studies, it is apparent that the prevalence of inappropriate prescribing in Northern Irish care homes is towards the upper end of the scale.

Several studies have examined inappropriate prescribing in care home settings using MAI. Crotty, Halbert, et al., (2004) reported that a case conferencing approach conducted in ten aged care facilities, involving a multidisciplinary team of health professionals including a pharmacist, resulted in a significant improvement in MAI score for the intervention group. Furthermore, a significant reduction in MAI score for benzodiazepines was also observed. Crotty, Rowett, et al., (2004) also found the inclusion of a pharmacist as a transition coordinator between hospital and long-term care prevented the worsening of inappropriate prescribing as measured using MAI and was also related to a reduction in emergency department visits and hospital readmissions. The present findings extend those of previous studies by reporting evidence that pharmacist case management also results in a significant reduction in MAI scores in Northern Irish care homes.

As observed in the IC chapter (Chapter 3) a significant moderate positive correlation was observed between the number of medications and baseline MAI score. Associations between number of medications and likelihood of inappropriate prescribing have been reported internationally for a variety of screening tools (Hudhra et al., 2016; Jiron et al., 2016; Morin et al., 2015). This association is evidenced in a variety of older people contexts including hospitalisation, post-discharge and among those residing in the community (Galvin et al., 2014; Hudhra et al., 2016; McMahon et al., 2014). Within the UK and Northern Irish contexts, polypharmacy (operationalised as ≥ 4 medications) has been found to be significantly associated with inappropriate prescribing, with a significant linear trend observed in NI (Bradley et al., 2012; Bradley et al., 2014). Polypharmacy has also been shown to be positively correlated with the number of prescribed medications within nursing home populations in the Republic of Ireland (Ryan et al., 2013), Belgium (Anrys et al., 2018) and Norway (Halvorsen, Selbæk & Ruths, 2017).

The only intervention to drive MAI score reduction in CH was medication cessation. In contrast, dosage changes and addressing of Kardex issues were also found to contribute to a reduced MAI score in IC settings (Chapter 3). Proponents of a holistic approach to deprescribing would perhaps infer that the context of patient care goals is somewhat different within care homes (Edey et al., 2018). Deprescribing for those who may be approaching end of life is thus likely to be different than that for a more robust older person (Todd, Jansen, Colvin & McLachlan, 2018). Spinewine, Schmader, et al., (2007) argues that prescribing is a function of the patient, prescriber, and the environment. Environmental influences, such as the demand for beds in acute care may mean that there is insufficient time to address clinical aspects during an acute inpatient stay. The clinician's focus is often on the presenting acute illness with little time for follow up and collaboration between the different care interfaces (Edey et al., 2018). Thus, it is conceivable that IC participants, who transition into IC from acute care may require a broader range of interventions.

Deprescribing should be considered as an ongoing activity and not merely a reactionary response to an increased awareness of potential for medication related harm. It has been argued that deprescribing forms part of a good prescribing continuum, from medication initiation, dose adjustment, changes or additions to therapy and the cessation of medications (Scott et al., 2015). Thus, deprescribing should not be considered as a negative strategy aimed at denying effective medications (Scott et al., 2015), but rather as a positive continual improvement process, that remains dynamic to the changing patient context. The Scottish Government Polypharmacy Model of Care Group (2018) published guidance on the initiation and review of existing medications, with a holistic patient-centred approach to polypharmacy being advocated. Within this guidance document the emphasis is on considering 'what matters to the patient'. Deprescribing may occur as part of this but stopping medications is not necessarily the primary end point.

Approximately five times as many participants in the IC sample (50%) had a medication started, compared with the CH sample (10%), suggesting that prescribing omissions were more frequent in the IC sample or that the potential benefit of medications were outweighed by the risks in a frailer CH population. Recent prescribing guidance caution that those residing in a care home are at greater risk of inappropriate polypharmacy (Scottish Government Polypharmacy Model of Care Group, 2018). Thus, a lower proportion of participants having a medication started may be reflective of this risk consideration. In contrast, a study conducted across seven nursing homes in the Munster region of Ireland found that 42% of residents experienced at least one prescribing omission as assessed using the START criteria (Ryan et al., 2013). Thus, fewer medications being initiated may relate to the use of MAI as a medication review tool instead of the use of STOPP/START which likely prompts greater consideration of potential omissions.

It is imperative that medicines optimisation be viewed as a dynamic entity, and that opportunities for re-evaluation are considered going forward. For those in the care home setting who may experience substantive changes in functional status during their residency there is a continual need to re-evaluate therapy and not merely continue prescribing that occurred when community-dwelling. It has been argued that prescribing for care home residents is often a continuation of prescribing patterns within the community pre-admission as the resident's GP remains the primary prescriber (Maguire et al., 2013). As such it is conceivable that dosages of medications may not have been reviewed for residents following their admission. Participants within the care home data were resident in their care home for a considerable period of time and were likely to have become frailer during this time. Dosages of medications may have been appropriate on admission but no longer remained so due to this declining functional status, reinforcing the need for continual review of pharmacotherapy in the care home context. The possibility of this is evidenced in the significant association between care home length of stay and baseline MAI score. Those who were resident in the care home > 2 years had higher baseline MAI total scores.

The number of prescribed medications at baseline was the largest predictor of MAI score change for care home participants. The number of prescribed medications at patient 'wrap up' was not recorded within the care homes dataset, thus a calculation of the change in numbers of medications between both time points could not be completed. Having experienced at least one medication discontinuation was also a significant predictor of MAI score change in the care home context. Interestingly none of the other intervention types was significantly associated with MAI score change in this context. Such a finding may be suggestive of additional frailty within the care home participants in comparison with those in intermediate care.

A significantly smaller reduction in MAI score was observed for those care home residents who occupied a residential bed, compared with those who occupied an elderly mentally impaired bed. This finding is of particular note as no differences in baseline MAI score category were observed for the three different care home bed types. Previous studies have shown that inappropriate prescribing is highly prevalent among those care home residents living with dementia (Renom-Giuteras et al., 2018). Such knowledge may inform the future approach of case management pharmacists with a focus on addressing inappropriate prescribing for those residents living with dementia.

In comparison to those who were resident in their care home for more than two years, those who had been resident for less than six months, and those who were resident between six and 12 months both had significantly smaller reductions in MAI score following pharmacist intervention. A significant weak association was observed between care home length of stay and MAI total score category at baseline, with more residents in the > 2 years category observed to have MAI scores in the upper categories. Such a finding reinforces the need for continual review of medications for care home residents as what may be appropriate at admission may not continue to be so throughout the duration of their residency.

Care home residents who received IMM during their previous acute care admission experienced a smaller reduction in MAI score change, indicating that IMM may have already addressed any suboptimal prescribing. Burnett et al., (2009) previously reported evidence that IMM improved the appropriateness of prescribing when compared with standard pharmaceutical care. This finding supports IMM as a worthwhile initiative to support medicines optimisation across the primary-secondary care interface.

In the care home model, the case management pharmacist conducted as many visits to the participant as necessary in order to resolve medication related issues. Approximately one-tenth of CH participants received follow up interventions in addition to those conducted

at baseline. The majority of these were graded as Eadon ≥ 4, signalling that, at a minimum, an improvement in the standard of patient care was delivered. These additional interventions mostly comprised of medication stopped, started and information given. These additional interventions, facilitated by this patient-specific component of the care home model, improved the standard of care for a considerable portion of care home residents. This supports the view that some care home residents require additional support with medication related issues and that a pharmacist case management model can support this.

Within the care home context, direct access to the GP's computer system by the case management pharmacist was a significant predictor of MAI score change, indicating its superiority to alternative methods of communicating medication related changes to prescribers. However, it must be acknowledged that baseline MAI scores were observed to be higher for those participants where direct access was available. Such a finding has important implications for future service delivery.

Beginning in 2017 a number of Practice Based Pharmacists (PBPs) have been recruited into general practices in NI. Recruitment is ongoing with a future Department of Health Northern Ireland (DOHNI) goal to have a PBP in every GP practice in Northern Ireland (Miller, 2018). It is further aimed that all PBPs will hold or begin the process of gaining the additional qualification of independent prescriber. This PBP role has been designed to alleviate pressures within primary care by supporting the GP to address medication-related issues (Avery, 2017; Torjesen, 2015). This new role is likely to deliver improvements in communication between primary and secondary care and is thus to be welcomed. As these new stakeholders take up their positions there is a real need to formalise communication between the case management pharmacists and these PBPs. Given that direct access to the GP's computer system was found to be superior to alternative communication methods, such as letters and teleconferencing, it is vital that if this access is removed that it is replaced by a communication method that

maintains the benefits identified in the present study. Going forward, any changes in communication style, and the introduction of a new stakeholder to the model needs to be assessed.

In summary, a significant reduction in GP and ED visits was observed from pre- to post-intervention. This supports the findings in earlier pilot work of the care home model of a trend towards reduced ED visits (McKee et al., 2016). The degree of MAI score change did not reduce healthcare utilisation, save for a reduction in hospital length of stay on first unplanned readmission. The significant reduction in MAI total score did not predict the likelihood of hospital admission and was not predictive of time to readmission.

Within the care home context, a significant relationship was observed between MAI score change and length of stay on first unplanned readmission, with larger reductions in MAI score associated with shorter durations of hospital stay. Hospital admissions may not be entirely avoidable for older people, particularly among those residing in care homes who may be experiencing greater levels of frailty (Collard, Boter, Schoevers & Oude Voshaar, 2012; Kojima, Taniguchi, Ilifem Jivrak & Walters 2019). It is widely accepted that hospital admission is detrimental to the functional status of older people (Covinsky et al., 2003; Hirsch et al., 1990). In the present study, improvements in prescribing appropriateness, as indicated by reductions in MAI scores, was found to minimise the length of time spent in acute care for those care home residents who experienced an unplanned hospital admission. This reduction in length of stay may have further benefits for the older person but is beyond the scope of the present study.

For care home residents the magnitude of MAI score reduction significantly predicted the number of GP call outs within the 30-day observation period, but not the 90-day period. For every unit reduction in MAI total score, from baseline to post-intervention, the number of GP call outs increased 1.02-fold. Thus, MAI score improvements, may be associated with an

initial increase in healthcare utilisation by care home residents, but this effect is not observed in the longer term.

There is some evidence increases in healthcare utilisation may indicate better chronic disease management (Rosstad et al., 2017). An increase in GP visits during 12-month follow up for those older people in a post-acute care discharge intervention group has been interpreted as an increase in the active management of patients by GPs. Thus, it is possible that the small increase in GP visits within 30 days, but not 90 days, may be reflective of a refocusing of attention by GPs following pharmacist engagement. No significant association was observed between MAI score change and out of hours GP call outs, ED visits or hospital readmission, suggesting that improvements in prescribing appropriateness does not result in increased levels of escalated healthcare by care home residents.

Medication discontinuation was associated with a longer duration of hospital readmission for those care home participants who had at least one medication discontinued, compared with those participants who did not. However, medication discontinuation was not associated with an increased likelihood of readmission. Thus, it is possible that medication discontinuation among the care home cohort may be related to the clinical status of the individual, with perhaps medications discontinued to prevent acute kidney injury or a move towards palliative care.

Medication initiation was found to increase healthcare utilisation among CH participants. Those who received had at least one medication started had an increased likelihood of hospital readmission within 90 days and increased numbers of OOH call outs within 30 days of pharmacist intervention, compared with those who did not have a medication initiated. Similarly, the initiation of a new medication may infer a deterioration in the clinical status of the individual and may not necessarily indicate that such an intervention is detrimental to the individual.

A request for blood testing was associated with a decrease in the number of OOH visits in both monitoring periods. This decrease may have occurred because of several mechanisms. The outcome of blood testing may have changed the care strategy for the individual and prevented further deterioration in clinical status. Alternatively, additional aspects of clinical care may have been attended to during the initial visit for a blood draw, thereby capturing at an earlier stage possible declines in clinical status and preventing the need for an out of hours call.

A referral to another healthcare professional was associated with significantly greater numbers of OOH call outs within 30 days, but not within 90 days of pharmacist intervention. No information was available as to whether these referrals had been actioned, but it is possible that care home residents had deteriorated whilst awaiting the input of another healthcare professional. Referrals to HCPs in IC are more readily facilitated as the individual is still placed within the HSCT at that time.

Healthcare resource utilisation by CH participants was significantly associated with several medical diagnoses. Those with chronic kidney disease (CKD) had longer durations of acute care admissions and more GP call outs. Alexander et al., (2009) have previously reported that adults with late stage (Stage 3 and 4) CKD are more likely to have more physician visits (OR 1.81, 95% CI 1.46, 2.23) and hospital admissions (2.12, 95% CI 1.66, 2.71) than those with no CKD or early stage CKD. A diagnosis of diabetes was also found to increase the likelihood of hospital admission < 90 days for CH participants. A previous medical history of falls was also associated with a greater number of GP call outs in both time periods. Whilst it was not possible within the available data to ascertain the recency of falls for CH participants there is some evidence to suggest that such falls are more common within the care home setting. It has been estimated that care home residents are three times more likely to experience a fall compared with their community dwelling counterparts (DOH, 2009).

The present results provide some further evidence to support the utility of IMM in Northern Ireland, with an association with lower numbers of GP call outs for care home participants observed. Such evidence supports the need for pharmacist involvement in the care of care home residents. Despite the proven effectiveness of IMM in reducing length of hospital stay (Scullin et al., 2007), the service is not delivered consistently across NI. The present study results highlight that the provision of this service can further complement the case management model of care for care home residents.

Among the CH cohort, neither MAI score differences nor the pharmacist intervention types had any association with mortality. Those who had received advanced care planning, had a diagnosis of chronic kidney disease, stroke or atrial fibrillation or flutter were more likely to die within the 90-day post-intervention period. Such a finding highlights that pharmacist intervention is not detrimental to care home residents.

Throughout the analyses presented here it was observed whereby previous healthcare resource utilisation was a significant predictor in a large proportion of the analyses. In Chapter 3 it was observed that the number of hospital admissions in the 12-month period prior to the index IC admission was a consistent predictor of likelihood for readmission in all periods, and of numbers of readmissions and thus may serve as a marker of the relative clinical instability of some IC participants. Similarly, the number of hospital admissions within the preceding 12 months was a significant predictor of likelihood for hospital admission for CH participants in all periods. Furthermore, the number of previous GP call outs and OOH visits were significantly predicted by previous patterns of usage, suggesting that clinical need was a dominant factor in healthcare resource usage by care home residents following pharmacist case management.

The results presented in this chapter must be interpreted within the context of several methodological limitations. Information was not available as to the recency of any previous medical history. Thus, any inferences regarding clinical instability of participants is speculative.

However, as a proportion of the total sample the level of hospital admission was relatively low and consistent with previous levels of healthcare resource usage. The absence of comparison to a control group prevent the assessment of model's effectiveness in comparison with usual care. The development of randomised trials in older people approaching end of life requires considerable ethical consideration. Hutchinson, Parikh, Tacey, Harvy & Lim, (2015) propose the use of observational studies when randomisation is not appropriate. The high proportion of participants who experienced a change in total MAI score further limits the statistical power to detect differences in healthcare usage post-intervention.

4.7 Conclusion

In the present study, it has been shown that inappropriate prescribing is highly prevalent among care home residents aged ≥ 65 years in Northern Ireland. No differences in baseline severity of MAI score was observed for age or sex. Regional differences in baseline severity of prescribing inappropriateness was observed, which may warrant further examination in future studies.

The majority of interventions delivered by the case management pharmacists were clinically significant, resulting in improvements in the standard of care. The most common was medication discontinuation. The results lend support to earlier pilot work in the NHSCT and highlight the need for clinical pharmacist involvement in care home settings. The present study findings indicated that the successful delivery of the care model was maintained when delivered by case management pharmacists who were supported and mentored by a consultant pharmacist.

The arrival of PBPs into general practice settings in Northern Ireland provides a new opportunity for both medicines optimisation models as it proffers a new channel for communication between primary and secondary care. Case management pharmacists operating within the care home model have found this new role to be beneficial to their case

management activities through the development of positive working relationships (Miller, 2018). Improved communication and liaison between the MOOP pharmacists, PBPs and community pharmacists was central to the COVID-19 enhanced pharmacy response within care homes (Scott, Fleming & Martin, 2020). As both the PBPs and the care home model embed further across Northern Ireland there is a clear need to understand how this may influence MAI score change, given that direct access to the GP's computer system explained variability in MAI score change for care home participants.

The present study has also shown that improvement in prescribing appropriateness, as indicated by the degree of change in total MAI score, was not significantly associated with a reduction in healthcare resource usage, save for a reduction in length of hospital stay for CH participants who had been admitted to hospital. A small increase in the number of GP visits to CH participants in the 30-day monitoring period was observed. Several medical diagnoses showed significant relationships with increased healthcare resource usage including chronic kidney disease, angina pectoris and diabetes.

Pharmacist impact is more granulated than can be captured using MAI. In the absence of the establishment of the care home model, inappropriate prescribing would go largely undetected, placing considerable demand on healthcare services. Previous levels of healthcare resource usage (pre-intervention) predicted healthcare utilisation in the post intervention period, remaining a dominant predictor in many analyses conducted. Such a finding points towards additional clinical need within the CH population. The clinical course of chronic conditions such as CKD, angina and diabetes are not directly modifiable by the clinical pharmacist, and thus lack of evidence of a significant association between MAI score change and healthcare resource usage must be cautiously interpreted. Multimorbidity and additional complexity inferred by increased levels of dependency may limit the degree of successful reduction in healthcare resource usage that can be achieved. No significant association with

likelihood of hospitalisation or death was associated with MAI score change, indicating that medicines can be discontinued with no detrimental effect for the older person in this context. Ultimately, the discontinuation of inappropriate medications is a laudable achievement, irrespective of any reduction in subsequent healthcare resource usage.

Healthcare usage by older people is a highly complex and dynamic interaction that requires additional analysis. The chapters which follow seek to address this complexity in two ways: first, by examining healthcare utilisation at a medication level, and secondly through the longitudinal examination of a more heterogeneous sample of community-dwelling older adults. The inclusion of more psychosocial information allows for a greater analysis of potential relationships.

5 Healthcare utilisation following optimisation of medications prescribed inappropriately in Intermediate Care and Care Homes in Northern Ireland

5.1 Chapter overview

The purpose of this chapter is to examine the MOOP data pertaining to medication type in greater detail. Specifically, it aims to identify those medication subgroups most frequently found to be inappropriately prescribed at baseline in both intermediate care and care home settings. It further aims to identify which of these subgroups, when subsequently improved, are associated with reductions in healthcare resource usage.

5.2 Introduction

Prescribing rates in Northern Ireland are believed to be 12% higher per head of population compared with England or Scotland (Appelby, 2011). Furthermore, net ingredient costs per head of population have also risen by over 8%, resulting in 40% higher costs than in England (Appleby, 2011). With a projected increase in the proportion of older people living in Northern Ireland it is likely that levels of prescribing will continue to increase. The potential for medication-related harm serves not only to result in unwanted consequences for the older person but also to add additional pressure to the healthcare system. Thus, it is vital that preventable hospital admissions, such as those that are related to ADEs are avoided.

Inappropriate prescribing was found to be highly prevalent in both IC and CH settings in Northern Ireland (refer to Chapters 3 and 4, respectively). The analysis presented thus far has considered the patient-level factors that explain variability in MAI score change and healthcare utilisation in both cohorts. However, an examination of the medication classifications has not been conducted. Whilst there is inherent value in understanding the quality of prescribing with respect to MAI scores, the nature of the inappropriate prescribing needs to be considered at an individual drug level also. Specifically, a more nuanced view of

the prescribing in terms of medication classifications provides valuable information regarding the prescribing culture for the respective cohorts. By doing so further refinements to the care models and opportunities for future intervention can be identified.

Identification of the prescribing culture for IC patients is particularly beneficial, given the small amount of studies conducted in this care context. The work of Millar (2016) identified those STOPP/START indicators that were frequently endorsed within IC in Northern Ireland and can be considered to be an empirically driven approach, guided by the screening tool. However, as aforementioned in preceding chapters, explicit screening tools such as STOPP/START are subject to continual revision and do not necessarily put the individual older person at the centre of the review. The MAI on other hand encourages a more data-driven approach, where all medications are reviewed by the same criteria. Thus, the use of MAI to frame the review provides an opportunity to identify medication classifications that may be inappropriate for older IC patients, other than those indicators put forward on STOPP/START. Furthermore, this method provides for a more person-centred review and challenges the assumption that older adults are a homogenous group. Such an approach proffers additional opportunities to extend the limited knowledge base that exists regarding suboptimal prescribing in IC.

Unsurprisingly, inappropriate prescribing was also found to be highly prevalent in Northern Irish care homes (refer to Chapter 4). The international literature is saturated with considerable evidence that suboptimal prescribing is pervasive in these care contexts (Anrys et al., 2018; Cool et al., 2014; Elseviers et al., 2013; Heppenstall et al., 2016; Lau et al., 2004; Ryan et al., 2013). The nature of inappropriate prescribing of psychoactive medications among the older adults is particularly concerning, especially among nursing home residents (Barry et al., 2015; Patterson et al., 2007) and people with dementia (Renom-Giuteras et al., 2018). A high proportion of older patients (73.9%) receive at least one psychoactive medication; more than

half of these are considered to be prescribed inappropriately (Arnold et al., 2017). A comparison of cross-sectional data in Norway reported an increase in inappropriate prescribing from 1997 to 2011, with the most common increase in inappropriate prescribing found to occur for psychoactive medication (Halvorsen et al., 2017).

Psychoactive medications are those which are capable of altering the mind, emotions, and behaviour of an individual. Psychoactive medications are often used to control the behavioural and psychological symptoms of dementia (BPSD) (Gustafsson, Sandman, Karlsson, Gustafson & Lövheim, 2013; Gustafsson, Karlsson & Lövheim, 2013; Mesquida et al., 2019) but can result in many unwanted sequelae such as falls, delirium, cerebrovascular events and death (Hill & Wee, 2012; Liperoti, Pedone & Corsonello, 2008; Mittal, Kurup, Williamson, Muralee & Tampi, 2011). Psychoactive medication use has been found to be higher among nursing home residents compared with those residing in the community, and to increase sharply following admission to such facilities (Maguire et al., 2013).

Maguire et al., (2013) argue that a high prevalence of psychoactive prescribing in residential care and nursing homes has persisted despite numerous regulatory agencies issuing warnings regarding safe use. Whilst a reduction in prescribing of psychoactive medications following warnings from the Food and Drug Administration (FDA) in the US, and the Medicines and Healthcare Products Regulatory Agency (MHRA) in the UK has been observed, prescribing of such medications remains high (Guthrie, Clark, Reynish, McCowan & Morales, 2013; Kales et al., 2011). In the US approximately 30% of those newly admitted to nursing homes received an antipsychotic medication in 2006, despite the earlier 2005 FDA warning regarding excess mortality associated with the use of such medications (Chen et al., 2010). More concerning was the finding that 17% of residents with no clinical history of psychosis or dementia received an antipsychotic medication (Chen et al., 2010). Thus, for many older people, the risk of

cerebrovascular events and sudden death associated with the use of antipsychotic medication to treat BPSD remains despite the best efforts of regulatory agencies to eliminate these risks.

Chen and colleagues (2010) found that variation in antipsychotic prescribing within nursing home settings was related to the prescribing culture already in existence within the nursing home. Residents who were admitted to those nursing homes with the highest prescribing rates had a 34% increased risk of receiving an antipsychotic medication compared with those in nursing homes with the lowest prescribing rates (Chen et al., 2010). The use of antipsychotic medication among US nursing home residents must also be appreciated within the context of overall antipsychotic prescribing in the US. The use of second-generation antipsychotics nearly tripled from 1995 to 2008, resulting in more than 16 million prescription items (Alexander, Gallagher, Mascola, Moloney & Stafford, 2011). Between 1st January and 3rd June 2007, it was found that 14% of nursing home residents had Medicare claims for antipsychotic medication (Levinson, 2011). More concerning is the finding that 83% of these were for unlicensed indications and 88% were for residents diagnosed with conditions specified in the FDA warnings (Levinson, 2011).

Westbury, Gee, Ling, Kitsos and Peterson (2018) found that almost two thirds of Australian care home residents were regularly prescribed a psychoactive medication, including antidepressants (41%), antipsychotics (22%), and benzodiazepines (22%). Benzodiazepines are often prescribed to alleviate anxiety, sleep disturbance an agitation in older adults. However, their use is problematic due to increased sensitivity to their sedating properties (Cook, 1986; EIDesoky, 2007; Shader & Greenblatt, 1981) and the increased risk of adverse outcomes such as falls, fractures, pneumonia and dementia (Díaz-Gutiérrez et al., 2017; Donnelly, Bracchi, Hewitt, Routledge & Carter, 2017; Glass, Lantôt, Herrman, Sproule & Busto, 2005; Islam et al., 2006; Taipale, 2017; Seppala et al., 2018; Sun, Zhang, Zhang, Wu & Hu, 2019). Concerns have also been raised regarding the use of antidepressants in older people due to the increased risk

of falls, hyponatraemia, cerebrovascular events, seizures, and all-cause mortality (Coupland et al., 2011).

Snowdon, Galanos and Vaswani (2011) contend that the rates of psychoactive prescribing in Australian nursing home are lower when compared to other countries. Repeated cross-sectional analyses of prescribing in nursing homes in Sydney between 1993 and 2009 revealed an overall reduction in psychoactive prescribing during the period. However, reductions in benzodiazepine prescribing were coupled with a rebound return to previous levels of antipsychotic prescribing despite initial reductions (Snowdon et al., 2011). Furthermore, the prevalence of antidepressant prescribing increased from 15% in 1993 to 25% in 2009 (Snowdon et al., 2011). Such findings highlight the need to consider type of psychoactive prescribing that occurs and not just the overall prevalence rates. Any reduction in risk associated with one medication classification may inadvertently be replaced with the initiation of alternative medications with considerable risk profiles.

Increased attention is being drawn to the use of anticholinergic medications in older adults. The normal ageing process has been suggested to be associated with a deterioration of the central cholinergic system, and that this may contribute to the cognitive decline aspect of older age (Lechevallier-Michel, Molimard, Dartigues, Fabrigoule & Fourrier-Reglat, 2005). A recent case-control study in the United Kingdom identified an association between increasing medication anticholinergic burden over the preceding 4-20 years and incident dementia diagnosis (Richardson et al., 2018).

Nevertheless, concerns regarding appropriateness of pharmacotherapy for older adults is not reserved solely for psychoactive medications. Non-steroidal anti-inflammatory drugs (NSAIDs) and antihistamines have also been found to be prescribed inappropriately (Lucchetti & Lucchetti, 2017). Particular concern has been raised regarding prolonged treatment with proton pump inhibitors (PPI) due to associations with an increased risk of

osteoporotic fractures, *Clostridium difficile* infection, dementia, and pneumonia (Maes, Fixen & Linnebur, 2017). Aggressive treatment of hypertension can increase the risk of orthostatic hypotension and thus the risk of falls. Thus, it is imperative that any assessment of inappropriate prescribing considers the possibility of all medication classifications as contributing to adverse events.

5.3 Objectives

- Identify and describe the prevalence of those medication subclassifications most frequently prescribed inappropriately at baseline within both intermediate care and care homes
- Identify those medication subclassifications, prescribed inappropriately at baseline, which when improved by pharmacist intervention result in altered healthcare resource utilisation
- Identify and describe the prevalence of psychoactive medication subclassifications prescribed inappropriately at baseline within both intermediate care and care homes

5.4 Method

5.4.1 Study population

The present study involved secondary data analysis of the medication information collated by the MOOP pharmacists as described in further detail in Chapter 2 (Methodology).

5.4.2 Design and variables

Prescribed medicines were examined according to their subclassification within the BNF 70th Edition. The BNF classifies medications firstly by physiological system (refer to Chapter 2, Figure 2-3) before further subdivision according to mechanism of action. Microsoft Excel was used to distinguish, for each recorded medication subgroup, cases where the baseline MAI score was zero and where it was greater than zero. These drug groups were consolidated to identify the medication subgroups which were most frequently identified as

inappropriately prescribed at baseline, as identified by counts. These counts were arranged in decreasing order of prevalence and analysis was conducted on the ten most prevalent medication subgroups in both cohorts.

In the original datasets the medication subgroup prescribed was recorded across several variables (Med1 to Med24). Each BNF subcategory was coded between 1 and 352 across each of these 24 variables. The accompanying MAI scores at baseline and post-intervention were captured within two additional accompanying variables e.g. MAIpre1 and MAIpost1.

Variables were restructured and new variables created to indicate those drug subgroups which decreased in MAI and those where MAI score stayed the same or increased from baseline to post-intervention for each of the Med1-Med24 variables. For each of the drug subgroups most frequently prescribed inappropriately two count variables were created: one for the number of instances where the subgroup's MAI score decreased and one for the number of instances where the MAI score stayed the same or increased. This was to account for the fact that some participants had duplicate prescribing within the same subgroup.

Duplication of therapy meant that several different MAI score change trajectories were possible. For the participant who received multiple medications within the same BNF subgroup it was possible that some but not all medications were improved, '*incomplete improvement*, that *'all medications within this class improved'*, or that *'MAI score stayed the same or worsened'* from baseline to post-intervention (Appendix F). Thus, the *'incomplete improvement'* does not refer to those whose MAI score improved but did not return to zero but rather those who had one medication within that class be improved upon and another that did not. Due to small frequency values in the '*incomplete improvement'* category it was collapsed with the '*all medicines in this class improved'* to form a new '*partial or complete improvement'* category. It must also be noted that those whose MAI score at baseline and

post-intervention were both zero would be categorised by the '*MAI same or worsened'.* These new categorical variables were operationalised as independent variables in the analyses.

Binary outcome variables for the IC data included *readmission (yes/*no) and *death (yes/no)* for the periods of <30 days, 31-90 days and <90 days of discharge. Outcome variables for the CH data included *unplanned hospital admission (yes/no)* and *death (yes/no)* <30 days, 31-90 days and <90 days of pharmacist intervention. Count outcome variables for CH participants *included number of GP visits* <30 and <90 days, *number of 'OOH GP visits* <30 and <90 days, and *number of ED visits* <30 and <90 days.

5.4.3 Data analyses

Analyses were completed independently in both samples to reflect the distinct nature of the two cohorts. Frequencies of endorsement across the drug group categories were tabulated and compared between cohorts using Microsoft Excel. Descriptive statistics were completed using IBM SPSS Statistics for Windows 24 (IBM Corp., 2016), and are expressed in terms of counts and frequencies. Chi-square tests for differences for binary categorical outcomes were conducted using IBM SPSS Statistics for Windows 24 (IBM Corp., 2016). Where sample sizes were small, and an expected cell count was less than five, Fisher's exact tests are reported. Poisson regression analyses were completed for count outcome variables using the robust estimator of the 'Generalized' function within IBM SPSS Statistics for Windows 24 (IMB Corp., 2016).

5.5 Results

The reader is referred back to Chapter 2 (Figure 2-4) for a comparison of prescribing by BNF physiological chapter in both IC and CH cohorts. Within IC the most frequently endorsed chapter was the '*Cardiovascular system'*, with 464 (87.2%) participants prescribed at least one cardiovascular medication. In the CH cohort, the most frequently endorsed chapter was the '*Nervous system'*, from which a total of 1067 (97.4%) participants were prescribed at least one

medication. Irrespective of the high prevalence of prescribing within these chapter classifications, an examination of the subclassifications (by mechanism of action) revealed that '*non-opioid analgesics and compound analgesics'* was the most frequently endorsed in IC (Fig. 2-5). Within the CH setting the most frequently prescribed subclassification was for '*osmotic laxatives'* (Fig 2-6). Thus, an examination at subgroup level provides a more nuanced view of the prescribing culture in both contexts and reveals that it is the combination of several drug subgroups that has contributed to the overall high count when examined at chapter level.

5.5.1 Intermediate Care

When inappropriate prescribing was considered among IC participants, the BNF subgroup found to be the most frequently prescribed inappropriately was the '*opioid analgesics'* group (Figure 5-1). Approximately 60% of all instances of opioid prescribing were inappropriate at baseline, as defined by a MAI score > 0. As a proportion of overall prescribing counts, '*z-drugs'* had the highest proportion of inappropriate prescribing, with approximately 65% of '*z-drug'* prescribing found to be inappropriate to some degree at baseline.

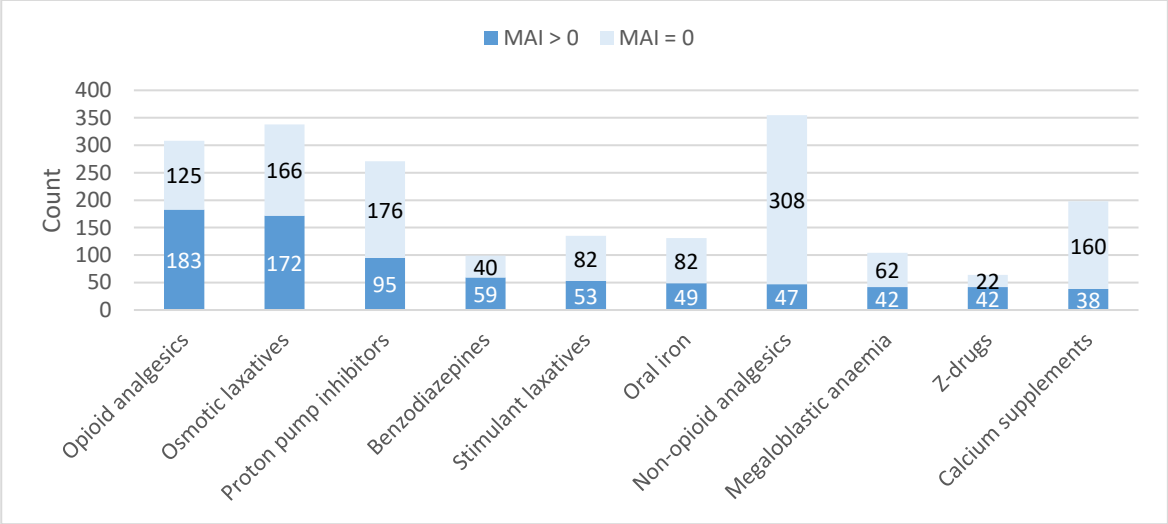

Figure 5-1: Counts for the top 10 most frequently endorsed BNF subgroups with baseline MAI > 0 and MAI=0 in IC (N = 532)

A review of duplicate prescribing of drug subgroups within the IC cohort for the Top 10 most frequently inappropriately prescribed medications can be observed in Table 5-1. Duplication of therapy was observed for several drug subgroups including '*opioid analgesics', 'osmotic laxatives*, *'stimulant laxatives', 'benzodiazepines'*, and *'drugs used for megaloblastic anaemia'*, which may have contributed to the overall prevalence of inappropriate prescribing within these drug subgroups.

Table 5-1: Frequencies for duplication of prescribing for the BNF drug subgroups most frequently identified as prescribed inappropriately within the intermediate care sample (N = 532)

	Number of medications			
BNF drug subgroup	**0**	**1**	**2**	**3**
Opioid analgesics	294	176	54	8
Osmotic laxatives	247	232	53	-
Proton pump inhibitors	261	271	-	-
Benzodiazepines	442	81	9	-
Stimulant laxatives	413	104	14	1
Oral iron	401	131	-	-
Non-opioid analgesics	178	353	1	-
Drugs used in megaloblastic anaemia	439	82	11	-
Z-drugs	468	64	-	-
Calcium supplements	334	198	-	-

Frequencies for the MAI score change trajectories for the top ten BNF subgroups in IC can be observed in Table 5-2. The reader is referred to Appendix F for a more detailed view of the original '*incomplete improvement*' and '*all medicines in this class improved*' categories.

Table 5-2: Frequencies for MAI score change type for the top ten BNF subgroups most frequently prescribed inappropriately within the IC sample (N=532)

BNF drug subgroup	MAI same or worsened	Partial or complete improvement	Missing MAI score at one time point	Not on this medication
Opioid analgesics	82	142	14	294
Osmotic laxatives	135	130	20	247
Proton pump inhibitors	161	92	18	261
Benzodiazepines	40	43	7	442
Stimulant laxatives	64	48	7	413
Oral iron	78	46	7	401
Non-opioid analgesics	284	46	24	178
Drugs used in megaloblastic anaemia	46	39	8	439
Z-drugs	23	37	4	468
Calcium supplements	155	32	11	334

The relationship between these categories of score change and readmission variables for IC participants can be observed in Table 5-3. A significant difference was observed for '*proton pump inhibitors'* during both the 31-90-day and 0-90-day periods. A significant relationship between MAI score change category and death within 90 days of discharge from IC was also observed for *'proton pump inhibitors (PPI)'* (Table 5-3).

Table 5-3: Chi-square tests for differences and Fisher's exact tests for MAI score change, readmission, and death within IC sample

BNF drug subgroup			**Readmission <30 days**		**Readmission 31-90 days**		**Readmission <90 days**		**Death < 90 days**	
	N	*df*	X^2	*p*	X^2	*p*	X^2	*P*	X^2	*P*
Opioid analgesics	222	1	.012	.913	.016	.901	.000	.985	-	.102[b]
Osmotic laxatives	264	1	.001	.970	.026	.872	.060	.806	.261	.610
Proton pump inhibitors	252	1	2.410	.121	**5.511**	**.019**	**6.525**	**.011**	**-**	**.028[a]**
Benzodiazepines	82	1	.639	.424	1.210	.271	.255	.614	.525a	.469
Stimulant laxatives	111	1	.288	.591	.924	.337	.006	.940	-	1.00[b]
Oral iron	123	1	.446	.504	.284	.594	.022	.883	.126	.723
Non-opioid analgesics	328	1	-	.196[a]	.981	.322	2.400	.121	-	.703[a]
Drugs used in megaloblastic anaemia	84	1	.965	.326	.072	.789	.236	.627	-	.464[b]
Z-drugs	59	1	-	1.00[a]	-	.510[a]	.000	.992	.042	.837
Calcium supplements	186	1	-	.205[a]	-	.260[a]	2.051	.152	-	1.00[b]

Note. [a]25%, [b]50% cells have an expected count less than 5, thus the reported *p* value is for the Fisher's exact test, two-tailed

Fewer participants who experienced an improvement in MAI score for PPIs experienced a readmission in the longer term or died within three months of IC discharge, compared with those whose MAI score stayed the same or worsened (Table 5-4).

Table 5-4: Crosstabulation of MAI score change trends for proton pump inhibitors and readmission to IC within 31-90 days readmission <90 days and death <90 days of discharge (N = 252)

		Readmission 31-90 days[a]			**Readmission <90 days[b]**			**Death <90 days[c]**		
		No	**Yes**	**Total**	**No**	**Yes**	**Total**	**No**	**Yes**	**Total**
MAI	N	124	37	161	113	48	161	152	9	161
worsened/stayed	%	49.2	14.7	63.9	44.8	19.0	63.9	60.3	3.6	63.9
same										
All medicines in	N	81	10	91	77	14	91	91	0	91
this class	%	32.1	4.0	36.1	30.6	5.6	36.1	36.1	0	36.1
improved										
Total	N	205	47	252	190	62	252	243	9	252
	%	81.3	18.7	100.0	75.4	24.6	100.0	96.4	3.6	100.0

Note. [a]Cramer's V = .148, p = .019; [b] Cramer's V = .161, p = .011; [c] Cramer's V = .145, p = .022

5.5.2 Care Homes

The BNF subgroups most frequently found to be prescribed inappropriately for CH participants can be observed in Figure 5-2. As a proportion of total prescribing within the subgroup *'drugs used to treat megaloblastic anaemia'* had the highest proportion, with 61.94% of instances considered to be inappropriate to some degree (MAI > 0). Approximately 54% of *'z drugs'* prescribing was found to be inappropriate and 35% of *'benzodiazepine'* prescribing was also found to be suboptimal.

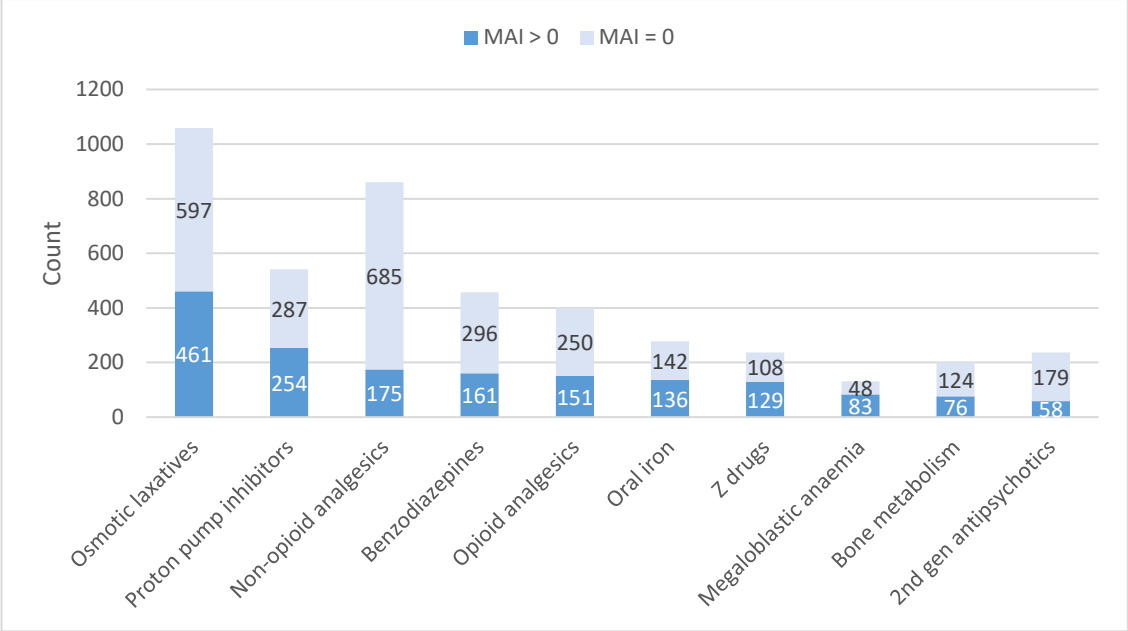

Figure 5-2: Counts for the top 10 most frequently endorsed BNF subgroups with baseline MAI >0 and MAI=0 in CH (N= 1095)

'Osmotic laxatives' were the most frequently endorsed as having been prescribed inappropriately and may be related to the considerable levels of duplicate prescribing observed for this medication class (Table 5-5). A sizeable cohort of care home residents were prescribed two '*osmotic laxatives'* (n=225), with smaller numbers in receipt of three or more *'osmotic laxatives'*.

Table 5-5: Frequencies for duplication of prescribing of the BNF drug subgroups most frequently identified as prescribed inappropriately within care home sample (N = 1095)

	Number of medications				
BNF drug subgroup	**0**	**1**	**2**	**3**	**4**
Osmotic laxatives	320	521	225	25	4
Proton pump inhibitors	552	542	1	-	-
Non-opioid analgesics	278	771	45	1	-
Benzodiazepines	708	317	68	2	-
Opioid analgesics	744	301	45	5	-
Oral iron	816	279	-	-	-

Z drugs	859	235	1	-	-
Megaloblastic anaemia	975	106	14	-	-
Bone metabolism	894	201	-	-	-
Second-generation antipsychotics	866	219	10	-	-

Duplication of therapy, in itself an indicator of inappropriate prescribing, was also evident for *'non-opioid analgesics'*, *'benzodiazepines'* and *'opioid analgesics'*. Some duplication was also observed for *'second generation antipsychotics'* and *'drugs used to treat megaloblastic anaemias'*. Owed to this duplication of prescribing several possible trends for MAI score changes were possible for each drug subgroup. Possible change trends include all medications within this class had a MAI score that stayed the same or worsened, some medications within this class improved (*incomplete improvement*) and all medications within the class were improved upon. Frequencies for the various type of score change trends for each of the BNF subgroups examined can be observed in Appendix G. The small cells of *'incomplete improvement' and 'all medicines within this class improved'* were collapsed into a new *category 'partial or complete improvement'* to facilitate further analyses (Table 5-6).

Table 5-6: Frequencies for MAI score change type for the top 10 BNF subgroups most frequently prescribed inappropriately within CH (N = 1095)

BNF drug subgroup	**MAI same or worsened**	**Partial or complete improvement**	**Missing MAI at one time point**	**Not on this medication class**
Osmotic laxatives	503	265	7	320
Proton pump inhibitors	296	240	7	552
Non-opioid analgesics	670	139	8	278

Benzodiazepines	293	90	4	708
Opioid analgesics	213	131	7	744
Oral iron	146	128	5	816
Z drugs	174	61	1	859
Megaloblastic anaemia	34	81	5	975
Bone metabolism	127	73	1	894
2nd gen. antipsychotics	189	37	3	866

The relationship between these MAI score change trends and hospital readmission can be observed in Table 5-7. No significant differences in readmission were observed between those individuals who experienced a partial or complete improvement of MAI scores and those for which their MAI scores stayed the same or worsened. Significant differences were observed for drug groups *'proton pump inhibitors'*, *'oral iron'* and death within 90 days of pharmacist intervention (Table 5-7).

Table 5-7: Chi-square test of differences and Fisher's exact tests for MAI score change, readmission, and death within CH sample

BNF drug subgroup	**Readmission <30 days**				**Readmission 31-90 days**				**Readmission <90 days**				**Death <90 days**			
	N	*df*	X^2	*p*	*N*	*df*	X^2	*p*	*N*	*Df*	X^2	*p*	*N*	*df*	X^2	*p*
Osmotic laxatives	735	1	.998	.318	718	1	.005	.945	699	1	.732	.392	756	1	1.044	.307
Proton pump inhibitors	512	1	.052	.819	501	1	1.137	.286	496	1	.493	.483	527	1	**4.259**	**.039**
Non-opioid analgesics	775	1	.250	.617	759	1	.427	.513	747	1	.075	.784	796	1	.822	.365
Benzodiazepines	360	1	-	.771[a]	355	1	.034	.855	344	1	.986	.321	372	1	.227	.634
Opioid analgesics	326	1	.647	.421	317	1	.047	.828	309	1	.192	.661	339	1	.439	.508
Oral iron	263	1	1.406	.236	252	1	1.502	.220	246	1	3.423	.064	272	1	**4.352**	**.037**
Z drugs	227	1	-	.531[a]	223	1	3.022	.082	221	1	2.895	.089	234	1	-	.564[a]
Megaloblastic anaemia	108	1	-	.692[a]	102	1	-	.748[a]	102	1	-	1.00[a]	113	1	-	.519[a]
Bone metabolism	190	1	-	.332[a]	189	1	.086	.769	188	1	.338	.561	198	1	1.211	.271
2nd gen. antipsychotics	219	1	-	.605[a]	217	1	-	.482[a]	209	1	-	.208[a]	222	1	-	.387[a]

Note. [a]25% cells have an expected count less than 5, thus the reported p value is for the Fisher's exact test, two-tailed

No incomplete improvement was observed for the *'proton pump inhibitors'* and *'oral iron'* subgroups (Appendix G). As such the crosstabulation of these drug subgroups and the death outcome variables (Tables 5-8 and 5-9) consider the MAI score change trends of *'MAI stayed the same or worsened'* and *'all medicines within this class improved*'.

Table 5-8: Crosstabulation of MAI score change trends for proton pump inhibitors and death <90 days of pharmacist intervention in CH (N = 527)

		Death < 90 days		
		No	**Yes**	**Total**
MAI worsened/stayed same	N	263	25	288
	%	49.91%	4.74%	54.65%
All medicines in this class improved	N	229	10	239
	%	43.45%	1.90%	45.35%
Total	N	492	35	527
	%	93.36%	6.64%	100%

Note. Cramer's V = .090, *p* = .039

Fewer participants who experienced an improvement in their MAI score for *'proton pump inhibitors'* died within 90 days of pharmacist intervention in comparison to those whose MAI score stayed the same or worsened.

Table 5-9: Crosstabulation of MAI score change trends for oral iron and death <90 days of pharmacist intervention in CH (N = 527)

		Death < 90 days		
		No	**Yes**	**Total**
MAI worsened/stayed same	N	127	19	146
	%	46.69%	6.99%	53.68%
All medicines in this class improved	N	119	7	126

	%	43.75%	2.57%	46.32%
Total	N	246	26	272
	%	90.44%	9.56%	100%

Note. Cramer's V = .126, *p* = .037

Within the care home sample additional outcome variables included number of GP visits, number of OOH GP visits and ED visits, within both 30 and 90 days were examined. These variables were recorded as count variables and thus examined using Poisson regression, the results of which are summarised in Table 5-10. *'Non-opioid analgesics'* had a significant effect on GP visits <90 days of pharmacist intervention. When compared to the reference group *'partial or complete improvement of all medications within this class'* those whose *'MAI score remained the same or worsened'* from pre- to post-intervention experienced reduced numbers of GP visits within the period (OR = 0.73, 95% CI 0.53, 0.99). Those care home residents on *'drugs used to treat megaloblastic anaemia' whose 'MAI score remained the same or worsened'* were found to have more than twice the number of OOH GP visits in comparison with those who experienced a *'partial or complete improvement of all medications within this class'* (OR= 2.25, 95% CI 1.10, 4.60). No significant differences in the numbers of GP, OOH or ED visits were observed for the other BNF subgroups most frequently identified as inappropriately prescribed at baseline.

Table 5-10: Poisson regressions for count outcomes of GP, OOH GP and ED visits in the care home sample

BNF subgroup	GP30	GP90	OOHGP30	OOHGP90	ED30	ED90
Osmotic laxatives (N=694-742)	0.91 (0.63, 1.32)	0.82 (0.62, 1.08)	0.88 (0.58, 1.36)	0.82 (0.60, 1.14)	1.51 (0.67, 3.39)	1.38 (0.81, 2.34)
Proton pump inhibitors (N=495-520)	0.83 (0.56, 1.23)	0.84 (0.63, 1.12)	0.98 (0.59, 1.62)	0.83 (0.57, 1.19)	-	0.67 (0.39, 1.15)
Non-opioid analgesics (N=743-783)	0.73 (0.47, 1.13)	**0.73 (0.53, 0.99)**	0.67 (0.43, 1.06)	0.84, (0.59, 1.20)	0.54 (0.35, 1.15)	1.17 (0.64, 2.14)
Benzodiazepines (N=344-368)	0.99 (0.57, 1.75)	-	1.09 (0.57, 2.08)	1.57 (0.94, 2.63)	1.15 (0,32, 4.14)	1.47 (0.62, 3.53)
Opioid analgesics (N=310-332)	0.84 (0.55, 1.61)	1.10 (0.74, 1.64)	0.78 (0.45, 1.35)	0.91 (0.60, 1.39)	-	-
Oral iron (N=241-264)	1.17 (0.68, 1.97)	1.35 (0.92. 1.99)	1.41 (0.76, 2.62)	1.20 (0.77, 1.86)	2.44 (0.80, 7.45)	-
Z drugs (N=220-228)	1.64 (0.77, 3.47)	1.12 (0.71, 1.77)	0.92 (0.40, 2.09)	0.71 (0.42, 1.21)	0.98 (0.31, 3.14)	0.97, (0.44, 2.14)
Megaloblastic anaemia (N=101-110)	1.92 (0.83, 4.48)	1.55 (0.77, 3.12)	-	**2.25 (1.10, 4.60)**	0.80 (0.08, 7.42)	1.74 (0.41, 7.42)
Bone metabolism (N=188-194)	1.04 (0.56, 1.96)	0.96 (0.58, 1.59)	0.68 (0.33, 1.43)	0.92 (0.50, 1.69)	1.13 (0.29, 4.38)	-
Second-generation antipsychotics (N=206-221)	0.83 (0.30, 2.35)	0.72 (0.37, 1.42)	2.63 (0.64, 10.81)	0.75 (0.38, 1.46)	1.21 (0.14, 10.29)	-

Note. Significant odds ratios in bold. Reference group is 'partial or complete improvement of medicines within this drug class'. GP30= number of GP visits within 30 days; GP90= number of GP visits within 90 days; OOH30= number of out-of-hours GP visits within 30 days; OOH90= number of out-of-hours GP visits within 90 days; ED30= number of Accident and Emergency visits within 30 days; ED90= number of Accident and Emergency visits within 90 days.

5.5.3 Psychoactive medications

Several psychoactive medications were observed to be frequently prescribed inappropriately upon admission into IC, including *'opioid analgesics', 'benzodiazepines', 'non-opioid analgesics'*, and *'z-drugs'*. The remainder of this results section will present results pertaining to other subgroups of the Central Nervous System BNF chapter not examined thus far. Several Central Nervous System BNF drug subgroups showed no or low levels of endorsement within the IC sample, preventing their examination in crosstabulation analyses. For reference these subgroups as listed in Appendix H.

The Central Nervous System chapter subgroups most frequently found to be inappropriately prescribed upon admission into IC, in addition to those previously examined in Table 5-3 can be observed in Figure 5-3. Medications used in *the 'control of the epilepsies'* had the greatest level of endorsement. In total 46.25% of prescribing within this subgroup was found to exhibit some degree of inappropriateness. As a proportion of total prescribing within the subgroup *'tricyclic antidepressants'* had the greatest proportion (66.6%), whereas *'drugs used for dementia'* had the lowest proportion (12.12%).

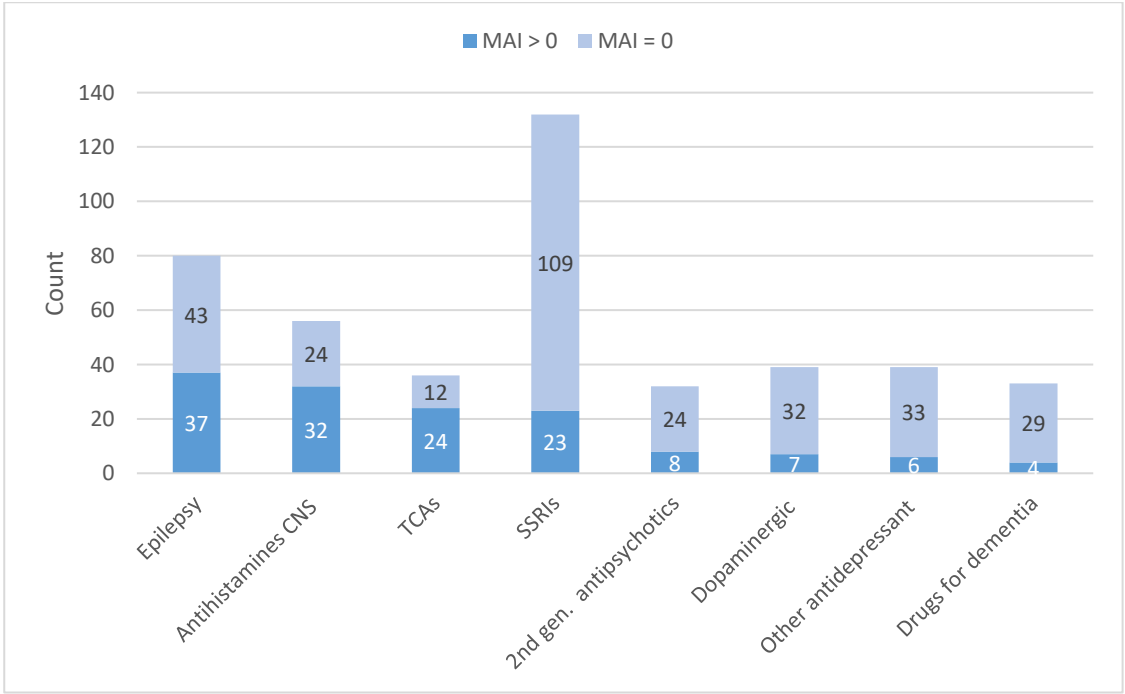

Figure 5-3: Counts for the frequently endorsed Central Nervous System chapter subgroups with baseline MAI > 0 and MAI=0 in IC (N = 532)

An examination of duplication of therapy for subgroups identified in Figure 3 revealed that duplication of therapy occurred for all subgroups, save for *'tricyclic antidepressants'* (TCAs) and *'selective serotonin reuptake inhibitors'* (SSRIs) (Table 5-11).

Table 5-11: Frequencies for the duplication of prescribing of Central Nervous System BNF chapter subgroups most frequently identified as prescribed inappropriately within IC (N = 532)

	Number of medications			
Central Nervous System subgroup	**0**	**1**	**2**	**3**
Control of the epilepsies	456	72	4	-
Antihistamines for nausea	479	50	3	-
TCAs	496	36	-	-
SSRIs	400	132	-	-
Second-generation antipsychotics	201	28	3	-
Dopaminergic drugs Parkinson's	505	17	8	2
Other antidepressant drugs	494	37	1	-
Drugs for dementia	502	27	3	-

Type of MAI score change for the psychoactive subgroups in the IC sample can be observed in Table 5-12. Only a small number of IC participants who were prescribed *'antihistamines CNS nausea', 'dopaminergic drugs Parkinson's'* or *'other antidepressant drugs'* experienced a partial improvement for all instances of duplication within these subgroups (Appendix J).

Table 5-12: Frequencies for MAI score change type for Central Nervous System chapter subgroups most frequently prescribed inappropriately in IC (N=532)

BNF drug subgroup	MAI same or worsened	Partial or complete improvement	Missing MAI score at one time point	N/a Not on this medication
Control of the epilepsies	40	31	5	456
Antihistamines for nausea	17	30	6	479
TCAs	14	19	3	496
SSRIs	103	20	9	400
Second-generation antipsychotics	21	7	3	501
Dopaminergic drugs Parkinson's	19	7	1	505
Other antidepressant drugs	30	4	4	494
Drugs for dementia	26	4	-	502

An examination of the '*Central Nervous System'* chapter subgroups and readmission outcome variables indicated that a significant difference was observed for *'antihistamines for nausea'* and readmission <90 days (Table 5-13). No significant differences were observed for any of the 'Central Nervous System' chapter subgroups and readmission <30 days, readmission within 31-90 days and death <90 days of pharmacist intervention (Table 5-14).

Table 5-13: Chi-square tests of differences and Fisher's exact tests for psychoactive drug subgroup MAI score change, readmission, and death within IC (N = 532)

BNF drug subgroup			**Readmission <30 days**		**Readmission 31-90 days**		**Readmission <90 days**		**Death < 90 days**		
	N	*df*	X^2	*p*	X^2	*p*	X^2	*p*	*N*	*df*	*p*
Control of the epilepsies	70	1	.087	.768	.023	.881	.100	.751	70	1	.580[a]
Antihistamines for nausea	47	1	-	.054[b]	.-	.653[a]	-	**.041[b]**	47	1	1.00[a]
TCAs	33	1	-	.698[b]	-	1.00[a]	-	1.00[a]	33	1	.628[a]
SSRIs	122	1	.075	.785	-	1.00[b]	.159	.690	122	1	1.00[a]
Second-generation antipsychotics	28	1	-	1.00[a]	-	.075[a]	-	.364[a]	28	1	1.00[a]
Dopaminergic drugs Parkinson's	26	1	-	.278[a]	-	1.00[a]	-	.357[a]	26	1	-
Other antidepressant drugs	34	1	-	1.00[e]	-	1.00[a]	-	1.00[a]	34	1	1.00[e]
Drugs for dementia	30	1	-	.360[e]	-	.360[e]	-	.454[e]	30	1	-

Note. [a]50% cells have expected count less than 5, [b]25% cells, [c]66.7% cells, [d]83.3% cells, [e]75% cells, thus the reported p value is for the Fisher's exact test, two-tailed

Table 5-14: Crosstabulation of MAI score change trends for antihistamines for nausea and readmission <90 days of pharmacist intervention within IC (N = 47)

		Readmission < 90 days		
		No	**Yes**	**Total**
MAI worsened/stayed same	N	9	8	17
	%	19.1%	17.1%	36.2%
Partial/complete improvement for all	N	25	5	30
medicines in this class	%	53.2%	10.6%	63.8%
Total	N	34	13	47
	%	72.3%	23.7%	100%

Several psychoactive medications were observed to be frequently identified as inappropriately prescribed at baseline for CH participants, including *'benzodiazepines', 'opioid analgesics', 'z-drugs'* and *'second-generation antipsychotics'*. The remainder of this results section will present results pertaining to other subgroups of the Central Nervous System BNF chapter not examined thus far. Several of these subgroups showed either no endorsement or a low level of endorsement within the CH sample, preventing their examination in crosstabulation analyses. For reference these are listed in Appendix I.

The most frequently endorsed psychoactive subgroups, in addition to those aforementioned in Figure 5-2 and Table 5-7, can be observed in Figure 5-4. An examination of the counts for each of these subgroups indicates that *'SSRIs', 'antihistamines for nausea'* and *'first-generation antipsychotics'* were the most frequently identified as inappropriate at baseline. When considered as the total proportion of prescribing within their respective subgroup it was found that this amounted to approximately 17% of total '*SSRI'* and 45% of both *'antihistamines for nausea'* and *'first-generation antipsychotic'* prescribing.

The subgroup with the highest proportion of inappropriate prescribing was *'betahistine'* with almost all prescribing (approximately 96%) found to be inappropriate. High prevalence of inappropriate prescribing was also found for *'domperidone and metoclopramide'*, with approximately 68% of prescribing of both of these medications found to be inappropriate. Approximately one half of *'tricyclic antidepressant'* and *'5HT3 antagonists'* were also found to be inappropriately prescribed.

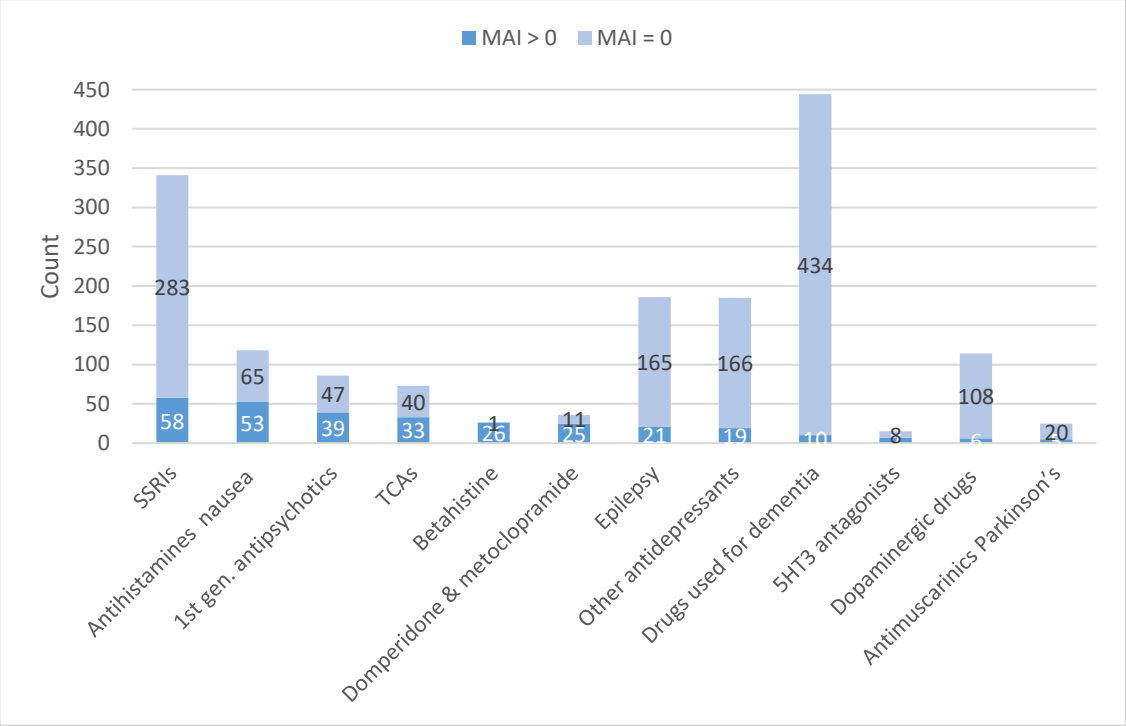

Figure 5-4: Counts for the most frequently endorsed Central Nervous System chapter subgroups with baseline MAI > 0 and MAI=0 in CH (N = 1095)

Duplication of therapy was also evident among CH participants for several subgroups including *'drugs used for dementia'*, *'control of the epilepsies'* and *'dopaminergic drugs used in Parkinson's'*, which may reflect the fact that monotherapy is often insufficient with these conditions (Table 5-15). Duplication of antidepressant therapy was identified for '*SSRIs'* (n=2), *'tricyclic antidepressants (TCAs)'* (n=1) and *'other'* (n=6).

Table 5-15: Frequencies for duplication of prescribing for the Central Nervous System BNF chapter subgroups most frequently identified as prescribed inappropriately within CH sample (N = 1095)

	Number of medications					
Central Nervous System chapter subgroup	**0**	**1**	**2**	**3**	**4**	**5**
SSRIs	753	340	2	-	-	-
Antihistamines for nausea	979	113	3	-	-	-
First-generation antipsychotics	1011	81	3	-	-	-
TCAs	1023	71	1	-	-	-
Betahistine	1068	27	-	-	-	-
Domperidone metoclopramide	1060	33	2	-	-	-
Control of the epilepsies	940	132	17	5	-	1
Other antidepressants	916	173	6	-	-	-
Drugs used for dementia	723	298	74	-	-	-
5HT3 antagonists	1080	15	-	-	-	-
Dopaminergic drugs Parkinson's	1018	47	21	8	1	-
Antimuscarinics Parkinson's	1070	25	-	-	-	-

Types of MAI score changes from pre- to post-intervention can be observed in Table 5-16. Most CH participants prescribed duplicate medications from the same subgroup and who experienced a change in MAI score did so for all instances of drugs within the respective subgroup. Some exceptions were noted including '*first generation antipsychotics'*, '*tricyclic antidepressants', 'domperidone and metoclopramide'* and '*other antidepressants'* where one individual for each drug group did not have all medicines within this class improved. Two individuals in both the '*control of the epilepsies'* and '*drugs used for dementia'* also had incomplete improvement of all medicines within these classes.

Table 5-16: Frequencies for MAI score change type for Central Nervous System BNF chapter subgroups for CH participants (N = 1095)

Central Nervous System subgroup	MAI same or worsened	Partial or complete improvement	Missing MAI at one time point	Not on this medication class
SSRIs	295	43	4	753
Antihistamines for nausea	66	49	1	979
First-generation antipsychotics	62	20	2	1011
TCAs	50	20	2	1023
Betahistine	2	25	-	1068
Domperidone metoclopramide	12	22	1	1060
Control of the epilepsies	139	16	-	940
Other antidepressants	163	16	-	916
Drugs used for dementia	360	10	2	723
5HT3 antagonists	8	7	-	1080
Dopaminergic drugs Parkinson's	71	5	1	1018
Antimuscarinics Parkinson's	21	4	-	1070

These MAI score change trends were cross tabulated with readmission and death outcome variables (Table 5-17). No significant differences in readmission rates were observed for either of the psychoactive drug groups examined, in either period. Furthermore, no differences in death within 90 days of pharmacist intervention were observed. Results for Poisson regressions conducted on count outcomes of GP, OOH GP and ED visits can be observed in Table 5-18. When compared to the reference group (*partial or complete improvement of all medicines within this class*), those residents whose *'MAI score stayed the same or worsened'* for *'dopaminergic drugs Parkinson's'* experienced significantly fewer GP visits, both within and out-of-hours, within both timeframes.

Table 5-17: Fisher's exact tests for psychoactive medication MAI score change, readmission and death for CH participants (N = 1095)

Central Nervous System subgroup	Readmission <30 days			Readmission 31-90 days			Readmission <90 days			Death <90 days		
	N	*df*	*p*	*N*	*df*	*p*	*N*	*df*	*p*	*N*	*df*	*p*
SSRIs	322	1	.245[a]	317	1	1.00[a]	312	1	.434[a]	332	1	.248[a]
Antihistamines for nausea	111	1	.381[b]	108	1	1.00[b]	109	1	.728[a]	113	1	.295[a]
First-generation antipsychotics	79	1	.182[a]	77	1	.568[b]	77	1	.103[a]	80	1	328[a]
TCAs	68	1	.294[b]	67	1	1.00[b]	66	1	.496[b]	69	1	1.00[b]
Betahistine	-	-	-	25	1	1.00[c]	25	1	1.00[c]	27	1	1.00[c]
Domperidone and metoclopramide	32	1	1.00[b]	-	-	-	31	1	1.00[b]	33	1	.104[b]
Control of the epilepsies	146	1	1.00[a]	141	1	.217[a]	139	1	.465[a]	152	1	1.00[a]
Other antidepressants	171	1	.504[a]	167	1	1.00[a]	163	1	.631[a]	176	1	.602[a]
Drugs used for dementia	359	1	1.00[a]	351	1	1.00[a]	345	1	1.00[a]	365	1	1.00[a]
5HT3 antagonists	-	-	-	-	-	-	-	-	-	14	1	1.00[b]
Dopaminergic drugs Parkinson's	75	1	1.00[c]	74	1	1.00[c]	74	1	1.00[c]	76	1	1.00[c]
Antimuscarinics Parkinson's	-	-	-	24	1	1.00[c]	21	1	1.00[c]	25	-	-

Note. [a]25% cells have an expected count less than 5; [b]50% cells have an expected count less than 5; [c]75% cells have an expected count less than 5, thus the reported p value is for the Fisher's exact test, two-tailed

Table 5-18: Poisson regressions for count outcomes of GP, OOH GP and ED visits

Psychoactive Drug	GP30	GP90	OOHGP30	OOHGP90	ED30	ED90
SSRIs (N=315-330)	0.94 (0.52, 1.72)	1.19 (0.75, 1.91)	0.58 (0.30, 1.11)	1.26 (0.71, 2.23)	0.36 (0.11, 1.16)	1.48 (0.55, 3.95)
Antihistamines for nausea (N=105-112)	0.88 (0.42, 1.83)	0.63 (0.33, 1.20)	1.09 (0.46, 2.59)	0.84 (0.41, 1.73)	0.78 (0.16, 3.69)	0.71 (0.26, 1.97)
First generation antipsychotics (N=75-80)	0.75 (0.28, 2.03)	1.16 (0.55, 2.45)	2.67 (0.66, 10.83)	2.30 (0.73, 7.29)	-	-
TCAs (N=65-68)	0.51 (0.17, 1.50)	0.58 (0.23, 1.51)	1.67 (0.20, 14.00)	0.88 (0.24, 3.16)	0.28 (0.04, 1.94)	0.30 (0.05, 1.86)
Betahistine	-	-	-	-	-	-
Domperidone and metoclopramide (N=31-33)	-	0.76 (0.21, 2.78)	0.50 (0.06, 4.43)	0.79 (0.15, 4.16)	-	3.15 (0.62, 15.97)
Control of the epilepsies (N=138-149)	0.53 (0.25, 1.15)	0.64 (0.33, 1.24)	3.97 (0.57, 27.70)	-	-	-
Other antidepressants (N=163-174)	1.39 (0.48, 4.08)	1.90 (0.79, 4.56)	1.57 (0.38, 5.65)	1.75 (0.61, 5.07)	-	-
Drugs used for dementia (N=344-363)	0.56 (0.09, 3.63)	-	0.66 (0.19, 2.32)	1.04 (0.28, 3.92)	0.36 (0.05, 2.45)	1.08 (0.17, 7.01)
5HT3 antagonists (N=13-14)	2.00 (0.23, 17.34)	1.17 (0.20, 6.75)	-	-	-	-
Dopaminergic drugs Parkinson's (N=73-76)	**0.21 (0.06, 0.76)**	**0.25 (0.12, 0.54)**	**0.14 (0.05, 0.40)**	**0.30 (0.10, 0.92)**	0.28 (0.04, 2.07)	0.88 (0.13, 5.89)
Antimuscarinic Parkinson's (N= 22-25)	0.25 (0.04, 1.72)	0.37 (005, 2.99)	-	-	-	-

Note. Significant odds ratios in bold. Reference group is 'partial or complete improvement of medicines within this drug class'. GP30= number of GP visits within 30 days; GP90= number of GP visits within 90 days; OOH30= number of out-of-hours GP visits within 30 days; OOH90= number of out-of-hours GP visits within 90 days; ED30= number of ED visits within 30 days; ED90= number of ED visits within 90 day

5.6 Discussion

The results presented within this chapter build upon those within Chapters 3 and 4, by identifying medication classifications contributing to inappropriate prescribing within both contexts. Despite the fact that some similarities were identified in both contexts there is evidence to indicate that the prescribing culture in both settings is distinctive in nature. The disparity between both cohorts in terms of sample size limit the comparisons that can be made with respect to absolute prescribing counts. However, the order of frequency of these counts, and the proportion of overall prescribing within the subclassification lends itself to comparison.

'Opioid analgesics' were the most frequently identified medication subclassification contributing to inappropriate prescribing within the IC cohort. Whilst opioids were also found to be inappropriately prescribed within the CH cohort, a greater proportion of IC participants received opioids inappropriately. Approximately 60% of opioid prescribing within IC (versus 35% in CH) was found to be inappropriate at baseline review. This may be reflective of the rehabilitative nature of intermediate care, with participants having been discharged from acute care, and the higher likelihood that these participants may have experienced a fracture or surgery and thus required pain relief.

Opioid analgesics are used in the management of both chronic and acute pain, both of which occur frequently among older people. They are usually reserved for moderate to severe pain due to the increased risk of adverse events with their use. Age-related changes in renal and hepatic clearance increase the susceptibility of older people to the sedating properties of opioid analgesics (Chau, Walker, Pai & Cho, 2008; Wilder-Smith, 2005). Thus, the risk of falls can be increased with the use of these agents. Reduced doses are recommended in older adults in order to limit the possibility of adverse effects. Furthermore, the potential for interaction with other medications is greater among older adults due to the higher levels of

polypharmacy observed. Duplication of opioid prescribing was evidenced in both cohorts and may be warranted in order to provide adequate pain management. Modified release presentations which provide a continual release of opioids over a prolonged period, such as 12 hours, are often used to provide a background level of analgesia, with additional immediate release preparations used to relieve any 'breakthrough' pain that occurs prior to the next dosing interval. Thus, some duplication of therapy may be considered clinically necessary. However, in a scenario where an individual no longer requires any opioid analgesia, the use of multiple preparations will result in a higher patient total MAI score following individual mediation MAI score summation. An examination of inappropriate prescribing and self-reported adverse events in an older adult cohort in the US found that opioid analgesics was the most commonly duplicated medication group (Chrischilles, Van Gilder, Wright, Kelly & Wallace, 2009).

Furthermore, common adverse effects of opioid analgesics, for example urinary retention and constipation, can lead to the development of a prescribing cascade as additional medications are prescribed in order to alleviate these common side effects. *'Osmotic laxatives'* were identified as the most frequent inappropriately prescribed drug subgroup within the CH cohort, with the identified duplication of therapy likely contributing to this. Osmotic laxatives are considered first line therapy for the treatment of constipation in older adults and so the high prevalence of inappropriate prescribing of this subgroup is somewhat surprising and may be due to a prescribing cascade that developed from the maintenance of unnecessary opioid analgesia. Despite a greater proportion of CH participants being prescribed an osmotic laxative (71% vs. 53% in IC), a greater proportion of osmotic laxatives were found to be inappropriately prescribed within IC (51% vs. 44% in CH), which may be related to the overall higher prevalence of opioid prescribing within IC.

Similar to the findings of Peréz et al., (2018) and earlier Cool et al., (2014), it was found that *'proton pump inhibitors'* (PPIs) were also frequently prescribed inappropriately for both IC and CH participants. The prolonged use of PPIs beyond the duration required for a therapeutic effect is a particular concern in older people due to associations with unwanted adverse effects such as the increased risk of osteoporotic fractures, *Clostridium difficile* infection, dementia, and pneumonia (Maes et al., 2017). Almost half (47%) of PPI prescribing within CH was found to be inappropriate with a smaller proportion of PPI prescribing found to be inappropriate upon admission to IC (35%).

The high prevalence of inappropriate prescribing of PPIs within care homes may give credence to the argument that the prescribing culture for care home residents is often centred on the maintenance of medication that was prescribed pre-institutionalisation (Maguire et al., 2013). Whilst no information was available as to the duration of treatment in either cohort, the identification of a high prevalence of inappropriate PPI prescribing points to a lack of regular medication review. Such evidence would suggest that there is much to be gained from pharmacist intervention in care home settings, irrespective of the duration of residence.

Huiskes et al., (2017) called for the cessation of widespread cross-sectional medication reviews as standard care, arguing that the absence of any effect on clinical outcomes such as hospital admissions, mortality or quality of life and inconclusive evidence as to the impact on economic outcomes undermined the effectiveness of such an approach. Rather, Huiskes and colleagues contend that medication review should take place longitudinally instead, with more of an integrated approach to pharmaceutical care whereby a review is conducted at initiation but also during specific 'at risk' moments for the patient. However, as Avery and Bell (2019) argue, the absence of impact of deprescribing initiatives on clinical outcomes does not remove one from the ethical argument regarding patient autonomy. That the risks and benefits of medicines change over time, particularly in relation to aging or increasing frailty, demands that

a collaborative, shared decision-making process for deprescribing is encouraged. As such "deprescribing remains a worthwhile investment, however, and should be done in partnership with the patients and families who cope every day with burdensome polypharmacy" (Avery & Bell, 2019, p. I570). Accordingly, perhaps a pertinent question that we should ask ourselves is, by what metric do we consider an intervention to be effective?

One can argue that the primary purpose of any medicines optimisation intervention is to do just that. The cessation or deprescribing of potentially harmful medication, the alteration of unsuitable dosages and the initiation of omitted medications that would provide a clinical benefit is the embodiment of the initiative in the first place. Secondary outcomes such as reductions in healthcare usage must be considered as an additional success. The absence of reductions in healthcare usage does not undermine the successful discontinuation of hazardous medications.

The examination of interventions in purely economic terms does not always consider future cost savings that have been avoided through the prevention of adverse events and thus associated hospitalisations. In this instance the work of Karnon and colleagues (2008) can be used to estimate the monetary cost of preventable adverse drug events (ADEs) and the value of health lost as a consequence of such ADEs. If the purpose of an intervention is aimed at improving patient care, then the individual should remain central to the evaluation and not be considered as secondary to the impact of overall service efficiency. Van Bussel et al., (2019) reported that patients trust their GP to make the right decision on their behalf with respect to medication decision making and that a "conspiracy of silence" (p. 6) prevents shared decision-making from occurring. This is despite the fact that many older people wish to take an active part in their own care (Bastiaens, Van Royen, Pavlic, Raposo & Baker, 2007). The patient-centred aspect of the MOOP care models respects the autonomy of the older person through active involvement in the generation of the pharmaceutical care plan.

Across both cohorts some differences in post-intervention healthcare resource usage was observed following improvements in MAI scores for some medication subgroups, indicating that medicines optimisation can be beneficial to the healthcare system as well as to the individual patient. Within IC, fewer readmissions between 31 and 90 days and within 90 days of IC discharge were observed for those who had partial or complete improvement in their MAI scores for their PPIs, when compared with those who had no change or a worsening of MAI scores. Furthermore, in both settings, fewer participants who had partial or complete improvement in their MAI scores for PPIs died in the 90-day period. This finding further extends the literature regarding the safe use of PPIs among older adults. Prolonged treatment with PPIs has previously been shown to be associated with an increased risk of several negative outcomes for older adults, including osteoporotic fractures, *Clostridium difficile* infection, dementia, and pneumonia (Maes et al., 2017). Moriarty, Bennett, Cahir and Fahey (2016) previously identified a dramatic increase in long-term maximal dose use of PPIs among a cohort of community dwelling older Irish adults from 2007 to 2012. When compared to those who had partial or complete MAI score improvement for '*drugs used in megaloblastic anaemia'*, those who had no change in MAI score or a worsening of MAI scores for this drug subgroup had over twice the number of OOH visits <90 days of pharmacist intervention.

Inappropriate prescribing of psychoactive medications was prevalent in both contexts with the prescribing of *'benzodiazepines'* notable in both care settings. Considerable duplication of benzodiazepines was identified among CH participants and is a particularly concerning practice. Older adults have an increased susceptibility to the pharmacodynamic effects of benzodiazepines (EIDesoky, 2007) and thus experience an associated increased risk of falls (Bloch et al., 2011; Díaz-Guitérrez, et al., 2017; Hill & Wee, 2012; Landi et al., 2005). Falls can be a contributing factor in the return of a care home resident to an acute care setting, particularly if a fracture is experienced (Quinn, 2011; NHS Scotland, 2016; Smith et al., 2015).

The cumulative sedative effects of duplicate benzodiazepine prescribing further the risk of falls and adverse consequences.

Nevertheless, it would appear that a greater challenge of inappropriate prescribing of benzodiazepines is present within IC, where approximately 60% of benzodiazepine prescribing was inappropriate. In contrast, the proportion of inappropriate prescribing of benzodiazepines was lower in CH, accounting for approximately 35% of overall benzodiazepine prescribing. Such evidence builds on that identified within Chapter 3 such that pharmacist involvement within intermediate care is warranted. Those who were reviewed within IC were likely exhibiting pharmacotherapy issues that had not been addressed either within the community or during their acute care admission. Thus, if unaddressed during the IC admission, the continuation of suboptimal prescribing practices would fail to address the risk of adverse events for the older person. The assumption that medications had been optimised during the acute care admission would likely compound this risk.

Furthermore, inappropriate use of the non-benzodiazepine sedative *'z-drugs'* (zopiclone, zolpidem and zaleplon) was more often found to be inappropriate for IC participants, accounting for 65% of overall prescribing of this subclassification of psychoactive medications. Just over half of z-drug prescribing within CH was found to be inappropriate at baseline pharmacist review. Several interpretations may be drawn from this finding. Participants in IC may have experienced the onset of sleep disturbances during their acute care admission, leading to the initiation of a new medication which was then continued at discharge into IC. Alternatively, it may indicate that levels of inappropriate prescribing of *'z-drugs'* is prevalent within the community context and is not addressed during acute care admission and thus continues following discharge from acute care.

A lower proportion of inappropriate z-drug prescribing in CH contexts may indicate an awareness on the part of the prescriber, usually a GP, of the concerns regarding the use of

such medications for older people. In this study a large proportion of CH participants were resident within the CH home setting for 2 years or more and may have had their pharmacotherapy reviewed at an earlier stage, given the increased concerns regarding psychoactive medication use in care homes. The sheer lack of studies examining inappropriate prescribing within IC may suggest an overall underestimation of the severity of inappropriate prescribing of psychoactive within settings outside of care homes.

There was considerable variety in the psychoactive medication subgroups prescribed inappropriately for both cohorts, with some distinctions evident between both settings. With respect to antidepressant medications, approximately one fifth of *'SSRI'* prescribing was identified as inappropriate in both contexts. As a proportion of overall prescribing within the subclassification, inappropriate prescribing of *'TCAs'* was highly prevalent in both settings, with a greater proportion of IC participants prescribed a TCA inappropriately. Antidepressant use in older people increases the risk of falls, hyponatraemia, cerebrovascular events, seizures, and all-cause mortality (Coupland et al., 2011), thus antidepressant prescriptions among older adults should be reviewed to identify if they are still clinically necessary.

Similarly, whilst *'antihistamines for nausea'* were found to be suboptimal in both care contexts, a greater proportion of overall prescribing within the classification was identified as inappropriate among IC participants (59% versus 45% for CH participants). Previous research in intermediate care in Northern Ireland identified a low prevalence of prescribing for this subgroup with only just over 1% of participants prescribed a first-generation antihistamine (Millar, Hughes & Ryan, 2017).

First-generation antihistamines are centrally active due to their ability to penetrate the blood brain barrier. Hence, adverse effects such as sedation, dizziness, impaired thinking and memory, agitation and hallucinations can result from their use (Tietze, 2012). Some older people may experience a paradoxical excitation and agitation (Tietze, 2012). First-generation

antihistamines can also produce adverse effects as a result of their anticholinergic effects. Consequently, blurred vision, dizziness, memory impairment, postural hypotension, constipation, and urinary retention may also occur in conjunction with their use (Tietze, 2012). Whilst the risks associated with the prescribing of antipsychotics, opioids, benzodiazepines, and other sedatives for older adults has received considerable attention, a refocus of attention on first-generation antihistamines may be required. The American Beer's and European STOPP lists both advocate against the use of first-generation antihistamines in older adults, however the frequency of inappropriate prescription of such agents identified within both care settings could suggest that perhaps there is further room for clinical education with respect to this medication subgroup.

Concerningly almost half of all prescribing of '*first-generation antipsychotics'* for CH participants was found to be inappropriate at baseline review. Behavioural and psychological symptoms of dementia (BPSD) is a common cause for hospital admission among those living with dementia (Scottish Intercollegiate Guidelines Network, 2006). Antipsychotic medications are often prescribed to alleviate symptoms of BPSD, in spite of clear warnings regarding the increased risk of cerebrovascular accidents and cardiac death that have been issued by regulatory agencies (Chen et al., 2010; Guthrie, et al., 2013; Kales et al., 2011; Maguire et al., 2013; Westbury et al., 2013). A lower prevalence of inappropriate prescribing was identified for '*second-generation antipsychotics'* and was found to be similar in both settings (approx.25%). Patterson, Hughes, Crealey, Cardwell & Lapane (2010) previously reported that 60% of antipsychotic prescribing in Northern Irish care homes was inappropriately at baseline. Recent data assessing prescribing in long term care homes in Canada estimates that 27.5% of antipsychotics are prescribed inappropriately (Kirkham et al., 2017).

Within CH almost all *'betahistine'* (96%) prescribing was found to be inappropriate and may reflect the continuation of medication when no longer clinically indicated and may

therefore point to the continuation of pre-admission medications within this care context in the absence of a thorough review. Furthermore, approximately two-thirds of prescribing of *'domperidone or metoclopramide'* was inappropriate within CH. It is impossible to determine which of these two medications that contributed to this. It could indicate the inappropriate use of metoclopramide in those with Parkinson's Disease, given the risk of extrapyramidal side effects. Alternatively, it could indicate the failure to address domperidone prescribing in light of alerts relating to the risk of cardiac arrythmias and associated increased risk of death. In 2014, the Coordination Group for Mutual Recognition and Decentralised Procedures – Human (CMDh) of the European Medicines Agency endorsed a recommendation to restrict the use of domperidone in terms of indication, dosage, and length of treatment, following a review of the risk of serious cardiac effects. Such an example indicates that the risk benefit ratio of a medication is a dynamic balance and can change considerably with increased data collection regarding its use. Prescribing within these two subclassifications points the clear need for continual review of medications for CH residents, irrespective of when they were admitted into the care home.

From a healthcare utilisation perspective, the amelioration of psychoactive prescribing had little or no effect on healthcare outcomes for IC or CH participants. A difference in readmission within 90 days of IC discharge was observed for IC participants with respect to prescribing of *'antihistamines for nausea'*. Fewer readmissions within 90 days were recorded for those who had partial or complete improvement for MAI scores than those whose MAI scores stayed the same or worsened. Conversely, those CH participants who experienced 'no change or a worsening in MAI score' for their '*dopaminergic drugs for Parkinson's'* reported fewer GP and OOH GP visits within both 30 and 90 days, when compared with those who experienced 'partial or complete improvement' for this medication classification.

Several methodological limitations must be considered when considering the findings presented here. No assessment could be made as to whether any discontinued medications remained withdrawn during the follow up period. Thus, it is possible that some discontinued medications may have been resumed following pharmacist intervention and during the healthcare usage data collection period. A multidisciplinary intervention aimed at reducing psychoactive prescribing among nursing home residents living with dementia found that of the 28% reduction in psychoactive prescribing achieved only 12% of discontinued medications were restarted at 6 months follow up (Mesquida et al., 2019).

Furthermore, the analysis of medication subgroups was conducted independently to identify individual drug classifications that were of particular concern. Thus, it was not possible to identify whether combinations of optimised medications resulted in alterations in healthcare utilisation post-intervention. For example, the use of multiple psychoactive medication results in an additive sedative effect and so the cessation of multiple medications may have resulted in a reduction in the number of falls experienced by participants, evidenced as altered healthcare usage in the post-intervention period. Additionally, a considerable proportion of participants who would have been classified as '*MAI score stayed the same or worsened'* would have been those whose medication MAI score was zero at both baseline and post-intervention. Thus, for some participants no improvement in MAI score would have been possible as medications had already been optimised.

5.7 Conclusion

Considerable variation in inappropriate prescribing occurs in both contexts with several medication subclassifications endorsed as having been prescribed inappropriately. These findings add nuance to the findings reported in Chapters 3 and 4 by providing insight into the culture of inappropriate prescribing evident in both locations. Inappropriate psychoactive prescribing was highly evident in both contexts, with the prescribing with some

psychoactive subclassifications more prevalent in IC than in CH. This could indicate that those responsible for prescribing for care home residents are attuned to the risks associated with psychoactive medications and that the prescribing culture has adapted to safety warnings. However, a considerable proportion of inappropriate prescribing was identified within the CH data also. Nevertheless, the findings extend the conclusions made in Chapter 3 that medicines optimisation interventions are warranted within intermediate care, and that particular attention should be paid to psychoactive prescribing within this context also. Addressing inappropriate prescribing of psychoactive medications at an earlier stage in the care journey may prevent negative outcomes such as falls and altered cognition, thereby delaying, or reducing the risk of institutionalisation.

Overall, improvements in prescribing appropriateness at a medication subclassification level did not influence outcomes widely, save for some differences identified for '*proton pump inhibitors', 'oral iron', 'non-opioid analgesics', 'drugs used in the treatment of megaloblastic anaemia'* and '*antihistamines for nausea*'. Nevertheless, the identification of those drug groups that are most frequently prescribed inappropriately can form the basis of future brief interventions, not only by the MOOP team pharmacists, but also by pharmacists across the entire healthcare journey. Furthermore, the absence of direct relationships between improvements within specific drug groups and healthcare utilisation and outcomes extends the discussion regarding deprescribing initiatives. It provides further weight to the narrative that the assessment of interventions for older people is challenging to disentangle into its constituent parts.

6 Longitudinal patterns of healthcare usage among older adults: latent transition analysis of The Irish Longitudinal Study on Ageing (TILDA)

6.1 Chapter overview

The purpose of this chapter is to investigate temporal changes in healthcare utilisation among older people. In particular, the chapter seeks to determine whether distinguishable patterns of healthcare usage that remain stable over time can be elucidated. By doing so this chapter forms a foundation for subsequent analyses, which will provide a more detailed characterisation of healthcare utilisation by older people through the incorporation of those individual or person-centred characteristics that influence healthcare utilisation via the inclusion of relevant covariates.

6.2 Introduction

An ageing global population, living for longer with multimorbidity, is a considerable challenge to health systems globally. The idealistic healthcare model is one where healthcare is delivered in response to the needs of the population in a manner and form that is accessible to the recipient. Accessing healthcare involves a dynamic interplay of a broad range of factors, including those at an individual level, such as illness level and attitudes toward health, and those at a societal level, such as accessibility of services. Andersen and Newman (1973) proposed that the broad range of factors which influence healthcare utilisation could be categorised into three principal domains, *predisposing, enabling* and *need* factors. In doing so they sought to characterise the myriad of factors that influence the decision to access healthcare in a coherent and parsimonious manner, whilst retaining breadth and depth of these complexities.

Predisposing factors are considered to be those that exist prior to the onset of the specific period of illness and are not considered to be a reason for seeking healthcare but

rather influence the likelihood of accessing services. (Andersen & Newman, 1973). These include demographic factors such as age, sex, and past illness. Social structural variables such as education and occupation are also considered to be predisposing variables, as they indicate the social environment within which the individual resides and may point towards the lifestyle of the individual (Andersen & Newman, 1973). Attitudinal variables such as health beliefs and attitudes towards health services are also deemed to be predisposing factors as they do not indicate a direct reason for healthcare services but may describe differential patterns of healthcare service use. *Enabling* factors are considered to be aspects that make healthcare services available to the individual (Andersen & Newman, 1973), including financial aspects such as family income or health insurance coverage, as well as accessibility of healthcare services. The availability of healthcare services in terms of personnel, facilities and location of these facilities are proposed to influence the individual in terms of their decision to access a service. *Need* factors include illness level, representing the most immediate cause of health service use (Andersen & Newman, 1973). This is further categorised by Andersen and Newman as perceived illness, such as self-reported general health status or self-reported symptoms, and evaluated illness, which may include a physical examination by a medical professional.

Andersen and Newman (1973) in their theorising also considered the degree to which each of these factors can be altered to influence the distribution of health services, referring to this aspect as the mutability of the factors. Thus, demographic factors are deemed to have low mutability whereas enabling factors are considered to have higher mutability. In doing so, Andersen and Newman (1973) drew our attention to those factors which are potential targets for action when considering altering healthcare utilisation patterns.

Chapters 3 and 4 examined two distinct populations of older people where concerns have been raised regarding the appropriateness of healthcare utilisation by these cohorts. Intermediate care as a distinct healthcare location was developed as a means to reduce

burden on secondary care, indicating that this was not an appropriate location for older people's care. Similarly, concerns have been raised internationally about the appropriate transfer of care home residents to emergency departments (Lemoyne et al., 2019).

This raises the question as to what is the 'ideal' or optimum type of healthcare utilisation by the population, broadly speaking, and by older people, specifically? Findings from Chapters 3 and 4 highlighted that the evaluation of an intervention for older people in terms of secondary outcomes, such as healthcare usage, requires an appreciation of the pre-existing levels of healthcare usage pre-intervention. Analysis from these preceding chapters highlighted that older people who have high levels of healthcare usage are likely to continue with such usage patterns, irrespective of significant improvements in the appropriateness of their pharmacotherapy. Thus, an understanding of heterogeneity in terms of healthcare usage may prove an additional source of understanding of inter-individual differences in healthcare usage, over and above those characteristics identified in Chapters 3 and 4.

However, it must be considered that whilst accessing healthcare involves a discrete visit, the person living with chronic multimorbidity may often find that multiple visits are required to ensure optimal management of their condition(s). Thus, we need to consider access of healthcare services over a longer period of time. As evidenced in Chapters 3 and 4, previous levels of healthcare attendances were significant predictors of healthcare resource usage within 90 days of pharmacist intervention. This evidence underscores the continual need that older people have for healthcare services, irrespective of the improvements made in their pharmacotherapy. Thus, this raises the question as to whether we have an in depth understanding of what governs healthcare usage by older people over a longer term.

As much as we are aware that admission to secondary care can have detrimental effects for older people in terms of increasing frailty, decreasing cognition and increased risk of inappropriate prescribing, there is a need to identify the characteristics of older people who

present to secondary care in the first place. The identification of those characteristics that differentiate the frequent attenders from those with low levels of healthcare utilisation may offer greater insights into appropriate healthcare service design, over and above that of developing policy initiatives such as intermediate care and reductions in secondary care bed numbers. Furthermore, given the considerable heterogeneity that exists amongst older cohorts it is somewhat reductionist to assume that all older people exhibit the same high levels of healthcare utilisation. Rather, it is imperative that we identify those individuals who are at greatest risk of requiring high levels of healthcare usage. Kansagara et al., (2011) argue that most risk prediction studies have displayed poor predictive ability, indicating a better capability at predicting mortality rather than the risk of hospital readmission. Kansagara and colleagues call for the inclusion of broader factors such as wider social and environmental aspects when considering healthcare usage.

Moreover, the identification of hospital admission risk, whilst highly important does little to inform of healthcare usage at primary care level. In many Western societies, GPs are considered to be the gatekeepers of access to secondary care, primarily via one of two pathways. The first is a referral to a specialist medical consultant for an outpatient consultation and is often considered to be the most appropriate means of initiating secondary-level care. The second pathway that can be adopted is a referral to ED, whereby the patient may be admitted to secondary care for further investigation and treatment. This admission may facilitate the escalation of secondary-level care for the admitted inpatient as a means of encouraging a timely discharge and the vacation of an occupied hospital bed. Therefore, it is imperative that any profiling of healthcare usage among older people accounts for attendances at outpatient and ED departments, to serve as a proxy indicator for appropriate versus inappropriate referral.

However, it is important to caution that referral to ED on the part of the GP is largely rooted in a valid concern for the declining health of the referred person and the exhaustion of options at a primary care level. In fact, such a referral pathway is largely indicative of a poorly functioning outpatient service that can often be characterised by long waiting lists, during which the condition of an older person is likely to diminish during this waiting time. Therefore, we can reframe the narrative such that the two referral mechanisms be considered as a functioning health service versus a malfunctioning service, rather than that of an appropriate versus an inappropriate referral.

Our awareness of any concept is predicated upon the amount of information that we use to form our reasoning. The examination of healthcare usage as a single snapshot in time does little to inform of variation in healthcare utilisation longitudinally. Thus, an alternative approach is to examine the trajectories of healthcare usage that older members of our population follow over time. This also proffers an opportunity to consider the relative stability of these trajectories and the differential impact that they have. Through longitudinal assessments of healthcare usage, the 'dynamic and recursive nature' of health services use could be better understood (Andersen, 1995, p. 7).

Longitudinal cohort studies that include healthcare usage questions within their study design offer an opportunity to examine healthcare utilisation over time within a wider context of sociodemographic and epidemiological information. Various longitudinal studies of ageing are currently in progress in England (ELSA), Ireland (TILDA) and Northern Ireland (NICOLA). Such studies gather information on a host of demographic, socioeconomic and psychosocial aspects of ageing in the study sample and have been designed to be representative of the population in question. The inclusion of broader contextual factors allows for a more thorough examination of the factors which influence healthcare utilisation. These studies are largely designed to be compatible with one another and thus also offer the opportunity of cross-

country comparisons. Previous research conducted on healthcare utilisation in the TILDA sample has considered the Andersen Behavioural Model when selecting covariates for inclusion in the analysis (Hudson & Nolan, 2015; Mohan, Nolan & Lyons, 2019; Murphy, Whelan & Normand, 2014; Nolan, McCrory & Moore, 2019; Roe et al., 2017). However, these studies look at different types of healthcare utilisation e.g. GP visits, outpatient visits etc. as independent outcome variables and do not consider profiles of multiple healthcare usage. Furthermore, these studies largely consider healthcare usage cross-sectionally and do not examine changes in healthcare utilisation over time.

A fundamental aspect must first be established prior to any understanding of the factors which influence healthcare service usage can be gleaned. The nature of healthcare usage over time by the population must be characterised. There are a whole host of analysis models that the researcher can adopt to examine longitudinal data, the selection of which is largely determined by the research question and the available data (Nylund, 2007). Latent variable modelling offers the opportunity to simplify a large amount of information into subpopulations that share commonality. Latent class analysis can be conducted to identify subpopulations who differ from one another in their response patterns to selected indicators. Such methodology provides a medium by which the considerable heterogeneity that exists among older people can be more easily manipulated within subsequent analyses. Latent variable modelling can also be applied within a longitudinal context to provide a simplified assessment of change over time, which remains true to the subtle nuances of each subpopulation.

Latent transition analysis (LTA) can be considered to be a longitudinal extension of the latent class model. It incorporates two modelling traditions: latent class analysis (LCA) and autoregressive modeling (Nylund, 2007). LCA identifies unique subpopulations or groups at each point in the analysis and the autoregressive component identifies the transitions that occur among the classes over time (Nylund, 2007). Thus, LTA estimates class membership at

each time point whilst also estimating the probability of transition from each class to another over time. In effect, LTA estimates the probability of latent class membership at time *t+1*, conditional upon membership at time *t.* Figure 6-1 outlines a simple LTA model consisting of two time points.

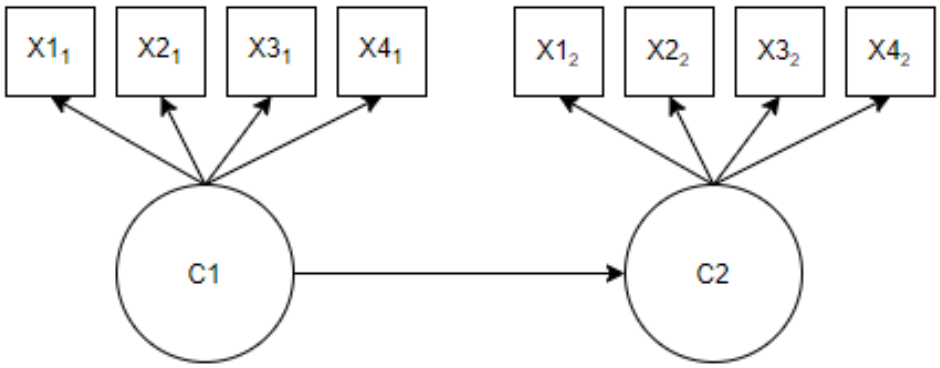

Figure 6-1: Simple latent transition model (LTA) comprised of two time points

Ryoo, Wang, Swearer, Hull and Shi (2018) propose that model building within LTA should follow a stepwise approach that is largely influenced by the researcher's goals. By doing so, Ryoo and colleagues' approach is an attempt to provide clarity to model building in LTA. According to Ryoo et al., (2018), the application of LTA within the literature has been the victim of much subjectivity, thereby resulting in confusion for applied researchers who seek to identify the optimal approach for LTA model building.

Measurement invariance is a crucial step to the successful application of LTA, with the first step to assess the equivalence of the optimal number of classes at each time point. Where this has been satisfied the fit of two LTA models, one with freely estimated parameters and one with constrained parameters can be compared. The establishment of measurement invariance allows for greater confidence in the interpretation of transition parameters, and thus the model as a whole (Collins & Lanza, 2010).

LTA provides an opportunity to examine inter-individual and intra-individual heterogeneity of a construct. We can identify latent classes or statuses that are distinguishable from one another and thus address inter-individual patterns in healthcare utilisation, whilst also identifying changes in healthcare utilisation within the individual over time, intra-individual heterogeneity. The selection of LTA as a technique accounts for the dynamic interplay of health and illness over time, as well as providing an opportunity to investigate those covariates which influence the transition from one state to another. Thus, in addition to identifying heterogeneity in healthcare utilisation within a sample it also provides an opportunity to characterise divergent healthcare trajectories.

6.3 Objectives

- To identify whether latent subpopulations characterised by different patterns of healthcare utilisation are present within a nationally representative data sample of older people, TILDA
- To identify if these latent subpopulations are equivalent across three measurement occasions
- To determine the probability of transitioning from one latent class to another over time

6.4 Method

6.4.1 Sampling and participants

The present study utilised data from the Irish Longitudinal Study on Ageing (TILDA) as introduced in Chapter 2 (Methodology). Participants at Wave 1 were 8175 TILDA respondents who had completed the CAPI element of the survey and who were aged 50 years and over. Participant ages at Wave 1 ranged from 50 to 80[3] years (M = 63.53, SD = 9.16). The sample comprised of 54.2% females. Participant numbers at Wave 2 and Wave 3 were 6917 and 6128,

[3] Age at wave 1 was aggregated such that those aged >= 80 years recorded as 80 years of age.

respectively. Thus, resulting in attrition rates of 15.39% at Wave 2 and 25.04% at Wave 3, respectively. The sample size available for healthcare utilisation variables ranged from 8164 to 8172 at Wave 1, 6903 to 6915 at Wave 2, and 6115 to 6124 at Wave 3. Further details on data collection sample and sample demographics can be observed Chapter 2 (Methodology).

6.4.2 Design and variables

Data collection during the TILDA study involved a Computer Assisted Personal Interview (CAPI), conducted on a two-yearly basis. To date, data pertaining to four waves of TILDA data collection are available. In the present study Latent Transition Analysis (LTA) was conducted using data from the first three study waves.

6.4.3 Measures

The derivation of latent classes was based upon four indicators available in each wave of the TILDA data capture. During the CAPI interview, respondents were asked the following questions:

- HU005-In the last 12 months, about how often did you visit your GP?
- HU007-In the last 12 months, how many times did you visit a hospital Emergency Department as a patient?
- HU008-In the last 12 months, about how many visits did you make to a hospital as an outpatient?
- HU010-In the last 12 months, on how many occasions were you admitted to hospital overnight?

In the case of variable HU008, respondents were advised that outpatient visits included all types of consultations, tests, operations, procedures, or treatments (Kenny et al., 2010). These questions remained the same in subsequent data collection waves, irrespective of the fact that data collection was conducted on a biennial basis.

Respondents self-reported a total count value for each of these questions, which were reported as ordinal categories in the publicly available dataset from wave two onwards. Number of GP visits was reported in the following categories *none, 1-4, 5-9, 10-14,* and *15+* visits. For ED, outpatient and inpatient visits data was presented in the following categories *none, single visit,* and *multiple visits (2+).* Wave 1 data was available at a continuous level and was thus recoded to align with the aforementioned ordinal categories.

6.4.4 Analytical plan

Analysis was completed using Mplus version 8.1. Analysis was guided as per the methodology outlined by Ryoo and colleagues (2018), as illustrated in Figure 6-2.

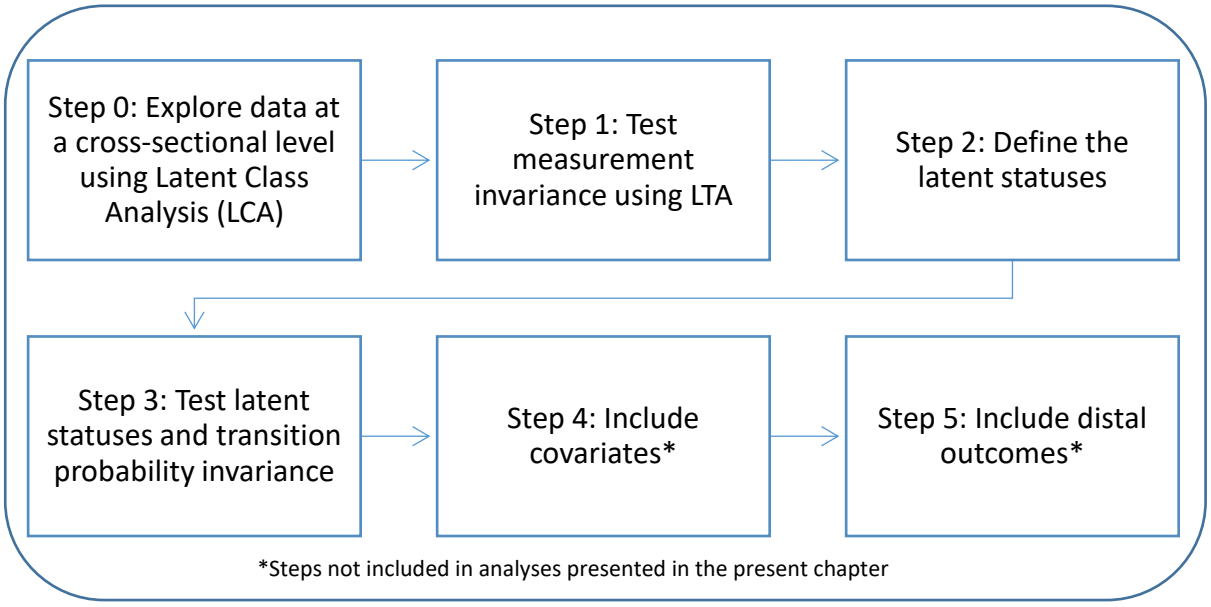

Figure 6-2: Summary of LTA model building procedure from Ryoo et al., (2018)

Preliminary analysis was conducted at a cross-sectional level, with latent class analysis conducted on Waves 1 to 3 separately. Measurement models ranging from 1-5 latent classes were specified for each of the three time points as a preliminary step to model building. Manifest indicators used at each wave included GP, ED visits, outpatient visits, and inpatient admissions. These indicators were coded as follows

- GP: *none*=0*; 1-4* =1; *5-9* =2; *10-14* =3; *15+* =4
- ED: *none* =0*; single visit* =1; and *multiple visits (2+)* =2
- Outpatient: *none* =0*; single visit* =1; and *multiple visits (2+)* =2
- Inpatient: *none* =0*; single visit* =1; and *multiple visits (2+)* =2

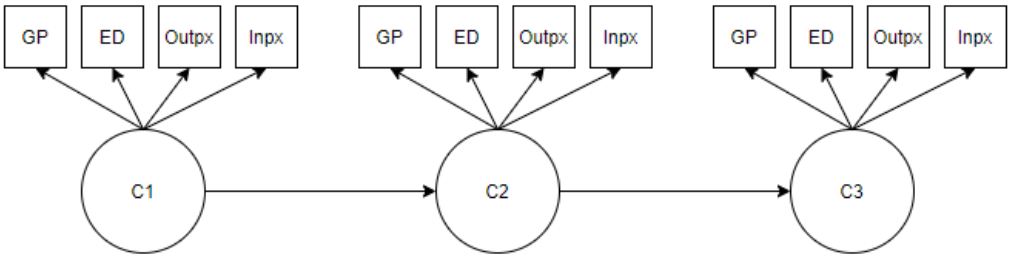

Figure 6-3: Latent transition model examined using three waves of TILDA data

Latent class analysis was conducted using the Maximum Likelihood estimator. With mixture models it is possible that multiple maxima of the likelihood often exist (Muthén & Muthén, 1998-2017). Thus, it is advised to use more than one set of starting values in order to find the global maximum. The highest loglikelihood value should be replicated in a minimum of two final stage solutions, in order to rule out a local solution having been reached (Muthén & Muthén, 1998-2017). If the loglikelihood has not been replicated as such interpretation of the model should not continue without further investigation. Thus, analysis was commenced using the default number of initial stage random sets of starting values of 20 and final stage optimisations of 4, increased where required to ensure convergence to a global maximum (Muthén & Muthén, 1998-2017).

Following the fitting of a one class model, additional classes should be included on an incremental basis, one at a time, in order to identify which model provides the best fit to the data (van de Schoot Sijbrandij, Winter, Depaoli & Vermunt, 2016). Van de Schoot and colleagues (2016) argue that the inclusion of additional classes need not cease once model fit

stops improving, but rather that, at a minimum, one or two additional models should also be explored in order to ensure that all possible models has been investigated thoroughly.

Selection of the optimum number of classes at each wave was based upon a review of the Akaike Information Criterion (AIC; Akaike 1981), Bayesian Information Criterion (BIC; Schwarz, 1978), the sample size adjusted BIC (ssBIC; Sclove, 1987) and entropy as well as a review of the substantive value of the classes observed. Lower AIC and BIC values indicate better model fit. Entropy assess the accuracy of classification into the most likely class and can range from 0 to 1; higher scores represent greater classification accuracy. The Vuong- Lo-Mendell Rubin (VLMR) likelihood ratio test and the Lo-Mendell Rubin (LMR) adjusted LRT were used to compare neighbouring class models (e.g. two vs. three class etc.) to determine whether the inclusion of an additional class led to an improvement in model fit. A non-significant LMR *p* value favours the selection of the *k*-1 solution.

Van de Schoot, Sijbrandij, Winter, Depaoli and Vermunt (2016) advocate that more than one model comparison tool should be used to select the final model. There is some consensus regarding the utility of BIC to evaluate model fit for LCA models (Nylund, Asparouhov & Muthen, 2007; van de Schoot et al., 2016). However, the evaluation of model fit and selection of the optimal number of classes should not solely be determined by statistical criteria; it has been argued that a judgement call on the part of the researcher will also be required (Chen, Curran, Bollen, Kirby & Paxton, 2008; Collins & Lanza, 2010; van de Schoot et al., 2016). Parsimony and interpretability of the latent classes should also play a role in model selection (Collins & Lanza, 2010). In a case where fit indices disagree with respect to the optimal number of classes, van de Schoot and colleagues (2016) argue that this finding should be acknowledged within the text.

In the LTA model building, model fit was examined primarily by comparing differences in BIC values at each step, with lower BIC values considered to provide better fit (Asparouhov,

2020). Raftery (1995) provides guidance such that a BIC difference of >10 provides very strong evidence for a better fitting model. The likelihood-ratio statistic (G^2) is commonly used to assess absolute model fit, whereby a *p* value for G^2 can be generated via comparison to the chi-square distribution that corresponds to the degrees of freedom in the model (Collins & Lanza, 2010). However, G^2 can be impacted by the phenomenon of sparseness, which indicates the degree to which the average expected cell count is small (Collins & Lanza, 2010). Sparseness can be considered to be a function of the total sample size *N* and the size of the contingency table *W*, expressed as *N/W* (Collins & Lanza, 2010). Collins and Lanza (2010) argue that sparseness can occur quite readily, even in the presence of large sample sizes when the contingency table is large, such as that found in complex latent class models including LTA.

In the analysis presented here the contingency table would follow a 5 x 3 x 3 x 3 pattern resulting in 135 cells, with each cell representing a particular response pattern to the four questionnaire items (GP, ED, Outpatient, and Inpatient). Furthermore, Maydeu-Olivares and Cai (2006) express caution with the use of G^2 as a measure of absolute model fit. In the case of comparisons where the least restrictive model has been misspecified, differences in G^2 are no longer appropriate, as in this instance the G^2 statistic does not approximate the χ^2 distribution (Maydeu-Olivares & Cai, 2006). Owed to the possibility of sparseness becoming an issue, concerns regarding assurances that G^2 meets the chi-square distribution and advice to Mplus users (Asparouhov, 2020) it was decided to examine model fit in LTA using BIC.

Measurement invariance over time was conducted by comparing a model with freely estimated item-response probabilities with one in which these were constrained to be equal over time. Thus, measurement invariance assumes that any observed class differences in terms of latent class prevalence are purely quantitative in nature, with some classes larger than others and remaining so over time (Zammit et al., 2020).

6.5 Results

Table 6-1 summarises healthcare utilisation in terms of GP, ED, outpatient, and inpatient visits at the three times points examined in LTA. Usage of secondary healthcare resources such as ED, outpatient and inpatient admissions was less common in comparison to usage of primary care resources of GP visits. Considerably fewer TILDA participants reported no GP visits in comparison with frequencies that endorsed no ED, outpatient, or inpatient visits.

Table 6-1: Descriptive statistics for healthcare utilisation across three waves of TILDA data collection

Number of	Wave 1 n(%)	Wave 2 n(%)	Wave 3 n(%)	Wave 4 n(%)
GP visits				
None	1022 (12.5)	700 (8.6)	485 (5.9)	442 (5.4)
1-4	5033 (61.6)	4448 (54.4)	4079 (49.9)	3624 (44.3)
5-9	1243 (15.2)	1127 (13.8)	986 (12.1)	933 (11.4)
10-14	666 (8.1)	444 (5.4)	438 (5.4)	356 (4.4)
15+	200 (2.4)	184 (2.3)	127 (1.6)	91 (1.1)
Missing				
Refused to answer	1 (0.0)	-	2 (0.0)	-
Responded 'do not know'	10 (0.1)	14 (0.2)	11 (0.1)	11 (0.1)
System missing	-	1258 (15.4)	2047 (25.0)	2718 (33.2)
ED visits				
None	6943 (84.9)	5808 (71.0)	5081 (62.2)	4527 (55.4)
Single visit	901 (11.0)	834 (10.2)	798 (9.8)	729 (8.9)
Multiple visits (2+)	323 (4.0)	273 (3.3)	241 (2.9)	199 (2.4)
Missing				
Refused to answer	1 (0.0)	1 (0.0)	2 (0.0)	-
Responded 'do not know'	7 (0.1)	1 (0.0)	6 (0.1)	2 (0.0)
System missing	-	1258 (15.4)	2047 (25.0)	2718 (33.2)
Outpatient visits				

None	4824 (59.0)	3761 (46.0)	3439 (42.1)	3030 (37.1)
Single visit	1315 (16.1)	1271 (15.5)	1125 (13.8)	1020 (12.5)
Multiple visits (2+)	2029 (24.8)	1881 (23.0)	1553 (19.0)	1401 (17.1)
Missing				
Refused to answer	1 (0.0)	-	2 (0.0)	-
Responded 'do not know'	6 (0.1)	4 (0.0)	9 (0.1)	6 (0.1)
System missing	-	1258 (15.4)	2047 (25.0)	2718 (33.2)
Inpatient admissions				
None	7115 (87.0)	5956 (72.9)	5255 (64.3)	4600 (56.3)
Single admission	770 (9.4)	681 (8.3)	625 (7.6)	623 (7.6)
Multiple admissions (2+)	287 (3.5)	278 (3.4)	244 (3.0)	230 (2.8)
Missing				
Refused to answer	-	1 (0.0)	2 (0.0)	1 (0.0)
Responded 'do not know'	3 (0.0)	1 (0.0)	2 (0.0)	3 (0.0)
System missing	-	1258 (15.4)	2047 (25.0)	2718 (33.2)

Step 0: Explore data at a cross-sectional level

Prior to commencing LTA building, cross-sectional data was examined using LCA, as advocated by Ryoo and colleagues (2018). The goal of this preliminary examination was to identify the existence of distinct homogenous groups at each of the three time points and to determine if the same number of latent classes was observed at each of the three times points. Table 6-2 summarises the results of this preliminary cross-sectional LCA work.

Table 6-2: Results of LCA for healthcare utilisation indicators at each wave of TILDA data collection (Step 0)

# classes	Fit indices				Likelihood ratio tests		Entropy
	LL	BIC	ssBIC	AIC	VLMR *p*	Adjusted LMR *p*	
Wave 1							
1	-25070.680	50231.447	50199.669	50161.360			
2	-23622.332	47433.647	47366.913	47286.464	<.0001	<.0001	.649
3	-23426.318	47140.915	47039.225	46916.636	<.0001	<.0001	.591
4	-23323.546	**47034.467**	46897.821	46733.092	**<.0001**	**<.0001**	**.717**
5	-23283.704	47053.878	**46882.277**	**46675.408**	1.00	.1.00	.611
6	-23273.510	47131.867	46925.309	46676.301	.5873	.5902	.627
Wave 2							
1	-21506.693	43101.804	43070.026	43033.387			
2	-20215.639	40616.954	40500.221	40473.277	<.0001	<.0001	.675
3	-20042.490	40367.915	40266.227	40148.979	<.0001	<.0001	.555
4	-19959.411	**40299.016**	**40162.372**	40004.821	.0005	.0005	**.661**
5	-19930.033	40337.520	40165.921	**39968.066**	**.0004**	**.0005**	.586
Wave 3							
1	-18911.826	37910.856	37879.079	37843.653			
2	-17719.070	35261.267	35554.535	35480.141	<.0001	<.0001	**.711**
3	-17571.965	**35422.979**	35321.292	35207.930	<.0001	<.0001	.609
4	-17525.931	35426.836	**35290.193**	35137.863	**.0466**	**.0486**	.669
5	-17498.980	35468.857	35297.260	**35105.961**	.9625	.9632	.618

Note. LL= log likelihood; VLMR = Vuong-Lo-Mendell Rubin. The best solution for the corresponding fit index is indicated in bold. A six-class solution could not be identified at Wave 2 or Wave 3.

At Wave 1 BIC and entropy favoured a 4-class solution, whilst ssBIC and AIC suggested a five-class solution. The Lo-Mendell Rubin (LMR) tests favoured the selection of a four-class solution. An examination of the probability plots (Appendix K) suggested that the inclusion of a fourth class did not provide any additional meaningful interpretations. Furthermore, the inclusion of a fourth class resulted in the formation of two small classes both comprised of 7% of the sample.

Nylund et al., (2007) argue that if the LMR incorrectly identifies a model, it generally tends to overestimate the number of classes present., Nylund and colleagues (2007) further argue that if using LMR and one obtains a non-significant *p* value for LMR, one can have reasonable confidence that it indicates the maximum number of classes present, but also that there might actually be fewer classes. The authors further argue that overestimation of the number of classes is preferable to an underestimation, "as the true *k* class solution can still be extracted from the *k*+1 class solution" (Nylund et al., 2007, p. 562). It could be the case where one of the classes in the *k*+1 solution may be very small, and thus hard to identify or that one of the classes does not make substantive sense (Nylund et al., 2007). Thus, the researcher may be justified in selecting the *k* class solution despite the LMR identifying a *k*+1 solution.

Meus, van de Schoot, Klimstra and Branje (2011) also contend that if the addition of another class results in the formation of a class which is a slight variation of one already in existence, then the more parsimonious solution should be accepted. Given that the selection of the optimal number of classes should not be conducted using statistical criteria alone (Chen et al., 2008, Collins & Lanza, 2010; van de Schoot et al., 2016) and that parsimony and interpretability of the classes are key considerations (Collins & Lanza, 2010), the more parsimonious three-class solution was selected as the optimal solution.

For Wave 2 BIC, ssBIC and entropy favoured a four-class solution. The AIC suggested a five-class model as the optimal solution. The likelihood ratio tests could not be conducted as a six-class solution was not identified within the data irrespective of an increase to 2000 starts and 500 final stage optimisations. The inclusion of a fourth class resulted in the identification of two classes in the middle of the distribution that were not qualitatively different from one another. The inclusion of a fifth class resulted in a similar plot, with the three classes in the middle of the distribution showing some small distinctions. However, one of the classes at the extreme end of the distribution was very small (approx. 3%) and another class comprised of

only approximately 6% of the sample. When considering transitions between classes, the next step in the analysis, each class should represent at least 5% of the sample in order to facilitate such transitions (Meus et al., 2011). Thus, a three-class solution was selected on the grounds of parsimony and interpretability.

At Wave 3 the BIC favoured a 3-class solution, the ssBIC favoured a 4-class solution, AIC favoured a 5-class solution and entropy favoured a 2-class solution. The likelihood ratio tests favoured a 4-class solution. A 6-class solution could not be identified within the data. The inclusion of a fourth class did not add any meaningful contribution despite having a more favourable ssBIC. The addition of a fifth class resulted in two classes with little discernible difference. Furthermore, two of the classes comprised of 6-8% of the sample. Again, a 3-class solution was identified as the most meaningful explanation of the data.

Based upon the meaningful interpretation provided by the 3-class solution it was selected as the basis for further analysis using LTA. Ryoo and colleagues (2018) previously found two classes at the centre of a four-class solution to merge when specified as a three-class LTA, whereas the classes at either end of the distribution were found to remain relatively unchanged. Ryoo et al., (2018) argue that in a more diverse sample the distinction between these two classes may become more apparent.

Step 1: Test measurement invariance using LTA

Following the preliminary cross-sectional LCA analysis, an LTA model was specified, following which longitudinal measurement invariance was tested. Item thresholds were constrained to be equal over time. Results indicated that the measurement invariance held (Table 6-3), with the decrease in BIC of 221.742 in excess of Raftery's (1995) recommendations for strong evidence for measurement invariance.

Table 6-3: Results of longitudinal measurement invariance for three class LTA (Step 1)

	Loglikelihood	# free parameters	BIC	ssBIC	AIC	Entropy
Non-invariance	-51137.812	104	103182.569	102852.085	102483.624	.733
Invariance	-51288.560	44	102960.827	102821.007	102665.120	.735

Step 2: Define the latent statuses

Based upon the probabilities for each of the four indicators of healthcare utilisation the three latent statuses were defined as *effective referral* (LS1), *multiple utilisation* (LS2), and *primary care only utilisation* (LS3) (Table 6-4). The *effective referral utilisation* (LS1) status was characterised by higher probabilities of multiple GP visits and outpatient visits with a low probability of ED visits and inpatient admissions. This status was defined as an '*effective referral'* as it was characterised by higher probability of GP and outpatient visits in combination with a low probability of ED visits or inpatient admissions. The *multiple utilisation* status (LS2) showed moderate probabilities of endorsement of the various categories of GP visits, with thus, a low probability of endorsing the 'no GP visit' category.

Table 6-4: Probabilities of item parameters of healthcare utilisation across three waves of TILDA data collection

		Latent status		
	Response	**LS1**	**LS2**	**LS3**
GP visits	None	.002	.014	.188
	1-4	**.517**	**.417**	**.771**
	5-9	**.313**	**.299**	.039
	10-14	.137	.178	.003
	15+	.031	.093	.000
ED visits	None	**.925**	**.314**	**.947**

	Single visit	.075	**.465**	.048
	Multiple (2+)	.000	**.222**	.005
Outpatient	None	**.319**	**.217**	**.791**
	Single visit	**.252**	**.209**	.139
	Multiple (2+)	**.429**	**.574**	.071
Inpatient	None	**.945**	**.324**	**.983**
	Single visit	.055	**.452**	.015
	Multiple (2+)	.000	**.224**	.002

Note. Bold indicates probability >.20.

Furthermore, probabilities of endorsement of ED visits, outpatient visits and inpatient admissions were much higher for LS2 than either of the other latent statuses. The *primary care only utilisation* (LS3) status consisted of a high probability (.771) of endorsing 1-4 GP visits within the last year and low probabilities of endorsement of secondary healthcare such as ED, outpatient, or inpatient healthcare usage.

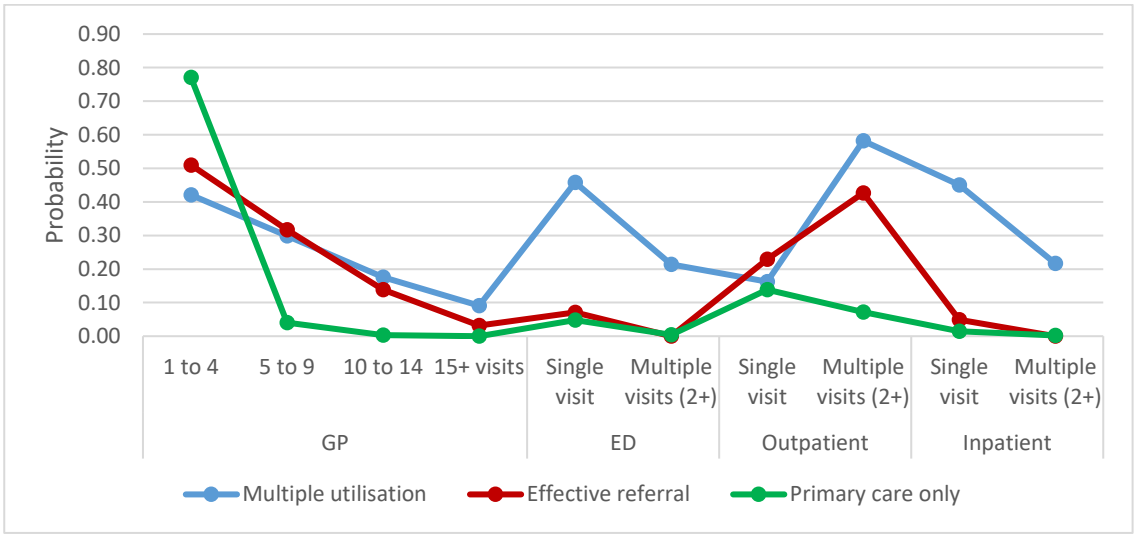

Figure 6-4: Probability plot for latent statuses of healthcare utilisation from Wave 1 to Wave 3

The latent status prevalence and transitions across the three waves can be observed in Table 6-5. The probabilities of being in the *effective referral* group were relatively high across the three time points: 0.28 at Wave 1, 0.30 at Wave 2 and 0.28 at Wave 3. The prevalence rates indicated that the *multiple utilisation* group were the lowest among the three statuses, 0.14 at Wave 1, 0.14 at Wave 2 and 0.17 at Wave 3. Also, the prevalence rates indicated that the probabilities of being in the *primary care only utilisation* group were the highest across all three waves.

Table 6-5: Latent status prevalence (δ) estimates and transition matrix (τ) estimates of healthcare utilisation over three time points

	δ estimate				**τ^a estimate**			**τ^b estimate**		
Time	**LS1**	**LS2**	**LS3**		**LS1**	**LS2**	**LS3**	**LS1**	**LS2**	**LS3**
1	.2791	.1352	.5858	LS1	**.774**	**.200**	.026	**.704**	**.225**	**.**071
2	.3011	.1436	.5553	LS2	**.405**	**.369**	.226	**.414**	**.394**	.192
3	.2804	.1653	.5543	LS3	.043	.074	**.884**	.035	.080	**.885**

Note. LS1 = effective referral utilisation; LS2 = multiple utilisation; LS3 = primary care only utilisation. [a] Transition matrix from Wave 1 (rows) to Wave 2 (columns). [b] Transition matrix from Wave 2 (rows) to Wave 3 (columns). Bold indicates probability >.20.

The *effective referral* status (LS1) tended to stay within this status from Wave 1 to Wave 2 (.774) and also from Wave 2 to Wave 3 (.704). As discussed in Chapter 2 (Methodology), data collection was conducted at approx. two-yearly intervals. Similarly, the *primary care only utilisation* (LS3) status tended to stay within the LS3 group from Wave 1 to Wave 2 (.884) and from Wave 2 to Wave 3 (.885). The *multiple utilisation* (LS2) status were more likely to transition into *effective referral* (LS1) (.405) from Wave 1 to Wave 2 rather than stay within LS2 (.369). The *multiple utilisation* group were also less likely to transition into the *primary care only utilisation* group (.226) in comparison to staying within LS2 from Wave 1 to Wave 2. When the transition from Wave 2 to Wave 3 was examined, the multiple utilisation group were more likely to transition into the *effective referral* status (.414) than remain within

LS2 (.394). However, that said more movement was evident for LS2 at both time transitions in comparison with either of the other two statuses.

Step 3: Test transition probability invariance

Transition probability invariance of the three-status model was tested and reported in Table 6-6. The results indicated that the invariant model had lower AIC and BIC values. Furthermore, Δ BIC= 45.881 provided evidence for a better fitting model (>10) when considered according to the recommendations of Raftery (1995).

Table 6-6: Results of transition probability invariance for three latent status solution

	Loglikelihood	**# free parameters**	**BIC**	**ssBIC**	**AIC**	**Entropy**
Non-invariant	-51288.560	44	102960.827	102821.007	102665.120	.735
Invariant	-51291.781	38	102914.946	102794.192	102659.562	.733

6.6 Discussion

The present study used latent transition analysis to ascertain whether meaningful groups or latent statuses characterised by different types of healthcare utilisation by older adults could be identified across three different time points. Preliminary analysis using LCA identified three distinct classes of healthcare utilisation that were replicated across the three time points. Whilst comparative fit indices and likelihood ratio tests suggested the possibility of a 4-class or 5-class solution, a review of the probability plots indicated that no substantive additional interpretation was to be gleaned by the inclusion of additional and often small classes (Appendix K). Accordingly, LTA analysis proceeded using a 3-class solution. The three classes observed indicated a larger class of low healthcare utilisation restricted to primary care, a medium-sized class with higher probability of GP visits and outpatient visits (*effective*

referral healthcare utilisation), and a third smaller class with a higher probability of multiple types of healthcare usage across both primary and secondary care.

Measurement invariance, a fundamental aspect of LTA model building was established, as indicated by the reduction in BIC signalling improved model fit. Thus, the class patterns identified were equivalent over time, indicating no differences in the latent statuses at each measurement occasion. Constraining the transition probabilities over time also resulted in a reduction in BIC, indicating an improvement in model fit.

In general, over half of the cohort were found to display healthcare usage that consisted of GP visits only (LS3), and this proportion of the sample remained relatively stable over time. Similarly, just under a third of the sample was comprised of *effective referral utilisation*, displaying a high likelihood of endorsing GP visits as well as outpatient visits. Such a status is not surprising given that GPs largely act as the gatekeepers to other forms of healthcare usage, particularly in the form of referral to specialists. The co-occurrence of a high likelihood of outpatient visit endorsement suggests that this status can be defined as an appropriate step up to required care when necessary. All of the latent statuses identified in the present study were characterised by moderate to high probabilities of endorsing GP visits, reinforcing the view that GPs are central to healthcare for older people within Irish society (Barrett et al., 2011; Collins, O'Shea, Cunniffe & Finegan, 2018) and lending support to the contention that primary care must be adequately resourced in order to meet the healthcare demands of increasing complexity associated with multiple chronic conditions (HSE, 2017). The smallest status prevalence belonged to the *multiple utilisation* group (LS2) who exhibited a likelihood of endorsing all four of the healthcare utilisation indicators.

With respect to probability of transitioning from one latent status to another over the three waves of TILDA data collection, the results indicated that movement between the statuses was more likely to occur for LS1 and LS2 statuses. Moving from LS2 into LS1 could be

seen to be an improvement in chronic disease management for the individual and can be observed to occur from Wave 1 to Wave 2, as well as from Wave 2 to Wave 3. The probability of transitioning from LS1 to LS2 was slightly higher from Wave 2 to Wave 3 and could be indicative of those participants who were in LS2 at Wave 1, had transitioned into LS1 at Wave 2 and who were then transitioning back to LS2 by Wave 3.

Transitions out of, as well as into the *multiple utilisation* (LS2) status may serve as potential targets for future study. This will be further explored in Chapter 8 through the incorporation of covariates into the model to explain what governs these transitions. The identification of both pathways (into LS2 and out from LS2) as a future study target not only provides an opportunity to deepen our understanding of healthcare usage within this cohort more broadly, but also aids in comparing the differential impact of those factors which have high mutability on health service usage.

The results presented here indicated that healthcare utilisation by older people in the Republic of Ireland (ROI) is relatively stable across approximately six years, with the majority of participants remaining within their status during this time. Transitions that did occur were out of the *multiple utilisation* group either into the *primary care only utilisation* or *effective referral utilisation* groups. The majority of older adults were observed to adopt healthcare utilisation patterns that were stable over time, namely those in LS1 and LS3. Both of these latent statuses were characterised by moderate to high probabilities of endorsing GP visits and/or outpatient visits, with low probabilities of ED visits and inpatient admissions. Thus, usage of more expensive secondary care is perhaps less prevalent than would previously have been thought.

The identification of heterogeneity in healthcare utilisation within the TILDA cohort provides clarity to the contention that all older people are frequent attenders to the different healthcare access points across the primary-secondary care interface. The *multiple utilisation* status, whilst present across all time points, was the smallest of the three latent statuses

identified, indicating that multiple types of healthcare usage by older people may not be as prevalent as the general concern regarding adequate healthcare provision for this cohort would suggest.

The analysis presented herein must be considered in light of several methodological limitations. The number of categories of GP visits was different from that of the other healthcare utilisation indictors. It is possible that the fewer category levels in the ED visits, outpatient visits and inpatient admission variables may absorb some of the heterogeneity in existence within the sample. The publicly available form of the TILDA dataset reports categorical information in such a way as to ensure the anonymity of respondents is maintained. Thus, in the present study, the lack of a more granulated assessment of secondary care healthcare usage could not be overcome. Future replications of the current analysis could be considered in collaboration with TILDA researchers on the original dataset through analysis conducted at the secure data location site.

The present study utilises self-report healthcare utilisation data which is subject to recall bias on the part of the participant. Furthermore, the disparity between the interview questions regarding healthcare utilisation (in the last 12 months) versus other study questions (since the last time of interview approximately 24 months) also increases the risk of reporting error.

Wallace et al., (2018) compared healthcare utilisation rates of a sub-sample of TILDA participants with a comparable cohort where such information was available in an electronic medical record. In multivariate analyses adjusted for cofounders such as age, gender, number of prescribed medications, education, social class, health insurance coverage there was no difference between the two cohorts in the number of GP visits and outpatient visits reported. However, TILDA respondents reported more ED visits. Wallace and colleagues (2018) propose that the possibility of underreporting of ED visits in the GP's electronic medical record must be

also be considered, given that patients may not report all visits to the GP and issues can arise with respect to the receipt of electronic notifications for ED visits from secondary care. Thus, whilst the limitations of self-report healthcare utilisation data must be borne in mind, such reporting need not undermine the value of such information, which ordinarily may be more difficult to gather by other means.

The data examined in the present study included all individuals who were aged 50 years and over at the first Wave 1 interview and are thus a considerably younger cohort of individuals than those examined in earlier chapters. Whilst there is no consensus on a cut-off age by which one is considered to be an older person, the proportion of TILDA participants in the present study who were aged 65 years or older by Wave 3 was 55%. This was an increase compared with Wave 1, where 39% of the sample who provided data up until Wave 3 were aged 65 years or older. Given the considerable length of time between the 3 waves of TILDA data capture (approx. six years) it was considered prudent to include all participants who could have become aged 65 years by Wave 3. Thus, rather than to reduce the sample size available, an important consideration for longitudinal studies where attrition is an ongoing challenge, it was decided to include all TILDA participants who were aged 50 years and over at Wave 1 and exclude those aged below this threshold. Such a strategy would better facilitate comparisons with other studies conducted using the TILDA data, which have been largely conducted using participants aged 50 years and upwards.

Furthermore, the examination of a cohort from the ROI limits the direct comparisons that can be made with the Northern Irish samples examined in Chapters 3 and 4, given considerable differences in the provision of universal healthcare between both jurisdictions. That said, within ROI those older adults over the age of 70 years qualify for universal healthcare, in addition to those whose income falls below the means-tested threshold. Future research is needed to examine whether the latent statuses observed in the present study are

relevant to the NI population once sufficient waves of data collection have been conducted in the NICOLA study. The analysis presented here provides an adequate foundation for such future work.

Notwithstanding the aforementioned limitations, the present study may serve to support better allocation of resources to support those older adults who access multiple healthcare services. It has been estimated that 30-60% of healthcare costs relate to the care of older adults (Hasan et al., 2017). The analysis presented here has identified that only 15% of community dwelling older adults in Ireland use multiple healthcare services at both primary and secondary care levels. A further 30% utilise GP and outpatient services. Notably, considerable movement between these two types of usage profiles occurs over time. Movement from *effective referral utilisation* to *multiple utilisation* indicates an increase in healthcare need that is not being met in a timely manner by existing service interactions. Prolonged waiting times for outpatient specialist appointments and procedures can lead to an escalation of care usage when the clinical status of the individual deteriorates further in the intervening period. Yet, despite this, a reduction in the number of acute care beds has been observed internationally (Appleby, 2013). Furthermore, an increase in the number of hospital admissions and readmissions for older adults has been observed (Godden et al., 2019). An ageing population, with increased levels of clinical complexity, is likely to exert additional demands upon health services for many years to come.

It is increasingly being recognised that older adults may benefit more from integrated models of care provided within the communities within which they live (DOH, 2001; HSE, 2017). Hospital admissions themselves can lead to declines in physical and cognitive functioning of older adults (Covinsky et al., 2003; Hirsch et al., 1990), stressing the need for a responsive model of care that provides the appropriate level of healthcare in the right setting for the individual. Fundamental to the delivery of such a responsive model is the need to

prioritise care for those older adults who have greater healthcare needs. The identification of those characteristics that differentiate between latent populations of healthcare service usage may provide valuable opportunities where interventions can be targeted to prevent unnecessary escalation to multiple service use.

6.7 Conclusion

To date, there has been a lack of studies that have examined changes in healthcare utilisation by older people over time. The results indicated that three latent statuses of healthcare utilisation could be discerned within the sample population. Measurement invariance also indicated that these latent statuses remained stable over the three measurement occasions, which occurred at two-yearly intervals. The findings presented here support the view that the identification of latent sub-populations of healthcare utilisation provides a more nuanced view of healthcare usage by older people over and above the examination of individual indicators of healthcare usage. What was particularly interesting was that the greater levels of transitioning across statuses was for the LS2 cohort, as evidenced in their lower probability of remaining within this status from Wave 1 to Wave 2 and from Wave 2 to Wave 3. Given that this status was defined as those with multiple types of healthcare usage it is necessary to ask the question as to what influences the transition from this status into that of others? Similarly, movement into LS2 from other latent statuses requires further characterisation. This evidence will be further built upon in the following two chapters through an examination of longitudinal change in a range of theoretically relevant covariates, in preparation for their inclusion to explain the transition between statuses observed here. Of particular interest is to identify the characteristics that best describe those older people who transition out of LS2 at either time point, as this could help identify targets for future intervention.

7 A multidimensional model of healthcare utilisation: selection and examination of relevant covariates for further analysis

7.1 Chapter overview

The purpose of this chapter is to serve as a foundation to the analyses presented in Chapter 8. This chapter functions to identify and operationalise potential covariates which may explain differences in healthcare utilisation patterns, as identified in Chapter 6 (latent transition analysis). This chapter will identify, select, and prepare covariate variables for inclusion in the subsequent multivariate analyses presented in Chapter 8. In order to retain the breadth of possible covariates for inclusion in Chapter 8, this chapter seeks to summarise the longitudinal change that occurs in these covariates themselves using data reduction techniques.

7.2 Introduction

The Andersen Behavioural Model (Andersen, 1968, 1995; Andersen & Newman, 1973) proposes that the decision to access healthcare services is influenced by a multitude of factors, which could be broadly characterised as either predisposing, enabling or need factors. This conceptual framework proposes the broader view that environmental and social characteristics influence healthcare usage in addition to individual health behaviours. Thus, according to this model, utilisation of health services must be considered within the context of aspects such as occupation, educational attainment, location of residence, and access to transport and not merely regard clinical diagnoses, symptoms, and disability level.

Taking a broader view of what governs healthcare usage may prove advantageous for service planning and delivery. Within the context of a rapidly growing ageing population it is imperative that those factors that influence service usage are identified. The identification of demographic characteristics that show differential associations with patterns of healthcare usage can augment census information with respect to planning for future service provision.

Whilst many disease characteristics may not be modifiable, the identification of additional factors, with greater degrees of mutability, may also allow for the development of an adaptive service.

The conceptual work of Andersen and colleagues (Andersen, 1968, 1995; Andersen & Newman, 1973) provide a systematic means of identifying potential covariates for examination without being prescriptive in what must be included. Rather, their work proposes categories for consideration. Therefore, the framework can be adapted to consider aspects that are more relevant to the population under examination. For older adults, an accumulation of factors over the life course may result in a considerable number to be considered. Table 7-1 outlines how such factors may be considered within the framework, with examples provided for each category.

Table 7-1: Possible characteristics that influence health service utilisation (adapted from Andersen & Newman, 1973)

Predisposing	Enabling	Illness/need
Demographic	***Family***	***Perceived***
e.g. age, sex, marital status	e.g. income, health insurance, access to services	e.g. symptoms, diagnoses, disability level
Social structural	***Community***	***Evaluated***
e.g. education, occupation, family size	e.g. urban/rural character, region of country, services available	e.g. symptoms, diagnoses
Beliefs		
e.g. health beliefs, health literacy		

Furthermore, Andersen (1995) considers that a relationship exists between healthcare service use itself and the triad of predisposing, enabling, and need factors. In other words, existing use of health services may influence future use of health services via these categories. For example, a healthcare visit that results in the initiation of a new sedative medication, could limit ability to drive and thus restrict access to future healthcare visits, if no other means of transport is accessible to the individual. Similarly, a hospital admission may alter a person's attitudes towards health services thereby influencing future engagement with similar services. Thus, not only must we consider the breadth of factors that come to influence levels of health service usage, but also that which influence service utilisation going forward. The findings identified in Chapter 6 indicate that subpopulations of healthcare usage exist within the older Irish adult population, differentiated by intensity of service usage. Noticeable movement between these latent statuses was identified over three time points. The next logical step is to understand what governs movement from one status to another. In order to facilitate this step consideration must be given to potential covariates for inclusion.

7.2.1 Multimorbidity

Improvements in life expectancy, largely due to advances in public health including improved sanitation, air quality, housing, education, nutrition, antibiotics, vaccinations and chemotherapeutic advances, has resulted in the need for chronic disease management within the population, which is associated with higher levels of healthcare utilisation (Hutt et al., 2004; Lehnert et al., 2011). An estimated one third of emergency admissions to NHS hospital beds among those aged 65 years and older are related to chronic conditions (Hutt et al., 2004). Multimorbidity, the presence of multiple chronic conditions, is also consistently shown to be more prevalent among older sections of the population (Violan et al., 2014). Among those aged ≥65 years prevalence estimates range from 55-83% in England, 65-82% in Scotland, 80-87% in Spain (Barnett et al., 2012; Cassell et al., 2018; Violan et al., 2013). Among those Australians aged ≥75 years it is estimated that 83% have multimorbidity (Britt et al., 2008). An

examination of Medicare beneficiaries aged ≥65 years in the US revealed that 43% had ≥ 3 or more chronic conditions and 24% had ≥ 4 chronic conditions (Wolff et al., 2002). An analysis of the top 5% of highest cost patients treated within the US Veterans Affairs health system identified that 77% of them reported ≥3 chronic conditions and 41% reported ≥ five chronic conditions (Zulman et al., 2015). Hernandez, Reilly & Kenny (2019) report that the lifetime prevalence of multimorbidity to approximate 73% in the TILDA cohort.

Management of multimorbidity places additional demands on health services and can be evidenced in the increased expenditure observed in the US, where healthcare spending on multimorbidity care increased from 78% in 1998 to 84% by 2010 (Anderson, 2010). In the US, approximately 80% of Medicare expenditure relates to those with four or more chronic conditions (Wolff et al., 2002). Anderson (2010) postulates that healthcare spending for one chronic condition is approximately three times greater than that for someone with no chronic illness, and that it is approximately 17 times greater when someone has ≥5 long term conditions. Båhler et al., (2015) reported higher cost estimates from their analysis of insurance claims data among community-dwelling older people in Switzerland. Total healthcare costs were 5.5 times higher for multimorbid patients when compared with those with none or only one long term condition (Båhler et al., 2015). Each additional chronic condition was associated with a 33% increase in costs and 3.2 additional consultations (Båhler et al., 2015). In addition to the degree of multimorbidity, the number of healthcare consultations in the previous year was also a significant predictor of healthcare utilisation, congruent with findings from Chapters 3 and 4 (Båhler et al., 2015).

Those with multimorbidity are more likely to be hospitalised, have longer hospital stays, receive more prescription medications, and have increased physician visits (Cassell et al., 2018; Glynn et al., 2011; Marengoni et al., 2011; Palladino et al., 2016). It is estimated that 80% of GP consultations and 60% of hospital bed days are related to chronic diseases (DOHC,

2008). In a study examining a large cohort representative of the UK adult population, it was found that approximately 53% GP consultations, 79% of prescriptions and 56% of hospital admissions were accounted for by those with multimorbidity (Cassell et al., 2018). Furthermore, the costs and risk of avoidable hospital admissions increase dramatically with the number of comorbidities (Wolff et al., 2002). Those with ≥ 4 chronic conditions were more than 90 times more likely to experience a hospitalisation that could have been prevented with more appropriate care at a primary care level and a hospital admission with preventable complications (Wolff et al., 2002).

Boyd and Fortin (2010) claim that those with multimorbidity are less likely to have their needs met by modern healthcare systems, arguing that existing systems are fragmented, incomplete, and thus ineffective. There is considerable evidence that the distribution of multimorbidity, and thus associated healthcare needs, is influenced by other demographic factors in addition to age. Those who live alone are more likely to report multimorbidity and single disease morbidity than those living as a couple (Savva & McDaid., 2011). Associations have also been identified between a higher likelihood of multimorbidity and lower socioeconomic status (Barnett et al., 2012; Cassell et al., 2018; Savva & McDaid, 2011; Violan et al., 2014). This risk has been shown to be more pronounced for those living in Northern Ireland than in the Republic of Ireland (Savva & McDaid, 2011). Furthermore, regional differences in levels of multimorbidity have been identified across Northern Ireland and the Republic of Ireland, with approximately a 2% variance in multimorbidity across ROI but a 4% variance observed across Northern Ireland (Savva & McDaid 2011).

In light of such evidence it is unsurprising that Boyd and Fortin (2010) argue for an approach to care that is patient-centred and family-centred and away from a focus on single disease management. Thus, the adage ‘the whole is greater than the sum of its parts’ aptly captures the need for a broader perspective when considering healthcare service need, and

thus supply. The accumulation of many factors over the life course demands that any evaluation of healthcare utilisation by older people incorporate a comprehensive assessment.

7.2.2 Frailty

Increasing attention is being placed upon the functional status of older people as opposed to chronological age when examining medical need within this cohort. Frailty is a multidimensional state or condition of increased vulnerability characterised by an inability to maintain homeostasis in the presence of stressors, underpinned by an age-related decline in physiological reserve (Rockwood et al., 2005; Xue, 2011). It is typified by diminished strength, reduced physical functioning and exhaustion accompanied by unintentional weight loss and loss of muscle mass (Fried et al., 2001). More specifically, Fried and colleagues (2001) operationalised the frailty phenotype as a syndrome comprised of three or more criteria including unintentional weight loss (10 lbs in the past year), self-reported exhaustion, weakness (measured using grip strength), slow walking speed and low levels of physical activity. In this context, a relatively minor stressor, such as an infection or the addition of a new medication, leads to a dramatic and disproportionate change in the status of the individual, resulting in dramatic consequences (Clegg, Young, Iliffe, Rikkert & Rockwood, 2013). The older person may transition “from independent to dependent; mobile to immobile; postural stability to falling; lucid to delirious” (Clegg et al., 2013, p. 753).

Notably, frailty may possess some overlap with comorbidity and disability but is nevertheless a distinct state which poses independent risks for adverse events among older people including an increased risk of falls, increased disability, hospitalisation, institutionalisation, and death (Ensrud et al., 2008; Fried et al., 2001; Rockwood et al., 2004). An intermediate or pre-frail state is indicated by the presence of one or two of these criteria and is accompanied by an increased risk of becoming frail in the intervening three to four years (Fried et al., 2001).

Frailty has also been operationalised using a cumulative deficits approach whereby a risk index is calculated to represent the proportion of deficits that have been accumulated (Mitnitski, Mogilner & Rockwood, 2001). Indicators selected for assessment as deficits are varied but broadly speaking include symptoms, diseases, disability, and results of clinical investigations. Thus, a frailty index can be considered as a quantitative assessment of the frailty syndrome that seeks to assess aging at an individual level (Mitnitski et al., 2001). Hence, "the frailty index can be considered a state variable, in that it characterises the whole health of individuals and validly classifies risk across a wide range of people" (Rockwood & Mitnitski, 2007, p. 725). In doing so, the frailty index provides a more sensitive measure to examine associations with outcomes, rather than the phenotypical approach which may be more beneficial in a clinical setting (Rockwood, Andrew & Mitnitski, 2007).

Deficit accumulation frailty indices have been shown to predict mortality, disability, falls and institutionalisation (Rockwood et al., 2005; Rockwood & Mitnitski, 2007; Searle, Mitnitski, Gahbauer, Gill & Rockwood, 2008; Shi, McCarthy, Mitchell & Kim, 2020; Song, Mitnitski & Rockwood, 2010). Frailty has also been shown to be associated with increased levels of GP and practice nurse consultations, hospital admissions and hospital length of stay (Han et al., 2019). A retrospective longitudinal analysis of the Clinical Research Datalink in the UK identified that the rate of consultations and admissions increased with increasing severity of frailty, equating to a total annual cost to the NHS of £5.8 billion per annum (Han et al., 2019).

7.2.3 Polypharmacy

Older adults who are pre-frail and frail are more likely to receive polypharmacy than those who are non-frail (Palmer et al., 2019; Saum et al., 2017). The significant association between polypharmacy and pre-frailty or frailty persists even following adjustment for comorbidity (Palmer et al., 2019). Furthermore, those who receive polypharmacy are at a

higher risk for incident frailty at 3 year follow up (Saum et al., 2017). However, the lack of longitudinal studies examining polypharmacy and frailty limits any inferences that can be made regarding the causal direction that drives this association (Palmer et al., 2019). Furthermore, the breadth in definitions of polypharmacy make it difficult to conduct meta-analyses (Masnoon et al., 2017). The coexistence of frailty and polypharmacy deserves particular attention as those with both are found to have longer hospital lengths of stay, more discharges to nursing homes and are more likely to be readmitted to hospital (Rosted et al., 2016).

Previous examinations of polypharmacy defined as ≥5 medications, within the TILDA cohort identified an increase in point prevalence from 21% at Wave 1 to 26% at Wave 2 (TILDA, 2014). Using the same threshold definition for polypharmacy, an examination of prescription claims data for older Irish adults (≥65 years) living in the former Eastern Health Board region reported an increase in polypharmacy from 18% in 1997 to 60% in 2012 (Moriarty, Hardy, et al., 2015). During the same period, inappropriate prescribing was found to increase from 32% to 37%. An updated examination of the year 2013 revealed that 64% of those aged 45 years and older were in receipt of polypharmacy (Tatum, Curry, Dunne, Walsh & Bennett, 2019).

7.2.4 Falls

Experiencing a fall is an additional healthcare concern among older adults. Approximately 28-35% of those aged ≥ 65 years fall each year, with an increased prevalence observed in those >70 years (WHO, 2007). Those older adults residing in long-term care have higher rates of falls and tend to experience falls with more serious complications such as fractures (Rubenstein, 2006). Functional impairment, cognitive impairment, altered gait, cardiovascular disorders, and the use of psychotropic medications are all recognised risk factors for falls (Gama & Gómez-Conesa, 2008; Rubenstein, 2006; Stenhagen, Ekström, Nordell & Elmståhl, 2013).

In the UK, 30% of falls-related ED visits and 65% of falls-related hospital admissions occur in those aged ≥ 65 years (Scuffham, Legood, Wilson & Kennedy-Martin, 2002). The cost of falls is considerable, totalling £981 million in the UK for the year 1999, with 66% of costs attributable to fallers aged ≥ 75 years (Scuffham, Chaplin & Legood, 2003). ED attendances and hospital admissions were more prevalent among those aged ≥ 75 years, accounting for 66% of total attendances and 78% of admissions, respectively. Those aged ≥75 years were found to be four times more likely to be admitted following an unintentional fall compared with those aged 70-74 years, and 11 times more likely to be admitted when compared to those aged 60-64 years (Scuffham et al., 2003). Older fallers were more likely to be admitted into long-term care following an unintentional fall; 8.6% of those aged 70-74 years were admitted into long-term care and this rose to 27% for those aged ≥ 75 years (Scuffham et al., 2003).

Common outcomes from falls include hip fractures, other fractures, and traumatic brain injuries. An examination of 1760 falls-related hospitalisations among those aged ≥ 65 years in the Eastern region of ROI in 2002 found that 82% had sustained a fracture, with approximately half of these found to be hip fractures (Carey & Laffoy, 2005). Females were found to be more likely to experience a fracture whereas males were more likely to experience a head injury (Carey & Laffoy, 2005), congruent with findings from a Finnish study (Nurmi & Lüthje, 2002). It is worth noting that these falls-related hospital admissions accounted for 76% of all admissions in the ≥ 65 years age group (Carey & Laffoy, 2005). Those resident in long-term care accounted for 6.5% of hospitalisations and 11% of hip fracture cases (Carey & Laffoy, 2005).

Hip fractures are associated with longer hospital stays, increased likelihood of institutionalisation and death (Carey & Laffoy, 2005; Judge et al., 2016; Nazrun, Tzar, Mokhtar & Mohamed, 2014). It is estimated that between 26-31% of those who experience a hip fracture die within a year (Judge et al., 2016). Falls among older people are also related to

psychological sequelae. Several falls-related psychological concerns (Moore & Ellis, 2008), including fear of falling (Tinetti & Speechley, 1989) and falls-related self-efficacy (Tinetti, Richman & Powell, 1990) have been examined within the literature (Hughes, Kneebone, Jones & Brady, 2015). Such concerns can pose additional harm for the older person leading to avoidance of activity, social withdrawal, and muscle deconditioning. Psychological constructs such as anxiety and depression have shown some associations with fear of falling and falls-related self-efficacy, however methodological limitations question the strength and consistency of identified associations (Hughes et al., 2015).

7.2.5 Cognitive impairment

Cognitive impairment, which is increasingly prevalent among older adults, also increases the risk for hospitalisation. Behavioural problems, such as agitation and wandering, place people with dementia at an increased risk of being admitted to hospital (Toot et al., 2013). Those living with dementia possess greater risk of an orthopaedic crisis, such as a fall or fracture, resulting in hospital admission in comparison with those without dementia (Malone et al., 2009; Natalwala et al., 2008; Nourhashemi et al., 2001; Tuppin et al., 2009). People with dementia have also been found to be at greater risk of experiencing a respiratory crisis resulting in hospitalisation compared with people without dementia (Natalwala et al., 2008; Sampson et al., 2009; Tuppin et al., 2009). Similarly, they are at greater risk of experiencing a urological crisis, such as a urinary tract infection, leading to hospital admission, compared with people without dementia (Carter & Porell, 2005; Natalwala et al., 2008; Sampson et al., 2009; Tuppin et al., 2009). Furthermore, those with cognitive impairment experience a significantly longer length of stay on admission and when discharged to their usual place of residence are more likely to experience hospital readmission within 28 days, compared with those without cognitive impairment (Tropea et al., 2018). Such evidence indicates that cognitive functioning is an important aspect to consider when examining healthcare usage among older people.

Altered cognition is also known to occur within older people during periods of acute illness and hospitalisation. Delirium is characterised by rapid onset of confusion and impaired awareness and is independently associated with adverse outcomes (Clegg et al., 2013). It is estimated that delirium occurs in approximately one quarter of older persons admitted to hospital, with an estimated prevalence of 15% in long-term care settings (Inouye et al., 2014; Clegg et al., 2013). Thus, healthcare utilisation in and of itself can result in alterations in cognition for older people. Alterations in cognition can also increase the potential for adverse drug event related hospitalisation as impairments in cognitive functioning can increase the difficulty for the older person to manage their medicines in a safe manner.

7.2.6 Depression and anxiety

Variation in functional status and cognitive function of older people has been shown to be related to depression (Song et al., 2014). The relationship may extend bidirectionally with poorer cognitive function and reduced functional status related to greater depressive symptoms in older adults (Vankova et al., 2008). Poorer cognitive function and impairments in activities of daily living (ADLs) were found to be predictive to depressive symptomology, even when controlling for antidepressant medication use (Vankova et al., 2008). However, the significant relationship between depression and functional dependency among older people appears to be weaker in older old age (≥ 85 years) (Tomita & Burns, 2013).

Depression may exacerbate the relationship between chronic illness and healthcare utilisation. A review of 161 studies that examined the association between depression and healthcare utilisation among those with long term conditions found an overall 49% increase in odds for urgent healthcare utilisation (Dickens et al., 2012). However, studies which included multivariate analyses reported equivocal findings (Dickens et al., 2012). Among community-dwelling older adults, healthcare service utilisation has been shown to be higher for those with depressive mood (Roelands, Van Oyen, Depoorter, Baro & Van Oost, 2003).

The prevalence of depression and anxiety is high in both COPD and chronic heart failure (Yohannes, Willgoss, Baldwin & Connolly, 2010). Furthermore, it is estimated that patients with COPD and comorbid depression or anxiety have greater levels of healthcare utilisation and costs (Gudmundsson et al., 2005; Laurin et al., 2009; Maurer et al., 2008; Xu et al., 2008). Similarly, those patients with chronic heart failure and comorbid depression have been shown to have increased medical costs, increased likelihood of hospital readmission and longer hospital stays (Albert et al., 2009; Jiang et al., 2001; Sullivan, Simon, Spertus & Russo, 2002). Depressive symptoms have been shown to be associated with increased risk of cardiovascular mortality among older adults (Win et al. 2011). A review of 31 studies found that hospitalisation rates, outpatient visits, emergency department visits, medication costs and overall healthcare costs are higher for those with diabetes who have comorbid mental disorders, such as depression, when compared with those without such comorbidity (Hutter, Schnurr & Baumeister, 2010).

7.2.7 Healthcare provision in the Republic of Ireland

Within the Irish healthcare system, GPs adopt the role of gatekeeper, with referrals made to specialist consultants when required. The ROI has a mixed private and publicly funded health service. Those with an income below a certain threshold are given access to free medical care under the General Medical Services (GMS) Scheme through the issuance of a medical card. These individuals are registered to a single GP and receive primary care services free at the point of access, as well as free secondary care within the public hospital system. They also receive access to free prescription medications, subject to an item levy for each item dispensed, as well as a range of additional health services including dental, optical, and aural services. Individuals who are above the threshold for a medical card may qualify for a GP visit card, which has a higher income threshold. Under this scheme the individual is entitled to free access to a registered GP but must pay for prescriptions and hospital charges where required. Those individuals who do not have a medical card, due to being over the income threshold, are

entitled to free public hospital services but have to pay inpatient and outpatient hospital charges. They must also pay for services at a primary care level at the point of access.

For older Irish adults, a GP visit card is available to everyone over the age of 70 years irrespective of means. Many older Irish adults also qualify for a medical card as the income threshold is considerably higher for those aged over 70 years compared with those younger than 70 years. Those medical card holders over the age of 70 years also pay a lower rate of prescription levies. Additional schemes are in existence that provide free medical care based on healthcare need, including the Long Term Illness (LTI) Scheme which provide free medicines and appliances to those with a diagnosis from a list of qualifying conditions, irrespective of age or income. The GMS and LTI schemes are not mutually exclusive and thus individuals may have coverage under both.

Owed to the mixed public-private provision many Irish adults subscribe to health insurance, with a range of coverage options available, including day to day primary care expenses and inpatient treatment in a private hospital. The relative cost of insurance policies means that many people who qualify for GMS do not have private health insurance. However, those who have paid into health insurance during their working life may opt to continue their health insurance coverage whilst they become eligible for free GP care at the age of 70 years. Thus, several health cover permutations exist in ROI, including no cover/entitlement, medical/ GP visit card only, medical /GP visit card and private health insurance, and private health insurance only.

Several policy changes have taken place during the course of TILDA data collection, resulting in altered healthcare entitlements/costs for TILDA participants including: the introduction of means testing for medical card entitlement for those aged 70 years and older in 2009; reductions in the financial threshold for a medical card during austerity Budgets; and the introduction of universal free GP for the over 70s in 2015 *(*TILDA, 2018*).* Thus, when

considering trends of healthcare utilisation, it is important to consider changes in healthcare coverage over time.

With respect to healthcare utilisation by older adults, the literature discussed thus far suggests that broad range of factors may exert an important influence. In order to fully appreciate the 'dynamic and recursive nature' (Andersen, 1995, p. 7) of health service usage the temporal element must also be considered within the breadth of factors examined. In order to build upon the heterogeneity in healthcare usage by older people identified within Chapter 6, it is necessary to consider the role of these key factors in describing qualitative differences in health outcomes, and by doing so identify those mutable characteristics which may serve as targets for increasing capacity and improving efficiency within the health service. A fundamental step to achieve this aim is to summarise change in those elements which influence service usage in a manner that facilitates an interpretable model. Thus, this chapter serves to examine potential variables, identified within the preceding literature, and seeks to summarise those which are time varying in a manner conducive to further analysis.

7.3 Objectives

- Examine key variables available within the TILDA data using the Andersen Behavioural Model as a framework for variable identification
- Operationalise those selected variables, describing key steps taken to transform or summarise any variables for inclusion in subsequent multivariate analyses

7.4 Method

7.4.1 Sampling and participants

The present study utilised data from TILDA as introduced in Chapter 2 (Methodology). Data pertaining to the first three waves of data collection were used, in line with analysis reported in Chapter 6. Further details on data collection and sample demographics can be observed Chapter 2 (Methodology).

7.4.2 Design and variables

This study operationalises relevant covariates for further analysis in Chapter 8, where the influence of these variables on patterns of healthcare utilisation identified in Chapter 6 will be explored. Figure 7-1 outlines potential covariates that will be explored and operationalised in the present chapter. The purpose of this chapter is to capture longitudinal change within these variables in a concise manner, thereby supporting the retention of a breadth of covariates in the multivariate analyses presented in Chapter 8. Data reduction of longitudinal change in numeric covariates is conducted using Latent Growth Curve Models (LGCMs). As such, three waves of data collection are summarised through the estimation of a unique intercept and slope value for each participant for each of these covariates. These intercept and slope values are then examined as predictors of the healthcare utilisation patterns in the analyses presented in Chapter 8.

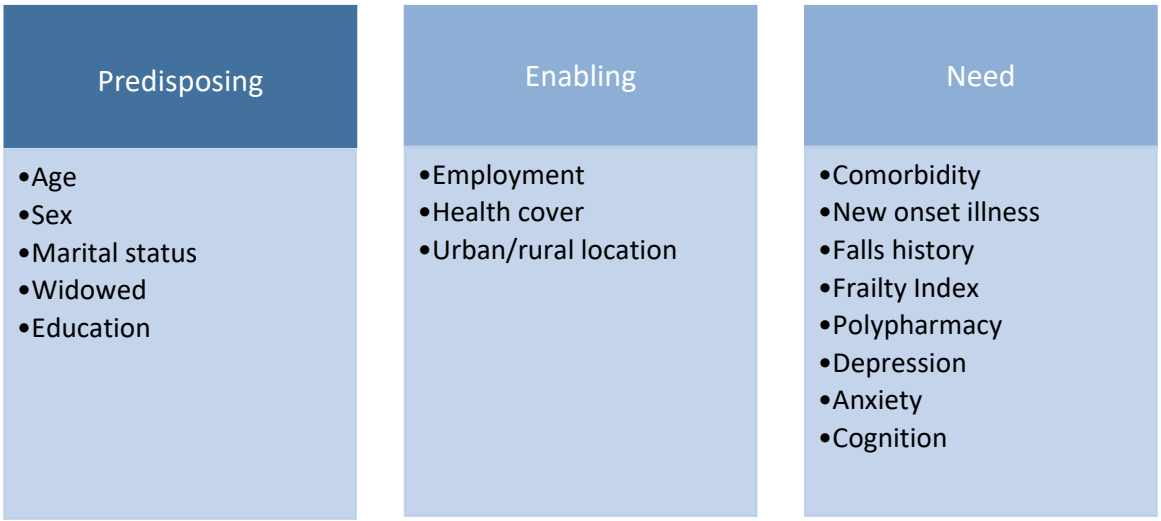

Figure 7-1: Potential covariates for inclusion in further analysis, as per the Andersen Behavioural Model

Variables were coded as follows:

- Age: Continuous variable obtained from Wave 1. Continuous data with top coding such that those participants aged over 80 years at were coded as 80 years of age.
- Sex: Binary covariate obtained from Wave 1, coded such that males=1, females=2.

- Marital status: Categorical variable captured at Wave 1, coded as 1= married, 2=never married, 3= separated/divorced and 4=widowed.
- Widowed: Two binary variables collected at Waves 2 and 3 indicating whether the participant had become widowed (coded 0=No, 1=Yes).
- Education: Categorical variable from Wave 1, coded such that 1=primary/none, 2=secondary and 3=third level/higher.
- Employment: Three categorical variables collected at Waves 1-3, coded such that 1=employed, 2=retired and 3=other.
- Health cover: Three categorical variables collected at Waves 1-3, coded such that 1= no cover, 2=medical or GP visit card only, 3= private health insurance only and 4= medical/GP visit card AND private health insurance (dual cover).
- Urban/rural location: Categorical variable from Wave 1, coded such that 1=Dublin city or county, 2= another town or city and 3=a rural area.
- Falls history: Three binary variables were available at each wave indicating whether the participant experienced a fall in the last 12 months (coded 0=No, 1=Yes).
- Frailty: Several variables were available within the data that could be operationalised to describe frailty status (see next section, Measures).
- Polypharmacy: Number of medications (excluding supplements) recorded at each wave, top-coded at 10.
- Depression: Measured at each wave and captured as a continuous score, ranging from 0-24, with higher scores indicating greater depressive symptomology.
- Anxiety: Measured at each wave and recorded as a continuous score, ranging from 0-21, with higher scores indicating greater anxiety symptoms.
- Cognition: Measured at each wave and recorded as a continuous score, ranging from 0-30, with higher scores indicating better cognitive status.

7.4.3 Measures

7.4.3.1 Frailty (Frailty Index)

An adapted frailty index was created using 30 of 32 functional deficits created by Roe et al., (2017), using the methodology of Searle et al., (2008). The 30 indicators were obtained from the CAPI questionnaire and can be observed in Appendix D. Two questions were omitted, '*feeling lonely'* and '*presence of knee pain'*, on the basis that they were not available in the publicly available dataset across all data collection waves. Furthermore, no suitable proxy measures were available. The variable indicating *'daytime sleepiness'* (variable bh201) was not available across all waves and was substituted with variable mh007 *'everything is an effort'* as the most suitable alternative. Exhaustion is considered to be a key aspect of the frailty syndrome and thus it was decided to retain an item with conceptual overlap rather than omitting it in its entirety. The final 30 indicators had no more than 1% missing data across all data collection waves.

Indicators were scored between 0 and 1 as follows. For binary indicators, the presence of a deficit e.g. 'has difficulty walking 100m' resulted in a score of 1. The absence of said deficit was scored as zero. Categorical indicators with multiple response categories were scored in accordance with increasing severity. For example, three response categories of no difficulty, some difficulty, or much difficulty were scored as 0, 0.5 and 1. Those with four response categories were scored 0, 0.33, 0.66, and 1. Indicators with five possible response categories were scored 0, 0.25, 0.5, 0.75, and 1. A total frailty score was computed for each participant by summating their scores for each individual item. This total frailty score was then divided by the number of indicators (30) to provide a frailty index score, ranging from 0 to 1. Frailty indices were calculated for each of the first three waves of data. Indicators relating to a diagnosis of various morbidities e.g. hypertension, angina etc. were only available at Wave 1 and thus the calculation of frailty indices for Waves 2 and 3 were calculated using the information provided for these indicators at Wave 1 given their invariant nature.

7.4.3.2 Depression (CESD-8)

Depression was measured during the CAPI using the Center for Epidemiologic Studies Depression (CES-D: Radloff, 1977) questionnaire. The CES-D comprises of 20 items designed to measure how often the respondent has felt in line with item statements in the previous week, scored using a Likert response. Following factor analytic examination by O'Halloran, Kenny and King-Kallimanis (2014) a short form version of the CES-D comprised of eight items has been used by the TILDA research team was used from Wave 3 onwards in order to reduce the possibility of response fatigue. These items were scored on a four-point Likert scale (0-3), with two positively worded items reverse scored. A total scale score was computed by summating all responses resulting in a possible range of scores between 0 and 24, with higher scores indicating greater depressive symptomology.

7.4.3.3 Anxiety (HADS-A)

Anxiety was measured using the seven-item anxiety scale of the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983). Participants were asked to report the frequency of which they experience feelings in line with items statements during the past week. Items were scored on a four-point Likert scale (0-3), with responses to two items reverse scored. Total scale scores are summated resulting in a possible range of scores between 0 and 21, with higher scores indicating greater levels of anxiety. At Wave 1 the HADS-A questionnaire was included in the self-completion questionnaire but at subsequent waves was included in the CAPI.

7.4.3.4 Cognition (MMSE)

Cognitive status at each wave was measured using a variety of measures. The analysis presented herein refer to the Mini Mental State Examination (MMSE; Folstein, Folstein & McHugh, 1975) which comprises of 11 tasks aimed at providing a global assessment of cognition. The tasks are designed to assess aspects including orientation, registration,

attention and calculation, recall, and language. Examples of tasks include asking the date and location, completing the serial 7's task and recall of words provided earlier in the assessment. Scores are calculated as per the MMSE scoring instructions such that a maximum that can be scored is 30, with higher scores indicating better cognitive performance. Further details on MMSE scoring can be obtained from the TILDA release guide (TILDA, 2020). At Wave 1 the MMSE assessment was conducted during the health assessment, whereas at subsequent waves it was included during the CAPI.

7.4.4 Analytical plan

A review of the Andsersen Behavioural Model and the available variables was first conducted to identify any variables that required computation. During this preliminary step it was identified that certain variables of interest such as illness or comorbidity level were not readily available within the data and would thus require the creation of new variables. Furthermore, several enabling factors such as health coverage and employment status were available at each wave but would require additional transformation in order to capture their relative stability. Thus, further categorical variables were created to describe the change in categorical variable as either change or no change. Several variables were available within the data that could be operationalised in order to describe frailty status. Thus, an adapted Frailty Index was created, following the previously reported methodology of Roe and colleagues (2017), established within the TILDA data (see Measures section and Appendix D).

The change over time of those covariates which were numeric (frailty, anxiety, depression, polypharmacy, and cognition) were further summarised using latent growth curve models (LGCM). Growth models explore the development of individuals on an outcome over time, using random effects to describe individual differences in development (Muthén & Muthén 1998-2017). LGCM analysis allows for the examination of intraindividual change over time as well as the interindividual variability in this intraindiviudal change (Preacher, Wichman,

MacCallum & Briggs, 2008). Thus, growth models seek to estimate between-person differences in within-person change (Curran, Obeidat & Losardo, 2010).

Individual trajectories are composed of fixed and random effects. The fixed effect represents the value within the population (e.g. population mean) and the random effect represents the random probability distribution around the fixed effect (population variance) (Curran et al., 2010). Thus, the fixed effect is the mean of the trajectory, incorporating all of the individual trajectories within the sample and the random effect is the variance in individual trajectories around this group mean (Curran et al., 2010). Crucially, random effects allow for the estimation and thus further exploration of individuals' intercept and slopes.

In LGCM, change is modelled as a function of time, represented through the specification of two latent growth factors, intercept, and slope, based upon individual trajectories (Felt, Depaoli & Tiemensma, 2017). The intercept represents the initial status whereas the slope describes the rate of change over time. These growth factors summarise the average trajectory and individual variation around the average trajectory (Felt et al., 2017). Thus, LGCM allows for the estimation of intraindividual growth trajectories, through the estimation of an intercept and slope, whilst also simultaneously allowing the estimation of interindividual differences in these two parameters (Wu, West & Taylor, 2009). Several growth trajectories are possible including flat (no change over time), linear (either increasing or decreasing) or non-linear change (Curran et al., 2010). In the case of a linear growth curve the mean intercept (initial status) and the mean slope (rate of change) jointly inform of the underlying mean trajectory within the sample (Curran et al., 2010).

Growth curve models can be estimated within structural equation modelling (Duncan, Duncan & Stryker, 2006; McArdle & Epstein, 1987), where observed repeated measures serve as indicators of one or more latent factors used to characterise the unobserved growth trajectories (Curran et al., 2010). The ability of LGCM to provide a parsimonious account of

both intra- and interindividual variability in a construct in the form of intercept and slope values for each participant emerged as an attractive means of data reduction, without loss of key information, in advance of subsequent multivariate analyses (presented in Chapter 8).

Latent growth curve models were specified using three observed variables, representing three waves of data collection, for each of the covariates. Factor loadings for the intercept latent factor were fixed at 1, such that the mean represented the average score of the covariate at Wave 1. Factor loadings for the slope latent variable were fixed at 0, 1, and 2, in order to specify a linear change trajectory (Figure 7-2).

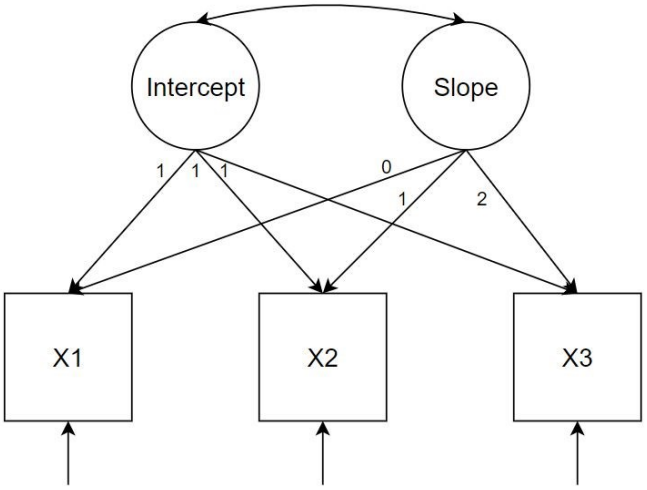

Figure 7-2: Linear specification of a latent growth curve model with three time points

The latent growth models were specified in Mplus 8.1 using the robust maximum likelihood estimator (MLR) to account for missing data. Following the specification of a linear model, the residual variances were then constrained to be equal over time, to assess if any improvement in model fit could be obtained. Following this, the second slope parameter was allowed to be freely estimated, to investigate the possibility of a non-linear model as representative of the change trajectory for the population.

Fit statistics determine how well or how poorly a model fits the data examined. Goodness of model fit was examined using a combination of fit statistics including the Comparative Fit Index (CFI; Bentler, 1990), Tucker-Lewis Index (TLI; Tucker & Lewis, 1973) and the root mean square error of approximation (RMSEA; Steiger, 1980) and associated confidence intervals. RMSEA, CFI and TLI are suitable for evaluating the fit of growth curve models (Wu, West & Taylor, 2009). Preacher and colleagues (2008) recommend the use of RMSEA when assessing growth curve fit as it provides an estimate of misfit within the population and not merely an estimate of misfit in the sample. Furthermore, the available confidence intervals for RMSEA provide an insight into the precision of the fit index also (Preacher et al., 2008).

CFI and TLI values are bounded by an upper limit of 1.0, with values close to 1.0 indicating a model that fits the data well. Yu (2002) reported that a cut off value for CFI of 0.96 had higher power to reject misspecified models. A TLI value above 0.95 indicates a well-fitting model (Hu & Bentler, 1999). An RMSEA value of .05 or lower indicates a close-fitting model in relation to the degrees of freedom (Browne & Cudeck, 1992; Duncan, Ducan & Strycker, 2006). Furthermore, an examination of RMSEA confidence intervals to ensure that they do not exceed 0.08 is also required (Browne & Cudeck, 1992). The use of several fit statistics to evaluate model fit is advisable owed to different tolerance for identification of model misspecification (Wu et al., 2009). Relative model fit is also assessed using the AIC (Akaike 1981), BIC (Schwarz, 1978) as well as the ssBIC (Sclove, 1987). Such criteria can be used to compare competing models, where the model with the lowest value is considered to be the best model. Felt et al., (2017) advise that should a discrepancy arise between some indices indicating model fit and others suggesting poor fit, an examination of the substantive theory surrounding the model should be considered also.

When estimating the growth curves for covariates consideration was given to the role of missing data. Missing data can be accounted for in the estimation of growth models in two manners. The first is to use Maximum Likelihood (ML) estimation, such that the model is estimated as a summation of individual contributions of each case, with those with a larger number of data points weighted more heavily than those with fewer data points (Curran et al., 2010). An alternative approach is multiple imputation, where the growth curve is estimated in a two-step procedure. The first is to impute the missing data using information from the non-missing data, the imputation of which is conducted multiple times (Curran et al., 2010). The second step involves the specification of the growth mode line in each of the imputed data sets separately, with the results aggregated to provide a final set of estimates (Curran et al., 2010).

Estimation of models with missing data can be conducted in Mplus using both frequentist and Bayesian approaches (Muthén & Muthén, 1998-2017). In the case of Bayesian analysis multiple imputation can be conducted for missing data with the generation of plausible values for latent variables (Muthén & Muthén, 1998-2017). Modelling missing data in Bayesian analysis gives asymptotically the same results as maximum-likelihood estimation under missing at random conditions (Muthén & Muthén, 1998-2017). Thus, the specification of growth curves in the present study was conducted whilst simultaneously imputing missing data. This was conducted in a two-step manner. The first step involved the identification of the true model, specified using the robust maximum likelihood estimator (MLR) following frequentist methods, and the estimation of factor scores for the intercept and slope (Asparouhov & Muthén, 2010). Once identified, this true model was then specified, as per the guidance of Muthén & Muthén (1998-2017) in User Guide Example 11.7, using a Bayesian estimator with simultaneous data imputation. Using this methodology, plausible values for the latent factors (Asparouhov & Muthén, 2010; Mislevy, Johnson & Muraki, 1992; von Davier, Gonzalez & Misleavy, 2009) were obtained for inclusion in subsequent analysis (presented in

Chapter 8). A total of 10 imputed data sets were created from which a distribution of factor scores, plausible values for the intercept and slope factors, was generated for each participant.

7.5 Results

Descriptive statistics for the covariates examined as explanatory factors in healthcare utilisation patterns among the TILDA cohort can be observed in Table 7-2.

Table 7-2: Descriptive statistics for covariates examined in healthcare utilisation analysis

Covariate	**Wave 1**	**Wave 2**	**Wave 3**
	N = 8715	**N = 6917**	**N = 6128**
Age *M (SD)*	63.53 (9.16)	-	-
Sex *n (%)*			
Male	3744 (45.8)	-	-
Female	4431 (54.2)	-	-
Marital *n (%)*			
Married/cohabiting with partner	5638 (69.0)	-	-
Never married	791 (9.7)	-	-
Separated/divorced	551 (6.7)	-	-
Widowed	1195 (14.6)	-	-
Widowed *n (%)*			
No	-	5900 (72.2)	5184 (63.4)
Yes	-	1017 (12.4)	944 (11.5)
Education *n (%)*			
Primary/none	2504 (30.6)	-	-
Secondary	3263 (39.9)	-	-
Third/higher level	2404 (29.4)	-	-
Employment status *n (%)*			
Employed	2934 (35.9)	2296 (28.1)	1927 (23.6)
Retired	3046 (37.3)	2880 (35.2)	2905 (35.5)
Other	2195 (26.9)	1741 (21.3)	1285 (15.7)
Location *n (%)*			
Dublin city/county	1936 (23.7)	-	-
Another town or city	2311 (28.3)	-	-

Rural location	3916 (47.9)	-	-
Healthcare coverage *n (%)*			
No public or private cover	842 (10.3)	620 (7.6)	530 (6.5)
Private health insurance only	3281 (40.1)	2663 (32.6)	2366 (28.9)
Medical card or GP visit card only	2621 (32.1)	2267 (27.7)	2007 (24.6)
Dual cover	1418 (17.3)	1334 (16.3)	1214 (14.9)
Fall in previous 12 months *n (%)*			
No	6590 (80.6)	5369 (65.7)	4666 (57.1)
Yes	1583 (19.4)	1541 (18.9)	1460 (17.9)
Polypharmacy *M (SD)*	2.33 (2.45)	2.75 (2.61)	2.83 (2.67)
Frailty Index *M (SD)*	0.16 (0.12)	0.17 (0.12)	0.17 (0.11)
Depression *M (SD)*	2.99 (3.84)	2.84 (3.76)	3.27 (3.84)
Anxiety *M (SD)*	5.39 (3.64)	3.40 (3.36)	3.52 (3.43)
Cognition *M (SD)*	28.29 (2.16)	28.46 (2.16)	28.45 (2.08)

Note. Dual cover= medical card/GP visit card and private health insurance.

Prior to the operationalisation of change in employment status, the employment categorical variables at each wave were first collapsed into binary variables, representing 'employed' or 'retired or other'. The 'other' category was considered to be distinct from employment as it would include those who were in receipt of unemployment benefit, disability benefit and those who would have been categorised as a homemaker for national insurance purposes. As the goal was to identify those covariates that may explain change in healthcare usage over time, the change from one type of social welfare status to that of another would not be as distinctive the change from employment into either retirement or one of these other categories. This binary categorisation was deemed prudent in order to investigate the effect of employment. Following the creation of three binary employment variables for each wave, two binary variables were created to represent change from Wave 1 to Wave 2 (coded 0=No, 1=Yes) and from Wave 2 to Wave 3 (coded 0=No, 1=Yes). A further binary variable was created to represent change in employment from Wave 1 to Wave 3 (coded 0=No, 1=Yes).

Similarly, the change in category of health coverage was also summarised through the creation of two new binary variables, representing change in health cover between Wave 1 and Wave 2 and between Wave 2 and Wave 3 (coded 0=No, 1=Yes). A further binary variable, 'cover changer' was created such that those who experienced any change in health coverage between Wave 1 and Wave 3 could be identified. This binary variable was coded such that 0=no change in healthcare coverage and 1=change in healthcare coverage at some point between Wave 1 and Wave 3.

Falls history across the three waves was also summarised through the creation of a new binary 'faller' variable, representing those participants who reported a fall at any wave (coded 0=No, 1=Yes). Comorbidity at baseline was examined using a count of long-term conditions reported across multiple binary variables at Wave 1. These counts were then categorised as follows: 0=none, 1= one condition, 2=two conditions, and 3=three or more comorbidities. New onset illness was captured by counting the number of new incident cases of new disease reported by WHO International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) between Wave 1 and Wave 2 and between Wave 2 and Wave 3. These new incident cases had been recorded using binary variables representing 16 classifications of disease types within ICD-10. Count variables were created for Waves 2 and 3 as a count of new incident disease across these 16 disease categories. These counts were then categorised using the same coding as the comorbidity variable. Descriptive statistic for these newly operationalised variables can be observed in Table 7-3.

Table 7-3: Descriptive statistics for additional covariates created for examination in further analyses

Covariate		**Wave 1**	**Wave 2**	**Wave 3**
Change in employment *n (%)*			*W1→W2*	*W2→W3*
	No	-	6094 (74.5)	5290 (64.7)
	Yes	-	823 (10.1)	624 (7.6)
Change in employment *n (%)*				*W1→W3*

	No	-	-	4756 (58.2)
	Yes	-	-	1259 (15.4)
Faller *n (%)*				
	No	-	-	3284 (40.2)
	Yes	-	-	3267 (40.0)
Change in healthcare coverage *n (%)*			*W1→W2*	*W2→W3*
	No	-	6035 (73.8)	5234 (64.0)
	Yes	-	839 (10.3)	655 (8.0)
Healthcare coverage change *n (%)*				*W1→W3*
	No	-	-	4694 (57.4)
	Yes	-	-	1308 (16.0)
Comorbidity *n (%)*				
	None	1210 (14.8)	-	-
	1	1720 (21.0)	-	-
	2	1699 (20.8)	-	-
	≥3	3546 (43.3)	-	-
New incident disease *n (%)*				
	None	-	5109 (62.5)	5831 (71.3)
	1	-	2141 (26.2)	1726 (21.1)
	2	-	729 (8.9)	492 (6.0)
	≥3	-	196 (2.4)	126 (1.5)

Fit statistics for latent growth curves can be observed in Table 7-4. An examination of the fit statistics, in particular RMSEA, and associated confidence intervals, CFI and TLI favoured the selection of linear growth models, with residuals constrained to be equal over time, for all covariate examined, except anxiety. For Anxiety, allowing the second slope parameter to be freely estimated resulted in an improved model fit. Parameter estimates for each of the LGCMs can be observed in Table 7-5, with plots for each LGCM shown in Figures 7-3 to 7-7.

Table 7-4: Fit statistics for growth curves for frailty, depression, polypharmacy, anxiety, and cognition

	LL	AIC	BIC	ssBIC	RMSEA	CFI	TLI	SRMR
FRAILTY								
MLR, linear	22237.824	-44459.647	-44405.882	-44431.304	.051 (.032, .074)	.997	.991	.007
MLR, linear, residuals constrained	22237.396	-44462.791	-44422.468	-44441.534	.019 (.007, .033)	.999	.999	.010
DEPRESSION								
MLR, linear	-48620.705	97257.411	97311.176	97285.754	.086 (.066, .108)	.971	.913	.024
MLR, linear, residuals constrained	-48621.873	97255.747	97296.071	97277.004	.034 (.023, .048)	.986	.986	.022
POLYPHARMACY								
MLR, linear	-36208.429	72432.858	72486.623	72461.201	.095 (.074, .116)	.984	.952	.015
MLR, linear, residuals constrained	-36234.335	72480.670	72520.993	72501.927	.054 (.043, .067)	.984	.984	.017
ANXIETY								
MLR, linear‡	-44355.997	88727.994	88781.757	88759.336	.314 (.293, .335)	.797	.392	.085
MLR, linear, residuals constrained	-44375.644	88763.288	88803.611	88784.545	.161 (.149, .174)	.839	.839	.075
MLR, residuals constrained, time 2 freed	-43936.878	87887.756	87934.799	87912.555	.030 (.016, .046)	.996	.994	.016
MMSE								
MLR, weightings, linear ‡	-34239.936	68495.871	68549.636	68524.214	.094 (.074, .116)	.975	.924	.041
MLR, linear, residuals constrained	-34250.778	68513.555	68553.879	68534.812	.041 (.029, .054)	.986	.986	.154

Note. ‡ Warning message regarding psi matrix due to a negative slope variance, issue resolved once residuals constrained to be equal over time

Table 7-5: Summary of parameter estimates (standard errors) for covariate growth curve models specified for subsequent analyses

Parameter		Frailty	Depression	Polypharmacy	Anxiety	MMSE
Latent variable means						
	Intercept mean	**.157 (.002) ***	**2.94 (.057) ***	**2.28 (.036) ***	**5.443 (.056) ***	**28.304 (.035) ***
	Slope mean	**.009 (.001) ***	**.158 (.030) ***	**.327 (.013) ***	**-.954 (.026) ***	.022 (.017) p = .195
Slope loadings						
	Wave 1	0	0	0	0	0
	Wave 2	1	1	1	2.070	1
	Wave 3	2	2	2	2	2
Intercept-slope correlation		.000 (.000) p = .908	**-.731 (.212) p =.001**	.046 (.046) p = .319	**-.755 (.135) ***	.070 (.072) p = .328
Variances						
	Intercept variance	**.011 (.000) ***	**8.56 (.499) ***	**5.02 (.147) ***	**8.891 (.363) ***	**2.782 (.235) ***
	Slope variance	**.000 (.000) ***	**.728 (.147) ***	**.287 (.031) ***	**.351 (.079) ***	.075 (.052) p = .151
Residual variances						
	Wave 1	**.002 (.000) ***	**6.702 (.231) ***	**1.040 (.040) ***	**4.617 (.144) ***	**1.640 (.072) ***
	Wave 2	**.002 (.000) ***	**6.702 (.231) ***	**1.040 (.040) ***	**4.617 (.144) ***	**1.640 (.072) ***
	Wave 3	**.002 (.000) ***	**6.702 (.231) ***	**1.040 (.040) ***	**4.617 (.144) ***	**1.640 (.072) ***

Note. *p < .001; significant parameter estimates bolded.

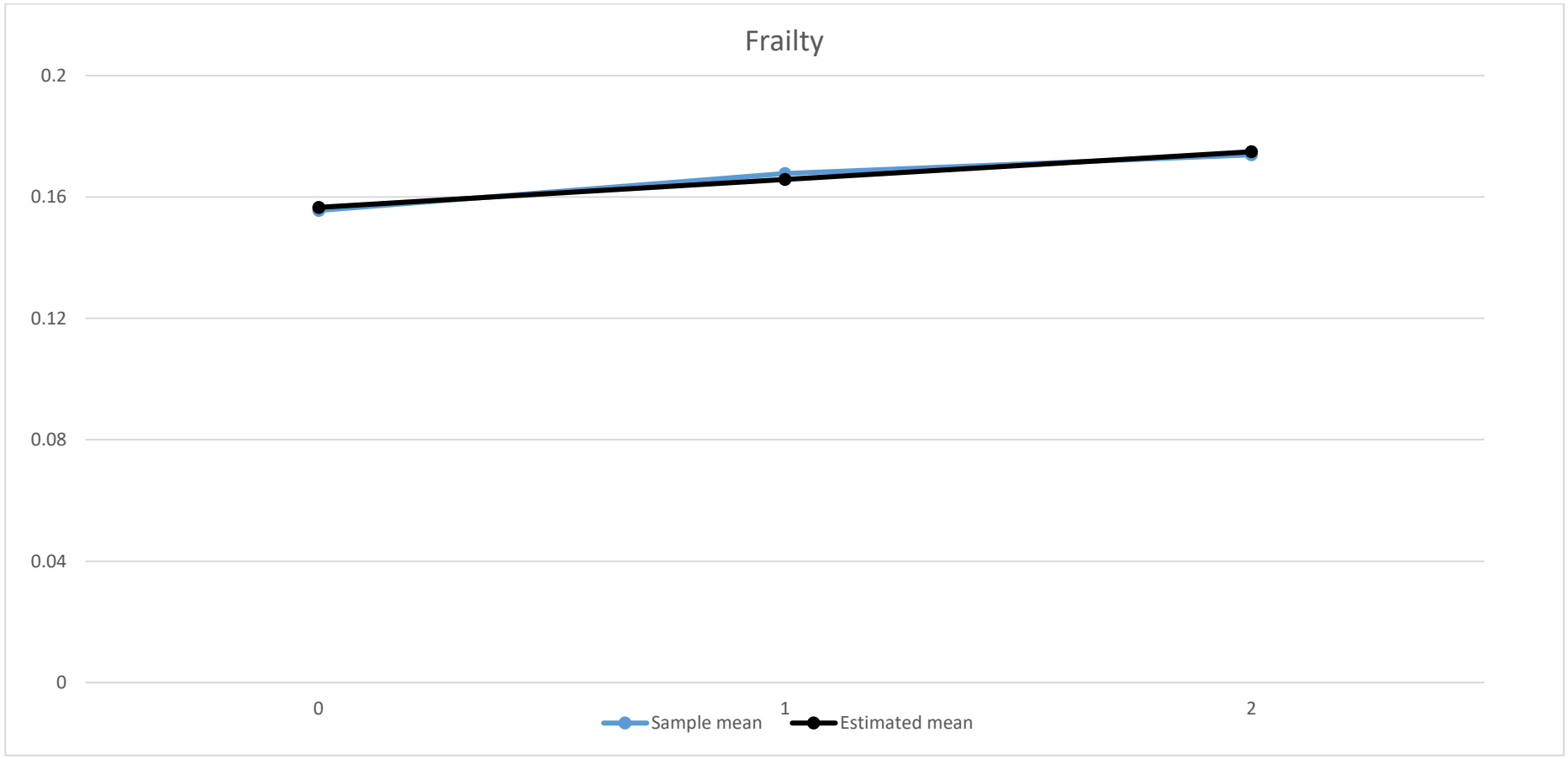

Figure 7-3: Linear growth curve for frailty, with residual variances constrained to be equal

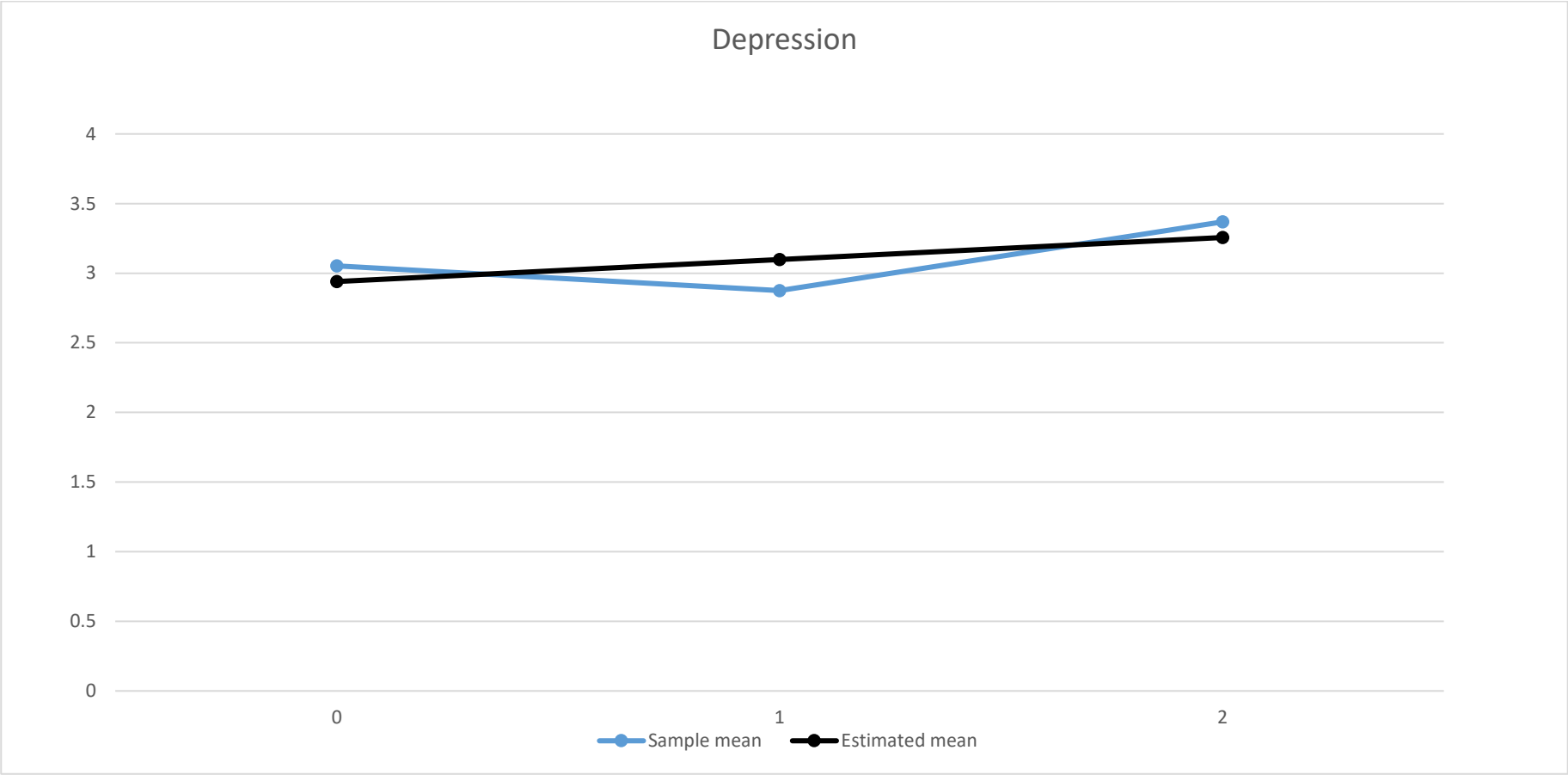

Figure 7-4: Linear growth curve for depression, with residual variances constrained to be equal

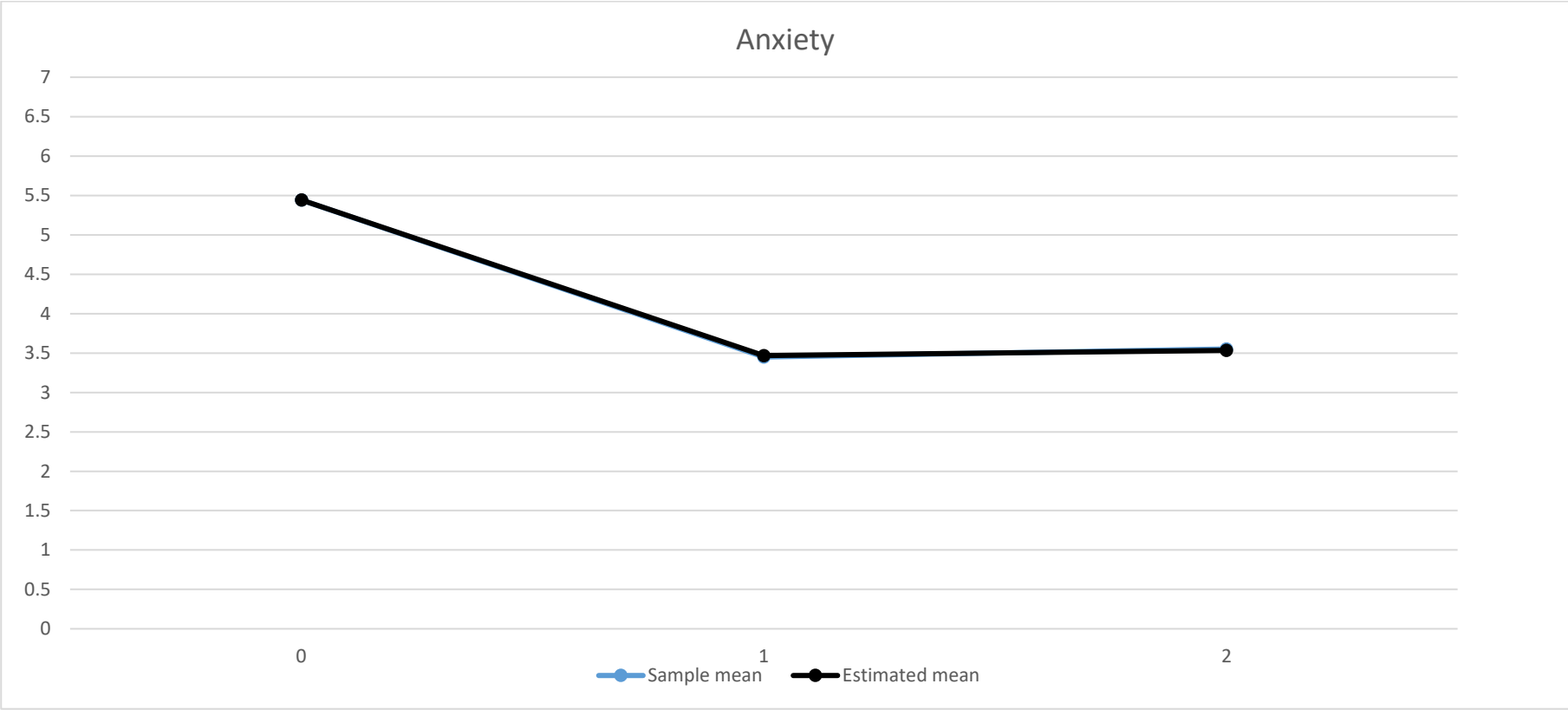

Figure 7-5: Non-linear growth curve for anxiety, with residual variances constrained to be equal[4]

[4] In Figure 5 the sample mean and estimated mean lines are overlaid on one another

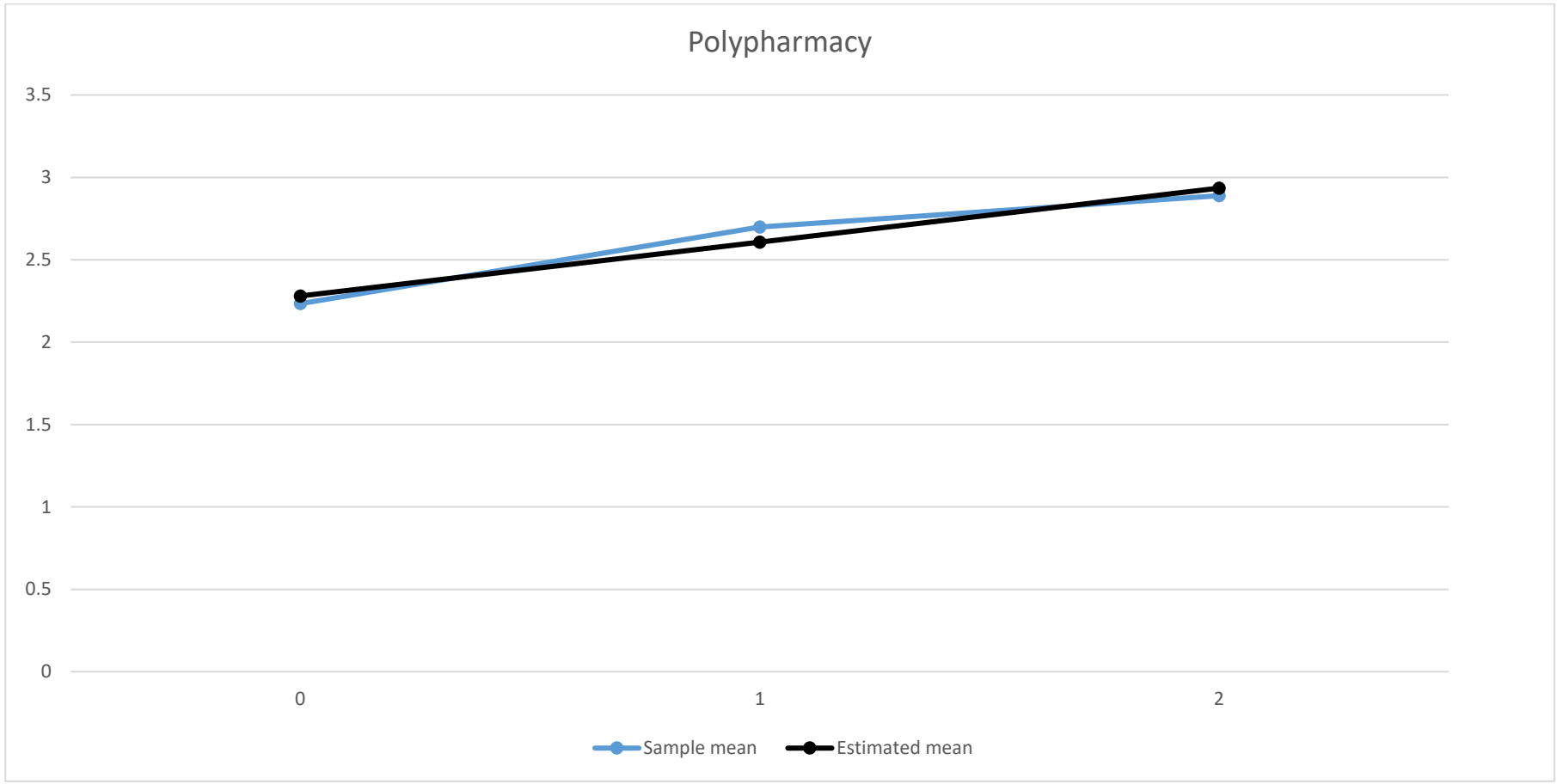

Figure 7-6: Linear growth curve for polypharmacy, with residual variances constrained to be equal

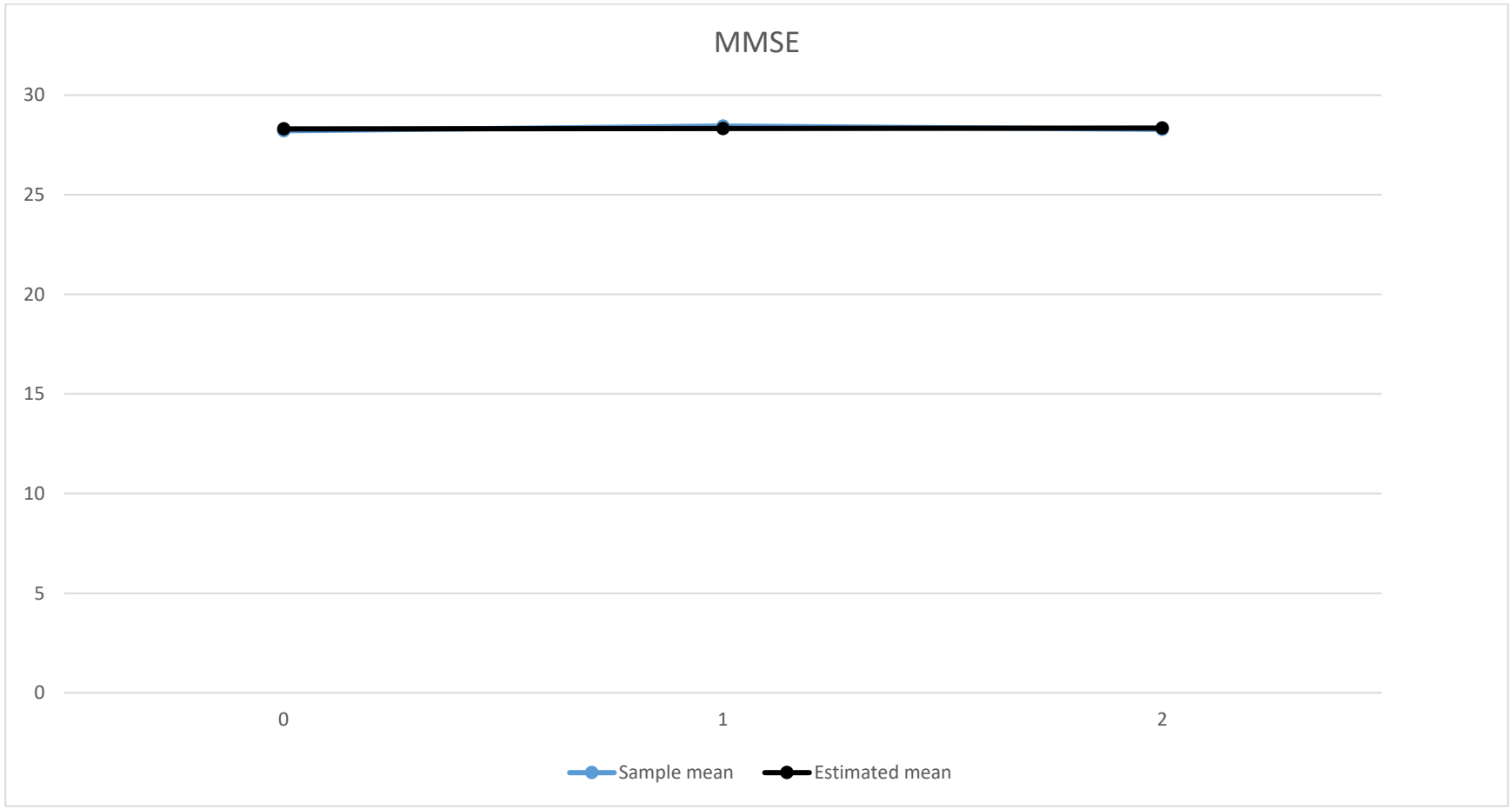

Figure 7-7: Linear growth curve for cognition (MMSE), with residual variances constrained to be equal

7.6 Discussion

The present chapter sought to identify suitable covariates for inclusion in analyses to explain identified patterns of healthcare utilisation by older Irish adults. Using the Andersen Behavioural Model (Andersen, 1968, 1995; Andersen & Newman, 1973) as a guide for potential variable selection, several variables from each of the first three waves of TILDA data were first examined using descriptive statistics. Consideration was given to those variables which were time-varying by nature and how the dynamic change in these variables could best be captured, dependent on whether the variable was measured at a categorical or a continuous level.

Several demographic variables, which could be considered as predisposing or enabling characteristics were reflected as categorical variables, some of which were not available at every wave of data collection. Marital status and location of residence were both available at baseline data collection but were not replicated in subsequent waves. In the case of marital status and additional variable representing widowhood as a binary variable was available at waves 2 and 3 and could thus be operationalised as a measure of a type of likely marital status change observed within an older cohort.

Change in employment status was operationalised as new binary variables, reflective of whether an individual transition between employment and a retired/other category. It was theorised that a change into or out of employment would be the more prominent status change than perhaps a change between retirement and an 'other' category. By restructuring employment status as a binary measure at each wave new binary measures reflective of change between the waves could be created. Change in employment status could be hypothesised to influence healthcare usage in two ways. A greater availability of time for those who became retired may increase the likelihood of attending a GP during normal visiting hours, and/or decrease the likelihood of attending ED outside of hours. Alternatively, a

decrease in income may reduce the likelihood of healthcare service usage if costs were prohibitive. Based upon the binary recategorisation it was observed that 15% of the original sample reported a change in employment status from Wave 1 to Wave 3.

An observance of change in healthcare coverage indicated that similar proportions of individuals possessed dual healthcare cover (public and private) throughout the three waves. Differences in the proportions of those who reported no healthcare cover were observed at the three data collection points. Given the existence of historical changes in healthcare entitlements it was decided to examine movement in healthcare cover type. It was not possible to isolate changes in healthcare cover that would result in increased coverage from those of decreased coverage. Specifically, no assessment could be made regarding the level of private insurance cover that an individual possessed, only the presence or absence of such cover. Therefore, it could not be ascertained whether those with dual cover had a greater degree of private health cover than those who reported having a private insurance policy only. It is entirely possible that those with dual cover (public and private insurance) may have had a more limited health insurance policy than those relying solely on private health insurance. Thus, new variables were created to represent any change in cover between the time points. Between Wave 1 and Wave 3 a total of 16% of the baseline sample reported some change in healthcare coverage.

A similar proportion of older Irish adults reported a fall at each of the three waves of data collection, with approximately one fifth of the sample reporting a fall at each time point. When considered over the longer term, Wave 1 to Wave 3 approximately twice that number experienced a fall. Such findings suggest that there is variance in fall occurrence within the sample with some perhaps reporting only one fall over the three waves of data collection and others experiencing multiple falls.

In terms of examining those health need factors to be incorporated consideration was given to the manner in which comorbidity could be operationalised over time using information available within the dataset. At Wave 1 a number of binary indicators for chronic conditions were captured e.g. hypertension, diabetes mellitus, arthritis etc. These binary variables were used to categorise level of comorbidity using a count of conditions that was then categorised as none, one, two or three and above. At each subsequent wave, new ICD-10 indicators were reported providing information as to whether the individual had an incident case diagnosed according to the ICD-10 criteria which was recorded by body system e.g. disease of the eye, disease of the digestive system, certain infectious diseases etc. At Wave 2 and Wave 3 a count was conducted across all of the ICD-10 variables and also categorised in the same manner as the comorbidity level. Between one fifth and one quarter of participants reported at least one new ICD-10 diagnoses, 6-8% two new diagnoses and 1-2% three or more new diagnoses, between the data collection waves.

However, a fundamental limitation of the ICD-10 categorical variables was that they only indicated the body system which the diagnosis related to but gave no indication of the acute or chronic nature of these diagnoses. Thus, it was difficult to isolate those acute self-limiting illnesses, such as an infective episode, from the development or diagnosis of a new chronic condition. The challenge in mapping these ICD diagnoses onto the original binary variables used to create the comorbidity categorisation created a limitation in how change in comorbidity burden over time could be accounted for.

Furthermore, a concern regarding conceptual overlap with elements used to create the frailty index and the possibility of issues of multicollinearity arose during variable preparation. It is somewhat reasonable that frailty may possess more utility when examining older cohorts, as it considers not only the presence of a chronic illness but also provides an estimation of the functional capacity of the individual living with said chronic illness. Thus, it

perhaps can be argued that frailty provides a more nuanced view of the burden of chronic illness and thus may serve as a more sensitive indicator of health service need among older adults. Therefore, on the basis of eliminating potential multicollinearity and retaining information that would infer the functional status of the individual it was decided to omit the comorbidity variable from subsequent analysis and instead include frailty as a covariate.

Frailty has been shown to be related to adverse events among older people including an increased risk of falls, increased disability, hospitalisation, institutionalisation, and death (Ensrud et al., 2008; Fried et al., 2001; Rockwood et al., 2004). Frailty indices have also been described as a means of characterising the "whole health of individuals" (Rockwood & Mitnitski, 2007, p. 725) and thus serves as a more holistic assessment than the inclusion of a count of chronic conditions instead. Furthermore, the significant association between pre-frailty or frailty states and polypharmacy has been shown to persist even when one accounts for comorbidity (Palmer et al., 2019). Those who receive higher numbers of medications are also at higher risk for incident frailty at three year follow up (Saum et al., 2017).

Latent growth curve analysis with data imputation was used to summarise change in several health need variables including frailty. LGCM allows for the incorporation of both nomothetic and idiographic aspects of change over time (Preacher et al., 2008), thereby situated, as argued by Curran and Willoughby (2003), at the "intersection between variable-centred and person-centred analysis" (p. 603). This estimation identified a trend of increasing level of frailty over time as indicated by the significant positive slope value. The prevalence of frailty has been found to increase with age (Buchman, Wilson, Bienias & Bennett, 2009; Collard et al., 2012; Lohman, Mezuk & Dumenci, 2017) and when assessed longitudinally has also been found to increase at a faster rate than that reported in cross-sectional studies (Hoogendijk et al., 2018). Furthermore, frailty status may increase more rapidly in the last year of life. Stow, Matthews & Hanratty (2018) examined longitudinal changes in frailty, as assessed by an

electronic frailty index, and identified a distinctive frailty trajectory for those at highest risk of death. This was characterised by a rapid rise in frailty from a low base and followed by a plateau.

The initial frailty status of the cohort, as indicated by the intercept mean, indicated that on average participants were in a pre-frail state as per Roe and colleagues' (2017) threshold cut off values. A study of community-dwelling older Chinese adults found that approximately 50% of the sample were pre-frail when frailty was assessed using the Fried phenotype (Lee, Auyeung, Leung, Kwok & Woo, 2014). At two year follow up approximately one quarter of these who were pre-frail at baseline improved in terms of frailty status, with men found to be more likely to experience a decline in frailty than women (Lee et al., 2014). Prevalence of frailty within community samples has been reported to be broad ranging, from 4-49% due to differences in how the syndrome is operationalised (Collard et al., 2012).

Nevertheless, the importance of considering an intermediate state of pre-frailty when examining change in frailty over time is evidenced in the systematic review findings of Kojima et al., (2019). A review of 16 studies which examined frailty using a 5-item phenotype found that improvements in frailty over time related to the intermediary state of pre-frailty. Of those who were identified as frail at baseline, 55% remained frail, only 3% transitioned to robust but 40% transitioned to pre-frail. For those who were pre-frail at baseline, 58% remained prefrail, 23% transitioned to robust and only 15% transitioned into a frail status (Kojima et al., 2019). Pre-frailty has also been identified in much younger adults. Hanlon et al., (2018) examined a sample of adults aged 37-73 years from the UK Biobank using a phenotype approach and found that 38% were identified as pre-frail. Whilst transitions between frailty states can occur in both directions, transitions to states of increasing frailty are more common than to states of lesser frailty, and the probability to transition from frail to non-frailty has been reported to be very low (Gill, Gahbauer, Allore & Han, 2006).

The LGCM analysis indicated that many health need covariates observed a linear trend, with polypharmacy showing a trend of increased numbers of medications over time. An examination of prescription trends in the US from 1988 to 2010 previously revealed that the median number of medications for those aged ≥65 years doubled from two to four, and the proportion of those prescribed ≥ 5 medications tripled, from approximately 13% to 39% (Charlesworth, Smit, Lee, Alramadhan & Odden, 2015). Gao, Maidment, Matthews, Robinson & Brayne (2017) report similar dramatic increases in medication numbers among older adults living in England. An examination of two comparable studies conducted in 1991-1994 and 2008-2011 found that the proportion of older adults prescribed five or more medications increased from 12 to 49%, representing a four-fold increase (Gao et al., 2017). Furthermore, the proportion of those not taking any prescribed medication was found to decrease from approximately 20% to approximately 8% (Gao et al., 2017).

Given the preponderance for clinical best practice guidelines in chronic disease management it is not unusual to observe an increase in the number of medications prescribed for a given condition, irrespective of comorbidity. For example, over time an individual living with diabetes mellitus may require additional medication for optimum blood glucose control and may also receive additional medication as primary prevention for cardiac events, the risk of which increases with advancing age. Furthermore, improvements in life expectancy have largely been attributed to advances in medical treatments and as such many of us are living with more chronic conditions, necessitating the use of multiple medications. Thus, the focus has begun to shift away from considering the absolute number of medications to the relative appropriateness of each medication. In the present data it was not possible to assess appropriateness of pharmacotherapy. However, the estimation of an intercept and slope for polypharmacy serves as a useful indicator as to whether growth in medication burden is associated with changes in healthcare utilisation.

An increasing trend was also observed for depression (Figure 4). A LGCM with the second time point allowed to be freely estimated resulted in a worse model fit (not reported) and so whilst the plot indicates an observed decrease at Wave 2, the overall trend is one of increasing scores over time, albeit a small increase, when one observes the scale on the y-axis. Depression scores were measured on a scale of 0-24, with higher scores indicating greater depressive symptomology and so overall depression scores were observed to be low among the cohort.

In contrast to depression, freeing the second time point for anxiety resulted in a better fitting curve (Figure 7-5). Anxiety scores were found to decrease by approximately two points on average, between Wave 1 and Wave 2 before then increasing slightly between Wave 2 and Wave 3. Given the magnitude of change in anxiety score between these time points it is evident that a non-linear growth curve would provide a better representation of the data. Several possible mechanisms may explain this non-linear change trajectory within the TILDA sample. At Wave 1 the anxiety questionnaire was included in the SCQ assessment, whereas subsequent data collection was conducted using the CAPI. Thus, whilst missing data was less evident at Wave 1, the reporting of lower scores at Waves 2 and 3 could represent a socially desirable type of response pattern.

Interestingly, the growth parameters for both depression and anxiety were found to exhibit divergent trajectories. The average initial status for the cohort (intercept mean) indicated that participants began with a low score on the depression inventory and whilst this increased over time (positive significant slope), the increase was small, with depression score only increasing by .158 points at each wave. Given that the scale ranged from 0-24, overall depressive symptomology was considered to be low. De la Torre-Luque et al., (2019) previously reported that between two-thirds and three-quarters of older adults in UK followed a trajectory of minimal depressive symptoms with an increasing pattern over time, never

exceeding the clinical cut-off. In contrast, anxiety showed a non-linear trajectory, beginning with a higher mean intercept value, which decreased over time.

Depression is purported to be common among older adults with prevalence estimated to range between 17% and 35% (Horackova et al., 2019). However, challenges in diagnosing late life depression may lead to an underestimate of the prevalence of depression among older adults (Mitchell, Rao & Vaze, 2010). It has been argued that for older adults, declines in physical functioning and the presence of multimorbidity can overwhelm the ability to cope, thereby creating a vulnerability for anxiety and depression (Nelson et al., 2009).

However, the literature reports conflicting findings with respect to depression and aging. Depressive symptoms have been shown to remain stable for those older than 70 years of age (Nguyen & Zonderman, 2006), and to exhibit a stable trajectory over as many as five waves of data collection (Lohman et al., 2017). Thomas et al., (2016) examined a sample of 1,546 adults ranging in age from 21 to 50 years and compared age cohorts using polynomial regression to examine trends in physical and cognitive functioning with age. A linear improvement in anxiety and depression scores was identified (Thomas et al., 2016). This in contrast to studies which have identified a U-shaped curve for psychological wellbeing (Blanchflower & Oswald, 2008; Stone, Schwartz, Broderick & Deaton, 2010).

A review of studies examining anxiety, depression and distress across the lifespan concluded that no consistent pattern could be identified (Jorm, 2000). Some evidence suggesting an initial increased prevalence of anxiety and depressive symptoms across age groups which was then followed by a drop. The inclusion of additional risk factors in multivariate analysis revealed a more consistent pattern characterised by a decrease in anxiety, depression, and distress emergence across the age groups, suggesting that ageing may be associated with a reduction in anxiety and depression (Jorm, 2000). Similarly, Scott et al., (2008) concluded that depression and anxiety disorders decreased in prevalence between age

50 and 90, in the absence of comorbid physical or pain conditions. In those with comorbidity, mental disorders peaked in middle age and decreased in older age (Scott et al., 2008). However, no significant difference was found in the relationship between age and mental disorders as a function of comorbidity (Scott et al., 2008). Byers, Yaffe, Covinsky, Friedman & Bruce (2010) examined the prevalence of mood, anxiety and comorbidity of mood and anxiety disorders in a nationally representative sample of the US population. Likelihood of having any disorder was found to exhibit a general pattern of decline with increasing age.

Overall, cognitive status was found to remain both high and stable over the course of the first three waves of TILDA data collection, when assessed using MMSE. At a cohort level, no significant change in cognition was observed over time as indicated by the non-significant slope value. Terrera, Matthews and Brayne (2008) examined cognitive change across four waves of the Cambridge City over 75 Cohort Study. Latent growth models were combined with logistic regression to account for missing data. A quadratic curve, characterised by an initial decrease followed by a deceleration in the rate of decline was observed (Terrera et al., 2008). Such a finding is in in contrast with the stable trajectory observed in the present study and may reflect differences in the age profile of the respective cohorts. Furthermore, the present study is limited as only three repeated measures of MMSE over time were examined, eliminating the investigation of a quadratic model within the sample.

Johnson et al., (2012) examined longitudinal cognition trends among healthy controls and individuals with mild cognitive impairment using latent growth modelling. A decline in memory was observed for both groups; however, a faster rate of decline was observed in the mild cognitive impairment group. Further declines were observed in the MCI group for non-memory cognitive factors, whereas the control group did not report any such declines (Johnson et al., 2012). Mortality appears to be higher among those who exhibit faster cognitive

decline, irrespective of cognition at baseline, especially for those with normal baseline levels of cognition (Lv et al., 2019).

The present study's findings of a trajectory characterised by high levels of cognition which remain stable over time is aligned with the findings of an American and Canadian study which examined cognitive and functional change over time, by combining a clinical sample with healthy controls prior for analysis. Hochstetler et al., (2016) used growth mixture modeling (GMM) to identify latent classes of participants that could be characterised according to their divergent trajectories of cognitive and functional change over time. The sample comprised of those with Alzheimer's Disease (AD), early or late mild cognitive impairment (EMCI or LMCI) and healthy controls. Assessments were conducted at baseline, six, 12 and 24 months in approximately 1200 participants. GMM was conducted on the total sample irrespective of the presence of AD, EMCI, LMCI or absence of any cognitive impairment. Three quadratic trajectories were identified for cognitive and functional impairment. A small class was identified (approx. 14%) characterised by high degree of impairment at baseline and the steepest worsening trajectory. A much larger class (approx. 69%) characterised by low level of cognitive and functional impairment at baseline, with minimum change in both over time (Hochstetler et al., 2016). Whilst this group included some healthy controls (39%), it also included participants with EMCI or LMCI (59%). Thus, the overall growth trajectory for the TILDA cohort mirrors the large subpopulation identified by Hochstetler and colleagues (2016).

Previously Xie, Mayo & Koski, (2011) reported five trajectories of MMSE score change in a smaller sample of participants with either MCI or AD. The two groups with the least level of cognitive impairment were found to have a stable course over a period of approx. 3.5 years, providing further support for the overall growth trajectory identified here. Two classes of slow decline and one class of fast decline in MMSE score were also identified, with quadratic

trajectories identified for two of these classes. A smaller study conducted in a sample of possible or probable AD over 13.5 years identified six different trajectories of MMSE score change (Wilkosz et al., 2010). Those who had higher baseline MMSE score tended to follow trajectories with slower decline and those with lower initial scores were found to decline more rapidly. All trajectories were found to decline to low levels of MMSE when examined over the longer study period (Wilkosz et al., 2010). The Cache County Dementia Progression Study (Leoutsakos et al., 2015) also identified a large class of AD patients which exhibited a slow progression of decline in MMSE scores over approx. a 12-year period. Three further smaller classes characterised with more rapidly declining cognition were also identified.

The analysis presented here must be interpreted in light of several methodological limitations. All LGCMs were specified as unconditional models with no examination of any interrelationships in the growth processes of these covariates considered. Additionally, no time varying or time invariant covariates were included in the specification of the LGCMs. The purpose of the LGCMs was to summarise the covariates for subsequent analysis in Chapter 8.

7.7 Conclusion

The present chapter serves as a foundation for subsequent analysis presented in Chapter 8. Several new categorical variables representing change in covariates over time were created including change in healthcare cover, change in employment and the reporting of a fall during any of the waves. Several variables which were captured at a continuous level were summarised using latent growth curve models to generate an intercept and slope value for inclusion in further analysis, presented in the next chapter. All of the latent growth curve models specified indicated that an increase was observed over the course of the first three waves of TILDA data collection, save for anxiety which showed a decrease and cognition which remained stable. The analysis presented herein serve as a precursor to the analysis in the

subsequent chapter. Nevertheless, they serve to provide an insight into those variables which have shown some relationship with healthcare utilisation within the literature. The identification of many of these covariates as dynamic in nature themselves lends further support to a longitudinal examination of healthcare usage. What follows in Chapter 8 is the integration of findings presented in the present chapter and in the previous chapter, Chapter 6.

8 Biopsychosocial predictors of variation in longitudinal patterns of healthcare utilisation among community dwelling older Irish adults

8.1 Chapter overview

This chapter integrates the findings from Chapter 6 (latent transition analysis) and Chapter 7 (covariate examination) to provide a more in-depth analysis of identified healthcare utilisation patterns. Explanatory differences between these patterns will be examined using multinomial logistic regression analyses, by incorporating covariates which have been identified and operationalised in Chapter 7.

8.2 Introduction

Health services research is considered to be a large field of enquiry that seeks to examine the breadth of factors which influence how care is organised, delivered, financed, and accessed (Lohr & Steinwachs, 2002). A particular driver for health services research is the increased demand that is being placed upon services by an ageing population that is living for longer with chronic disease and multimorbidity. The high proportion of expenditure on hospital inpatient beds has led to an increased scrutiny of the nature of inpatient bed use (Tucker, Hargreaves, Wilberforce, Brand & Challis, 2017). An increased focus on unnecessary or avoidable hospital admissions has led to the development of alternative models, such as intermediate care, particularly for the care of older adults within increased levels of clinical complexity (Melis et al., 2004; Smith et al., 2014; Steiner, 2001). Predicting future healthcare utilisation is an important aspect for providing adequate capacity and yet most risk prediction models for hospital readmission perform poorly (Billings, Dixon, Mijanovich & Wennberg, 2006; Cooksley et al., 2016; Kansagara et al., 2011). Readmissions are complex and influenced by system, cultural and environmental factors as well as clinical need (Cooksley et al., 2016). Thus, an evaluation of health care usage needs to consider these broader contextual factors

and may serve to identify opportunities for intervention, where medical need is not modifiable.

The analysis presented in Chapter 3 (IC analysis) identified that the number of hospital admissions in the 12-month period prior to the index admission into IC was a consistent predictor of the likelihood and number of readmissions in the post-intervention period. Each additional hospital admission in the 12-month period preceding IC admission increased the likelihood of unplanned hospital admission following intermediate care discharge by 37% in the <30 day and 31-90 day periods, and by 44% in the <90 day period (refer to Chapter 3, Tables 3-10 and 3-11). The increased odds ratios identified for the number of previous admissions is notable when one considers the multivariate nature of the analysis, adjusted for age, sex, demographic and intervention variables, and the presence or absence of the 25 most common medical diagnoses within the cohort. Similar findings were also obtained within the CH cohort (Chapter 4), where likelihood of unplanned hospital admission was increased by 27-38% (across the three monitoring periods) for each previous hospital admission in the 12 months preceding pharmacist intervention (refer to Chapter 4, Table 4-8). Thus, medical history alone does not predict likelihood of hospital admission and consideration should be given to the influence of healthcare utilisation itself.

The analyses presented in Chapter 6 indicate that heterogeneity in healthcare utilisation patterns can be observed in a community-dwelling cohort of older adults and that considerable transition between these latent sub-populations also occurs. The analysis presented thus far makes the case for an examination of the factors which influence different types of healthcare utilisation, characterised by increasing severity, and the transition into and out of such healthcare utilisation patterns over time. At a time when global health systems are under pressure to cope with the demands of an ageing population living for longer with multimorbidity there is an increasing need to identify those characteristics influencing high

levels of healthcare usage. More specifically those factors which are considered to be mutable deserve particular attention. Such modifiable factors may serve as suitable points for intervention within a high-pressured health service and may provide an evidence base from which new models of care can be built upon.

Theorists have long since advocated for the adoption of a wider viewpoint when assessing population healthcare usage (Andersen, 1968; Andersen, 1995; Andersen & Newman, 1973). In advocating a move away from the biomedical model, Engel (1980) proposed that clinicians should pay attention to the biological, psychological, and social aspects of illness. By doing so, Engel offered a counter argument to the biomedical model which could be interpreted as inherently reductionist and thus dehumanising (Borrell-Carrió, Suchman & Epstein, 2004). Behaviour does not occur within a vacuum but rather is shaped by the environment within which the individual is located (Bronfenbrenner, 1979; Grzywacz & Fuqua, 2000).

Lehman, David and Gruber (2017) further propose that this biopsychosocial approach can be made more dynamic through the integration of Bronfenbrenner's ecological approach, in order to emphasise the fact that influences on health interact with one another over time. Originally conceptualised as a theory of child development, Bronfenbrenner's (1979) ecological systems framework provides an opportunity to account for the complexity of interactions between individual and environmental influences on behaviour. The ecological perspective is predicated on the notion that health and health behaviours are influenced at multiple levels, including at the personal, organisational, environmental and policy levels (Maus & Satariano, 2018). Furthermore, the ecological perspective assumes that each of these levels of influence interact with one another and that reciprocal causation occurs among levels (McLaren & Hawe, 2005).

Richard, Gauvin and Raine (2011) posit that “ecological models offer an elegant conceptual contour of these levels of influence and guide the development of multilevel intervention models, which underscore the need for enacting various health education and promotion strategies to achieve population-level changes” *(*p. 309). Due to the comprehensiveness of this approach it is not surprising that ecological approaches to public health research and intervention have become increasingly popular in the last two to three decades (Grzywacz & Fuqua, 2000; Richard et al., 2011; Maus & Satariano, 2018).

One of the greatest assets of an ecological framework is that it is comprehensive in nature. However, it may also perhaps be a considerable limitation (Grzywacz & Fuqua, 2000). Maintaining a balance between comprehensive assessments of influencing factors and the need for a parsimonious explanation in order to make testable predictions is a continual challenge. The concept of “leverage points” as proposed by Grzywacz and Fuqua (2000, p. 101) may provide an opportunity to reduce the comprehensive ecological perspective into factors which can be operationalised.

Gryzwacz and Fuqua (2000) described several factors as ‘leverage points’ as they were multidimensional constructs with an influence on health and illness. Through this multidimensionality these factors could still represent the comprehensiveness of the social ecological perspective, whilst providing opportunities for intervention. For example, Grzywacz and Fuqua (2000) argue that socioeconomic status is often assessed using a unidimensional characteristic such as educational attainment, income, or occupational status, thereby restricting the identification of socioeconomic targets for intervention. According to Grzywacz and Fuqua (2000), multiple assessments of socioeconomic status are required to gain a deeper understanding of the phenomenon and how it links to individual and public health. Familial structure and employment are also considered to be key leverage points with respect to individual and thus population health (Grzywacz & Fuqua, 2000).

The work of Andersen and colleagues adopts an ecological perspective on healthcare service usage, when one considers the following definition: “a conceptual framework designed to draw attention to individual and environmental determinants of behaviour” (McLaren & Hawe, p. 9). In diagrammatical terms the Andersen Behavioural Model infers a linear process, however, in reality the Phase 4 version of the model does draw attention to the reciprocity between healthcare utilisation and enabling factors (Andersen, 1995). This particular iteration of the model sought to incorporate the recursive nature of health services use through the incorporation of feedback loops, whereby the outcome (service use) could in turn subsequently influence predisposing and enabling factors, as well as perceived need for health services (Andersen, 1995). A previous systematic review of 16 studies, conducted using Andersen’s Behavioural Model, identified a lack of consistency in findings relating to factors associated with healthcare usage (Babitsch et al., 2012). A criticism offered by the review authors, Babitsch and colleagues (2012), is that many studies that have evaluated factors have not used a multivariate approach and have not operationalised the complexity of health service use through the use of structural equation modelling techniques.

Within aging research an increased focus of attention has been directed towards the frailty syndrome (Han et al., 2019; Sloane & Cesari, 2018). Whilst there is considerable merit in including frailty as an assessment of future healthcare utilisation, given its predictive associations with poorer outcomes, the many conceptualisations and measures of frailty do not consider wider contextual aspects that impinge upon hospital readmission. Hubbard and colleagues (2017) consider the limits in frailty measures and capture it quite succinctly by the following: "readmissions to the acute sector are notoriously difficult to predict but medical instability and socio-environmental vulnerability seem to be the key contributors, none of which is captured by current single-point frailty measures" (Hubbard et al., 2017, p805).

Thus, even the inclusion of a multidimensional construct such as frailty will fail to account for the "system, cultural and environmental factors exerting a significant influence" upon hospital admissions (Cooksley et al., 2016, p. 248). A wider viewpoint, such as that advocated by Andersen and colleagues, provides a suitable conceptual framework within which to place any examination of healthcare utilisation by older people, who are a cohort characterised by considerable complexity. This behavioural model of healthcare utilisation incorporates the work of Bromfenbrenner (1979) and Engel (1980) in a manner that is specific to healthcare usage. Owing to the challenges posed by the findings of Babitsch and colleagues (2012) there is a real need to consider factors associated with healthcare usage in a multivariate manner.

The findings of Chapter 6 identified three patterns of healthcare usage which remained stable over time. These findings added credence to the argument that combinations of healthcare usage, such as GP and outpatient consultant visits, should be examined rather than examining the various services used as isolated outcomes. Chapter 7 explored the dynamic stability of a range of covariates and identified considerable growth or change in many of these factors. Thus, there is a need to now integrate these two studies to identify which factors influence movement from one type of healthcare usage at a given point in time, to that of another. The identification of those factors which influence healthcare usage behaviour may serve as a basis for the development of strategies to preserve and promote public health.

8.3 Objectives

- Examine the role of predisposing, enabling and need factors in explaining differences in healthcare utilisation patterns of TILDA participants over three time points
- Examine the influence of these factors in both bivariate and multivariate analyses, given that many previous studies have not adopted multivariate methods

8.4 Method

8.4.1 Sampling and participants

The present chapter utilised data from the first three waves of data collection from the TILDA study. The reader is referred to Chapter 2 (Methodology) for further detail on data collection and sample characteristics.

8.4.2 Design and variables

This study builds on the results of Chapter 6 by examining the patterns of healthcare utilisation identified within the latent transition analysis. Specifically, variables outlined in Figure 8-1 will be examined in relation to these patterns. Figure 8-1 outlines how the selected covariates map onto the theorising of Andersen and Newman (1973). Variables were coded as follows:

- Age: Continuous variable obtained from Wave 1. Continuous data with 'top coding' such that those participants aged over 80 years at were coded as 80 years of age.
- Sex: Binary covariate obtained from Wave 1, coded such that males = 1, females = 2.
- Marital status: Categorical variable captured at Wave 1, reverse coded as 1= widowed, 2=separated/divorced, 3= never married and 4=married.
- Widowed: Two binary variables collected at waves 2 and 3 indicating whether the participant had become widowed (0=no, 1=yes).
- Education: Categorical variable from Wave 1, reverse coded such that 1=third level/higher, 2=secondary and 3=primary/none.
- Baseline employment status: Binary variable coded such that 1=employed, 2=retired/other.
- Change in employment status W1→W2: Binary variable coded such that 0=no change, 1=change in status from Wave 1 to Wave 2.

- Change in employment status W2→W3: Binary variable coded such that 0=no change, 1=change in status from Wave 2 to Wave 3.
- Change in employment status W1→W3: Binary variable coded such that 0=no change, 1=change in status from Wave 1 to Wave 3.
- Change in healthcare coverage W1→W2: Binary variable coded such that 0=no change, 1=change in healthcare cover from Wave 1 to Wave 2.
- Change in healthcare coverage W2→W3: Binary variable coded such that 0=no change, 1=change in healthcare cover from Wave 2 to Wave 3.
- Change in healthcare coverage W1→W3: Binary variable coded such that 0=no change, 1=change in healthcare cover from Wave 1 to Wave 3.
- Urban/rural location: Categorical variable from Wave 1, reverse coded such that 1=a rural area, 2= another town or city and 3=Dublin city or county.
- Falls history: Two binary variables indicating whether a participant experienced a fall in the last 12 months (0=no, 1=yes), captured at Wave 2 and Wave 3, respectively.
- Faller: binary variable indicating whether the participant reported a fall at any wave (0=no, 1=yes).
- Frailty Index: Operationalised as the intercept and slope values obtained from latent growth curve model specified in Chapter 7. Frailty intercepts were categorised according to the thresholds previously reported by Roe and colleagues (2017), 0 to 0.09374 as robust (1); 0.09375 to 0.2499 as prefrail (2); and ≥0.25 as frail (3). Frailty slopes were summarised as two categorical variables, coded such that 0= zero or negative frailty slope value (stable or decreasing frailty) and 1= positive frailty slope value (increasing).
- Polypharmacy: Operationalised as the intercept and slope values obtained from latent growth curve model specified in Chapter 7.

- Depression: Operationalised as the intercept and slope values obtained from latent growth curve model specified in Chapter 7.
- Anxiety: Operationalised as the intercept and slope values obtained from latent growth curve model specified in Chapter 7. Owed to the non-linear change in anxiety over time, adjustments were made to the anxiety slope values to isolate the slope change from Wave 1 to Wave 2 from that of the slope change from Wave 2 to Wave 3, for those analyses which examined the time periods separately. Anxiety slope values were adjusted by the slope factor mean score for time 2 (2.070) and time 3 (2), via a multiplication by 2.070 and -0.070, respectively.
- Cognition: Operationalised as the intercept and slope values obtained from latent growth curve model specified in Chapter 7.

Due to conceptual overlap and the potential for multicollinearity, it was decided to omit comorbidity level and new incident disease as variables in the present analysis. The Frailty Index already accounts for several comorbidities and thus it would not be appropriate to retain both Frailty Index and comorbidity category within the analysis. Furthermore, the operationalisation of incident disease diagnosed at Waves 2 and 3 is somewhat crude, given that many such incident diagnoses could be time limited and therefore not count as an increase in chronic disease comorbidity e.g. an isolated infective episode. Frailty is a multidimensional construct that has previously been shown to be related to healthcare utilisation (Fried et al., 2001; Han et al., 2019; Roe et al., 2017). Thus, it serves as a more nuanced description of the inherent complexity of older people and proffers the opportunity to examine healthcare utilisation behaviours as a combination of disease level and functional limitations.

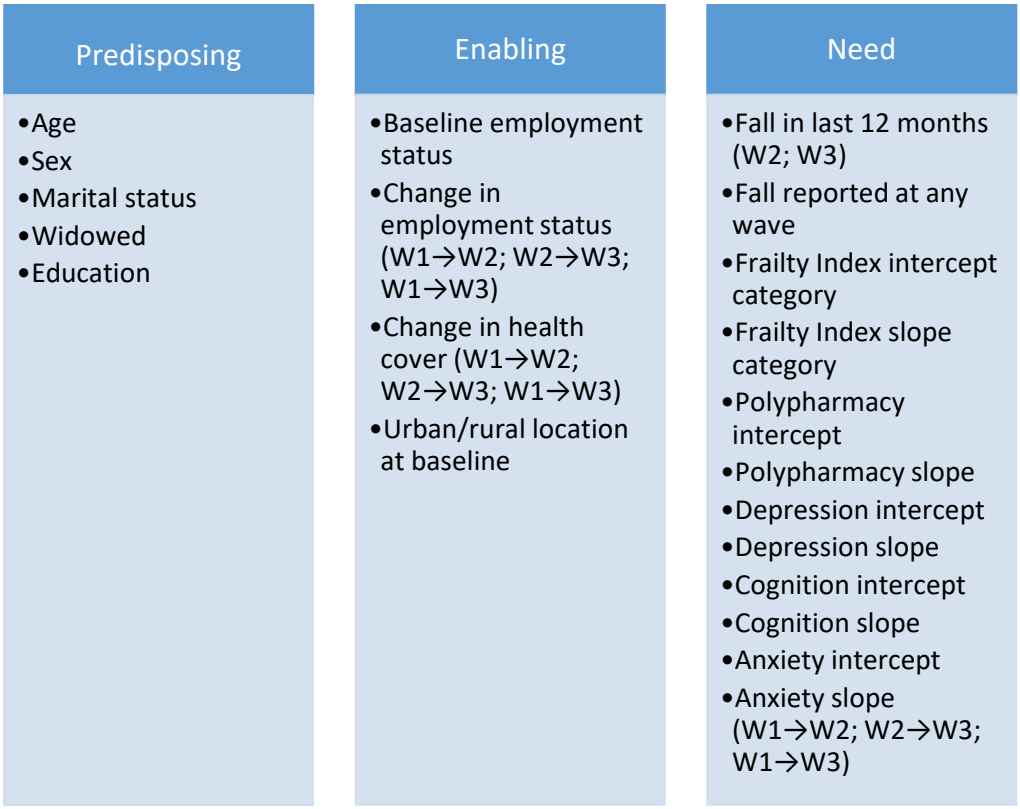

Figure 8-1: Final selection of covariates for inclusion in Chapter 8 analyses, as per the Andersen Behavioural Model)

8.4.3 Analytical plan

Examination of movement from one healthcare utilisation pattern to another was conducted using multinomial logistic regression using Mplus 8.1 (Muthén & Muthén, 2018). In order to operationalise categorical variables within Mplus those with more than two categories were dummy coded against a reference category. For example, baseline marital status was dummy coded such that marital1 (widowed), marital2 (separated/divorced) and marital3 (never married) were included in the analysis, in comparison to the omitted reference category of 'married'. Similarly, education was dummy coded such that edu1 (third level/higher level) and edu2 (secondary level) were compared against the omitted reference category of 'primary level/none '. Location was also dummy coded such that loc1 (rural) and loc2 (another town/city) were compared against the omitted reference category of 'Dublin city or county'.

Three distinct latent statuses were identified in Chapter 6: *effective referral utilisation* (LS1), *multiple utilisation* (LS2) and *primary care only utilisation* (LS3). The identification of three latent statuses at three time points resulted in a total of 3^3 or 27 distinct patterns of healthcare utilisation. In order to summarise the large number of patterns identified it was decided to conduct the multinomial regression in three complementary steps: transition patterns from Wave 1 to Wave 2; from Wave 2 to Wave 3; and from Wave 1 to Wave 3.

Table 8-1: Frequencies for healthcare utilisation patterns from Wave 1 to Wave 2 and Wave 2 to Wave 3 (N = 6128)

Healthcare utilisation pattern	**Wave 1 to Wave 2 n (%)**	**Wave 2 to Wave 3 n (%)**
1→ 1	1325 (21.6)	1301 (21.2)
1→ 2	311 (5.1)	401 (6.5)
1→ 3	75 (1.2)	106 (1.7)
2→ 1	322 (5.3)	333 (5.4)
2→ 2	321 (5.2)	347 (5.7)
2→ 3	188 (3.1)	225 (3.7)
3→ 1	161 (2.6)	109 (1.8)
3→ 2	273 (4.5)	251 (4.1)
3→ 3	3152 (54.1)	3055 (49.9)

Note. 1 = effective referral utilisation; 2 = multiple utilisation; 3 = primary care only utilisation

In the case of transitions from Wave 1 to Wave 3 many of the groups identified within the 27 patterns were small in nature. Furthermore, Mplus limits the analysis of categorical outcome variables to 10 categories. Thus, it was further decided to amalgamate those groupings of latent status transition which possessed some conceptual overlap prior to analysis, rather than omit small sample size patterns which would have reduced the overall sample size. The combination of groups can be observed in Table 8-2. For each of the multinomial logistic regressions conducted, the reference group was those who remained in latent status 3 *'primary care only utilisation'* at each time point.

Table 8-2: Frequencies for combined healthcare utilisation patterns for multinomial regression from Wave 1 to Wave 3 (N = 6128)

Combined category	Healthcare utilisation patterns	n (%)
Continued *effective referral utilisation*	111	990 (16.2)
Continued *multiple utilisation*	222	140 (2.3)
Late improver	221 + 223	181 (3.0)
Improved and maintained	211 + 233 + 231 + 213	417 (6.8)
Declined with no recovery	122 + 322	207 (3.4)
Late decline	112 + 332 + 132 + 312	559 (9.1)
Improvement but reverted	212 + 232	93 (1.5)
Temporary decline	121 + 323 + 123 + 321	377 (6.2)
No multiple utilisation	113 + 131 + 133 + 313 + 331 +311	324 (5.3)
Continued *primary care only utilisation*‡	333	2840 (34.7)

Note. ‡= reference category for multinomial regression; 1 = effective referral utilisation; 2 = multiple utilisation; 3 = primary care only utilisation

8.5 Results

8.5.1 Healthcare utilisation patterns from Wave 1 to Wave 2

The transitions between the latent statuses identified in Chapter 6 from Wave 1 to Wave 2 can be observed in Table 8-3. Several covariates were found to increase the likelihood of remaining in the *'multiple utilisation status'* when compared to the *'primary care only'* status between Wave 1 and Wave 2. Whilst some associations were observed in unadjusted analyses for predisposing factors such as marital status or education, no such associations were observed in the fully adjusted model. Overall, no predisposing or enabling factors described the likelihood of remaining a user of multiple health services between Wave 1 and Wave 2. Rather, maintenance within this status was described by health need factors only. Having had a fall in the year before Wave 2 interview, higher depression intercept values, higher polypharmacy intercept and slope values, and pre-frail or frail intercept categories at

baseline were associated with an increased likelihood of remaining in the '*multiple utilisation'* status between Wave 1 and Wave 2.

Similarly, having had a fall in the previous 12 months, higher polypharmacy intercept and slope values, baseline frailty intercept of pre-frail or frail were more likely to move from '*effective referral'* at Wave 1 into '*multiple utilisation'* by Wave 2. Those who had an increasing frailty slope between Wave 1 and Wave 2 were less likely to transition out of '*multiple utilisation'* and into '*effective referral utilisatio*n', when compared with those who remained primary care only service users between both time periods. Similarly, those who had an increasing frailty slope value were more likely to be in the *primary care only→ multiple utilisation* pattern than remain users of primary care only services. Having experienced a fall in the 12 months before the Wave 2 interview, higher depression slope values along with higher polypharmacy intercept and slope values were all associated with an increased likelihood of escalating from *'primary care only utilisation'* to '*multiple utilisation'* between Waves 1 and 2.

Table 8-3: Multinomial logistic regression from Wave 1 to Wave 2

	Unadjusted	Adjusted
Covariate	**OR (95%CI)**	**OR (95% CI)**
Wave 1 effective referral→ W2 effective referral		
Age	**1.05 (1.05, 1.06)**	1.01 (0.99, 1.02)
Sex	**1.40 (1.22, 1.61)**	1.14 (0.97, 1.34)
Marital status (married)	1.00	1.00
Marital status (widowed)	**1.92 (1.54, 2.38)**	0.78 (0.39, 1.59)
Marital status (separated/divorced)	**1.42 (1.07, 1.87)**	**1.39 (1.02, 1.90)**
Marital status (never married)	1.01 (0.79, 1.30)	0.99 (0.75, 1.31)
Widowed at W2	**1.85 (1.51, 2.27)**	1.22 (0.62, 2.40)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.44 (0.37, 0.54)**	0.82 (0.66, 1.03)
Education (third level/ higher level)	**0.57 (0.48, 0.68)**	0.88 (0.71, 1.07)
Employment at W1 (retired/other)	**2.82 (2.42, 3.29)**	**1.26 (1.04, 1.53)**
Change in employment status since last wave	0.80 (0.65, 1.00)	1.23 (0.97, 1.55)
Change in health cover since last wave	1.11 (0.89, 1.37)	1.19 (0.94, 1.51)

Location (Dublin city or county)	**1.00**	1.00
Location (rural)	0.90 (0.75, 1.08)	0.92 (0.75, 1.13)
Location (another town/city)	0.97 (0.79, 1.18)	0.85 (0.68, 1.06)
Fallen in the last 12 months	**1.61 (1.36, 1.91)**	1.17 (0.96, 1.42)
Anxiety intercept at W1	**1.12 (1.09, 1.15)**	**1.06 (1.01, 1.11)**
Anxiety slope (from W1 to W2)	**0.86 (0.77, 0.96)**	1.06 (0.91, 1.24)
Depression intercept	**1.20 (1.16, 1.23)**	1.04 (1.00, 1.09)
Depression slope	1.18 (0.99, 1.41)	1.10 (0.90, 1.34)
MMSE intercept	**0.86 (0.81, 0.90)**	1.04 (0.97, 1.11)
MMSE slope	1.40 (0.51, 3.82)	1.02 (0.31, 3.38)
Polypharmacy intercept	**1.76 (1.69, 1.85)**	**1.46 (1.38, 1.55)**
Polypharmacy slope	**4.36 (3.44, 5.51)**	**1.96 (1.53, 2.52)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**4.53 (3.74, 5.49)**	**2.20 (1.78, 2.73)**
Frailty intercept (frail)	**19.75 (15.12, 25.80)**	**3.35 (2.37, 4.75)**
Increasing frailty slope	1.06 (0.88, 1.26)	1.03 (0.85, 1.26)
Wave 1 effective referral→ W2 multiple utilisation		
Age	**1.05 (1.04, 1.07)**	0.99 (0.97, 1.01)
Sex	1.14 (0.88, 1.49)	0.90 (0.66, 1.21)
Marital status (married)	1.00	1.00
Marital status (widowed)	**1.78 (1.21, 2.62)**	0.60 (0.16, 2.35)
Marital status (separated/divorced)	**1.76 (1.08, 2.89)**	1.52 (0.91, 2.54)
Marital status (never married)	0.90 (0.56, 1.47)	0.81 (0.49, 1.34)
Widowed at W2	**1.78 (1.24, 2.56)**	1.34 (0.37, 4.91)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.48 (0.34, 0.66)**	1.11 (0.74, 1.67)
Education (third level/ higher level)	**0.56 (0.41, 0.77)**	1.04 (0.73, 1.49)
Employment at W1(retired/other)	**3.05 (2.28, 4.09)**	1.12 (0.78, 1.61)
Change in employment status since last wave	0.76 (0.51, 1.15)	1.15 (0.74, 1.79)
Change in health cover since last wave	0.76 (0.51, 1.14)	0.81 (0.52, 1.26)
Location (Dublin city or county)	1.00	1.00
Location (rural)	**0.70 (0.51, 0.95)**	**0.65 (0.46, 0.91)**
Location (another town/city)	0.82 (0.58, 1.15)	**0.65 (0.45, 0.93)**
Fallen in the last 12 months	**2.65 (1.99, 3.53)**	**1.75 (1.27, 2.40)**
Anxiety intercept at W1	**1.17 (1.12, 1.23)**	1.04 (0.96, 1.12)
Anxiety slope (from W1 to W2)	**0.74 (0.60, 0.90)**	0.92 (0.72, 1.19)
Depression intercept	**1.27 (1.21, 1.33)**	1.07 (1.00, 1.15)

Depression slope	**1.48 (1.04, 2.10)**	1.34 (0.98, 1.85)
MMSE intercept	**0.79 (0.74, 0.85)**	0.91 (0.83, 1.00)
MMSE slope	**0.79 (0.74, 0.85)**	**0.05 (0.01, 0.33)**
Polypharmacy intercept	**1.99 (1.87, 2.12)**	**1.57 (1.45, 1.71)**
Polypharmacy slope	**6.98 (4.50, 10.82)**	**2.51 (1.64, 3.84)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**7.42 (4.50, 12.24)**	**3.21 (1.90, 5.43)**
Frailty intercept (frail)	**53.08 (30.94, 91.04)**	**6.90 (3.50, 13.59)**
Increasing frailty slope	1.21 (0.86, 1.72)	1.23 (0.85, 1.78)
Wave 1 effective referral→ W2 primary care only		
Age	1.03 (1.00, 1.06)	0.98 (0.94, 1.02)
Sex	1.06 (0.59, 1.92)	0.93 (0.49, 1.74)
Marital status (married)	**1.00**	**1.00**
Marital status (widowed)	1.94 (0.86, 4.39)	1.59 (0.26, 9.80)
Marital status (separated/divorced)	0.36 (0.05, 2.65)	0.34 (0.05, 2.46)
Marital status (never married)	2.13 (0.90, 5.06)	2.01 (0.86, 4.69)
Widowed at W2	1.69 (0.77, 3.67)	0.99 (0.18, 5.41)
Education (primary/none)	**1.00**	1.00
Education (secondary)	**0.32 (0.15, 0.70)**	0.45 (0.17, 1.17)
Education (third level/ higher level)	**0.39 (0.20, 0.76)**	**0.46 (0.22, 0.95)**
Employment at W1(retired/other)	**3.61 (1.89, 6.90)**	**3.05 (1.44, 6.49)**
Change in employment status since last wave	1.34 (0.63, 2.82)	2.08 (0.97, 4.50)
Change in health cover since last wave	1.43 (0.63, 3.26)	1.45 (0.65, 3.23)
Location (Dublin city or county)	1.00	1.00
Location (rural)	1.23 (0.56, 2.71)	1.20 (0.52, 2.74)
Location (another town/city)	1.44 (0.60, 3.43)	1.37 (0.60, 3.15)
Fallen in the last 12 months	1.46 (0.71, 3.00)	1.32 (0.60, 2.89)
Anxiety intercept at W1	**1.13 (1.04, 1.24)**	1.13 (0.98, 1.32)
Anxiety slope (from W1 to W2)	0.66 (0.40, 1.11)	0.88 (0.51, 1.51)
Depression intercept	**1.12 (1.01, 1.26)**	0.96 (0.81, 1.15)
Depression slope	0.99 (0.47, 2.07)	1.06 (0.49, 2.30)
MMSE intercept	**0.82 (0.70, 0.96)**	0.99 (0.83, 1.19)
MMSE slope	4.88 (0.07, 328.54)	2.12 (0.04, 108.63)
Polypharmacy intercept	**1.41 (1.20, 1.65)**	**1.29 (1.11, 1.50)**
Polypharmacy slope	1.26 (0.53, 3.02)	0.80 (0.36, 1.80)
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**2.25 (1.12, 4.54)**	1.20 (0.54, 2.64)

Frailty intercept (frail)	**3.54 (1.11, 11.3)**	0.79 (0.22, 2.85)
Increasing frailty slope	0.79 (0.39, 1.61)	0.79 (0.37, 1.66)
Wave 1 multiple utilisation→ W2 effective referral		
Age	**1.04 (1.03, 1.06)**	0.99 (0.97, 1.01)
Sex	**1.33 (1.03, 1.72)**	1.11 (0.84, 1.46)
Marital status (married)	1.00	1.00
Marital status (widowed)	1.47 (0.99, 2.19)	0.48 (0.17, 1.39)
Marital status (separated/divorced)	**1.65 (1.04, 2.64)**	1.53 (0.95, 2.49)
Marital status (never married)	1.28 (0.84, 1.94)	1.28 (0.81, 2.01)
Widowed at W2	1.44 (1.00, 2.09)	1.65 (0.58, 4.66)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.41 (0.30, 0.58)**	0.77 (0.52, 1.13)
Education (third level/ higher level)	**0.56 (0.42, 0.76)**	0.88 (0.63, 1.23)
Employment at W1 (retired/other)	**3.54 (2.64, 4.76)**	**1.74 (1.24, 2.45)**
Change in employment status since last wave	1.06 (0.73, 1.53)	**1.85 (1.23, 2.77)**
Change in health cover since last wave	1.25 (0.87, 1.80)	1.32 (0.89, 1.97)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.94 (0.69, 1.30)	0.98 (0.69, 1.38)
Location (another town/city)	0.98 (0.69, 1.39)	0.83 (0.57, 1.21)
Fallen in the last 12 months	**1.89 (1.41, 2.54)**	1.33 (0.97, 1.83)
Anxiety intercept at W1	**1.16 (1.11, 1.22)**	1.08 (0.99, 1.17)
Anxiety slope (from W1 to W2)	**0.80 (0.64, 0.99)**	1.07 (0.82, 1.41)
Depression intercept	**1.25 (1.20, 1.31)**	1.06 (0.98, 1.14)
Depression slope	1.32 (0.92, 1.88)	1.27 (0.91, 1.77)
MMSE intercept	**0.85 (0.79, 0.91)**	1.04 (0.95, 1.15)
MMSE slope	3.68 (0.63, 21.43)	2.43 (0.33, 17.72)
Polypharmacy intercept	**1.97 (1.85, 2.10)**	**1.72 (1.59, 1.86)**
Polypharmacy slope	**2.21 (1.34, 3.66)**	1.03 (0.68, 1.56)
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**5.06 (3.40, 7.54)**	**1.91 (1.25, 2.93)**
Frailty intercept (frail)	**27.57 (17.6, 43.18)**	**2.60 (1.44, 4.70)**
Increasing frailty slope	**0.67 (0.50, 0.91)**	**0.70 (0.51, 0.96)**
Wave 1 multiple utilisation→ W2 multiple utilisation		
Age	**1.06 (1.05, 1.08)**	1.00 (0.98, 1.02)
Sex	1.29 (0.99, 1.68)	1.03 (0.76, 1.40)
Marital status (married)	1.00	1.00
Marital status (widowed)	**2.04 (1.39, 3.00)**	0.74 (0.21, 2.52)

Marital status (separated/divorced)	**1.82 (1.12, 2.97)**	1.68 (1.00, 2.81)
Marital status (never married)	1.41 (0.92, 2.16)	1.33 (0.83, 2.11)
Widowed at W2	**1.80 (1.25, 2.58)**	1.15 (0.35, 3.75)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.49 (0.35, 0.69)**	1.18 (0.79, 1.79)
Education (third level/ higher level)	**0.59 (0.44, 0.81)**	1.10 (0.77, 1.58)
Employment at W1 (retired/other)	**3.58 (2.62, 4.88)**	1.11 (0.75, 1.64)
Change in employment status since last wave	0.78 (0.50, 1.22)	1.35 (0.81, 2.23)
Change in health cover since last wave	1.19 (0.81, 1.74)	1.31 (0.87, 1.97)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.94 (0.67, 1.30)	0.89 (0.63, 1.27)
Location (another town/city)	1.13 (0.79, 1.62)	0.90 (0.61, 1.33)
Fallen in the last 12 months	**3.77 (2.86, 4.96)**	**2.52 (1.84, 3.43)**
Anxiety intercept at W1	**1.16 (1.11, 1.21)**	1.05 (0.97, 1.13)
Anxiety slope (from W1 to W2)	0.87 (0.68, 1.10)	1.16 (0.87, 1.54)
Depression intercept	**1.28 (1.23, 1.34)**	**1.09 (1.01, 1.17)**
Depression slope	1.35 (0.95, 1.93)	1.28 (0.92, 1.77)
MMSE intercept	**0.79 (0.73, 0.85)**	0.97 (0.87, 1.07)
MMSE slope	2.63 (0.39, 17.57)	0.94 (0.12, 7.46)
Polypharmacy intercept	**2.20 (2.05, 2.35)**	**1.82 (1.67, 1.99)**
Polypharmacy slope	**6.25 (4.11, 9.51)**	**2.14 (1.42, 3.22)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**11.59 (6.77, 19.84)**	**3.76 (2.12, 6.66)**
Frailty intercept (frail)	**84.52 (48.01, 148.77)**	**5.13 (2.57, 10.24)**
Increasing frailty slope	0.92 (0.65, 1.28)	0.89 (0.62, 1.28)
Wave 1 multiple utilisation→ W2 primary care only		
Age	**1.03 (1.01, 1.05)**	0.99 (0.96, 1.02)
Sex	1.21 (0.86, 1.71)	1.22 (0.84, 1.77)
Marital status (married)	1.00	
Marital status (widowed)	1.27 (0.70, 2.33)	0.52 (0.15, 1.73)
Marital status (separated/divorced)	1.71 (0.93, 3.13)	1.60 (0.85, 3.00)
Marital status (never married)	1.63 (0.97, 2.73)	1.44 (0.85, 2.44)
Widowed at W2	1.19 (0.69, 2.05)	1.53 (0.50, 4.65)
Education (primary/none)	1.00	1.00
Education (secondary)	0.80 (0.53, 1.23)	1.23 (0.77, 1.97)
Education (third level/ higher level)	**0.60 (0.39, 0.93)**	0.84 (0.52, 1.34)
Employment at W1 (retired/other)	**1.58 (1.12, 2.22)**	1.02 (0.67, 1.55)

Change in employment status since last wave	0.93 (0.56, 1.54)	1.13 (0.66, 1.93)
Change in health cover since last wave	0.89 (0.52, 1.54)	0.95 (0.55, 1.66)
Location (Dublin city or county)	1.00	**1.00**
Location (rural)	1.18 (0.73, 1.89)	1.18 (0.71, 1.94)
Location (another town/city)	**1.74 (1.06, 2.86)**	1.62 (0.97, 2.69)
Fallen in the last 12 months	1.25 (0.81, 1.92)	1.03 (0.68, 1.59)
Anxiety intercept at W1	0.99 (0.92, 1.07)	1.00 (0.90, 1.11)
Anxiety slope (from W1 to W2)	1.00 (0.74, 1.34)	1.04 (0.73, 1.48)
Depression intercept	1.04 (0.94, 1.14)	0.94 (0.84, 1.06)
Depression slope	0.88 (0.60, 1.29)	0.79 (0.51, 1.22)
MMSE intercept	**0.84 (0.75, 0.95)**	0.91 (0.80, 1.03)
MMSE slope	0.87 (0.05, 14.8)	0.41 (0.03, 6.04)
Polypharmacy intercept	**1.51 (1.37, 1.66)**	**1.41 (1.26, 1.58)**
Polypharmacy slope	0.88 (0.49, 1.56)	0.62 (0.36, 1.07)
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**1.83 (1.25, 2.67)**	1.31 (0.85, 2.01)
Frailty intercept (frail)	**5.75 (3.32, 9.97)**	**2.15 (1.10, 4.17)**
Increasing frailty slope	0.77 (0.51, 1.15)	0.84 (0.55, 1.27)
Wave 1 primary care only→ W2 effective referral		
Age	**1.06 (1.04, 1.08)**	1.02 (0.99, 1.05)
Sex	1.28 (0.87, 1.90)	1.10 (0.72, 1.70)
Marital status (married)	1.00	1.00
Marital status (widowed)	**2.24 (1.32, 3.82)**	3.49 (0.37, 32.65)
Marital status (separated/divorced)	1.55 (0.73, 3.28)	1.63 (0.76, 3.50)
Marital status (never married)	0.75 (0.33, 1.74)	0.71 (0.31, 1.63)
Widowed at W2	**1.96 (1.17, 3.30)**	0.33 (0.04, 3.08)
Education (primary/none)	**1.00**	1.00
Education (secondary)	**0.48 (0.29, 0.80)**	0.97 (0.54, 1.74)
Education (third level/ higher level)	**0.62 (0.39, 0.99)**	1.01 (0.61, 1.68)
Employment at W1 (retired/other)	**2.68 (1.75, 4.12)**	1.36 (0.77, 2.39)
Change in employment status since last wave	**0.47 (0.24, 0.92)**	0.69 (0.34, 1.36)
Change in health cover since last wave	0.74 (0.40, 1.36)	0.74 (0.40, 1.39)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.81 (0.50, 1.29)	0.76 (0.46, 1.26)
Location (another town/city)	0.84 (0.49, 1.42)	0.75 (0.43, 1.29)
Fallen in the last 12 months	1.06 (0.63, 1.79)	0.85 (0.48, 1.50)
Anxiety intercept at W1	**1.09 (1.01, 1.17)**	1.05 (0.94, 1.18)

Anxiety slope (from W1 to W2)	0.79 (0.61, 1.01)	0.85 (0.60, 1.21)
Depression intercept	**1.14 (1.05, 1.23)**	1.05 (0.94, 1.16)
Depression slope	1.50 (0.95, 2.35)	1.41 (0.89, 2.25)
MMSE intercept	**0.82 (0.72, 0.93)**	0.93 (0.79, 1.09)
MMSE slope	0.57 (0.03, 11.05)	0.25 (0.01, 4.65)
Polypharmacy intercept	**1.42 (1.29, 1.56)**	**1.17 (1.03, 1.32)**
Polypharmacy slope	**6.02 (3.50, 10.35)**	**3.50 (2.02, 6.08)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**3.39 (2.12, 5.42)**	**1.86 (1.12, 3.10)**
Frailty intercept (frail)	**4.76 (2.15, 10.51)**	1.21 (0.50, 2.97)
Increasing frailty slope	1.69 (0.95, 3.01)	1.53 (0.83, 2.82)
Wave 1 primary care only→ W2 multiple utilisation		
Age	**1.03 (1.02, 1.05)**	1.00 (0.97, 1.02)
Sex	1.11 (0.84, 1.45)	1.06 (0.78, 1.44)
Marital status (married)	**1.00**	**1.00**
Marital status (widowed)	1.08 (0.71, 1.65)	**0.36 (0.14, 0.93)**
Marital status (separated/divorced)	1.20 (0.68, 2.13)	1.09 (0.60, 1.96)
Marital status (never married)	1.00 (0.62, 1.62)	0.98 (0.60, 1.61)
Widowed at W2	1.21 (0.82, 1.77)	1.77 (0.75, 4.21)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.52 (0.35, 0.75)**	0.73 (0.47, 1.13)
Education (third level/ higher level)	0.77 (0.55, 1.07)	1.03 (0.71, 1.51)
Employment at W1 (retired/other)	**1.79 (1.34, 2.38)**	1.07 (0.75, 1.53)
Change in employment status since last wave	0.91 (0.59, 1.40)	1.00 (0.63, 1.58)
Change in health cover since last wave	1.06 (0.70, 1.61)	1.06 (0.69, 1.61)
Location (Dublin city or county)	**1.00**	1.00
Location (rural)	1.08 (0.76, 1.53)	0.97 (0.67, 1.39)
Location (another town/city)	1.09 (0.74, 1.61)	0.93 (0.62, 1.39)
Fallen in the last 12 months	**2.28 (1.68, 3.09)**	**2.10 (1.54, 2.87)**
Anxiety intercept at W1	1.03 (0.97, 1.10)	0.98 (0.90, 1.06)
Anxiety slope (from W1 to W2)	1.07 (0.86, 1.34)	1.10 (0.85, 1.42)
Depression intercept	**1.10 (1.02, 1.18)**	1.06 (0.97, 1.16)
Depression slope	**1.52 (1.09, 2.12)**	**1.47 (1.04, 2.07)**
MMSE intercept	**0.88 (0.81, 0.96)**	0.98 (0.88, 1.09)
MMSE slope	0.46 (0.06, 3.52)	0.30 (0.04, 2.40)
Polypharmacy intercept	**1.47 (1.37, 1.59)**	**1.32 (1.19, 1.46)**
Polypharmacy slope	**6.82 (4.49, 10.35)**	**4.26 (2.76, 6.57)**

Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**2.12 (1.57, 2.87)**	1.24 (0.86, 1.79)
Frailty intercept (frail)	**3.91 (2.41, 6.33)**	0.97 (0.51, 1.86)
Increasing frailty slope	**1.88 (1.24, 2.85)**	**1.62 (1.05, 2.51)**

Note. Reference group: W1 primary care only → W2 primary care only

8.5.2 Healthcare utilisation patterns from Wave 2 to Wave 3

Transitions between latent statuses of healthcare usage between Wave 2 and Wave 3 can be observed in Table 8-4. The predisposing factors of age, female sex and marital status showed significant associations with healthcare utilisation patterns between Waves 2 and 3, even when adjusted for other covariates. Increasing age was associated with an increased likelihood of being in the *effective referral→ primary care only* pattern, as well as the *primary care only→ effective referral* pattern, when compared with the reference group. Females were less likely to escalate from '*primary care only'* to '*multiple utilisation'* and more likely than males to move from '*effective referral'* to '*primary care only'* utilisation.

A recent fall, higher depression intercept and slope values, higher polypharmacy intercept and slope values and an increasing frailty slope, were all associated with an increased likelihood of remaining a user of multiple types of health services between Waves 2 and 3. Those who were separated or divorced were more likely than those who were married at baseline to move from *'effective referral'* into *'multiple utilisation'*, or to remain in the *'multiple utilisation'* status between Waves 2 and 3. Transition into the *'multiple utilisation'* transition was also less likely for those who lived in a rural area or another town or city, when compared to those who lived in Dublin.

Again, between Wave 2 and Wave 3, health need factors were significant predictors of healthcare transition pattern membership. Movement into *'multiple utilisation'* by Wave 3 from either '*effective referral'* or *'primary care only'* was also significantly predicted by a recent history of a fall. A higher depression intercept and a higher depression slope value both

predicted movement into *'multiple utilisation'* from the *'effective referral'* latent status between Waves 2 and 3. Higher polypharmacy intercept and slope values predicted many transitions between Wave 2 and Wave 3, but polypharmacy intercept value was not associated with moving from *'primary care only'* to *'multiple utilisation'* between the two times. No association was observed between baseline cognitive status (MMSE intercept) nor improvement in cognition (MMSE slope) between Wave 2 and Wave 3.

Table 8-4: Multinomial logistic regression from Wave 2 to Wave 3

	Unadjusted	Adjusted
Covariate	**OR (95% CI)**	**OR (95% CI)**
W2 effective referral →W3 effective referral		
Age	**1.05 (1.04, 1.06)**	1.01 (0.99, 1.02)
Sex	**1.32 (1.15, 1.52)**	1.06 (0.90, 1.24)
Marital status (married)	1.00	1.00
Marital status (widowed)	**1.69 (1.35, 2.11)**	1.09 (0.63, 1.88)
Marital status (separated/divorced)	1.30 (0.97, 1.74)	1.29 (0.94, 1.76)
Marital status (never married)	0.99 (0.77, 1.26)	0.96 (0.73, 1.27)
Widowed at W3	**1.65 (1.34, 2.04)**	0.81 (0.49, 1.35)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.48 (0.40, 0.58)**	0.84 (0.67, 1.05)
Education (third level/ higher level)	**0.63 (0.53, 0.75)**	0.95 (0.78, 1.17)
Employment at W1 (retired/other)	**2.84 (2.43, 3.32)**	**1.33 (1.10, 1.62)**
Change in employment status since last wave	**0.61 (0.48, 0.77)**	0.93 (0.72, 1.20)
Change in health cover since last wave	1.11 (0.89, 1.39)	1.26 (1.00, 1.60)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.95 (0.79, 1.14)	1.00 (0.81, 1.22)
Location (another town/city)	0.97 (0.79, 1.19)	0.86 (0.69, 1.08)
Fallen in the last 12 months	**1.58 (1.33, 1.88)**	**1.23 (1.02, 1.48)**
Anxiety intercept at W2	**1.15 (1.11, 1.18)**	**1.08 (1.03, 1.13)**
Anxiety slope (from W2 to W3)	**100.08 (3.36, 2981.71)**	0.69 (0.01, 35.85)
Depression intercept	**1.20 (1.16, 1.24)**	**1.05 (1.01, 1.10)**
Depression slope	**1.21 (1.01, 1.45)**	1.18 (0.96, 1.45)
MMSE intercept	**0.88 (0.84, 0.93)**	1.06 (0.99, 1.13)
MMSE slope	1.49 (0.56, 3.99)	1.36 (0.43, 4.36)

Polypharmacy intercept	**1.70 (1.62, 1.78)**	**1.43 (1.35, 1.51)**
Polypharmacy slope	**4.12 (3.20, 5.32)**	**2.20 (1.70, 2.83)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**4.56 (3.77, 5.52)**	**2.22 (1.79, 2.75)**
Frailty intercept (frail)	**15.76 (12.05, 20.62)**	**2.76 (1.95, 3.91)**
Increasing frailty slope	0.99 (0.83, 1.18)	0.98 (0.81, 1.20)
W2 effective referral →W3 multiple utilisation		
Age	**1.07 (1.05, 1.08)**	1.01 (0.99, 1.03)
Sex	**1.30 (1.03, 1.64)**	1.05 (0.81, 1.36)
Marital status (married)	1.00	1.00
Marital status (widowed)	**2.36 (1.69, 3.28)**	2.00 (0.76, 5.21)
Marital status (separated/divorced)	**1.93 (1.29, 2.88)**	**1.85 (1.19, 2.88)**
Marital status (never married)	1.01 (0.66, 1.53)	0.88 (0.57, 1.38)
Widowed at W3	**2.01 (1.47, 2.76)**	0.45 (0.18, 1.11)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.35 (0.26, 0.48)**	0.82 (0.57, 1.19)
Education (third level/ higher level)	**0.53 (0.40, 0.70)**	0.97 (0.71, 1.34)
Employment at W1 (retired/other)	**3.06 (2.35, 4.00)**	0.97 (0.70, 1.35)
Change in employment status since last wave	**0.53 (0.34, 0.83)**	0.87 (0.54, 1.39)
Change in health cover since last wave	0.90 (0.61, 1.32)	1.08 (0.72, 1.63)
Location (Dublin city or county)	1.00	1.00
Location (rural)	**0.74 (0.56, 0.99)**	**0.72 (0.52, 0.99)**
Location (another town/city)	0.83 (0.61, 1.15)	**0.68 (0.48, 0.96)**
Fallen in the last 12 months	**1.89 (1.44, 2.48)**	**1.62 (1.23, 2.15)**
Anxiety intercept at W2	**1.16 (1.11, 1.22)**	0.99 (0.92, 1.06)
Anxiety slope (from W2 to W3)	**2563.33 (11.07, 5.9×10^5)**	49.45 (0.10, 2.5×10^4)
Depression intercept	**1.27 (1.22, 1.33)**	**1.16 (1.08, 1.25)**
Depression slope	**1.57 (1.16, 2.13)**	**1.66 (1.24, 2.20)**
MMSE intercept	**0.80 (0.74, 0.85)**	0.96 (0.87, 1.07)
MMSE slope	1.94 (0.31, 12.31)	0.91 (0.13, 6.32)
Polypharmacy intercept	**1.91 (1.79, 2.03)**	**1.54 (1.42, 1.66)**
Polypharmacy slope	**10.66 (7.41, 15.34)**	**4.70 (3.22, 6.86)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**4.68 (3.28, 6.69)**	**1.69 (1.14, 2.50)**
Frailty intercept (frail)	**27.56 (18.39, 41.32)**	**2.40 (1.40, 4.12)**
Increasing frailty slope	1.19 (0.87, 1.62)	1.05 (0.76, 1.46)

W2 effective referral →W3 primary care only		
Age	**1.08 (1.06, 1.11)**	**1.05 (1.01, 1.09)**
Sex	**2.18 (1.28, 3.70)**	**1.83 (1.04, 3.22)**
Marital status (married)	1.00	1.00
Marital status (widowed)	**2.63 (1.35, 5.12)**	0.64 (0.21, 1.91)
Marital status (separated/divorced)	1.52 (0.66, 3.50)	1.79 (0.76, 4.20)
Marital status (never married)	0.46 (0.13, 1.65)	0.48 (0.14, 1.73)
Widowed at W3	**3.32 (1.84, 5.98)**	1.64 (0.56, 4.81)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.33 (0.18, 0.61)**	0.59 (0.30, 1.15)
Education (third level/ higher level)	**0.51 (0.28, 0.90)**	0.75 (0.40, 1.40)
Employment at W1 (retired/other)	**3.13 (1.81, 5.41)**	1.02 (0.53, 1.97)
Change in employment status since last wave	**0.22 (0.07, 0.71)**	0.37 (0.11, 1.25)
Change in health cover since last wave	0.94 (0.40, 2.24)	1.21 (0.51, 2.90)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.62 (0.34, 1.11)	0.63 (0.34, 1.17)
Location (another town/city)	0.68 (0.35, 1.32)	0.59 (0.30, 1.17)
Fallen in the last 12 months	1.71 (0.95, 3.08)	0.78 (0.40, 1.52)
Anxiety intercept at W2	1.06 (0.95, 1.18)	1.08 (0.92, 1.26)
Anxiety slope (from W2 to W3)	36.37 (0.01, $2.07x10^5$)	7.08 (0, $1.06x10^5$)
Depression intercept	**1.10 (1.01, 1.20)**	0.97 (0.83, 1.15)
Depression slope	1.15 (0.66, 2.01)	1.07 (0.58, 1.98)
MMSE intercept	**0.86 (0.75, 0.98)**	1.07 (0.88, 1.29)
MMSE slope	2.08 (0.06, 69.57)	2.03 (0.04, 98.63)
Polypharmacy intercept	**1.60 (1.45, 1.77)**	**1.35 (1.17, 1.55)**
Polypharmacy slope	1.45 (0.53, 3.97)	0.88 (0.41, 1.89)
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**3.60 (1.94, 6.68)**	1.67 (0.87, 3.20)
Frailty intercept (frail)	**9.69 (4.54, 20.68)**	1.68 (0.55, 5.19)
Increasing frailty slope	1.12 (0.62, 2.01)	1.15 (0.64, 2.09)
W2 multiple utilisation →W3 effective referral		
Age	**1.04 (1.03, 1.06)**	0.98 (0.96, 1.01)
Sex	1.20 (0.93, 1.54)	1.02 (0.77, 1.34)
Marital status (married)	1.00	1.00
Marital status (widowed)	**1.62 (1.10, 2.38)**	0.82 (0.36, 1.88)
Marital status (separated/divorced)	**1.63 (1.03, 2.58)**	1.51 (0.93, 2.45)
Marital status (never married)	1.02 (0.67, 1.57)	0.97 (0.62, 1.53)

Widowed at W3	**1.60 (1.12, 2.29)**	1.08 (0.51, 2.26)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.53 (0.39, 0.73)**	1.14 (0.78, 1.65)
Education (third level/ higher level)	**0.58 (0.43, 0.78)**	1.02 (0.71, 1.44)
Employment at W1 (retired/other)	**2.93 (2.21, 3.87)**	1.34 (0.95, 1.89)
Change in employment status since last wave	0.79 (0.51, 1.21)	1.28 (0.81, 2.03)
Change in health cover since last wave	1.10 (0.75, 1.64)	1.26 (0.83, 1.92)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.84 (0.62, 1.15)	0.82 (0.59, 1.14)
Location (another town/city)	0.85 (0.60, 1.20)	0.69 (0.48, 1.00)
Fallen in the last 12 months	**2.29 (1.73, 3.04)**	1.26 (0.92, 1.74)
Anxiety intercept at W2	**1.15 (1.09, 1.21)**	1.01 (0.93, 1.09)
Anxiety slope (from W2 to W3)	**1253.95 (2.37, $6.6x10^5$)**	3.86 (0.01, 2206.92)
Depression intercept	**1.24 (1.18, 1.31)**	**1.11 (1.03, 1.19)**
Depression slope	1.23 (0.87, 1.75)	1.29 (0.94, 1.77)
MMSE intercept	**0.83 (0.77, 0.89)**	0.95 (0.86, 1.04)
MMSE slope	0.50 (0.08, 3.10)	0.25 (0.04, 1.61)
Polypharmacy intercept	**1.85 (1.74, 1.98)**	**1.56 (1.44, 1.69)**
Polypharmacy slope	**9.11 (6.28, 13.22)**	**4.19 (2.88, 6.09)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**5.02 (3.45, 7.30)**	**2.10 (1.38, 3.17)**
Frailty intercept (frail)	**22.27 (14.58, 34.02)**	**2.73 (1.54, 4.83)**
Increasing frailty slope	1.01 (0.73, 1.40)	0.96 (0.68, 1.35)
W2 multiple utilisation →W3 multiple utilisation		
Age	**1.07 (1.05, 1.08)**	1.01 (0.99, 1.03)
Sex	1.24 (0.96, 1.60)	0.94 (0.70, 1.26)
Marital status (married)	1.00	1.00
Marital status (widowed)	**1.99 (1.38, 2.86)**	1.28 (0.51, 3.20)
Marital status (separated/divorced)	**1.99 (1.25, 3.16)**	**1.90 (1.17, 3.09)**
Marital status (never married)	1.22 (0.80, 1.86)	1.05 (0.66, 1.67)
Widowed at W3	**1.85 (1.32, 2.60)**	0.57 (0.24, 1.34)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.43 (0.31, 0.60)**	1.10 (0.74, 1.63)
Education (third level/ higher level)	**0.67 (0.50, 0.90)**	1.33 (0.95, 1.86)
Employment at W1 (retired/other)	**3.42 (2.56, 4.58)**	0.95 (0.66, 1.36)
Change in employment status since last wave	**0.46 (0.27, 0.77)**	0.82 (0.48, 1.41)
Change in health cover since last wave	0.96 (0.64, 1.43)	1.13 (0.74, 1.74)

Location (Dublin city or county)	1.00	1.00
Location (rural)	0.82 (0.60, 1.12)	0.79 (0.56, 1.10)
Location (another town/city)	1.02 (0.73, 1.44)	0.79 (0.55, 1.15)
Fallen in the last 12 months	**3.17 (2.42, 4.15)**	**2.16 (1.61, 2.90)**
Anxiety intercept at W2	**1.21 (1.16, 1.27)**	1.04 (0.97, 1.12)
Anxiety slope (from W2 to W3)	105.86 (0.32, $3.48x10^4$)	0.35 (0, 272.54)
Depression intercept	**1.31 (1.25, 1.37)**	**1.14 (1.06, 1.22)**
Depression slope	**1.90 (1.37, 2.64)**	**1.65 (1.20, 2.27)**
MMSE intercept	**0.79 (0.74, 0.84)**	0.94 (0.86, 1.04)
MMSE slope	0.94 (0.17, 5.30)	0.44 (0.07, 2.84)
Polypharmacy intercept	**2.06 (1.93, 2.21)**	**1.63 (1.49, 1.78)**
Polypharmacy slope	**11.82 (7.62, 18.33)**	**4.44 (2.92, 6.74)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**9.97 (6.00, 16.57)**	**3.43 (1.98, 5.92)**
Frailty intercept (frail)	**69.57 (40.57, 119.3)**	**5.47 (2.78, 10.76)**
Increasing frailty slope	**1.70 (1.18, 2.45)**	**1.63 (1.10, 2.41)**
W2 multiple utilisation →W3 primary care only		
Age	**1.05 (1.03, 1.06)**	1.01 (0.99, 1.04)
Sex	0.96 (0.71, 1.31)	0.87 (0.61, 1.26)
Marital status (married)	1.00	1.00
Marital status (widowed)	1.21 (0.75, 1.95)	0.86 (0.33, 2.24)
Marital status (separated/divorced)	0.91 (0.43, 1.90)	0.97 (0.46, 2.03)
Marital status (never married)	0.75 (0.42, 1.32)	0.70 (0.40, 1.22)
Widowed at W3	1.29 (0.83, 2.02)	0.74 (0.31, 1.74)
Education (primary/none)	1.00	1.00
Education (secondary)	0.53 (0.35, 0.81)	0.85 (0.52, 1.40)
Education (third level/ higher level)	0.82 (0.57, 1.18)	1.22 (0.79, 1.90)
Employment at W1 (retired/other)	**1.67 (1.22, 2.28)**	0.82 (0.56, 1.20)
Change in employment status since last wave	0.64 (0.38, 1.08)	0.83 (0.49, 1.41)
Change in health cover since last wave	1.14 (0.72, 1.81)	1.20 (0.75, 1.92)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.96 (0.66, 1.40)	0.87 (0.59, 1.29)
Location (another town/city)	1.04 (0.68, 1.59)	0.89 (0.57, 1.37)
Fallen in the last 12 months	**3.83 (2.80, 5.26)**	1.29 (0.88, 1.89)
Anxiety intercept at W2	1.05 (0.98, 1.12)	1.03 (0.94, 1.12)
Anxiety slope (from W2 to W3)	0.54 (0, 1246.33)	0.07 (0, 246.14)
Depression intercept	**1.08 (1.01, 1.16)**	1.03 (0.94, 1.13)

Depression slope	1.42 (1.00, 2.02)	1.38 (0.95, 2.01)
MMSE intercept	**0.86 (0.79, 0.95**)	0.94 (0.85, 1.05)
MMSE slope	0.27 (0.03, 2.66)	0.18 (0.02, 1.69)
Polypharmacy intercept	**1.54 (1.43, 1.67)**	**1.40 (1.27, 1.55)**
Polypharmacy slope	**3.86 (2.22, 6.72)**	**2.51 (1.50, 4.20)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**2.15 (1.51, 3.04)**	1.20 (0.81, 1.80)
Frailty intercept (frail)	**5.56 (3.39, 9.13)**	1.35 (0.68, 2.67)
Increasing frailty slope	1.2 (0.79, 1.83)	1.11 (0.72, 1.73)
W2 primary care only →W3 effective referral		
Age	**1.05 (1.02, 1.08)**	**1.04 (1.01, 1.07)**
Sex	0.95 (0.61, 1.49)	0.89 (0.55, 1.46)
Marital status (married)	1.00	1.00
Marital status (widowed)	1.74 (0.94, 3.21)	2.01 (0.55, 7.34)
Marital status (separated/divorced)	0.89 (0.26, 3.04)	0.88 (0.28, 2.74)
Marital status (never married)	1.09 (0.46, 2.54)	1.03 (0.43, 2.45)
Widowed at W3	1.60 (0.89, 2.90)	0.53 (0.16, 1.75)
Education (primary/none)	1.00	1.00
Education (secondary)	0.63 (0.34, 1.16)	0.98 (0.53, 1.84)
Education (third level/ higher level)	0.98 (0.56, 1.72)	1.39 (0.80, 2.41)
Employment at W1 (retired/other)	**2.09 (1.30, 3.36)**	1.36 (0.85, 2.20)
Change in employment status since last wave	1.28 (0.66, 2.49)	1.61 (0.85, 3.04)
Change in health cover since last wave	1.72 (0.90, 3.28)	1.77 (0.95, 3.28)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.85 (0.48, 1.50)	0.77 (0.42, 1.41)
Location (another town/city)	1.04 (0.55, 1.98)	0.93 (0.49, 1.77)
Fallen in the last 12 months	1.30 (0.72, 2.35)	0.76 (0.42, 1.39)
Anxiety intercept at W2	1.00 (0.93, 1.08)	0.92 (0.81, 1.05)
Anxiety slope (from W2 to W3)	344.55 (0, $3.4x10^7$)	2167.31 (0.02, $3.1x10^8$)
Depression intercept	**1.11 (1.02, 1.20)**	**1.18 (1.02, 1.36)**
Depression slope	1.57 (0.85, 2.92)	1.91 (1.00, 3.66)
MMSE intercept	0.89 (0.77, 1.04)	1.02 (0.86, 1.21)
MMSE slope	3.87 (0.14, 107.77)	3.83 (0.14, 108.09)
Polypharmacy intercept	**1.30 (1.16, 1.47)**	**1.20 (1.06, 1.36)**
Polypharmacy slope	**4.63 (2.28, 9.41)**	**3.45 (1.69, 7.05)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	1.30 (0.79, 2.12)	0.70 (0.41, 1.22)

Frailty intercept (frail)	1.94 (0.78, 4.81)	0.48 (0.17, 1.42)
Increasing frailty slope	1.54 (0.73, 3.23)	1.21 (0.57, 2.58)
W2 primary care only →W3 multiple utilisation		
Age	**1.03 (1.01, 1.05)**	1.02 (1.00, 1.05)
Sex	0.85 (0.64, 1.14)	**0.71 (0.52, 0.98)**
Marital status (married)	**1.00**	1.00
Marital status (widowed)	1.13 (0.70, 1.84)	0.65 (0.28, 1.51)
Marital status (separated/divorced)	1.07 (0.59, 1.94)	1.08 (0.58, 2.01)
Marital status (never married)	**0.51 (0.28, 0.95)**	**0.50 (0.27, 0.93)**
Widowed at W3	1.19 (0.75, 1.87)	1.24 (0.59, 2.60)
Education (primary/none)	1.00	1.00
Education (secondary)	0.68 (0.45, 1.01)	0.91 (0.59, 1.42)
Education (third level/ higher level)	1.03 (0.72, 1.48)	1.30 (0.89, 1.89)
Employment at W1 (retired/other)	1.24 (0.93, 1.66)	0.85 (0.58, 1.25)
Change in employment status since last wave	0.94 (0.61, 1.44)	1.04 (0.66, 1.63)
Change in health cover since last wave	**1.65 (1.09, 2.49)**	1.49 (0.98, 2.27)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.91 (0.63, 1.31)	0.97 (0.66, 1.44)
Location (another town/city)	0.95 (0.63, 1.43)	0.94 (0.61, 1.44)
Fallen in the last 12 months	**1.49 (1.05, 2.12)**	**2.81 (2.06, 3.84)**
Anxiety intercept at W2	**1.10 (1.03, 1.17)**	1.09 (0.98, 1.20)
Anxiety slope (from W2 to W3)	5.76 (0.01, 4960.93)	0.33 (0, 525.59)
Depression intercept	**1.08 (1.02, 1.15)**	1.02 (0.93, 1.12)
Depression slope	**1.43 (1.03, 1.99)**	1.33 (0.91, 1.96)
MMSE intercept	0.93 (0.84, 1.02)	0.99 (0.89, 1.11)
MMSE slope	1.07 (0.11, 10.66)	1.32 (0.13, 13.9)
Polypharmacy intercept	**1.22 (1.12, 1.33)**	1.08 (0.96, 1.22)
Polypharmacy slope	**5.05 (3.19, 8.00)**	**4.46 (2.75, 7.24)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**1.80 (1.33, 2.45)**	1.19 (0.82, 1.73)
Frailty intercept (frail)	**1.98 (1.13, 3.49)**	0.83 (0.42, 1.66)
Increasing frailty slope	1.19 (0.82, 1.74)	1.00 (0.67, 1.49)

Note. Reference group: W2 primary care only → W3 primary care only. All intercepts related to Wave 1 values except for Anxiety, which exhibited non-linear change.

8.5.3 Healthcare utilisation patterns from Wave 1 to Wave 3

The transition patterns between Wave 1 and Wave 3 can be examined in Table 8-5. When maintenance in the *'multiple utilisation'* status was examined it was mostly predicted by health need factors, including having experienced at least one fall since Wave 1, higher baseline anxiety and depressive symptoms as well as increased rate of depressive symptom growth. Those who were pre-frail or frail at Wave 1 were also more likely to be in this pattern of continued usage of multiple healthcare services. Similarly, the greater the number of medications at baseline and the greater the increase in the number of medications over time were both associated with an increased likelihood of membership of '*continued multiple utilisation'* as opposed to *'continued primary care only'* usage pattern.

Several covariates showed no predictive relationship with membership of any transition when assessed over three points in time. Age, female sex, education level, change in employment status, change in healthcare cover, change in anxiety symptoms (anxiety slope), and cognitive status at baseline (MMSE intercept) were found not to be significant predictors of healthcare usage transition, when compared to a reference group of primary care only usage. Of the predisposing and enabling factors included within the model, those who were never married (at Wave 1) were less likely to be in a pattern characterised by '*late decline'* across the three waves. Those who were widowed by Wave 3 were also less likely to be in the *'continued multiple utilisation'* pattern. Those who were not employed at Wave 1 (retired or other occupation status) were more likely to be in either the '*continued effective referral'*, *'improvement maintained'* or *'no multiple utilisation'* patterns, when compared with the reference of *'continued primary care only'* utilisation.

Across the three waves health need factors were significant explanatory factors with respect to healthcare utilisation transition patterns. Having reported at least one fall between Wave 1 and Wave 3 predicted an increased likelihood of membership of all healthcare transition patterns except for the *'no multiple utilisation'* pattern, when compared to the

reference group. Higher odds ratios were identified for *'continued multiple utilisation'* (OR = 2.25), *'late improver'* (OR = 2.29), *'improved but reverted'* (OR = 3.89) and *'decline with no recovery'* (OR = 2.19) patterns.

Mental health factors such as anxiety, depression and cognitive function were all significant contributors also. Baseline anxiety levels predicted membership of several patterns, including *'continued effective referral'*, *'continued multiple utilisation'* and *'improvement maintained'* patterns. The rate of change in anxiety over time was not a significant predictor of healthcare usage across the three waves. Initial depressive status and increasing depressive symptomology over time predicted membership of several patterns, characterised by '*multiple utilisation'* at a minimum of one wave. Increasing cognitive status over time was associated with a lower likelihood of being in the *'decline with no recovery'* pattern, but no association was observed for baseline cognition for any of the transition patterns.

Table 8-5: Multinomial logistic regression from Wave 1 to Wave 3

	Unadjusted	**Adjusted**
Covariate	**OR (95% CI)**	**OR (95% CI)**
Continued effective referral		
Age	**1.06 (1.05, 1.07)**	1.01 (0.99, 1.02)
Sex	**1.36 (1.17, 1.59)**	1.06 (0.89, 1.27)
Marital status (married)	1.00	1.00
Marital status (widowed)	**1.89 (1.48, 2.41)**	1.06 (0.59, 1.89)
Marital status (separated/divorced)	1.29 (0.93, 1.78)	1.25 (0.88, 1.78)
Marital status (never married)	1.00 (0.76, 1.32)	0.97 (0.71, 1.31)
Widowed at W3	**1.79 (1.43, 2.23)**	0.86 (0.50, 1.47)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.46 (0.37, 0.56)**	0.85 (0.66, 1.08)
Education (third level/ higher level)	**0.60 (0.49, 0.72)**	0.94 (0.75, 1.17)
Employment at W1 (retired/other)	**2.94 (2.47, 3.50)**	**1.29 (1.04, 1.60)**
Change in employment status	**0.66 (0.53, 0.81)**	1.07 (0.85, 1.34)

Change in health cover	1.07 (0.88, 1.31)	1.18 (0.96, 1.45)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.94 (0.77, 1.16)	1.02 (0.82, 1.27)
Location (another town/city)	1.00 (0.80, 1.26)	0.93 (0.73, 1.19)
Reported a fall at minimum one wave	**1.71 (1.46, 2.01)**	**1.30 (1.09, 1.55)**
Anxiety intercept	**1.12 (1.09, 1.15)**	**1.06 (1.01, 1.12)**
Anxiety slope	**0.77 (0.59, 0.99)**	1.21 (0.86, 1.71)
Depression intercept	**1.20 (1.16, 1.24)**	1.05 (1.00, 1.11)
Depression slope	1.20 (0.98, 1.46)	1.16 (0.93, 1.45)
MMSE intercept	**0.87 (0.82, 0.92)**	1.06 (0.99, 1.14)
MMSE slope	1.35 (0.45, 4.08)	1.20 (0.34, 4.30)
Polypharmacy intercept	**1.78 (1.69, 1.87)**	**1.47 (1.38, 1.56)**
Polypharmacy slope	**4.40 (3.38, 5.74)**	**2.13 (1.62, 2.81)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**4.82 (3.88, 5.99)**	**2.32 (1.82, 2.96)**
Frailty intercept (frail)	**20.35 (15.05, 27.51)**	**3.33 (2.26, 4.91)**
Increasing frailty slope	1.07 (0.88, 1.31)	1.06 (0.86, 1.32)
Continued multiple utilisation		
Age	**1.08 (1.06, 1.11)**	1.03 (1.00, 1.06)
Sex	1.49 (1.00, 2.22)	1.11 (0.71, 1.74)
Marital status (married)	1.00	1.00
Marital status (widowed)	**2.82 (1.67, 4.75)**	4.99 (0.99, 25.11)
Marital status (separated/divorced)	1.83 (0.88, 3.81)	1.59 (0.78, 3.25)
Marital status (never married)	1.65 (0.91, 2.98)	1.41 (0.72, 2.75)
Widowed at W3	**1.96 (1.19, 3.23)**	**0.16 (0.03, 0.81)**
Education (primary/none)	1.00	1.00
Education (secondary)	**0.44 (0.26, 0.72)**	1.28 (0.72, 2.27)
Education (third level/ higher level)	**0.61 (0.39, 0.96)**	1.31 (0.82, 2.09)
Employment at W1 (retired/other)	4.02 (2.52, 6.41)	0.69 (0.39, 1.23)
Change in employment status	**0.50 (0.29, 0.87)**	0.92 (0.50, 1.71)
Change in health cover	1.04 (0.65, 1.66)	1.32 (0.83, 2.09)
Location (Dublin city or county)	1.00	1.00

Location (rural)	0.83 (0.50, 1.36)	0.82 (0.48, 1.39)
Location (another town/city)	1.28 (0.77, 2.12)	1.09 (0.64, 1.87)
Reported a fall at minimum one wave	**4.05 (2.64, 6.20)**	**2.25 (1.44, 3.50)**
Anxiety intercept	**1.23 (1.16, 1.31)**	**1.13 (1.02, 1.25)**
Anxiety slope	0.85 (0.46, 1.57)	1.89 (0.87, 4.13)
Depression intercept	**1.35 (1.28, 1.42)**	**1.11 (1.01, 1.22)**
Depression slope	**1.93 (1.16, 3.22)**	**1.59 (1.01, 2.51)**
MMSE intercept	**0.76 (0.69, 0.84)**	0.98 (0.84, 1.13)
MMSE slope	**23.41 (1.80, 304.12)**	7.57 (0.48, 118.66)
Polypharmacy intercept	**2.48 (2.27, 2.71)**	**1.95 (1.71, 2.22)**
Polypharmacy slope	**11.74 (6.5, 21.22)**	**3.80 (2.11, 6.82)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**11.60 (4.83, 27.86)**	**2.90 (1.13, 7.48)**
Frailty intercept (frail)	**155.52 (64.67, 373.99)**	**5.58 (1.80, 17.29)**
Increasing frailty slope	1.47 (0.83, 2.59)	1.53 (0.85, 2.73)
Late improver		
Age	**1.05 (1.03, 1.07)**	0.98 (0.96, 1.01)
Sex	1.13 (0.81, 1.59)	0.93 (0.63, 1.36)
Marital status (married)	1.00	1.00
Marital status (widowed)	1.63 (0.95, 2.79)	0.82 (0.28, 2.38)
Marital status (separated/divorced)	1.86 (0.99, 3.47)	1.69 (0.89, 3.21)
Marital status (never married)	1.15 (0.64, 2.08)	1.04 (0.57, 1.91)
Widowed at W3	1.53 (0.96, 2.46)	0.88 (0.33, 2.32)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.51 (0.33, 0.78)**	1.15 (0.69, 1.94)
Education (third level/ higher level)	**0.59 (0.39, 0.89)**	1.10 (0.68, 1.78)
Employment at W1 (retired/other)	**3.49 (2.33, 5.23)**	1.37 (0.82, 2.27)
Change in employment status	0.64 (0.39, 1.05)	1.19 (0.69, 2.08)
Change in health cover	1.04 (0.68, 1.60)	1.15 (0.74, 1.79)
Location (Dublin city or county)	**1.00**	1.00
Location (rural)	1.01 (0.66, 1.54)	1.04 (0.67, 1.61)
Location (another town/city)	1.02 (0.63, 1.65)	0.87 (0.52, 1.46)

Reported a fall at minimum one wave	**2.96 (2.07, 4.23)**	**2.29 (1.56, 3.36)**
Anxiety intercept	**1.10 (1.04, 1.18)**	0.95 (0.86, 1.06)
Anxiety slope	0.67 (0.32, 1.39)	0.93 (0.42, 2.08)
Depression intercept	**1.25 (1.18, 1.32)**	**1.12 (1.02, 1.24)**
Depression slope	1.10 (0.69, 1.76)	1.25 (0.82, 1.91)
MMSE intercept	**0.80 (0.73, 0.87**)	0.94 (0.83, 1.06)
MMSE slope	0.48 (0.04, 6.52)	0.19 (0.01, 2.70)
Polypharmacy intercept	**2.07 (1.91, 2.25)**	**1.76 (1.59, 1.95)**
Polypharmacy slope	**5.49 (3.17, 9.52)**	**2.28 (1.38, 3.78)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**12.44 (6.34, 24.40)**	**4.40 (2.18, 8.91)**
Frailty intercept (frail)	**58.55 (28.38, 120.8)**	**4.49 (1.91, 10.56)**
Increasing frailty slope	0.71 (0.47, 1.07)	0.72 (0.46, 1.13)
Improvement maintained		
Age	**1.04 (1.02, 1.05)**	0.99 (0.97, 1.01)
Sex	**1.27 (1.01, 1.60)**	1.09 (0.85, 1.40)
Marital status (married)	1.00	1.00
Marital status (widowed)	1.28 (0.86, 1.89)	0.58 (0.28, 1.19)
Marital status (separated/divorced)	**1.63 (1.06, 2.53)**	1.49 (0.96, 2.30)
Marital status (never married)	1.29 (0.90, 1.87)	1.20 (0.81, 1.79)
Widowed at W3	1.31 (0.93, 1.84)	1.26 (0.65, 2.45)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.57 (0.42, 0.75)**	0.95 (0.68, 1.32)
Education (third level/ higher level)	**0.59 (0.44, 0.78)**	0.90 (0.65, 1.23)
Employment at W1 (retired/other)	**2.47 (1.93, 3.15)**	**1.38 (1.03, 1.86)**
Change in employment status	0.77 (0.58, 1.03)	1.21 (0.88, 1.65)
Change in health cover	0.99 (0.75, 1.32)	1.08 (0.80, 1.45)
Location (Dublin city or county)	1.00	1.00
Location (rural)	1.00 (0.74, 1.35)	1.09 (0.79, 1.50)
Location (another town/city)	1.27 (0.91, 1.75)	1.17 (0.83, 1.64)
Reported a fall at minimum one wave	**1.91 (1.51, 2.41)**	**1.57 (1.23, 2.01)**
Anxiety intercept	**1.11 (1.06, 1.16)**	**1.08 (1.01, 1.16)**

Anxiety slope	0.78 (0.52, 1.18)	1.36 (0.83, 2.22)
Depression intercept	**1.17 (1.12, 1.23)**	1.00 (0.93, 1.08)
Depression slope	1.11 (0.82, 1.51)	1.07 (0.78, 1.47)
MMSE intercept	**0.84 (0.78, 0.91**)	0.98 (0.90, 1.08)
MMSE slope	3.84 (0.73, 20.18)	2.49 (0.42, 14.59)
Polypharmacy intercept	**1.78 (1.67, 1.89)**	**1.61 (1.49, 1.74)**
Polypharmacy slope	1.58 (0.99, 2.51)	0.96 (0.65, 1.43)
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**3.27 (2.44, 4.38)**	**1.54 (1.12, 2.13)**
Frailty intercept (frail)	**12.21 (8.27, 18.03)**	**1.82 (1.08, 3.08)**
Increasing frailty slope	**0.71 (0.54, 0.93)**	0.76 (0.57, 1.00)
Decline with no recovery		
Age	**1.06 (1.04, 1.08)**	0.99 (0.97, 1.02)
Sex	1.12 (0.82, 1.55)	0.88 (0.61, 1.26)
Marital status (married)	1.00	1.00
Marital status (widowed)	1.6 (1.00, 2.57)	0.66 (0.25, 1.69)
Marital status (separated/divorced)	**2.18 (1.23, 3.87)**	**1.92 (1.08, 3.43)**
Marital status (never married)	1.04 (0.58, 1.85)	0.92 (0.50, 1.68)
Widowed at W3	**1.62 (1.06, 2.47)**	0.97 (0.41, 2.26)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.41 (0.27, 0.63)**	0.95 (0.58, 1.57)
Education (third level/ higher level)	**0.66 (0.46, 0.96)**	1.27 (0.84, 1.93)
Employment at W1 (retired/other)	**3.32 (2.30, 4.78)**	1.15 (0.73, 1.83)
Change in employment status	**0.59 (0.37, 0.95)**	0.96 (0.58, 1.59)
Change in health cover	1.04 (0.71, 1.54)	1.13 (0.75, 1.70)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.83 (0.56, 1.22)	0.80 (0.53, 1.20)
Location (another town/city)	0.93 (0.60, 1.44)	0.75 (0.47, 1.18)
Reported a fall at minimum one wave	**2.94 (2.12, 4.06)**	**2.19 (1.56, 3.07)**
Anxiety intercept	**1.15 (1.08, 1.22)**	0.97 (0.89, 1.06)
Anxiety slope	0.70 (0.41, 1.2)	0.92 (0.48, 1.78)
Depression intercept	**1.28 (1.21, 1.36)**	**1.15 (1.06, 1.25)**

Depression slope	**1.87 (1.23, 2.85)**	**1.78 (1.21, 2.62)**
MMSE intercept	**0.79 (0.72, 0.85)**	0.92 (0.82, 1.03)
MMSE slope	**0.10 (0.01, 0.87)**	**0.05 (0.01, 0.47)**
Polypharmacy intercept	**1.97 (1.82, 2.13)**	**1.56 (1.40, 1.74)**
Polypharmacy slope	**11.58 (6.71, 19.97)**	**4.39 (2.56, 7.54)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**9.89 (5.36, 18.26)**	**3.89 (2.03, 7.45)**
Frailty intercept (frail)	**55.37 (28.47, 107.71)**	**5.88 (2.58, 13.39)**
Increasing frailty slope	**1.85 (1.16, 2.94)**	**1.73 (1.06, 2.81)**
Late decline		
Age	**1.05 (1.04, 1.06)**	1.01 (1.00, 1.03)
Sex	1.10 (0.90, 1.34)	0.91 (0.72, 1.13)
Marital status (married)	1.00	1.00
Marital status (widowed)	**1.82 (1.34, 2.47)**	1.21 (0.59, 2.48)
Marital status (separated/divorced)	**1.56 (1.07, 2.27)**	1.48 (0.99, 2.22)
Marital status (never married)	0.72 (0.49, 1.06)	**0.65 (0.44, 0.98)**
Widowed at W3	**1.78 (1.35, 2.34)**	0.75 (0.39, 1.45)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.45 (0.34, 0.59)**	0.86 (0.63, 1.18)
Education (third level/ higher level)	**0.66 (0.52, 0.84)**	1.06 (0.81, 1.40)
Employment at W1 (retired/other)	2.02 (1.63, 2.50)	0.90 (0.67, 1.20)
Change in employment status	**0.76 (0.58, 0.98)**	0.98 (0.73, 1.31)
Change in health cover	1.11 (0.86, 1.42)	1.16 (0.89, 1.51)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.79 (0.61, 1.01)	0.80 (0.61, 1.05)
Location (another town/city)	0.91 (0.69, 1.20)	0.82 (0.61, 1.11)
Reported a fall at minimum one wave	**1.96 (1.60, 2.41)**	**1.53 (1.23, 1.91)**
Anxiety intercept	**1.12 (1.08, 1.17)**	1.05 (0.98, 1.12)
Anxiety slope	0.72 (0.51, 1.01)	1.00 (0.65, 1.54)
Depression intercept	**1.20 (1.15, 1.25)**	**1.09 (1.02, 1.16)**
Depression slope	**1.49 (1.16, 1.92)**	**1.49 (1.14, 1.93)**
MMSE intercept	**0.82 (0.77, 0.88)**	0.95 (0.87, 1.04)

MMSE slope	2.16 (0.44, 10.75)	1.27 (0.24, 6.70)
Polypharmacy intercept	**1.66 (1.57, 1.76)**	**1.39 (1.28, 1.50)**
Polypharmacy slope	**8.73 (6.35, 12.00)**	**4.77 (3.39, 6.70)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**2.88 (2.25, 3.68)**	1.34 (1.00, 1.78)
Frailty intercept (frail)	**10.44 (7.43, 14.67)**	**1.63 (1.03, 2.58)**
Increasing frailty slope	1.27 (0.97, 1.66)	1.09 (0.82, 1.46)
Improved but reverted		
Age	**1.07 (1.04, 1.10)**	1.00 (0.96, 1.05)
Sex	1.29 (0.80, 2.09)	0.98 (0.60, 1.61)
Marital status (married)	1.00	1.00
Marital status (widowed)	**2.37 (1.21, 4.64)**	1.71 (0.40, 7.40)
Marital status (separated/divorced)	2.02 (0.96, 4.23)	1.71 (0.75, 3.91)
Marital status (never married)	1.62 (0.75, 3.50)	1.33 (0.61, 2.87)
Widowed at W3	1.78 (0.96, 3.30)	0.39 (0.09, 1.59)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.34 (0.17, 0.65)**	0.72 (0.35, 1.51)
Education (third level/ higher level)	**0.54 (0.32, 0.94)**	1.01 (0.57, 1.81)
Employment at W1 (retired/other)	**4.12 (2.34, 7.24)**	1.28 (0.65, 2.53)
Change in employment status	0.63 (0.33, 1.19)	1.34 (0.65, 2.77)
Change in health cover	0.97 (0.51, 1.82)	1.14 (0.60, 2.19)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.98 (0.54, 1.79)	1.04 (0.56, 1.93)
Location (another town/city)	0.91 (0.47, 1.76)	0.75 (0.38, 1.50)
Reported a fall at minimum one wave	**5.29 (3.11, 8.99)**	**3.89 (2.18, 6.92)**
Anxiety intercept	**1.14 (1.04, 1.24)**	0.89 (0.75, 1.04)
Anxiety slope	0.52 (0.23, 1.20)	0.53 (0.18, 1.61)
Depression intercept	**1.33 (1.24, 1.42)**	**1.24 (1.11, 1.40)**
Depression slope	1.65 (0.94, 2.89)	**1.97 (1.23, 3.16)**
MMSE intercept	**0.81 (0.72, 0.90)**	1.03 (0.89, 1.21)
MMSE slope	0.23 (0.01, 10.21)	0.13 (0, 6.69)
Polypharmacy intercept	**2.21 (1.98, 2.47)**	**1.74 (1.53, 1.99)**

Polypharmacy slope	**4.94 (2.30, 10.62)**	**1.99 (1.01, 3.89)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**3.69 (1.66, 8.17)**	1.17 (0.50, 2.72)
Frailty intercept (frail)	**47.21 (21.51, 103.62)**	2.63 (0.97, 7.17)
Increasing frailty slope	0.78 (0.44, 1.38)	0.76 (0.42, 1.37)
Temporary decline		
Age	**1.04 (1.03, 1.06)**	1.00 (0.98, 1.02)
Sex	1.11 (0.87, 1.40)	0.95 (0.73, 1.24)
Marital status (married)	1.00	1.00
Marital status (widowed)	1.43 (0.99, 2.07)	0.70 (0.32, 1.52)
Marital status (separated/divorced)	1.17 (0.71, 1.91)	1.08 (0.65, 1.80)
Marital status (never married)	0.85 (0.56, 1.30)	0.78 (0.51, 1.21)
Widowed at W3	**1.55 (1.12, 2.15)**	1.06 (0.53, 2.12)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.52 (0.38, 0.71)**	0.94 (0.65, 1.36)
Education (third level/ higher level)	**0.65 (0.49, 0.87)**	1.07 (0.76, 1.49)
Employment at W1 (retired/other)	**2.07 (1.62, 2.66)**	1.06 (0.78, 1.44)
Change in employment status	0.86 (0.64, 1.15)	1.18 (0.85, 1.62)
Change in health cover	1.04 (0.78, 1.38)	1.07 (0.79, 1.44)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.85 (0.63, 1.13)	0.83 (0.61, 1.13)
Location (another town/city)	0.92 (0.67, 1.28)	0.82 (0.58, 1.15)
Reported a fall at minimum one wave	**1.98 (1.56, 2.52)**	**1.64 (1.28, 2.12)**
Anxiety intercept	**1.1 (1.05, 1.16)**	1.03 (0.96, 1.11)
Anxiety slope	0.78 (0.53, 1.13)	1.07 (0.68, 1.67)
Depression intercept	**1.17 (1.11, 1.23)**	1.05 (0.98, 1.13)
Depression slope	**1.41 (1.04, 1.90)**	**1.36 (1.01, 1.83)**
MMSE intercept	**0.84 (0.78, 0.90)**	0.94 (0.86, 1.03)
MMSE slope	0.37 (0.07, 2.07)	0.21 (0.04, 1.14)
Polypharmacy intercept	**1.70 (1.59, 1.81)**	**1.47 (1.35, 1.59)**
Polypharmacy slope	**7.27 (5.00, 10.58)**	**3.86 (2.62, 5.68)**
Frailty intercept (robust)	1.00	1.00

Frailty intercept (prefrail)	**2.46 (1.85, 3.27)**	1.22 (0.88, 1.69)
Frailty intercept (frail)	**9.97 (6.82, 14.59)**	**1.75 (1.02, 3.00)**
Increasing frailty slope	1.35 (0.97, 1.87)	1.23 (0.87, 1.73)
No multiple utilisation		
Age	**1.05 (1.04, 1.07)**	1.02 (1.00, 1.04)
Sex	1.29 (0.98, 1.70)	1.10 (0.82, 1.48)
Marital status (married)	1.00	1.00
Marital status (widowed)	**2.02 (1.36, 2.99)**	1.33 (0.63, 2.80)
Marital status (separated/divorced)	1.22 (0.68, 2.19)	1.29 (0.72, 2.31)
Marital status (never married)	1.05 (0.63, 1.75)	1.02 (0.61, 1.71)
Widowed at W3	**1.90 (1.34, 2.71)**	0.87 (0.44, 1.72)
Education (primary/none)	1.00	1.00
Education (secondary)	**0.53 (0.37, 0.75)**	0.86 (0.57, 1.29)
Education (third level/ higher level)	**0.70 (0.50, 0.97)**	0.97 (0.68, 1.39)
Employment at W1 (retired/other)	**2.67 (1.99, 3.59)**	**1.73 (1.22, 2.44)**
Change in employment status	0.87 (0.62, 1.23)	1.34 (0.94, 1.89)
Change in health cover	1.27 (0.90, 1.78)	1.31 (0.93, 1.86)
Location (Dublin city or county)	1.00	1.00
Location (rural)	0.93 (0.67, 1.31)	0.95 (0.67, 1.34)
Location (another town/city)	0.99 (0.68, 1.45)	0.92 (0.63, 1.36)
Reported a fall at minimum one wave	**1.52 (1.16, 2.01)**	1.30 (0.97, 1.75)
Anxiety intercept	**1.06 (1.01, 1.12)**	1.03 (0.95, 1.12)
Anxiety slope	0.67 (0.43, 1.03)	0.76 (0.45, 1.28)
Depression intercept	**1.11 (1.05, 1.17)**	1.04 (0.96, 1.14)
Depression slope	1.27 (0.92, 1.76)	1.33 (0.92, 1.91)
MMSE intercept	**0.87 (0.79, 0.96)**	1.01 (0.91, 1.13)
MMSE slope	0.90 (0.13, 6.22)	0.71 (0.09, 5.49)
Polypharmacy intercept	**1.41 (1.31, 1.52)**	**1.23 (1.13, 1.35)**
Polypharmacy slope	**3.50 (2.26, 5.44)**	**2.28 (1.46, 3.56)**
Frailty intercept (robust)	1.00	1.00
Frailty intercept (prefrail)	**2.16 (1.58, 2.94)**	1.15 (0.82, 1.63)
Frailty intercept (frail)	**3.64 (2.17, 6.11)**	0.85 (0.44, 1.64)

	Increasing frailty slope	1.21 (0.84, 1.73)	1.07 (0.73, 1.57)

Note. Reference group: remained in primary care only W1 → W2 → W3

The number of prescribed medications at baseline predicted membership of all healthcare transition patterns when compared with the reference group. Similarly, the increase in the number of medications over time predicted an increased likelihood of membership of all patterns except for the *'improvement maintained'* pattern. Baseline frailty status was associated with almost all healthcare utilisation patterns between Wave 1 and Wave 3. No association was observed with the *'improved but reverted'* and *'no multiple utilisation'* patterns. Only those who were frail at Wave 1, compared with those who were robust, showed an increased likelihood of being in the '*late decline'* pattern, characterised by movement into the '*multiple utilisation'* status at Wave 3. Similarly, only those who were frail at Wave 1, and not those who were pre-frail, had an increased likelihood of being in the *'temporary decline'* pattern, when compared with the reference group of continued 'primary care only' service use.

8.6 Discussion

The present study sought to identify those factors which identify different longitudinal patterns of healthcare usage by older people, by comparing several different latent statuses against a reference trajectory typified by continual, stable, low level of primary care health usage. The inclusion of several demographic and health need factors allowed for an examination of those aspects which influence these different trajectories, and for the identification of possible intervention targets. Through a better understanding of what influences transition into and out of the *'multiple utilisation'* status identified in Chapter 6, clinicians and service providers may be able to turn their attention to not only identifying those at greater risk of multiple utilisation but to identify opportunities to redesign service

delivery around healthcare need. For older adults these healthcare need factors extend beyond the mere presence of comorbidities to include frailty status, falls history, number of prescribed medications, anxiety and depressive symptomology.

8.6.1 Predisposing factors

Age showed significant associations with healthcare usage patterns when examined as a bivariate relationship. However, across the three analyses presented, most of these associations were no longer significant when included in the fully adjusted model. However, between Wave 2 and Wave 3 age was associated with an increased likelihood of escalating from *'primary care only'* to '*effective referral'*, as well as an increased likelihood of de-escalating from *'effective referral'* to *'primary care only'*, in the fully adjusted model for Wave 2 to Wave 3. Previous studies have shown that older adults have lower odds of consultations with specialists but increased odds of ≥ 4 GP visits (Nabalamba & Millar, 2007).

In terms of other predisposing characteristics, some differences in longitudinal healthcare usage patterns were identified for females in unadjusted analyses, however, many of these became no longer significant when examined in the adjusted model. Associations did persist for an increased likelihood for females to be in the *effective referral→ primary care only* pattern and a decreased likelihood to be in the *primary care only→ multiple utilisation* pattern, between Wave 2 and Wave 3. Thus, it appears that females may be more likely to require primary care only services following a successful referral for outpatient services.

Several studies that have identified sex differences with respect to healthcare utilisation. Among young and low-income adult samples, females were found to be more likely to consult with a doctor than males (Broyles, McAuley & Baird-Holmes, 1999; Dhingra, Zack, Strine, Pearson & Balluz, 2010; Parslow, Jorm, Christensen & Jacomb, 2002). Among older adults more specifically, females have been reported to experience more GP visits but fewer specialist visits than males, in a study conducted in Canada (Vegda et al., 2009). Within the

same cohort females reported more chronic conditions than males and were in receipt of more medications (Vegda et al., 2009). Conversely, a separate Canadian study reported older females to be no more likely than males to consult with their GP but were less likely to visit a specialist (Nambalamba & Millar, 2007). In Norway, older females were less likely to visit a specialist or be hospitalised compared with males (Suominen-Taipale, Martelin, Koskelin, Holmen & Johnsen, 2006). Those Norwegian females in the 65-69 years category were found to visit a GP more often than males, but this difference was not observed for older age categories (Suominen-Taipale et al., 2006). In contrast, Finnish females were more likely to visit GPs and specialists more often than males (Suominen-Taipale et al., 2006). Cameron, Song, Manheim, and Dunlop (2010) found that after controlling for demographic, health need and economic access factors, females were 21% less likely to be hospitalised than males in an analysis of a national probability sample of community dwelling older American adults.

Marital status did show some associations with various healthcare usage patterns over the different time periods examined when accounting for other relevant covariates. Those who were separated or divorced at Wave 1 were more likely to exhibit stability in healthcare usage from Wave 1 to Wave 2 or from Wave 2 to Wave 3, and for some to escalate to *'multiple utilisation'* from *'effective referral'* from Wave 2 to Wave 3. When examined across the three waves those who were never married were less likely to occupy the *'late decline'* pattern. Those who were widowed at Wave 1 were less likely than those who were married to move from *'primary care only'* to *'multiple utilisation'* between Waves 1 and 2. When all three waves were examined, and baseline marital status was accounted for, widowhood was associated with a decreased likelihood of remaining in the *'multiple utilisation'* status across all three waves.

Several studies examining healthcare utilisation by older adults have shown significant associations with marital status. A Norwegian study of healthcare utilisation by colorectal

cancer decedents in the last year of life found that married patients and those who were previously married utilised more GP and outpatient services, spent fewer days in short- or long-term institutions and spent more days at home than those who were never married (Bjørnelv, Edwin, Fretland, Deb & Aas, 2020). Whilst this analysis did include younger participants approx. 90% of those included were over the age of 60 years. Being single in older adulthood has been shown to be associated with fewer GP and specialist visits as well as an increased risk of unplanned hospital admission within 28 days of hospital discharge compared with those who were married or cohabiting (Shebeshi, Dolja-Gore & Byles, 2020; Suominen-Taipale, Koskinen, Martelin, Holmen & Johnsen, 2004). Older COPD patients who lived with a spouse or another adult have been reported to experience fewer emergency department visits than those who lived alone (Wakabayashi et al., 2011). Similarly, older American adults who live alone have been shown to be 60% more likely to visit an ED than those who lived with their spouse (Hastings et al., 2008). As well as providing social support marriage may be associated with modified health risk behaviours. Schone and Weinick (1998) found that married men were more likely to engage in regular physical activity and to not smoke.

An assessment of marital status or experience of widowhood only provides a small insight into the possible social structure within which the individual is placed. The wider social structure of the individual as well as the subjective experience of loneliness may be an important factor that was not considered in the present study. Previous research has suggested that loneliness is predictive of ED and physician visits (Andrén & Rosenqvist, 1987; Cheng, 1992; Ellaway, Wood & Macintyre, 1999; Geller, Janson, McGovern & Valdini, 1999). A recent systematic review by Valtorta, Moore, Barron, Stow & Hanratty (2018) found insufficient evidence to suggest that older people with low levels of social support place greater demands on ambulatory healthcare services, independent of health status. Molloy, McGee, O'Neill, and Conroy (2010) found that greater levels of loneliness among older Irish adults was correlated with increases in emergency hospital admissions but not planned

admissions. More recently, Shaw and colleagues (2017) found that objective isolation was associated with increased levels of Medicaid spending in the US, but that loneliness predicted reduced spending, inferring that loneliness may serve as a barrier to seeking healthcare. Future research examining the broad topic of objective and subjective measures of isolation, loneliness and the social network may reveal additional insights regarding healthcare utilisation by the TILDA cohort but was considered to be beyond the scope of this thesis.

Those with a tertiary level of education were found to be less likely to move from *'effective referral'* to *'primary care only'* between the first two waves of TILDA data collection. When the transitions between Wave 1 and Wave 3 were examined, education beyond primary school level was found to be associated with all healthcare usage patterns in unadjusted analyses only. However, when education was included as a covariate in the adjusted model for Wave 1 to Wave 3 no association was observed. Such a finding is consistent with several studies which failed to find any association between education and healthcare usage (Lin, Chu, Chen, Xiao & Wan, 2020; Picco et al., 2016). However, one Scandinavian study reported some associations between secondary and third level education and increased likelihood of healthcare service use (Suominen-Taipale et al., 2004).

8.6.2 Enabling factors

Being retired or in a status other than employed at Wave 1 was associated with continued *'effective referral'*, irrespective if examined from Wave 1→ Wave 2, from Wave 2→ Wave 3 or from Wave 1→ Wave 3. They were also observed to exhibit a de-escalation of healthcare usage between Waves 1 and 2, as indicated by increased likelihood of membership of *effective referral→ primary care only* and *multiple utilisation→ effective referral* patterns. Furthermore, between Wave 1 and Wave 3 those who were retired/other were more likely than those who were employed at Wave 1 to occupy the *'improved and maintained'* and '*no multiple utilisation'* patterns. Such a finding suggests that the healthcare need is greater

among those older adults who are in employment in later life. Alternatively, those who were not employed may indicate those who adopted early retirement and thus may infer a better socioeconomic advantage, which may have additional benefits with respect to health status. Picco et al., (2016) previously found that those who were retired had higher combined health and social care costs than those in employment. No evidence was obtained for change in employment across the three waves in influencing healthcare usage patterns.

Our understanding of the role of health insurance and health care utilisation is largely shaped by research from countries such as the US, where it forms a large part of healthcare culture. Blackwell, Martinez, Gentleman, Sanmartin and Berthelot (2009) found that not having health insurance was associated with a decreased likelihood of attending a GP among a general population sample in the US. A systematic review of studies conducted by Babitsch et al., (2012) reported findings from seven studies that examined the Andersen Behavioural Model in the US and concluded that having healthcare insurance increased the likelihood of service use or decreased the delay in accessing services.

The costs associated with medical treatment in the absence of public health cover or private health insurance in Ireland, particularly in relation to primary care resources, would not be as prohibitive as those in the US. Thus, it is perhaps not surprising that in the present study change in healthcare coverage across the three waves did not impact upon healthcare usage patterns. This could be related to the manner in which change in cover was operationalised. Increases and decreases in coverage could not be easily identified from the data and thus the change in cover variable represented both types of change. Furthermore, the mixed public and private healthcare system presents challenges for elucidating the nuance associated with change in coverage. With universal access to free GP care available to TILDA respondents once they became 70 years of age, a change in cover may also be reported by those who did not

renew their private health insurance policy at this time but these respondents would also not have experienced a decrease in access to a GP per se.

The Andersen Behavioural Model posits that the rural-urban character wherein the individual resides may influence their ability to access healthcare services. In the present study, location was a significant predictor of healthcare usage patterns between Wave 1 and Wave 2 and between Wave 2 and Wave 3. However, no association for location of residence was observed when healthcare usage patterns were examined across three waves of data. Between Wave 1 and Wave 2, those living in a rural area were less likely to be in the *effective referral→ multiple utilisation* pattern, compared with those who lived in Dublin city or county. This effect was also observed between Wave 2 and Wave 3. Between Waves 2 and 3 those who lived in another town or city were also found to have a decreased likelihood of being in the *effective referral→ multiple utilisation* pattern when compared with those living in Dublin city or county. Taken together, these findings suggest that in the shorter term, those living outside Dublin city or county were less likely to transition to more intensive healthcare resource usage, which may suggest the need for improved services for older adults in population dense areas such as the greater Dublin area.

8.6.3 Need factors

Throughout the analyses presented here stronger, more consistent relationships were observed for those covariates that could be considered health need factors. Considerable relationships were observed for recent history of a fall across all three waves. In the adjusted model, having a history of a fall predicted membership of all healthcare transition patterns, save for the *'no multiple utilisation'* pattern from Wave 1 to Wave 3. Thus, overall, falls were associated with an increased level of healthcare usage when compared with the reference group of *'primary care only'* usage. Higher odds ratios were observed for those patterns which were characterised by multiple utilisations at more than one wave.

Such a finding is not surprising in the context of the many studies that have identified a strong relationship between falls and subsequent healthcare resource usage. In the UK, the cost of treating falls has been estimated to total £981 million for the year 1999; those fallers aged ≥ 75 years were responsible for two-thirds of these costs (Scuffham et al., 2003). Older fallers are more likely to be admitted to hospital than their younger counterparts (Scuffham et al., 2003). In a small study conducted in one region of Ireland, it was found that fall-related admissions accounted for approximately three quarters of all hospital admissions in the region (Carey & Laffoy, 2005). Falls often result in more complicated sequelae requiring intensive healthcare usage such as hip fractures, other fractures and traumatic brain injuries, which can increase the risk for a prolonged hospital stay, institutionalisation and death (Carey & Laffoy, 2005; Judge et al., 2016; Nazrun et al., 2014; Scuffham et al., 2003).

The findings observed here underscore the need for suitable falls prevention strategies and falls care pathways, given the persistent associations with escalated healthcare usage identified. Many falls are preventable, particularly when one considers the risks associated with the prescribing of medications that are established as increasing the risks of falls. The analysis of the intermediate care dataset presented in Chapter 5 highlighted that considerable prescribing of falls-risk medications occurs within older adults living in Northern Ireland. Previous research within the TILDA cohort has identified an association between medications with a high anticholinergic or sedative burden and an increased likelihood of falls (Byrne, Walsh, Cahir & Bennett, 2019). Approximately 42% of hospital admissions related to a hip fracture have been found to be related to a suspected medication-induced fall (Andersen et al., 2020).

Thus, considerable scope exists for medicines optimisation pathways within the Republic of Ireland, which could be modelled on those developed in Northern Ireland. In 2017, the South Eastern HSCT commenced a targeted prevention approach for falls and fractures

within Intermediate Care (Madden & Miller, 2019). A fracture prevention review comprised of bone health assessment, dietary assessments and a structured medicines review was conducted for all patients admitted into intermediate care with a fall. Prescribing appropriateness, the falls risk and anticholinergic effect on cognition were also assessed for each medication. Adopting a patient-centred approach, tailored pharmaceutical care plans were developed in order to adjust relevant medications and make onward referrals to other services, where required. A significant reduction in inappropriate prescribing and in falls-risk medications was observed (Madden & Miller, 2019). Such a finding highlights the value that can be added by incorporating pharmacist input into an integrated care pathway and the value of intermediate care destinations for optimising the health of older adults prior to their return home.

Internationally, falls prevention has become an increasing area of research, policy, and intervention (American Geriatrics Society (AGS), British Geriatrics Society (BGS) & American Academy of Orthopaedic Surgeons (AAOS) Panel on Falls Prevention, 2001; Close et al., 1999; Rubenstein, 2006; Rubenstein, Robbins, Josephson, Schulman & Osterweil, 1990). Programmes centred on risk prevention, environmental modifications, exercise, and education have been evaluated within the literature (Rubenstein, 2006). Clinical practice guidelines advocate the adoption of preventative strategies that incorporate a holistic risk assessment which is then related to targeted exercise interventions such as balance or strength training and with necessary environmental assessments and modifications, where necessary (AGS, BGS & AAOS, 2001). These guidelines have also been updated to reflect the need to consider a falls risk assessment in those older adults who report balance or gait issues, irrespective of falls history (Kenny et al., 2011). Several post-fall assessment interventions and fall prevention interventions have been shown to reduce falls and thus hospitalisations (Close et al., 1999; Rubenstein et al., 1990; Cooper et al., 2017). Several care pathways have been established within Irish EDs whereby fallers are triaged and referred for further services (Dunphy et al.,

2017; O'Keeffe et al., 2020). Furthermore, the HSE has established a national programme, AFFINITY National Falls and Bone Health Project, to coordinate the development of a falls and fracture prevention system through the integration of primary and secondary prevention and rehabilitation (HSE, 2019).

Baseline anxiety levels were associated with remaining in the *'effective referral'* status between Wave 1 and Wave 2, between Wave 2 and Wave 3 and between Wave 1 and Wave 3. Baseline anxiety levels were also found to predict maintenance in the *'multiple utilisation'* status from Wave 1 to Wave 3. An increased likelihood of membership of the *'improved and maintained'* pattern was also observed for increasing anxiety intercept level. Such findings are notable when one considers that an effect for anxiety and increased healthcare usage beyond primary care exists even when frailty status, falls and number of medications are accounted for. Such a finding is congruent with studies which have shown that anxiety is highly prevalent among COPD and CHF patients (Yohannes et al., 2010) and associated with increased numbers of GP and ED visits and an increased risk of hospital admission (Gudmundsson et al., 2005; Kim et al., 2000; Laurin et al., 2009). The non-linear change in anxiety levels across the three waves showed some relationships in unadjusted analyses, but no effect was observed in the fully adjusted model.

However, caution must be exercised when interpreting the role of anxiety in predicting healthcare utilisation transitions due to differences in data collection between Wave 1 and subsequent waves. At Wave 1 the HADS-A questionnaire was administered during the SCQ, whereas for all subsequent waves it was conducted during the CAPI assessment. Thus, it is possible that higher initial levels of anxiety were underreported during subsequent data collections due to socially desirable responding during the face to face CAPI interview. Thus, the change in anxiety over time may constitute a method effect and so further examination of subsequent waves of data collection is warranted. Nevertheless, the identification of an

association between baseline anxiety levels and increased primary and secondary healthcare usage over time may serve as a new target for intervention in chronic disease management. For example, interventions such as pulmonary rehabilitation and cardiac rehabilitation have been shown to decrease anxiety and depression among COPD and CHF patients (Benzer et al., 2007; Coventry & Hind, 2007).

Depressive symptomology also showed significant associations with membership of different healthcare usage patterns. Initial baseline levels of depression were associated with several patterns in unadjusted and adjusted analyses. From Wave 1 to Wave 2 initial baseline levels of depression were associated with an increased likelihood of remaining in the *'multiple utilisation'* status between both time points. This effect was also observed between Wave 2 and Wave 3; thus, it was not surprising that baseline levels of depression were associated with an increased likelihood of *'continued multiple utilisation'* across all three waves. Baseline depression was also found to predict a greater likelihood of being in the *'late improver'*, '*late decline'*, *'improved and reverted'* and *'declined with no recovery'* patterns also. Hence depression remains a key consideration when examining variability in healthcare utilisation among older adults.

Longitudinal increases in self-reported depressive symptoms were also associated with increased likelihood of escalating from *'primary care only'* healthcare usage to *'multiple utilisation'* healthcare from Wave 1 to Wave 2, when compared with continued usage of primary care services. An increased likelihood of remaining in the *'multiple utilisation'* status from Wave 2 to Wave 3 was also observed. When considered from Wave 1 to Wave 3, an increasing depression slope was also associated with an increased likelihood of being in the *'continued multiple utilisation'*, *'late improver'*, *'late decline'*, *'improved and reverted'* and *'declined with no recovery'* patterns. Thus, underscoring the association between increasing depressive symptoms and movement into escalated healthcare resource usage, if even for a

short period of time only. The literature evidence supports an increase in healthcare resource usage among those COPD, CHF and diabetic patients who also have comorbid depression (Hutter et al., 2010; Maurer et al., 2008; Xu et al., 2008).

The persistence of an association between initial depressive status and the rate of growth in depressive symptoms when included in the fully adjusted model is notable when one considers the many other factors that were incorporated in the model, including frailty, falls and polypharmacy. Such a finding runs contrary to previous studies which assert that once disease severity, comorbidity and previous hospitalisations are accounted for, the bivariate associations between depression and increased likelihood of ED visits, hospitalisation or readmission among COPD patients disappears (Almagro et al., 2005; Fan et al., 2007).

The presentation of depression in later life is distinct from the experience of depression at an earlier age. The different presenting clinical features suggest that late life depression is a different phenotype, owed to differences in social factors and different biological markers, such as altered vascular health and structural brain changes (Briggs, Kenny & Kennelly, 2016; Fiske, Wetherall & Gatz, 2009). Depression in older adults presents more as cognitive changes and somatic symptoms with a lower likelihood of affective symptoms (Fiske et al., 2009). Thus, the identification of depression separate form coexisting comorbidity or cognitive decline can lead to an underdiagnosis of the disorder. Given the evidence identified here that initial levels of depressive symptoms and increases in depressive symptoms are associated with fluctuations in healthcare usage beyond primary care level, and after controlling for other key aspects such as frailty, greater attention should be placed on the identification and management of depression among older adults. Screening for depression among those who are multiple users of healthcare or who attend outpatient clinics may identify those who have undiagnosed and untreated depression. Given the impact of hospital admission on functional status of older adults, appropriate treatment for depressive symptoms

could limit the risk of hospital admission and thus potentially associated declines in functional independence.

Little evidence was found in the present sample to support an association between cognitive status and variation in healthcare utilisation. Some associations were observed between MMSE intercept and slope when examined in unadjusted analyses but for the most part these associations became non-significant when examined in the fully adjusted model. Increases in MMSE scores from Wave 1 to Wave 2, indicating better cognitive performance, was associated with a decreased likelihood of being in the *effective referral→ multiple utilisation* pattern. Over the course of the three waves of data collection, increases in cognitive performance were associated with a decreased likelihood of being in the *'declined with no recovery'* pattern when compared with the *'continued primary care only'* reference group.

However, it must be acknowledged that the slope of the LGCM was non-significant for the sample overall, with on average high levels of cognitive performance observed across the three time points. Previous research has suggested that those with cognitive impairment experience a longer length of hospital admission and an increased likelihood of readmission within 28 days than those without cognitive impairment (Tropea et al., 2018). Furthermore, there is considerable evidence that those with dementia are at an increased risk of hospitalisation (Toot et al., 2013); reasons for hospital admission are wide ranging among those with dementia and include orthopaedic, respiratory, and urological crises (Carter & Porell, 2005; Malone et al., 2009; Natalwala et al., 2008; Nourhashemi et al., 2001; Sampson et al., 2009; Tuppin et al., 2009). The high levels of cognition observed in the present sample do not inform of longitudinal changes in healthcare transition of older Irish adults living with dementia in the community. In order to fully elucidate the relationship between cognitive status and changes in cognitive ability with healthcare resource usage purposive sampling of those with varying degrees of cognitive impairment is required.

Higher medication burden was associated with variation in healthcare usage patterns across the three waves of data collection. Higher initial numbers of prescribed medications were associated with healthcare utilisation patterns beyond '*primary care only'*. This effect persisted when examined in the adjusted model such that from Wave 1 to Wave 3, polypharmacy intercept values predicted membership of all patterns other than the reference group of *'continued primary care only'* usage. Such a finding is not surprising given that number of prescribed medications often serves as a proxy for medical need.

Similarly, the increasing growth in the numbers of prescribed medications was associated with increased likelihood of being in several healthcare usage patterns from Wave 1 to Wave 2; from Wave 2 to Wave 3; and overall, from Wave 1 to Wave 3. In fact, from Wave 1 to Wave 3 a trend of higher odds ratio values for polypharmacy slope than for polypharmacy intercept were observed, indicating that the rate of growth in medication numbers had a greater effect on membership of the various healthcare usage patterns.

Several possible mechanisms may be responsible for an increase in number of medications over time. Increases in medication numbers may indicate a declining health status, requiring additional medications for symptomatic control, and thus it could be expected that a greater need for more intensive healthcare services may emerge. Alternatively, increasing numbers of medications may suggest the development of a prescribing cascade, whereby a new medication leads to a side effect which is erroneously identified as a new symptom and not a side effect, leading to the initiation of further medications to alleviate these side effects.

Prescribing cascades (Rochon & Gurwitz, 1995, 1997, 2017) can occur with great ease among older patients. Time and resource pressures, in conjunction with a fragmented system of care, can lead to the emergence of new symptoms in older adults to be too often attributed to old age and disease and not to the medications that may have actually caused them

(Aronson, 2019). Nguyen and Spinelli (2016) outline such an example case study of a 71-year-old woman with a range of comorbidities admitted to ED post-fall. The cause of the fall was considered to be multi-factorial with medications playing a central role. In the months prior to the fall she was prescribed a new antihypertensive to control her blood pressure by her GP. This resulted in oedema of the lower limbs which was then interpreted as the development of heart failure and treated with two additional diuretic medications, prescribed by her cardiologist. This was soon to be followed by the initiation of an antimuscarinic medication by her urologist to treat her overactive bladder, likely aggravated by the two diuretics. This anticholinergic medication increased the risk of blurred vision, dry mouth, and postural hypotension. These four new medications, initiated by three prescribers were in addition to her already lengthy prescription for her multiple morbidities, leading to an increased anticholinergic burden and risks for postural hypotension and dizziness, Unsurprisingly, one month following its initiation she experienced a fall, multiple fractures and required a presentation to ED.

This case was resolved by the deprescribing of the antihypertensive, the two diuretics and the antimuscarinic and the initiation of an alternative antihypertensive. The case resulted in a 14-day hospital admission until symptoms were resolved, indicating the significant burden that unidentified medication related harm misattributed as a sign of age-related declines in health can have on our healthcare systems. Each physician was seeking to attend to the needs of the woman but did not seek to identify alternative explanations for reported symptoms. Thus, in the absence of the patient having been made aware of possible side effects to be aware of and to report, and in the absence of a comprehensive review of the wider context of reported symptoms, the woman in question experienced a fall, multiple fractures and a prolonged hospital admission. All entirely avoidable.

Taken together, the significance of polypharmacy intercept and slope indicates that those with higher levels of medications and those with more rapid increases in numbers of prescribed medication are more likely to display significant variation in healthcare usage over time. These findings underscore the importance of prescribing in influencing healthcare usage. Increasing numbers of medications has previously been identified as being associated with an increased risk of ED visits among community dwelling older adults (Cahir, Bennett, et al., 2014). The results presented here extend these previous findings by identifying that initial number of medications and rate of increase in medication numbers are both independent predictors of longitudinal profiles of healthcare usage across both primary and secondary care, even after accounting for other covariates including frailty status. Richardson et al., (2012) previously reported disproportionate healthcare resource usage among older TILDA participants with polypharmacy. Among those participants aged 50-64 years, those who reported polypharmacy (defined as ≥5 medications) constituted only 10% of the study sample and yet were responsible for 28% of hospital admissions, 30% of outpatient visits and 25% of GP visits reported by the sample. The effect was more pronounced for older TILDA respondents. For those aged 65 years and older, those reporting polypharmacy comprised 31% of the study sample but 51% of hospital admissions, 55% of outpatient visits and 41% of GP visits (Richardson et al., 2012).

Throughout the analyses presented here both numbers of medications and frailty remained significant predictors of healthcare utilisation patterns in the fully adjusted model. In many instances the greatest magnitude odds ratios were identified for polypharmacy intercept, polypharmacy slope and/or frailty intercept category. Polypharmacy has previously been shown to be related to pre-frailty and frailty, even after accounting for comorbidity (Palmer et al., 2019). Those who receive ≥5 medications have been shown to be at risk of frailty three years later (Saum et al., 2017). Combined polypharmacy (≥5 medications) and

frailty has been shown to result in longer hospital admissions, more discharges to long-term care and an increased likelihood of hospital readmission (Rosted et al., 2016).

Polypharmacy has also been shown to be a consistent predictor of inappropriate prescribing (Bradley et al., 2012; Bradley et al., 2014; Hudhra et al., 2016; McMahon, et al., 2014). In turn, inappropriate prescribing has been shown to be associated with an increased risk of GP visits (Moriarty, Bennett, Cahir, Kenny & Fahey, 2016), ED visits (Cahir, Bennett, et al., 2014; Moriarty, Bennett, Cahir, Kenny & Fahey, 2016), hospitalisations (Cahir, Moriarty, et al., 2014; Fick et al., 2008; Fillenbaum et al., 2004; Hytinnen et al., 2016; Klarin et al., 2005; Moriarty et al., 2014). Moriarty, Bennett, et al., (2015) previously examined longitudinal change in inappropriate prescribing, assessed using STOPP/START, in a subpopulation of TILDA participants where linked prescription claims data was available. In the 12-month period preceding the Wave 1 interview inappropriate prescribing was present in 52.7% of the sample and was found to increase to 56.1% in the 12-month period prior to the Wave 2 interview (Moriarty, Bennett, et al., 2015).

Given the consistent associations between polypharmacy slope and healthcare utilisation identified here, it is likely that some of the increase in polypharmacy observed in Chapter 7 is inappropriately prescribed. Therefore, there is a need to consider implementing interventions among the older Irish population living in the community to ensure that medications are optimised, and medication-related harm is avoided. The findings reported in Chapters 3 and 4 indicate the value that can be added through structured pharmacist intervention that is individualised to the needs and goals of the older person.

The present study's findings highlighted the consistent influence of frailty status on healthcare usage when examined longitudinally. Frailty intercept category was found to be associated with an increased likelihood of membership of most healthcare utilisation patterns other than the reference pattern of 'continued primary care only' usage. Whilst odds ratio (OR)

values were found to decrease in the fully adjusted model, most associations that were identified persisted following adjustment for relevant covariates. Furthermore, larger OR values were generally observed for those who were frail in comparison to those who were pre-frail, indicating that the greater the degree of frailty the greater the likelihood of membership of the particular healthcare usage pattern.

When examined from Wave 1 to Wave 3, baseline frailty and pre-frailty were both found to be associated with almost all healthcare utilisation patterns except the '*improved but reverted'* pattern, when compared with the reference group of *'continued primary care only'* usage. Only those who were frail at Wave 1 were more likely to be in the '*late decline'* and *'temporary decline'* patterns. Such findings underscore the important influence of frailty on healthcare usage that has been identified within the literature. Frailty has consistently been shown to increase the risk of falls, disability, GP and practice nurse consultations, hospitalisation, longer hospital admissions, institutionalisation, and death (Ensrud et al., 2008; Fried et al., 2001; Han et., al, 2019; Rockwood et al., 2004; Rockwood et al., 2005; Rockwood & Mitnitski, 2007; Searle et al, 2008; Shi et al., 2020; Song et al., 2010).

Longitudinal increases in frailty were also associated with several healthcare utilisation patterns, when compared those who exhibited stable or decreasing levels of frailty. Between Wave 1 and Wave 2 an increasing frailty slope was found to predict an increased likelihood of membership of the *primary care only→ multiple utilisation* pattern, thereby extending the literature regarding the associations between frailty and healthcare resource usage through the identification of an increased level of usage with increasing frailty status.

Furthermore, a lower likelihood of being in the *multiple utilisation→ effective referral* pattern was observed for increasing frailty slope, indicating that a decrease in healthcare usage was less likely. This is further supported by the increased likelihood of continued membership of the *'multiple utilisation'* status between Waves 2 and 3. Thus, unsurprisingly

between Wave 1 and Wave 3 increases in frailty were found to be associated with an increased likelihood of the *'declined with no recovery'* pattern. Thus, early identification of frailty and efforts to prevent further declines in functional status may serve to offset considerable increases in healthcare utilisation for older adults.

Several care pathways have been suggested for implementation within Ireland including ambulatory care hubs, acute frailty pathways in ED, specialist frailty wards and integrated care teams within the community (HSE, 2017). These pathways are aimed to be directed towards those older adults who experience falls, exhibit mobility problems, have complex comorbidities, are prescribed multiple medications and perceived as vulnerable to medication-related harm, on the basis that literature evidence reports that improvements in frailty status can be achieved via comprehensive assessment, targeted multidisciplinary interventions and physical activity interventions (Cameron et al., 2013; Puts et al., 2017). The Systematic Approach to improving care for Frail Older patients (SAFE) study has recently been established to explore the process required to implement a model of excellence for patient-centred integrated care for frail older people on acute admission to hospital (Ní Shé et al., 2018). The findings presented here lend further support to the establishment of such care pathways by highlighting the longitudinal influence of frailty on healthcare usage.

8.6.4 Limitations

The findings presented here do much with respect to explaining longitudinal variation in healthcare resource usage by older adults, but their interpretation must be considered in light of several methodological limitations. The analyses did not account for comorbidity per se, but rather comorbidity as a component of overall frailty status. Therefore, a challenge persists for applied clinicians and policy makers in quickly identifying those older adults who may benefit most from any intervention. Rather a comprehensive assessment of frailty status, as required in the calculation of any frailty index, is required. Nevertheless, frailty incorporates

a more holistic view of the overall functional status of the individual and their resilience to potential stressors and given its consistent association with increased healthcare usage remains an important consideration for the clinician. Thus, the establishment of frailty pathways, improved frailty triage and assessment may complement existing primary care services, which are increasingly overburdened.

Furthermore, no assessment of prescribing appropriateness could be considered such as in the manner explored in Chapters 3-5. Nevertheless, the significance of polypharmacy intercept and slope values in the fully adjusted model points to the importance of considering medication burden when examining healthcare utilisation. Future research and policy development would do well to consider the inclusion of pharmacists within integrated care programmes, particularly those frailty pathways that are being developed nationally. Polypharmacy and frailty have been shown to be closely related to one another and to be associated with increased healthcare resource usage when both are present (Palmer et al., 2019; Rosted et al., 2016; Saum et al., 2017). The findings of Chapters 3 and 4 indicate that appropriateness of prescribing for older adults can be significantly improved using a medicines optimisation medicines case management approach.

The data examined relates to self-reported healthcare resource usage and thus is vulnerable to memory bias. It has been suggested that underreporting of resource usage is more likely to increase as healthcare usage increases (Ritter et al., 2001). Nevertheless, Wallace and colleagues (2018), when comparing self-reported healthcare utilisation data with manual extraction of data from the GP electronic medical record, found no difference in the reported rates of GP or outpatient visits but did identify significantly higher self-reported visits to ED. The authors speculated that challenges with transfer of healthcare utilisation data between secondary and primary care and failure for ED visits to be notified to the GP as possible sources for the discrepancy (Wallace et al., 2018).

The analysis presented here examined self-reported symptoms of anxiety and depression and did not consider whether the respondents had a clinical diagnosis of either or were in receipt of treatment for same. Furthermore, caution must be exercised when examining the role of anxiety as data collection at Wave 1 was conducted during the SCQ, whereas for all subsequent waves anxiety data were collected using the CAPI. It is possible that lower levels of anxiety at Waves 2 and 3 are a consequence of a method effect, and so further examination of subsequent waves of data collection is warranted.

The high level of cognition observed within the sample limits the inferences that can be drawn regarding the role of cognition and healthcare utilisation among all community dwelling older people. Future analysis comparing those with and without cognitive impairment are required in order to elucidate any relationship with healthcare usage for those older adults living in the community.

The analysis in the present chapter is somewhat limited by the absence of additional covariates known to impact on healthcare utilisation, such as social support and loneliness. Recent analysis conducted within the TILDA cohort has found that loneliness was positively associated with the number of GP visits in both cross-sectional and longitudinal analyses (Burns, Leavey, Ward & O' Sullivan, 2020). Associations with ED visits were found to be less consistent (Burns et al., 2020). A differential impact was also observed for gender. Older women who reported loneliness had an increased risk of an ED visit at Wave 1, and increased number of GP visits at both Wave 1 and Wave 2 (Burns et al., 2020).

Such a finding also underscores the important influence of gender on healthcare utilisation. Some studies have shown females to be more likely to consult with a doctor than males (Broyles et al., 1999; Dhingra et al., 2010; Parslow et al., 2002) but less likely to attend a specialist doctor (Nambalamba & Miller, 2007; Vegda et al., 2009). The present study did not explore gender-specific patterns of healthcare utilisation but rather included gender as a

covariate in the fully adjusted model. Future research examining gender specific patterns of healthcare utilisation may identify an alternative latent structure of healthcare utilisation behaviour. For example, recent research conducted within the TILDA cohort and stratified by gender, examining symptoms of late life anxiety and depression, found that males and females diverged on some determinants of psychological disorders (Curran, Rosato, Ferry & Leavey, 2020).

Socio-demographic analyses were limited to education, occupational status and health insurance coverage to serve as indicators of relative income. The selection of these was governed by consistency of reporting of variables across the publicly available waves of data. When selecting variables for inclusion, emphasis was placed on examining the various health need factors in a multivariate manner in order to ascertain the independent associations between these factors and healthcare utilisation patterns. Future research, incorporating additional aspects such as social support, loneliness, health beliefs and income would enhance the findings presented here but was considered beyond the scope of the present thesis.

The analyses presented here have not considered the directional influences of the factors examined. Additional longitudinal analysis is required in order to elucidate further these longitudinal relationships through the use of path analysis, cross-lagged panel analysis, and/or mediation analysis in order to “capture fully the causal web of determinants leading to health behaviours and outcomes” (Richard et al., 2011, p. 321). Furthermore, interaction between the factors themselves must also be considered. Briggs, Kennelly, and Kenny (2017) found that depression was associated with an increased risk of falls within the TILDA cohort. The relationship between depression, falls and subsequent healthcare usage is thus one pathway that merits examination. Given the relationships between orthostatic hypotension and depression (Briggs, Kenny & Kennelly, 2016, 2017), a further potential target for intervention could be identified.

Nevertheless, the findings presented here lend support to the adoption of a broader ecological perspective when examining healthcare utilisation. Capturing change in a number of pertinent variables using LGCM methods highlights the importance of accounting for dynamic change within the influencing factors of healthcare utilisation themselves in as much as examining temporal change in healthcare utilisation. Given the considerable variability in healthcare usage patterns that were predicted by both growth factors in the multivariate analysis, the findings presented extend the work of Andersen and colleagues within a longitudinal context.

8.7 Conclusion

Risk prediction algorithms aimed at improving case finding of patients at high risk for hospital admission are often limited by their sensitivity and specificity (Billings et al., 2006). Those algorithms that are predicated on electronic admissions data are particularly vulnerable to inaccurate coding and missing data (Billings et al., 2006). Yet, the need to identify those at increased risk remains for effective targeting of resources and interventions.

The findings presented here have highlighted a number of factors associated with increased likelihood of membership of intensive resource usage over time. Whilst some predisposing and enabling factors do exert an influence on healthcare utilisation by older adults, many such associations become non-significant when one incorporates several health need factors prevalent within older cohorts. Significant relationships were identified including falls history, anxiety, depression, frailty, and number of prescribed medications. The identification of which proffers some opportunities for intervention to support older adults to age well.

Investment in falls prevention and frailty prevention strategies in particular may serve to reduce healthcare resource usage over time. Of course, the goal is not to eliminate healthcare utilisation by older adults entirely but rather to reduce the risk of unnecessary

hospital admissions, as such admissions can have detrimental effects for the independent status of older adults. The establishment of integrated care pathways which provide healthcare solutions within the community may support older adults to remain well in their homes for longer.

The identification of associations between anxiety and depression also serve to highlight the value of screening for psychological symptoms among older adults. The identification of late life depression is particularly challenging due to a different clinical presentation. Routine screening may not only help address underdiagnosis among older adults but may serve to reduce their risk of escalated healthcare usage which may have additional consequence for their functional and cognitive status.

Escalations in healthcare usage by older adults may also be addressed through the development of improved pharmaceutical care services centred on medicines optimisation. Persistent associations were observed between initial numbers of prescribed medications and the longitudinal increase in medications with more intensive healthcare resource usage. Given the previous literature findings pointing toward high levels of inappropriate prescribing within the TILDA cohort, medicines optimisation may serve as a key intervention target.

Longitudinal healthcare usage by older adults within the TILDA cohort is largely influenced by a variety of health need factors. By examining the different possible temporal patterns of healthcare usage, the findings provide a nuanced view of the complexity involved in healthcare usage by older adults, whilst also proffering insights that could serve as early warning signals for declining health and increasing healthcare resource usage.

9 General Discussion

9.1 Introduction

Health status is a consequence of the dynamic interaction between interpersonal, biological, psychological systems and contextual factors over the life span (Lehman et al., 2017). Thus, the breadth of these factors must be considered during service design and implementation. It also follows that health services research should be a multifaceted enquiry. Health services research has been defined by the Association for Health Services Research (ASHR; 2000) as

> "the multidisciplinary field of scientific investigation that studies how social factors, financing systems, organizational structures and processes, health technologies, and personal behaviours affect access to health care, the quality and cost of health care, and ultimately our health and wellbeing. Its research domains are individuals, families, organizations, institutions, communities, and populations" (Lohr & Steinwachs, 2002, p. 16).

Such a definition builds on the perspective put forward by the Institute of Medicine of the National Academy of Sciences in 1995, which emphasised the multidisciplinary nature of the field, encompassing a broad range of research, from basic to applied, with the aim of understanding the effects of health services on both individuals and populations (Lohr & Steinwachs, 2002).

The work presented in this thesis aims to fulfil these expectations through the evaluation of a health service intervention in terms of individual and health system outcomes, in conjunction with an examination of individual variation in health usage behaviour in a non-clinical dataset. This chapter will integrate the results obtained from the findings reported in preceding chapters in terms of theoretical, research and policy and practice implications.

9.2 Theoretical implications

9.2.1 Understanding inappropriate prescribing in context

The findings of Chapters 3, 4 and 5 do much to extend the literature surrounding inappropriate prescribing among older adults, particularly with respect to older adults in receipt of intermediate care following acute care discharge. Our understanding of the prevalence of inappropriate prescribing in this care context have been limited by the dearth of studies conducted in this area. Bakken et al., (2012) previously explored the prevalence of inappropriate prescribing among older adults admitted to IC in Norway (N = 157) and found it to be 24%. In contrast, Millar (2016) reported a prevalence of 72% on admission to IC (N = 74) in Northern Ireland. Both were prevalence studies, with no intervention delivered to address the inappropriate prescribing identified, and in both studies inappropriate prescribing was found to have increased by IC discharge.

The present thesis extends our understanding of the problem of inappropriate prescribing within IC in Northern Ireland by using a much larger sample (N = 532) than that previously examined by Bakken et al., (2012) and Millar (2016). As reported in Chapter 3, the majority (90%) of IC participants had some degree of inappropriate prescribing upon admission into IC. However, this inappropriate prescribing was significantly improved upon following pharmacist intervention in this care setting. Neither Bakken et al., (2012) nor Millar (2016) used MAI in their studies, therefore it is challenging to draw comparisons between the studies.

The high prevalence of inappropriate prescribing identified within care homes in NI (Chapter 4) is at the upper end of the scale in terms of prevalence estimates reported in international literature and greater than that previously reported in NI. Byrne and colleagues (2011) previously reported a prevalence of 67% among NI nursing homes and 73% among nursing homes in ROI. Within the international literature, differences in screening methods result in prevalence estimates ranging from 22-88%, making comparisons between studies

somewhat challenging (Anrys et al., 2018; Cool et al., 2014; Elseviers et al., 2014; Heppenstall et al., 2016; Lau et al., 2004; Ryan et al., 2013). Nevertheless, the findings of Byrne et al. (2011) are augmented by the present thesis, which investigates the phenomenon in a much larger sample (N = 1095 in the present thesis, compared with N = 315 examined by Byrne and colleagues). Furthermore, our understanding of how inappropriate prescribing can be successfully addressed within care homes is furthered by the examination of changes in MAI score from pre- to post- intervention.

The findings of Chapters 3-5 provide a more nuanced perspective of what is contributing to inappropriate prescribing within both care contexts. To date, IC has been a setting which has been overlooked with respect to pharmaceutical care. The present thesis adds further weight to the evidence that many medication related problems persist beyond acute care discharge (Belleli et al., 2013; Sargent et al., 2007; Tong et al., 2017). A broad range of pharmacist interventions contributed to the significant reduction in MAI score achieved in this setting, including deprescribing, dosage changes and the addressing of Kardex issues. Care home participants were observed to have a greater medication burden than their IC counterparts. A greater proportion of CH participants were prescribed >10 medications and approximately three times as many CH participants were prescribed >20 medications when compared with IC participants. It has been estimated that frail older adults in nursing homes consume up to four times more medications than the average age-matched community-dwelling non-frail older person (Verrue et al., 2009; Walley & Scott, 1995).

The findings of Chapters 4 and 5 suggest that overprescribing contributes to inappropriate prescribing within NI care homes, as medication discontinuation was the only pharmacist intervention driver of MAI score reduction. Maguire and colleagues (2013) previously argued that pre-admission prescribing patterns often continue following care home admission, as the resident's GP remains the primary prescriber. Evidence from Chapters 4 and

5 may provide support for this contention. Those resident in their care homes >2 years had significantly greater baseline MAI scores, perhaps indicating a lack of regular medication review once admitted into CH. Furthermore, considerable duplication of prescribing within several medication classifications was identified for the CH cohort in Chapter 5. This could suggest that new medications were initiated without the existing ineffective medications being discontinued.

9.2.2 Inappropriate psychoactive prescribing

The findings of Chapters 4 and 5 infer that cognitive impairment may be a driver for inappropriate prescribing within the care homes context, particularly if medications are used to treat BPSD. Cognitive impairment diagnoses were more common within the CH cohort, which is not surprising given that cognitive impairment increases the risk of institutionalisation for older adults (Abrahamsen et al., 2014; Luppa et al., 2010). Almost half of first-generation antipsychotics and one quarter of second-generation antipsychotics were prescribed inappropriately within the CH cohort, despite the established risks of cerebrovascular accidents and cardiac death associated with their use. Patterson and colleagues (2010) previously reported that 60% of antipsychotic prescribing in NI care homes was inappropriate. Thus, perhaps warnings regarding the safety of antipsychotics in older adults have been heeded to a certain degree within Northern Ireland. Nevertheless, considerable use of psychoactive medications was observed within the CH cohort and could point to a shift in prescribing of alternative psychoactive medications. Previous research of prescribing trends following the issuance of risk communications for antipsychotic use in dementia have failed to identify persistent trends of compensatory prescribing of other psychoactive medicines (Guthrie et al., 2013; Kales et al., 2011).

Irrespective of whether the prescribing of psychoactive medications was compensatory in nature, concerning findings regarding their use were identified within both

settings. Several falls-risk medication groups, including opioid analgesics, benzodiazepines and z-drug sedatives were found to be inappropriately prescribed in both IC and CH. Furthermore, a greater burden of inappropriate prescribing of benzodiazepines and other sedatives was observed within the IC cohort, which has traditionally received less attention within the literature. Given that older adults in NI are commonly admitted to IC following a falls-related acute care admission, it is somewhat concerning that falls-risk medications would be so commonly prescribed inappropriately within the IC cohort. Again, this extends the argument for expanding pharmaceutical care services to transitional care spaces such as IC.

The duplication of benzodiazepine prescribing is also concerning with respect to the risk of falls; older adults have an increased susceptibility to the pharmacodynamic effects of benzodiazepines. Falls have been shown to be a contributory factor in the transfer of care homes residents to acute care, particularly if a fracture has been sustained (Quinn, 2011; NHS Scotland, 2016; Smith et al., 2015). Within Chapter 4 it was observed that those CH participants with a previous history of falls had more GP visits within both 30 and 90 days of pharmacist intervention. Whilst the temporal relationship of these historical falls with healthcare utilisation cannot be elucidated, it does suggest that a subset of older CH residents with a history of falls have greater healthcare utilisation. When examined within the context of the considerable inappropriate prescribing of psychoactive medication identified within Chapter 5 these falls may have been related to the use of falls-risk medicines. The amelioration of falls-risk medications continues to serve as a potential target for intervention as a previous history of falls was also shown to be associated with variation in healthcare utilisation patterns within the TILDA cohort (Chapter 8).

Chapter 5 also highlights the importance of considering more than psychoactive medications as a source of inappropriate prescribing. Additional medications were identified as frequently prescribed inappropriately at baseline. Proton pump inhibitors (PPIs) were

frequently prescribed inappropriately in both IC and CH, supporting the existing literature regarding the high prevalence of inappropriate prescribing of this medication classification among older adults (Cool et al., 2014; Peréz et al., 2018). Chapter 5 furthers the literature surrounding inappropriate prescribing of PPIs by identifying an association between improvements in MAI scores for PPIs and fewer readmissions and lower mortality among IC and CH participants.

9.2.3 Deprescribing or medicines optimisation?

Overprescribing was found to be highly prevalent within both IC and CH, with almost three-quarters of participants having at least one medication stopped. Deprescribing initiatives have received considerable focus within the literature. The utility and cost-effectiveness of deprescribing initiatives have been questioned (Avery, 2019). No effect on all-cause mortality and a limited effect on hospitalisation have been reported in meta-analytic studies of randomised trials (Johansson et al., 2016; Page, Clifford, Potter, Schwartz & Etherton-Beer, 2016). Reductions in mortality have been shown in nonrandomised studies and in studies that applied patient-specific interventions compared with those which adopted generalised educational programmes (Page et al., 2016). The present thesis findings further extend the literature surrounding evaluation of deprescribing initiatives. Chapter 8 outlines the complexity of healthcare utilisation by older adults and the challenges that exist in isolating the impact of a pharmaceutical intervention on subsequent healthcare utilisation. Aspects such as falls, frailty, depression and anxiety were found to be independently associated with healthcare utilisation among a community dwelling cohort of older adults.

Furthermore, the concept of deprescribing faces additional challenges; there is a lack of consensus on the definition, variation in how the process is operationalised and no clear consensus on what the goal of deprescribing should be (Reeve, Gnjidic, Long & Hilmer, 2015). It has been proposed that “deprescribing is the process of withdrawal of an inappropriate

medication, supervised by a healthcare professional with the goal of managing polypharmacy and improving outcomes" (Reeve et al., 2015, p. 1266). Whilst medication cessation formed a key component of pharmacist intervention in both IC (Chapter 3) and CH (Chapter 4) contexts, patient education and dosage changes were also shown to be related to reductions in healthcare utilisation post-intervention. Thus, evaluations of medication-focused interventions may benefit from merely considering the impact of deprescribing on outcomes. In addition, deprescribing does not consider prescribing omissions, which was found to be highly prevalent among IC participants. Thus, deprescribing alone cannot fully address inappropriate prescribing.

Attempts have been made to extend deprescribing theory in a more comprehensive manner. Edey and colleagues (2018) define deprescribing as a "holistic and encompassing process that re-evaluates the risk-benefit ratio of medications in the context of individualized patient care goals, preferences and values" (p. 160). Furthermore, Todd and colleagues (2018) urge clinicians to consider the clinical, psychological, social, financial and physical determinants when deprescribing. Nevertheless, these approaches do not extend far enough with respect to considering additional medicines optimisation efforts. Deprescribing forms only one end of a good prescribing continuum, beginning with the initiation of medications and encompassing the adjustment of treatment regimens (Scott et al., 2015).

Rather, emphasis should be place on medicines optimisation and the concept of 'what matters to the patient' (Scottish Government Polypharmacy Model of Care Group, 2018). Medicines optimisation has been defined as "a person-centred approach to safe and effective medicines use, to ensure people obtain the best possible outcomes from their medicines" (NICE, 2015, p. 6). Such a definition is congruent with Tinetti, Huang and Molnar's (2017) description of the Geriatric 5Ms aide-memoire, which outlines the key components of geriatric care. The 5Ms are represented by mind, mobility, medications, multi-complexity and finally,

matters most. By placing the individual at the centre of geriatric care, a focus is placed on ensuring that therapy goals are aligned with that of the individual and that their care preferences are respected. The MOOP models of care, developed prior to the NICE Medicines Optimisation Guideline (2015), have been considered by NICE to be an exemplar for shared learning (NICE, 2017).

9.2.4 Review or intervention?

The thesis findings also extend the debate surrounding the utility of medication reviews. Huiskes et al., (2017) questioned their impact on healthcare utilisation outcomes and called for their discontinuation. However, a high prevalence of inappropriate prescribing was identified within both IC and CH settings in NI. Thus, there is a clear need to conduct some element of medication review in order to identify suboptimal prescribing. The findings of Chapters 3 and 4 draw attention to the need to demarcate those interventions which are medication review only, often conducted at only one time point, from those which incorporate active adjustment and associated monitoring of pharmacotherapy. Active pharmacist intervention was associated with positive impacts on healthcare utilisation. Within IC, those who received at least one education intervention had a lower likelihood of hospital readmission and fewer numbers of readmission within 30 days of IC discharge. Those IC participants who had at least one medication dosage changed had fewer unplanned hospital readmissions within 31-90 days and spent five fewer days in acute care on readmission. In contrast, more passive intervention types, such as the provision of medicines information to the prescriber or a referral to another healthcare professional, were associated with increases in healthcare resource usage.

9.2.5 Healthcare utilisation- the complexity

Taken together, the thesis findings underscore the inherent complexity of healthcare utilisation by older adults. For example, within the CH cohort a comparison of pre- and post-

intervention healthcare resource usage revealed a significant reduction in healthcare utilisation. Reductions in the number of GP visits and OOH GP visits within 90 days and a reduction in ED visits in both time periods was observed. Improvements in prescribing appropriateness, defined by a reduction in MAI score, was not associated with likelihood of hospital admission. However, each unit reduction in MAI score was found to be associated with a reduced length of stay on readmission of 0.24 days. With the average MAI score reduction for the cohort found to be 14 points, this suggests that a reduction in length of stay of 3 days could be achieved for CH residents following medicines optimisation by the MOOP pharmacist. Nevertheless, each unit reduction in MAI score achieved by CH participants was also associated with a small increase in GP visits within 30 days of intervention. Thus, such findings underpin the subtle and dynamic nature of health service usage and the challenges of evaluating interventions in terms of utilisation.

Intervention may be associated with some form of increased healthcare utilisation in the short term. Rosstad and colleagues (2017) previously reported similar findings and interpreted an increase in GP visits as greater engagement by the GP in the care of the older person. Thus, evaluation of interventions for older adults must consider the outcomes which are to be used to evaluate success. Consideration must also be given to the broad range of other factors that have been shown within the literature, and within the present thesis, to influence healthcare utilisation.

Within the MOOP intervention data, previous levels of healthcare utilisation that occurred in the pre-intervention period were consistently identified as independent predictors of healthcare utilisation in the post-intervention period. Andsersen (1995) had previously argued that previous encounters with healthcare services would impact upon future service usage. The findings reported in Chapter 8 indicated that a broad range of factors remained predictive of healthcare utilisation patterns even when included in multivariate analyses.

Sociodemographic aspects such as marital status and employment were found to predict membership of longitudinal healthcare utilisation even when accounting for health need aspects such as falls, frailty and psychological health. Chapter 8 also extends the literature surrounding healthcare utilisation by considering multiple factors as predictors of combinations of service use type, over a period of six years.

9.2.6 Understanding healthcare utilisation in terms of individual needs

Throughout the empirical work in the present thesis, it is evident that there is considerable heterogeneity within the healthcare service needs of older adults. As expected, the demographic profile differed between IC and CH, reinforcing the need for adaptive models of care to reflect individual needs. The intervention types required to address inappropriate prescribing and the impact of these interventions on healthcare service usage differed between the two cohorts. In addition, the health need factors associated with healthcare utilisation varied between both cohorts, again reinforcing the view that the influences on healthcare utilisation, even from a medical history standpoint are quite nuanced among older adults. Whilst both care models are broadly similar, the CH allows for additional visits by the case management pharmacist to review and monitor any emerging needs which may arise during intervention among a largely frailer population.

Optimal healthcare utilisation cannot easily be identified. For many older adults increased service usage will be required in order to achieve clinical stability. The optimal service will vary with respect to the unique needs of the individual. Irrespective of needs, the optimal model is one which supports the individual to achieve their health-related goals and preferences in an accessible manner which does not cause any unintentional harm. Concerns have been raised within the literature with respect to the appropriateness of transferring care home residents to ED (Lemoyne et al., 2019). The decision to transfer a care home resident to ED can often result from a lack of sufficient medical input to the care home (Arendts et al.,

2010). Given the detrimental impact hospitalisation can have in terms of cognitive and physical functioning of older adults, consideration must be given to services that can be developed to better meet the unique needs of older adults.

Chapter 8 furthers the theory surrounding the health need factors of older adults. Rather than considering multimorbidity alone several health need factors were examined in multivariate analyses in order to understand the independent associations between these health needs and healthcare service utilisation. These findings also draw attention to those factors which are modifiable and may serve as future intervention targets. The goal of such intervention targets is not to deny services but rather to optimise care in those locations which are more beneficial to older adults, whilst minimising those situations which may have negative implications for their functional and cognitive status.

The associations between factors such as number of prescribed medications, falls, frailty, depression and anxiety and healthcare service utilisation are extensively reported within the literature (Albert et al., 2009; Cahir, Bennett et al., 2014; Fried et al., 2001; Gudmundsson et al., 2005; Han et al., 2019; Hutter et al., 2010; Laurin et al., 2009; Maurer et al., 2008; Rosted et al., 2016; Scuffham et al., 2002; Scuffham et al., 2003; Sullivan et al., 2002). The findings of Chapter 8 extend this literature further, by considering the independent impact of these factors in multivariate models as well as considering longitudinal variation in health service utilisation patterns. Furthermore, the rate of change in health need factors over time was also examined. The methodology applied in Chapters 7 and 8 indicate that the breadth of factors which influence on healthcare utilisation can be accommodated within longitudinal analyses, through the application of LGCM as a means of data reduction.

Within Chapter 8 higher medication burden was associated with healthcare utilisation patterns beyond ‘primary care only usage’ supporting the literature that increasing numbers of medications are associated with increased numbers of ED visits, increased likelihood of

hospital admission and longer hospitalisations (Cahir, Bennett et al., 2014; Rosted, Schultz & Sanders, 2016). Interestingly, the rate of growth in numbers of prescribed medications had a greater effect on membership of the various longitudinal healthcare utilisation patterns. The influence of increasing numbers of medication over time was independent of changes other health need factors such as frailty. Studies which seek to examine the impact of medications on healthcare service usage should also consider dynamic trends within the numbers of medications as a factor independent of the number of medications at baseline.

The impact of frailty on longitudinal health service use observed in Chapter 8 extends what we know about the relationship between frailty and healthcare utilisation. Frailty has been shown to increase the likelihood for GP and practice nurse visits, hospitalisation and longer hospital admission (Fried et al., 2001; Han et al., 2019). Chapter 8 highlights that when the number of prescribed medications, often a proxy for level of multimorbidity, is accounted for, increasing levels of frailty at baseline and an increase in frailty over time predict the type of healthcare services an older individual uses over time.

Irrespective of level of frailty or changes in frailty over time, an independent association between falls and increased healthcare utilisation was observed within the TILDA cohort. Those who had experienced a fall were more likely to occupy healthcare utilisations patterns characterised by escalation into the 'multiple utilisation' status or remaining within this status between two time points. The prevalence of inappropriate prescribing of falls risk medications in both IC and CH contexts suggests that further attention could be directed at ameliorating such prescribing practices as a point of intervention in reducing the burden on health services. This is particularly relevant when one considers evidence within the literature of persistent prescribing of sedative medications to older adults following a falls-related hospitalisation (Walsh, Boland, Moriarty & Fahey, 2019).

9.3 Research implications

The adoption of an expanded definition of health services research at the turn of the century sought to emphasise the breadth of influence of individuals, organisations and communities on health service usage (Lohr & Steinwachs, 2002). The findings of Chapter 8 validate the complexity of factors which influence service usage by older adults, illustrating the limitations of the biomedical model in explaining healthcare utilisation. Social factors such as family structure and occupational status, in addition to psychological factors such as anxiety and depressive symptoms were also found to be independently associated with longitudinal healthcare utilisation patterns. Furthermore, as evidenced in Chapter 8, the health need factors are more nuanced than can be captured by comorbidity alone. Additional factors such as frailty, falls, medication numbers, anxiety and depressive symptoms were all shown to independently contribute to variation in healthcare utilisation patterns. This raises challenges for parsimonious approaches to research.

9.3.1 Intervention research

9.3.1.1 Accounting for complexity

The evaluation of healthcare interventions for older adults necessitates a design that accounts for the multiple factors shown in the present thesis to impact healthcare utilisation. Outcome selection and measurement are key considerations. Any assessment of a pharmaceutical care intervention to reduce inappropriate prescribing of fall-risk medications could reasonably select the number of falls experienced as a potential primary outcome, with number of ED visits and hospital admission as possible secondary outcomes. Nevertheless, medication related factors are not the sole contributory factor involved in the occurrence of falls. Environmental hazards, balance and mobility, sensory impairment, medication, footwear, and care equipment are key areas signposted by the Public Health Agency (PHA) in Northern Ireland as targets for falls prevention in nursing homes (PHA, 2015). Thus, a successful

medicines optimisation intervention may be lost in the confounding noise if other environmental factors are not addressed and the individual suffers a fall due to a trip hazard.

9.3.1.2 Selection of appropriate outcomes

Consideration must also be given to the outcomes that are relevant to the most important stakeholder, the individual themselves. It must be acknowledged that "older people have lived experience of the issues at stake, and we neglect their expertise at our peril" (Glasby et al., 2016, p. 4). For the older person in acute care, the more relational aspects of care supersede the technical aspects (Bridges, Flatley & Meyer, 2010). A systematic review of qualitative studies examining older patient's and/or their relative's experiences of acute care identified that an inpatient admission could instil feelings of fear, worthlessness and lack of autonomy among older adults (Bridges et al., 2010). Interpersonal connection, the ability to retain their identity and shared decision-making emerged as themes associated with more positive experiences of acute care (Bridges et al., 2010).

Glasby and colleagues (2016) argue that solutions to care provision are often devised from the perspective of the health and social care system, policy makers or researchers, and do not sufficiently incorporate the perspective of older people and the staff on the front-line who care for them. A reduction in inappropriate hospital admissions and ED attendances are often used as a metric when evaluating clinical interventions. When considering the 'appropriateness' of hospital admissions, Glasby and colleagues argue that the patient perspective must be considered. It is likely to differ from that of their GP, hospital clinicians or the bed manager (Glasby et al., 2016).

The operationalisation of healthcare attendances also requires considerable attention. A reduction in hospital admissions is conceptualised as an absolute target, whereas hospital admissions are affected by a range of factors, including other system policies and initiatives (Kumpunen, Edwards, Georghiou and Hughes, 2019). Cooksley and colleagues (2015) argue

that readmission rates are predicated on the concept that they are the result of poor care and that they are preventable. Alternatively, they could be conceptualised as the application of sound clinical judgement by attempting to prevent a decline in health for a high-risk individual (Cooksley et al., 2015). Older adults with complex multimorbidity who survive to hospital discharge may be an indicator of the receipt of high-quality care, and future readmission may inevitably result from this complex multimorbidity (Cooksley et al., 2015).

A systematic review of over 1500 interventions aimed at reducing avoidable hospital admissions found that most did not reduce hospital admissions (Purdy et al., 2012). Similarly, despite considerable innovation with respect to new service development, an almost 12% increase in emergency hospital admissions has been observed in England between 2004 and 2009 (Blunt, Bardsley & Dixon, 2010). Similarly, a review of integrated and community-based interventions found that most models were not associated with reduction in hospital admissions (Bardsley, Stevenson, Smith & Dixon, 2013). The review authors did note that whilst no reductions in emergency admissions were observed in many studies, changes to outpatient and elective care were identified. Damery, Flanagan and Combes (2016) argue that the extent of achievable improvements in service usage is not likely to satisfy the high expectations of policymakers and their targets for reduced hospital activity. Unrealistic expectations about outcomes, including a narrow focus on hospital utilisation, has been cited as a key reason why evaluations of integrated care models do not show positive impacts on health service utilisation (Kumpunen et al., 2019).

Bardsley and colleagues (2013) argue that reducing the costs associated with avoidable hospitalisations attracts a high degree of policy attention, thereby resulting in the inclusion of reduced hospital admissions as an outcome, irrespective of the legitimacy of such an outcome to the model under evaluation. The availability of hospital data in comparison with other outcomes further biases an approach to considering hospital admissions as a metric

(Bardsley et al., 2013). Furthermore, a system-wide priority to examine interventions "has set an unhelpful precedent to aim for impact on emergency admissions-even in cases where the programme should not logically have a significant impact on them" (Kumpunen et al., 2019, p. 7). Bardsley et al., (2013) argue that hospital admissions and costs are not the only important measures of impact; understanding how a model of care is being implanted may be as important as what it has achieved (Bardsley et al., 2013). Kumpunen and colleagues (2019) argue that evaluators should look beyond aspects of the model that are easy to measure and consider those metrics that matter. The incorporation of patient-reported outcome measures serves as one means of incorporating the patient experience.

9.3.1.3 Active public participation

The co-design approach to health service development encourages a partnership between those working within the system and those who have lived experience of using the system (Ní Shé et al., 2018; O'Donnell et al., 2019). Such an approach is likely to identify additional outcomes which are more relevant to the older person. A co-design study to improve care for frail older patients identified several patient-centred outcomes such as dignity, respectful communication, identity and independence as key outcomes for older adults (O'Donnell et al., 2019). Such outcomes are likely to pose challenges for evaluation but nevertheless cannot be discarded.

9.3.2 Healthcare utilisation research

The present thesis has shown that longitudinal assessments of healthcare utilisation can be enhanced by using latent variable methodology. Not only can heterogeneity in utilisation patterns be identified but the dynamic change in health needs over time can also be summarised using growth models. By specifying a unique intercept and slope value for each individual on many health need variables a greater number of variables could be accommodated within the analysis. In doing so, a more holistic assessment of what influences

change in healthcare utilisation behaviour of older adults over time was achieved. As argued by Babitsch and colleagues (2012) many previous studies have failed to adopt multivariate approaches within their analyses, thereby not truly accounting for the complexity of factors which influence healthcare utilisation. Whilst the analysis of Chapter 8 did not include other aspects which influence healthcare utilisation, such as health beliefs, social support etc., it has provided a basis for including multidimensional aspects of the health needs of older adults. Thus, it may serve as a foundation for future research which examines additional relevant covariates not included in the present thesis.

The examination of longitudinal patterns of healthcare utilisation using the TILDA cohort may also serve to influence future research themes within the NICOLA study in Northern Ireland. The identification of factors such as depression and anxiety as being independently associated with healthcare resource usage, may be stronger within a Northern Irish cohort which has experienced considerable conflict-related trauma. Analysis conducted in a representative sample of the NI population has estimated the lifetime prevalence of any mental health disorder to be 39% (Bunting, Murphy, O'Neill & Ferry, 2012). Within this sample a projected lifetime risk of any mental health disorder by age 75 years of 48% was identified (Bunting et al., 2012). Conflict-related trauma as well as economic adversity have previously been shown to be related to psychopathology among NI residents (McLafferty et al., 2015).

9.3.3 Pharmaceutical care research

9.3.3.1 Prescribing culture

The present thesis extends the research regarding inappropriate prescribing among older adults in several manners. The findings of Chapters 3 and 4 serves to support the extensive body of literature concerning the prevalence of inappropriate prescribing among older adults. When examined across the entire medication regimen, using the MAI to quantify the severity of inappropriate prescribing, the phenomenon may be more pervasive than

perhaps previously conceived. However, in the absence of a unified approach within the literature to detect and quantify inappropriate prescribing it will remain challenging to compare the extent of the phenomenon across different contexts. The prevalence of inappropriate prescribing in intermediate care is notable given the lack of research conducted in this setting and considerable attention should be diverted to further research in this care context. Further investigation is required in order to ascertain if any rebound prescribing of inappropriate medications occurs following optimisation by the case management pharmacist.

Regional differences in baseline severity of inappropriate prescribing were observed for both care models, which may warrant further examination in future studies. IC participants in the NHSCT and CH participants in the WHSCT were observed to have higher MAI total scores at baseline, and thus experienced greater change in MAI score following pharmacist intervention. Geographical differences in inappropriate prescribing may reflect local prescribing practices which may warrant further examination, as these disparities may serve as additional points for intervention to reduce the prevalence of inappropriate prescribing for older adults. The size, location and accessibility of GP practices have been shown to explain variation in high-risk prescribing practices (Cahir, Fahey, Teljeur & Bennett, 2014; Guthrie et al., 2011).

Alternatively, regional differences may occur as a result of inter-individual differences in MAI scoring by different pharmacists. Implicit tools such as MAI can be limited by the clinical experience of the user. MAI scores should be interpreted within their own context to account for differences in setting, medication numbers, types of patients and clinical experience (Castelino, Bajorek & Chen, 2010). Brenghøj and colleagues (2005) argue that those prescribed more medications may be more difficult to rate and may lead to lower agreement between evaluators. That said, reliability in MAI ratings is improved when assessments at two time points are carried out by the same individual, as was the case in the MOOP data. Furthermore,

Brenghøj and colleagues (2005) reported good intra-rater agreement for ratings conducted two years apart. Future delivery of both care models may be improved upon by a more in-depth understanding of regional differences in baseline MAI scores. Future studies may seek to consider the influence of pharmacist experience on the calculation of MAI scores and the importance of consultant pharmacist mentorship of case management pharmacists in their professional development.

9.3.3.2 Models of care and expanded pharmacy roles

The MOOP models of care may also stimulate research themes currently under investigation in ROI. An intervention to examine the utility of GP practice pharmacists at improving prescribing appropriateness and outcomes is presently under investigation (Cardwell et al., 2018). This intervention will involve the management of repeat prescribing within the GP practice and the completion of medication reviews. However, in the absence of the extended prescribing rights accessible to pharmacists within Northern Ireland, following completion of the requisite training, it is challenging to appreciate how effective such an intervention may be. The provision of outreach pharmacy services to at-risk older adults such as those in community hospital and residential care settings could also be established as research themes. Inappropriate prescribing has previously been examined among community dwelling older adults and nursing home residents in ROI (Byrne et al., 2011; Galvin et al., 2014; Moriarty, Bennett, et al., 2015; Moriarty, Bennett, Cahir, Kenny & Fahey, 2016; Moriarty et al., 2017). Thus, the utility of the MOOP care models could be investigated as a strategy for similar populations outside Northern Ireland.

The arrival of Practice Based Pharmacists (PBPs) into general practice in NI provides a new interface for both medicines optimisation care models, as it proffers a new channel for communication between primary and secondary care. Case management pharmacists operating within the CH model have reported positive working relationships with PBPs and

found the PBP role to be beneficial to their case management activities (Miller, 2018). Moving forward, future research will be required to outline how these roles may complement one another to ensure coordination of activities and to prevent duplication of effort. Furthermore, the future of integration of pharmacy services within NI needs will necessitate further research as respective roles interface with one another.

9.4 Policy and practice implications

9.4.1 Service delivery implications

9.4.1.1 Intermediate Care

The findings of Chapter 3 advocate for the inclusion of pharmacy services within IC beyond a 'supply only' function. Not only was a high prevalence of inappropriate prescribing detected and successfully addressed by pharmacist intervention, but the nature of longer admissions which occur within IC provide an opportunity to make inroads in addressing suboptimal prescribing among older adults. Each additional day spent in IC was associated with further reductions in MAI score.

The findings of Chapter 3 suggest that the needs of older adults are not being adequately served within the acute care system. The demand for inpatient beds and an increased focus on the presenting illness can result in insufficient time to address all the clinical needs of the patient during the hospital admission (Edey et al., 2018). A high level of prescribing omissions and Kardex issues to address indicates that medication-related issues were either not suitably addressed during the acute care stay or that inappropriate prescribing was initiated whilst in acute care. Peréz and colleagues (2018) previously found hospitalisation to be independently associated with inappropriate prescribing among a large sample (approx. n = 38,000) of community dwelling older Irish adults. Those who experienced a hospital admission were 72% more likely to receive inappropriate prescribing compared with before hospital admission (Peréz et al, 2018).

Almost three quarters (71%) of IC participants had previously been acute care inpatients. Thus, intermediate care is ideally placed as a setting to prevent the persistence of medication related issues beyond acute care discharge, further fulfilling its function as a bridge between hospital and home. Furthermore, the continual presence of a pharmacist within IC may explain why Kardex issues were more frequently addressed within the IC cohort in comparison with the CH cohort. This continual presence may facilitate the ability to deliver a more robust and wide-ranging intervention.

9.4.1.2 Care Homes

Considerable challenges regarding the governance of care homes in NI have become evident in recent years and these are likely to have been further compounded by the challenge of the Covid-19 pandemic. The care standards for nursing homes in NI are not fit for purpose and need to be overhauled to include medicines optimisation as the benchmark. At present these care standards (DHSSPS, 2015) only address the process aspects of medicines management, including documentation and storage, and do not incorporate the patient-centred approach of medicines optimisation as set out in the NICE (2015) guidance and as is delivered by the MOOP care home model. They do not assert a patient-centred approach for shared decision making and accounting for the individual's needs, preferences and values. In order to support the care of our older adults in residential care there needs to be a shift away from the procedural aspects of medicines management and towards the patient-centred approach of medicines optimisation. Medicines optimisations services are likely to be easier to initiate in settings such as IC as it falls mostly under the governance of the HSCT. Nevertheless, there is a need to ensure that a medicines optimisation strategy for care homes is consistently delivered across the region, considering the poor prescribing practices identified within Chapters 4 and 5.

9.4.2 Promotion of positive ageing

An ageing population with increasing levels of multimorbidity will serve to perpetuate the demand on healthcare systems. The Covid-19 pandemic has exposed gaps within healthcare systems across the globe, stimulating assessments and debate regarding how to ensure safe service delivery with minimal disruption. The pandemic has also forced timely innovation, challenged the approach of silo working and questioned how we care for the more medically vulnerable in our society.

Arguably our older generation has suffered disproportionate effects from the Covid-19 pandemic. Despite warnings about the need to plan for a pandemic and the challenges that congregated living settings such as care homes pose for infection control, greater levels of mortality have been identified among older adults aged ≥60 years and those in residential care (Burki, 2020; Centers for Disease Control, 2020; DOHNI 2020a, 2020b; Health Protection Surveillance Centre, 2020; Office for National Statistics, 2020; Powell, Bellin & Ehrlich, 2020). It has also cast a cold light on the disparaging lens within which older adults are often viewed. Enforcing a label of vulnerability upon older adults who have been living independently and contributing to society prior to the pandemic can have negative ramifications for those very older adults we have nobly sought to protect. Negative self-perceptions of health increase the odds for poorer functional status, with positive self-perceptions of aging protecting against a decline in functional status in later life (Levy, Slade & Kasl, 2002; Nogueira et al., 2010; Sargent-Cox, Anstey & Luszcz, 2012).

Lak, Rashidghalam, Myint and Baradaran (2020) argue that in order to achieve a healthy life expectancy an emphasis must be placed on promoting the positive aspects of aging, with particular attention being paid to encouraging older adults to be active participants in their own health. The WHO (2002) consider active aging to be the optimisation of "opportunities for health, participation and security in order to enhance quality of life as

people age" (p. 12), as well as incorporating the rights, needs and preferences of older people (WHO, 2002). Yet, when one considers the topic of healthcare service delivery, we have some way to go to achieve an active participation in respecting the rights, needs and preferences of older people to support them to age well in place. Service design must consider how it alters the ecological landscape, thereby influencing behaviour and thus interaction with services themselves.

This is not a suggestion that we move away from robust scientific practices and evidence-based medicine but rather that we consider that a scientific-only focus can also permeate the language we use around care. Aronson (2019) argues that this focus can relegate the importance of other aspects and can be inherently patient-blaming and often used to characterise certain patient groups such as older adults as 'difficult': "she is non-compliant, we said. Or, he failed the treatment" (p. 43). Going even further, older adults within the acute care system are often referred to as 'bed blockers' and have also been referred to as 'GOMERs', an acronym for 'get out of my emergency room', as described by Shem (1978) in his medical novel 'The House of God'. Aronson (2019) argues that whilst no physician would consider it acceptable to use racist, sexist, or homophobic language when discussing patients, there can be an acceptance of referring to older adults in such disparaging terms.

A more positive, inclusive view of positive ageing may be achieved through active partnership with older adults. The inclusion of older adults in policy and service design and the selection of more appropriate outcome measures, including patient reported outcomes can do much to ensure that services are developed that meet the needs of older adults. Recognising the fifth M of Tinetti et al.'s (2017) 5Ms, what matters most to the individual, can serve as a useful signpost for the direction of travel ahead.

9.4.3 Future of pharmacy services

9.4.3.1 Brief interventions across the spectrum of services

The thesis findings also have the capacity to shape future pharmacy service development. The identification of medications frequently prescribed inappropriately within Chapter 5 provide an opportunity to shape future brief interventions by pharmacists across the entire healthcare journey, and not solely within intermediate care and care home contexts. The identification of unsuitable prescribing practices may help the achievement of 'quick wins' by clinicians working across the entire healthcare landscape. Inappropriate prescribing of psychoactive medication requires a pathway with suitable opportunities for monitoring and follow up, given the additional challenges presented by their discontinuation or modification. The MOOP case management models are examples of suitable pathways.

The present thesis findings underscore the importance of providing clinical pharmacy services to settings such as intermediate care and care homes. The high prevalence of unresolved medication related issues following acute care discharge, identified within the IC cohort, also raises awareness of the potential for medication related harm that exists among older adults living within the community. The persistent and independent associations identified for polypharmacy and frailty with healthcare utilisation identified in Chapter 8 highlights the importance of considering both when examining future interventions or service delivery models. Palmer et al., (2018) contend that "any clinical evaluation of geriatric patients should include screening for frailty, as well as structured medication review that comprehensively evaluates prescribing and its appropriateness and clinical relevance" (p. 35).

9.4.3.2 Advancing the profession

The MOOP models evaluated in Chapters 3 and 4 benefit from the expanded legislative opportunities for pharmacists within the UK, where additional qualifications such as that of independent prescribers can be pursued. Prescribing rights are a particular asset to the MOOP

models and eliminate unnecessary delays in medicines optimisation whilst also reducing the burden upon existing members of the care team. Moving forward, any jurisdiction that seeks to pursue a viable and comprehensive healthcare strategy for older adults would do well to consider the aspects of the MOOP models of care which make them successful. Independent prescribing qualifications allow the case management pharmacist to make alterations to the medication regimen in a timelier manner, without the need to delay action via a referral process to the prescriber.

Despite repeated calls to action for strategies and interventions to tackle polypharmacy and inappropriate polypharmacy, little has been established within the Republic of Ireland (ROI). The findings reported in Chapters 3 and 4 outline the possibility and opportunity that exists. Thus, consideration should be given to what differentiates the MOOP models of care from previous interventions which have shown no impact on healthcare utilisation. The care models are innovative by not only placing clinical pharmacists into a new frontier to deliver medicines optimisation through the implementation of a personalised pharmaceutical care plan, but also in that they operate via a caseload approach. In doing so, appropriate monitoring and follow up is conducted, additional interventions are delivered where required and medication related problems are resolved to completion. Such an approach also renders better communication with additional members of the care team, whilst ensuring that the experiences of the older person remain front and centre. The ability to follow up with older adults following IC discharge serves to create an additional opportunity for the patient voice to be heard and importantly to be responded to. Both models were entirely new concepts within pharmacy services in Northern Ireland and due to their successful implementation, they have been rolled out regionally (Miller, 2018).

In contrast, the research themes in ROI are limited by the absence of independent prescribing qualifications. The investigation of a general practice pharmacist intervention to

optimise prescribing in primary care (Cardwell et al., 2018) could be further augmented were such roles to be granted prescribing rights. Within the ROI action is required to develop models of care that address inappropriate prescribing. Previous studies have estimated the prevalence of inappropriate prescribing to range from 28-42% and 20-53% among community dwelling older adults (Cahir, Moriarty, et al., 2014; Moriarty, Bennett, et al., 2015). International estimates suggest a higher prevalence to occur in in residential care settings, possibly related to the inappropriate use of psychoactive medications to manage BPSD (Renom-Giuteras et al., 2018). Again, the development of a model of care such as the MOOP care home model will require an expanded role for pharmacists and thus the necessary training and legislative framework in order to make such a role as effective as possible.

9.4.4 Policy and legislative changes

For a cohesive pharmacy strategy to be developed in the ROI several policy and legislative changes will be required. A vision for pharmacy and the wide variety of new pharmacy roles that have been established in other jurisdictions is required. Despite considerable advances in clinical specialisation within hospital pharmacy, the sector continues to be limited by a career structure in existence since the 1970s. Furthermore, the absence of additional legislative powers with respect to prescribing has meant that the pharmacy profession is now many years behind that in operation in many other jurisdictions. Regulations to permit pharmacists to prescribe independently came into effect in the UK in 2006. These additional powers are extended to those pharmacists to complete the requisite training on an accredited course as well as learning in a practice environment under the mentorship of a medical practitioner (General Pharmaceutical Council, 2020).

It has been said that independent prescribing by community pharmacists may pose a conflict of interest with respect to the dispensing of prescribed medication. Nevertheless, the Achieving Excellence in Pharmaceutical Care-A Strategy for Scotland sets out how community

pharmacist prescribing can be endorsed, supported and funded through policy drivers (Scottish Government Pharmacy and Medicines Division, 2017). Thus, scope exists for the safe continued prescribing of long-term medications provided access is granted to laboratory investigations and a shared care record. The ability of a patient to have their antihypertensive medications clinically reviewed and prescriptions renewed without having to consult their GP may serve to reduce the burden on GPs for chronic disease management. Alternatively, prescribing rights could be extended to pharmacists where no conflict of interest of dispensing exists, such as pharmacists working in general practice. The ageing population and increases in complex multimorbidity poses many challenges for primary care. A failure to consider alternative solutions to increasing capacity in primary care may only serve to increase the threat posed by an ageing population with increasing levels of multimorbidity.

9.4.5 Integrated care

9.4.5.1 The case for integrated care

Overall, the thesis findings support the opportunity that integrated care presents for improving the health and wellbeing of older adults. The health need factors among older adults are multiple and will likely require multidisciplinary input to address them. Reducing the risk of falls will likely require the input of physicians, physiotherapists, occupational therapists, pharmacists and perhaps more. Addressing frailty will require similar inputs. Aspects such as fear of falling, which has been shown to be associated with an increased risk of falling (Briggs, Kennelly & Kenny, 2018), depressive and anxiety symptoms will require additional input from mental health practitioners. Thus, an integrated approach is no longer a notional objective but rather is mandated.

Integrated care for older people switches the focus to that of the patient experience, outcomes and quality of care. The Institute for Healthcare Improvement enshrine the patient experience of care within their Triple Aim framework, which seeks to improve health system

performance. It calls for a three-dimensional approach to service design that seeks to improve the patient experience of care, the health of populations and to reduce per capita healthcare costs (Institute for Healthcare Improvement, 2020). Integrated care involves a move away from acute, episodic care to a coordinated approach that reflects the complexity of care required to attend to multimorbidity (HSE, 2017).

In ROI, the National Clinical Programme for Older People (NCPOP) Specialist Geriatric Services Acute Model of Care called for the establishment of a Specialist Geriatric Service to improve outcomes for frail older adults (HSE, 2012). This envisioned a complete patient journey from home, through primary care, acute care and to discharge home. Moving forward, the Integrated Care Programme for Older People (ICPOP; 2016) aims to amalgamate local health systems using a ten-step framework. Key aspects of this framework are to establish the needs of the population, develop services and pathways that reflect new ways of working in order to deliver person-centred services (HSE, 2017). The development of a multidisciplinary team seeks to make the best use of the complementary skills within the team, with agreed systems for communication and interaction between members (HSE, 2017). Examples of new pathways proposed by ICPOP to meet the needs of frail older adults, identified in Chapter 8 as being at higher risk for multiple healthcare utilisation, include the establishment of frailty pathways in acute care that enable an immediate response within ED or the development of specialist frailty wards that are resourced by multidisciplinary teams.

A frailty pathway has recently been piloted in the South Eastern HSCT in Northern Ireland. This pathway also used a case management approach based upon the IC model of care, which was adapted to reflect a referral due to frailty and thus, the need to include additional assessments of other appropriate outcomes. Risk stratification occurs with those aged 85 years and older accepted into the pathway. Those aged 65 years and older with two or more frailty syndromes of falls, immobility, delirium or cognition issues, incontinence,

prescribed five or more medications and socially isolated are also accepted. In addition to assessments of prescribing appropriateness the anticholinergic burden of medications is also examined. This frailty pathway operates like the IC model, with case management continuing for 30 days post-discharge. Interim evaluation of this service has indicated that prescribing appropriateness, as well as the anticholinergic burden of medications, were successfully improved upon following intervention by the case management pharmacist (Saeed et al., 2020). A total of 380 interventions were conducted in the sample of 72 patients; almost three-quarters of these were assessed as significant and resulting in improved care standards according to the Eadon grading system (Saeed et al., 2020).

In Northern Ireland, an Integrated Care Prototype has been developed in the Northern Trust to improve health outcomes through a collaborative approach between the Trust and GPs. To date GP services operate separately to the HSCTs in Northern Ireland. This prototype aims to bring the commissioning of services together (NHSCT, 2019). This approach seeks to embed a policy of 'no more silos' such that shared resources will provide a more efficient system of care. This new partnership seeks to rearrange the structure of health and social care, not only to integrate the work of primary care with that of the Trusts, but also to establish partnerships with the community and voluntary sector to focus on a shared goal of population health outcomes. Thus, significant change is occurring on the island with respect to integrated care. The importance of ensuring that medications are optimised throughout this process is supported by the findings of Chapters 3, 4, 5 and 8.

9.4.5.2 The future for integrated care in Ireland

The high prevalence of inappropriate prescribing reported in Chapters 3 and 4 highlight the large room for improvement that exists with respect to safe and efficacious use of medicines for older adults. When one considers that Chapter 8 identified that frailty and polypharmacy were both independently associated with healthcare usage patterns and that

frailty and polypharmacy have previously been found to be predictive of one another (Palmer et al., 2019; Saum et al., 2017), it is inconceivable to consider an integrated care strategy for older people that does not incorporate medicines optimisation across the entire patient journey. Nevertheless, both jurisdictions on the island of Ireland are faced with challenges with respect to delivering a comprehensive integrated care strategy which includes pharmacy services.

Medicines optimisation by pharmacists needs to be embedded across the entire patient journey. Within the NHSCT Integrated Care Prototype, HSCT pharmacists and GP pharmacists are represented at the appropriate level through the joint working of HSCT directors and GP Federation leads. In NI, there are 17 GP Federations which work to support GP practices and whose boundaries align with the 17 Integrated Care Partnerships in existence (HSCBNI, 2020b). However, community pharmacy must also align with this new Integrated Care Prototype in order to achieve an equal level of commissioning and decision making going forward. At present, the Integrated Care Prototype does not allow for this.

As the development of the Integrated Care Prototype advances, provision must be made for the inclusion of community pharmacy at the same level as that of HSCT pharmacists and GP pharmacists. This could be established by a structure akin to that represented by the Primary and Community Together (PACT) model. PACT seeks to deliver local patient-centred public health and medicine initiatives through the novel social enterprise of community pharmacists working in partnership with the community and voluntary sector (Mid and East Antrim Agewell Partnership: MEAAP, 2020; PACT, 2018). The IMPACT (Involving Many to Prescribe Alternative Care Together) Agewell initiative in the Mid and East Antrim area includes a PACT pharmacist to represent all community pharmacists within the local area. This approach is a move away from the traditional ‘silo’ model of community pharmacy provision and towards a more integrated care approach (MEAAP, 2020). These PACT pharmacists

provide support on pharmacy related issues and ensure that there are no gaps in the provision of commissioned community pharmacy services (MEAAP, 2020). Interim evaluation of the IMPACT Agewell initiative identified that for every £1 spent on community pharmacists an invest to save return of £3.86 was achieved (MEEAP, 2020).

The integrated care programme for older people currently established by the HSE in ROI does not provide for the type of care models examined in Chapters 3 and 4. Results from the MOOP care models indicate the value that can be added by expanding pharmacy services to older adults in care settings which traditionally do not have access to such services. The optimisation of medications in the post-discharge space of intermediate care can thus address potential medication related harm that persists beyond acute care discharge, whilst also providing a continuity of care for older adults as they transition from acute care back into the community. The HSE (2017) has already indicated that case management operating across care settings is a key aspect of care integration. Within the HSE's 2017 guidance for local implementation of integrated care for older adults, case management is recognised as a proactive approach to address the medical, nursing, pharmaceutical and social care needs of older adults (HSE, 2017). Nevertheless, no provision for expanded pharmacy roles is considered. Furthermore, when considering pharmacy services there is no apparent acknowledgement of those pharmacists already providing clinical pharmacy services within acute care. Acknowledgement is made within the guidance document that emerging roles to support integrated care for older adults may be developed within community pharmacy. However, in the absence of a national strategic vision for pharmacy it is difficult to envision how the pharmaceutical care needs of older adults will be delivered across the entire patient journey.

9.5 Conclusion

Rather than enshrine the care of older adults within our health and social care systems we have left it to the private sector and free market rules. Consequently, a disproportionate burden of morbidity and mortality associated with Covid-19 infection has been felt by those older adults that should be cherished within a system that aims to care for those citizens it serves. Shall we continue with the privatisation of the health and social care of our most valuable citizens? They have contributed to the development of our society, the services and resources that we take for granted, and without them we would not exist. As Aronson puts it so poignantly: “they are the future ‘us’, and we are the past ‘them’” (2019, p. 56).

The findings presented in this work align with the 5Ms of ‘the geriatric salute’. Mind characteristics such as depression, anxiety and cognitive impairment have been identified as associated with healthcare utilisation in the MOOP and TILDA datasets. Mobility, examined in terms of initial frailty status and increasing levels of frailty over time, was found to be consistently associated with patterns of healthcare usage characterised by more intensive service usage. The role of medications has been examined through the evaluation of pharmacist services to improve medicines optimisation among at risk older adults and among community dwelling older adults. Furthermore, an appreciation of the multi-complexity of older adults has been achieved through the distinct features identified for intermediate care patients, care home residents and community dwelling older adults. By examining different cohorts of older adults, this thesis has served to highlight the considerable heterogeneity that exists amongst a section of the population that are often assumed to be homogenous. What matters most is perhaps where we go from here.

What is the future goal of healthcare for our older adults? Encompassing the need for patient-centred care, Aronson (2019) argues that the goal for geriatric medicine is to “tailor care to the patient’s unique amalgam of health status, abilities, values, and care preferences,

no matter how healthy or sick they are" (p. 47). There is a clear need to move to a partnership with older adults and discourage the 'conspiracy of silence' that prevents shared decision-making (Van Bussel et al., 2019, p. 6). The discontinuation of inappropriate medications must be prioritised. Care must move beyond a process approach and instead preserve a person-centred approach. Within a healthcare system that is highly fractured, a move towards integrated care that supports the older person transitioning between care settings is required. Using an integrated approach can mean that care can be brought to the older person and unnecessary hospitalisations can be avoided. We also need to challenge ageist biases within the health and social care system. We cannot stop the ageing process, but nor should we inadvertently blame someone for succeeding in staying alive. Let us remove these biases as well as the accompanying denigrating language. Our elders are not bed blockers nor GOMERs but people. Humans. And one day, we hope, us.

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Appendix A: Ethical approval from ORECNI

HSC Business Services Organisation

Office for Research Ethics Committees Northern Ireland (ORECNI)

Customer Care & Performance Directorate
Unit 4, Lissue Industrial Estate West
Rathdown Walk
Moira Road
Lisburn
BT28 2RF
Tel: 028 95361400
www.orecni.hscni.net
HSC REC A

30 March 2017

Dr E F Ruth Miller
Lead Research Pharmacist & Project Manager (Medicines Optimisation in Older People)
WHSCT
Pharmacy, Altnagelvin Area Hospital, Glenshane Road
Londonderry, BT47 6SB

Dear Dr Miller

Study title: **Exploration of the relationship between the Medication Appropriateness Index (MAI) and Healthcare Resource Usage and Outcomes**
REC reference: **17/NI/0052**
IRAS project ID: **219777**

The Research Ethics Committee reviewed the above application at the meeting held on 28 March 2017. Thank you for attending to discuss the application with Ms Carmel Darcy.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details. Publication will be no earlier than three months from the date of this favourable opinion letter. The expectation is that this information will be published for all studies that receive an ethical opinion but should you wish to provide a substitute contact point, wish to make a request to defer, or require further information, please contact hra.studyregistration@nhs.net outlining the reasons for your request. Under very limited circumstances (e.g. for student research which has received an unfavourable opinion), it may be possible to grant an exemption to the publication of the study.

Ethical opinion

The members of the Committee present gave a **favourable ethical opinion** of the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

Conditions of the favourable opinion

The REC favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission must be obtained from each host organisation prior to the start of the study at the site concerned.

Providing Support to Health and Social Care

Management permission should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements. Each NHS organisation must confirm through the signing of agreements and/or other documents that it has given permission for the research to proceed (except where explicitly specified otherwise).

Guidance on applying for HRA Approval (England)/ NHS permission for research is available in the Integrated Research Application System, at www.hra.nhs.uk or at http://www.rdforum.nhs.uk.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of management permissions from host organisations.

Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database. This should be before the first participant is recruited but no later than 6 weeks after recruitment of the first participant.

There is no requirement to separately notify the REC but you should do so at the earliest opportunity e.g. when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non-clinical trials this is not currently mandatory.

If a sponsor wishes to request a deferral for study registration within the required timeframe, they should contact hra.studyregistration@nhs.net. The expectation is that all clinical trials will be registered, however, in exceptional circumstances non registration may be permissible with prior agreement from the HRA. Guidance on where to register is provided on the HRA website.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Ethical review of research sites

NHS Sites

The favourable opinion applies to all NHS sites taking part in the study taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Summary of discussion at the meeting

The Chair welcomed you and Ms Darcy to the meeting and thanked you for attending. The Chair advised that the Committee had no queries and had agreed that a favourable opinion of the application could be given.

Other ethical issues were raised and resolved in preliminary discussion before your attendance at the meeting.

Please contact the REC Manager if you feel that the above summary is not an accurate reflection of the discussion at the meeting.

Approved documents

The documents reviewed and approved at the meeting were:

Document	*Version*	*Date*
IRAS Checklist XML [Checklist_23022017]		23 February 2017
REC Application Form [REC_Form_23022017]		23 February 2017
Research protocol or project proposal [Study protocol]	1	21 February 2017
Summary CV for Chief Investigator (CI) [CI Summary CV]		21 February 2017

Membership of the Committee

The members of the Ethics Committee who were present at the meeting are listed on the attached sheet.

Mr Niall O'Kane advised that he knows Dr Miller and Ms Darcy in a professional capacity, but has had no involvement in the study under review. This was not considered a declaration of interest, and all members remained present during the review.

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The HRA website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website: http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/

HRA Training

We are pleased to welcome researchers and R&D staff at our training days – see details at http://www.hra.nhs.uk/hra-training/

17/NI/0052	**Please quote this number on all correspondence**

With the Committee's best wishes for the success of this project.

Yours sincerely

Kathryn Taylor

pp Dr Catherine Hack
Chair
E-mail: RECA@hscni.net

Enclosures: *List of names and professions of members who were present at the meeting and those who submitted written comments*

"After ethical review – guidance for researchers"

Copy to: *Ms Sally Doherty, Western Health and Social Care Trust*

HSC REC A

Attendance at Committee meeting on 28 March 2017

Committee Members:

Name	*Profession*	*Present*	*Notes*
Ms Margaret Brady	Deputy Chief Education Welfare Officer Operations	Yes	
Dr Avril Craig	Project Manager	No	
Dr Gordon Cran	Medical Statistician (Retired)	Yes	
Dr Catherine Hack	**Consultant in Academic Practice (STEM)**	Yes	Chair
Dr Helen Harty		Yes	
Dr Felicity Hasson	Senior Lecturer	No	
Ms Rejina Mariam Verghis	Junior Biostatistician	Yes	
Professor Suzanne Martin	Professor - Occupational Therapy	No	
Dr Toni McAloon	Nurse Lecturer	Yes	
Mr Niall McSperrin	Solicitor	Yes	
Mr Barry Mimnagh	Pharmacist	Yes	
Dr Charles Mullan	Consultant Radiologist	Yes	
Dr Mary Murphy	Registered Nurse	No	
Mr Niall O'Kane	Registered Pharmacist	Yes	
Dr Orla Quigley	General Practitioner (Retired)	Yes	
Professor Mahendra Varma	Consultant Physician in charge of Cardiology and Diabetic Services (Retired)	Yes	
Dr Alastair Walker	Retired Head of Education Services, CCEA	Yes	

Also in attendance:

Name	*Position (or reason for attending)*
Miss Kathryn Taylor	REC Manager

Appendix B: Substantial amendment approval

HSC Business Services Organisation

Office for Research Ethics Committees Northern Ireland (ORECNI)

Customer Care & Performance Directorate
Unit 4, Lissue Industrial Estate West
Rathdown Walk
Moira Road
Lisburn
BT28 2RF
Tel: 028 95361400
www.orecni.hscni.net

HSC REC A

22 February 2018

Dr E F Ruth Miller
Lead Research Pharmacist & Project Manager (Medicines Optimisation in Older People)
WHSCT
Pharmacy, Altnagelvin Area Hospital, Glenshane Road
Londonderry, BT47 6SB

Dear Dr Miller

Study title: **Exploration of the relationship between the Medication Appropriateness Index (MAI) and Healthcare Resource Usage and Outcomes**
REC reference: **17/NI/0052**
Amendment number: **1, January 26th 2018**
Amendment date: **26 January 2018**
IRAS project ID: **219777**

The above amendment was reviewed at the meeting of the Sub-Committee held on 21 February 2018 in correspondence.

Ethical opinion

The members of the Committee taking part in the review gave a favourable ethical opinion of the amendment on the basis described in the notice of amendment form and supporting documentation.

Approved documents

The documents reviewed and approved at the meeting were:

Document	*Version*	*Date*
Notice of Substantial Amendment (non-CTIMP) [Notice of Substantial Amendment]	1, January 26th 2018	26 January 2018
Other [Introduction to Good Clinical Practice Elearnign Certificate (secondary care) ADoherty]		27 September 2017
Other [Introduction to Good Clinical Practice Elearning Certificate (secondary care) GAdamson]		18 January 2018
Other [Introduction to Good Clinical Practice Elearning Certificate (secondary care) JMallet]		14 January 2018
Other [Introduction to Good Clinical Practice Elearning Certificate (secondary care) MShevlin]		17 January 2018
Other [Copy of REC Form Submitted 2.2.2018]		02 February 2018
Summary CV for student [CV Student AD]		31 January 2018
Summary CV for supervisor (student research) [CV Academic Supervisor GA]		31 January 2018
Summary CV for supervisor (student research) [CV Academic Supervisor MS]		31 January 2018
Summary CV for supervisor (student research) [CV Academic Supervisor JM]		01 February 2018

Membership of the Committee

The members of the Committee who took part in the review are listed on the attached sheet.

Working with NHS Care Organisations

Sponsors should ensure that they notify the R&D office for the relevant NHS care organisation of this amendment in line with the terms detailed in the categorisation email issued by the lead nation for the study.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

We are pleased to welcome researchers and R & D staff at our Research Ethics Committee members' training days – see details at http://www.hra.nhs.uk/hra-training/

17/NI/0052: **Please quote this number on all correspondence**

Yours sincerely
Denise Nesbitt
Ms Tamla Meredith
HSC REC A Manager

E-mail: RECA@hscni.net

Enclosures: *List of names and professions of members who took part in the review*

Copy to: *Mrs Sally Doherty, WHSCT*
Mrs Ann Doherty

Providing Support to Health and Social Care

HSC REC A

Attendance at Sub-Committee of the REC meeting on 22 February 2018

Committee Members:

Name	*Profession*	*Present*	*Notes*
Dr Catherine Hack (Chair)	Consultant in Academic Practice (STEM)	Yes	
Dr Charles Mullan	Consultant Radiologist	Yes	

Also in attendance:

Name	*Position (or reason for attending)*
Mrs Tamla Meredith	REC Manager

Appendix C: Non-substantial amendment approval

Ann Doherty

From: Researchgw Amendments <Research.Amendments@hscni.net>
Sent: Friday 3 May 2019 13:21
To: Ann Doherty
Cc: drefr.miller@gmail.com
Subject: IRAS 219777, NSA02. Amendment categorisation and implementation information

"This email is covered by the disclaimer found at the end of the message."

Amendment Categorisation and Implementation Information

Dear Ann,

IRAS Project ID:	219777
Short Study Title:	The Relationship between MAI and Healthcare Resource Outcomes
Date complete amendment submission received:	26/04/19
Sponsor Amendment Reference Number:	02
Sponsor Amendment Date:	27/03/19
Amendment Type	Non Substantial
Implementation date in NHS/HSC organisations in Northern Ireland and/or Scotland	31/05/19 **(providing conditions are met)**
For NHS/HSC R&D Office information	
Amendment Category	**A**

Thank you for submitting an amendment to your project. We have now categorised your amendment and please find this, as well as other relevant information, in the table above.

What should I do next?

Please read the information in IRAS, which provides you with information on how and when you can implement your amendment at NHS/HSC sites in each nation, and what actions you should take now.

If you have participating NHS/HSC organisations in any other UK nations please note that **we will** forward the amendment submission to the relevant national coordinating function(s).

1

If not already provided, please email to us any regulatory approvals (where applicable) once available.

When can I implement this amendment?

You may implement this amendment in line with the information in IRAS.

Please note that you may only implement changes described in the amendment notice.

Who should I contact if I have further questions about this amendment?

If you have any questions about this amendment please contact the relevant national coordinating centre for advice:

- England – hra.amendments@nhs.net
- Northern Ireland – research.gateway@hscni.net
- Scotland – nhsq.NRSPCC@nhs.net
- Wales – research-permissions@wales.nhs.uk

Additional information on the management of amendments can be found in the IRAS guidance.

User Feedback

We are continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the amendment procedure. If you wish to make your views known please use the feedback form available at: http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/.

Please do not hesitate to contact me if you require further information.

Kind regards,

Ciara

Ciara Neeson
Research Gateway Facilitator
C-TRIC
Altnagelvin Area Hospital
NORTHERN IRELAND
BT476SB

I AM RESEARCH
Be part of the solution

2

Appendix D: Adapted Frailty Index

A frailty index, adapted from the work of Roe et al., (2017) was created using the following 30 variables from the CAPI questionnaire for each wave of TILDA data collection.

			Wave		
Item	**Description**	**Variable ID**	**1**	**2**	**3**
1	Difficulty walking 100m	Fl001_01	✓	✓	✓
2	Difficulty rising from a chair	Fl001_04	✓	✓	✓
3	Difficulty climbing stairs	Fl001_06	✓	✓	✓
4	Difficulty stooping, kneeling, or crouching	Fl001_07	✓	✓	✓
5	Difficulty reaching above shoulder height	_08	✓	✓	✓
6	Difficulty pushing/pulling large objects	_09	✓	✓	✓
7	Difficulty lifting/carrying weights ≥10lb	_10	✓	✓	✓
8	Difficulty picking up a coin from a table	_11	✓	✓	✓
9	Poor self-rated physical health	SR_health	✓	✓	✓
10	Poor self-rated vision	Disvision	✓	✓	✓
11	Poor self-rated hearing	Dishearing	✓	✓	✓
12	Poor self-rated memory	Ph114 all waves	✓	✓	✓
13	Difficulty following a conversation	Disconverse4	✓	✓	✓
14	Everything an effort	Mh007	✓	✓	✓
15	Polypharmacy	mdpoly_excl_supps	✓	✓	✓
16	Hypertension	Ph201_1	✓	✓	
17	Angina	Ph201_2	✓		
18	Heart attack	Ph201_3	✓		
19	Diabetes	Ph201_5	✓		
20	Stroke and transient ischemic attack	Ph201_6 or _7	✓		
21	High cholesterol	Ph201_8	✓		
22	Irregular heart rhythm	Ph201_10	✓		
23	Other CVD	Ph201_11	✓		
24	Cataracts	Ph105_1	✓		
25	Glaucoma and age-related macular degeneration	Ph105_2 or _3	✓		
26	Arthritis	Ph301_3	✓		
27	Osteoporosis	Ph301_4	✓		
28	Cancer	Ph301_5	✓		
29	Varicose ulcer	Ph301_13	✓		
30	Incontinence	Any_CHRincontinence	✓	✓	✓

Self-report questions MH014 ‘feeling lonely’ and ph503_03 ‘knee pain’ were omitted as they were not consistently available across the first three waves of TILDA data collection. Variable mh007 ‘everything was an effort’ was operationalised instead of bh201 ‘daytime sleepiness’ due to inconsistency in item availability across all waves of interest. The categorical cut-points created by Roe and colleagues (2017) were retained and as follows: FI score <0.09374: Robust, FI score 0.09375-0.2499: Pre-frail and FI score ≥0.25: Frail. Responses to items 16-29 were used in the formation of the adapted Frailty Index at waves 2 and 3, given their relative invariant nature.

Appendix E: Ethical approval from School of Psychology

UNIVERSITY OF ULSTER **RESEARCH GOVERNANCE**

RG3 Filter Committee Report Form

Project Title	Patterns of healthcare utilisation in older people: secondary analysis of epidemiological data
Chief Investigator	Prof Gary Adamson
Filter Committee	Psychology

This form should be completed by Filter Committees for all research project applications in categories A to D (*for categories A, B, and D the University's own application form – RG1a and RG1b – will have been submitted; for category C, the national, or ORECNI, application form will have been submitted).

Where substantial changes are required the Filter Committee should return an application to the Chief Investigator for clarification/amendment; the Filter Committee can reject an application if it is thought to be unethical, inappropriate, incomplete or not valid/viable.

Only when satisfied that its requirements have been met in full and any amendments are complete, the Filter Committee should make one of the following recommendations:

The research proposal is complete, of an appropriate standard and is in

- category A and the study may proceed* (secondary data only) [X]
- category B and the study must be submitted to the University's Research Ethics Committee** Please indicate briefly the reason(s) for this categorisation [ ]
- category C and the study must be submitted to ORECNI along with the necessary supporting materials from the Research Governance Section*** [ ]
- category D and the study must be submitted to the University's Research Ethics Committee** [ ]

Signed: Date: 29.07.20
Chair of Filter Committee

***The application form and this assessment should now be returned to the Chief Investigator. The Filter Committee should retain a copy of the complete set of forms.**

**** The application form and this assessment should now be returned to the Chief Investigator so that he/she can submit the application to the UUREC via the Research Governance section. The Filter Committee should retain a copy of the complete set of forms for their own records.**

***** The application form and this assessment should now be returned to the Chief Investigator so that he/she can prepare for application to a NRES/ORECNI committee. The Filter Committee should retain a copy of the complete set of forms for their own records.**

For all categories, details of the application and review outcome should be minuted using the agreed format and forwarded to the Research Governance section

Please complete the following

The application should be accompanied by an appropriate and favourable Peer Review Report Form (if not, the Filter Committee should be prepared to address this as part of its review). Please comment on the peer review (include whether or not there is evidence that the comments of the peer reviewers have been addressed).

The application was reviewed and approved by the Chair of the FC

Please provide an assessment of all component parts of the application, including questionnaires, interview schedules or outline areas for group discussion/unstructured interviews.

Aims and objectives suited to the data set

Please comment on the consent form and information sheet, in particular the level of language and accessibility.

N/A secondary data only

Please comment on the qualifications of the Chief and other Investigators.

Prof Adamson is a Psychologist with a wealth of experience in the analysis of large secondary datasets and a member of the Psychology RI, Ann Doherty is a PhD Researcher in Psychology

Please comment on the risks present in conducting the study and whether or not they have been addressed.

N/A

Please indicate whether or not the ethical issues have been identified and addressed.

Approval to access and use the dataset has been provided

Please comment on whether or not the subjects are appropriate to the study and the inclusion/exclusion criteria have been identified and listed

Inclusion and exclusion criteria have been identified and are clearly listed in the documentation.

Appendix F: Intermediate Care MAI score change categories

BNF drug subgroup	MAI same or worsened	Incomplete improvement	All medicines in this class improved	Missing MAI score at one time point	N/a Not on this medication
Opioid analgesics	82	14	128	14	294
Osmotic laxatives	135	11	119	20	247
Proton pump inhibitors	161	-	92	18	261
Benzodiazepines	40	3	40	7	442
Stimulant laxatives	64	6	42	7	413
Oral iron	78	-	46	7	401
Non-opioid analgesics	284	1	45	24	178
Drugs used in megaloblastic anaemia	46	3	36	8	439
Z-drugs	23	-	37	4	468
Calcium supplements	155	-	32	11	334

Appendix G: Care Homes MAI score change categories

BNF drug subgroup	MAI same or worsened	Incomplete improvement	All medicines in this class improved	Missing MAI at one time point	Not on this medication class
Osmotic laxatives	503	79	186	7	320
Proton pump inhibitors	296	-	240	7	552
Non-opioid analgesics	670	9	130	8	278
Benzodiazepines	293	22	68	4	708
Opioid analgesics	213	12	119	7	744
Oral iron	146	-	128	5	816
Z drugs	174	1	60	1	859
Megaloblastic anaemia	34	13	68	5	975
Drugs used in bone metabolism	127	-	73	1	894
Second generation antipsychotics	189	2	35	3	866

Note. Incomplete improvement refers to where the participants were on more than one medication within this class and not all medications within this class were improved

Appendix H: Psychoactive medications with no or low endorsement in Intermediate Care data

Several central nervous system BNF drug subgroups showed no endorsement within the intermediate care sample. Thus, these were not examined in Chapter 5. These included:

'hypnotics chloral hydrate', 'hypnotics chlomethiazole', 'sodium oxybate for narcolepsy', 'meprobamate', 'barbituates', 'monoamine oxidase inhibitors', 'CNS stimulants and drugs used for ADHD', 'centrally acting appetite suppressants', 'neurokinin receptor antagonists CNS nausea and vomiting', 'nabilone CNS nausea and vomiting', 'hyoscine CNS nausea and vomiting', '5HT1 receptor agonists', 'prophylaxis of migraine CNS', 'drugs used in status epilepticus', 'drugs used in alcohol dependence' and 'drugs used in opioid dependence'.

Furthermore, a number of drug subgroups showed a low level of endorsement preventing their examination in crosstabulation analyses. These included:

'melatonin', 'buspirone', 'first generation antipsychotics', 'antipsychotic depot injections', 'antimanic drugs', 'lithium', 'orlistat', 'phenothiazines and related drugs for nausea and vomiting', '5HT3 receptor antagonists for nausea and vomiting', 'domperidone and metoclopramide', 'betahistine', 'tolfenamic acid', 'antimuscarinic drugs used in Parkinson's disease' and 'drugs used in essential tremor, chorea, tics and related disorders'.

Appendix I: Psychoactive medications with no or low endorsement in Care Homes data

Several central nervous system BNF drug subgroups showed no endorsement within the care home sample. Thus, these were not examined in Chapter 5. These included:

'hypnotics chlomethiazole', 'sodium oxybate for narcolepsy', 'meprobamate', 'CNS stimulants and drugs used for ADHD', 'orlistat', 'centrally acting appetite suppressants', 'neurokinin receptor antagonists CNS nausea and vomiting', 'nabilone CNS nausea and vomiting', 'tolfenamic acid', '5HT1 receptor agonists', 'ergot alkaloids', 'prophylaxis of migraine CNS', 'drugs used in alcohol dependence' and 'drugs used in opioid dependence'.

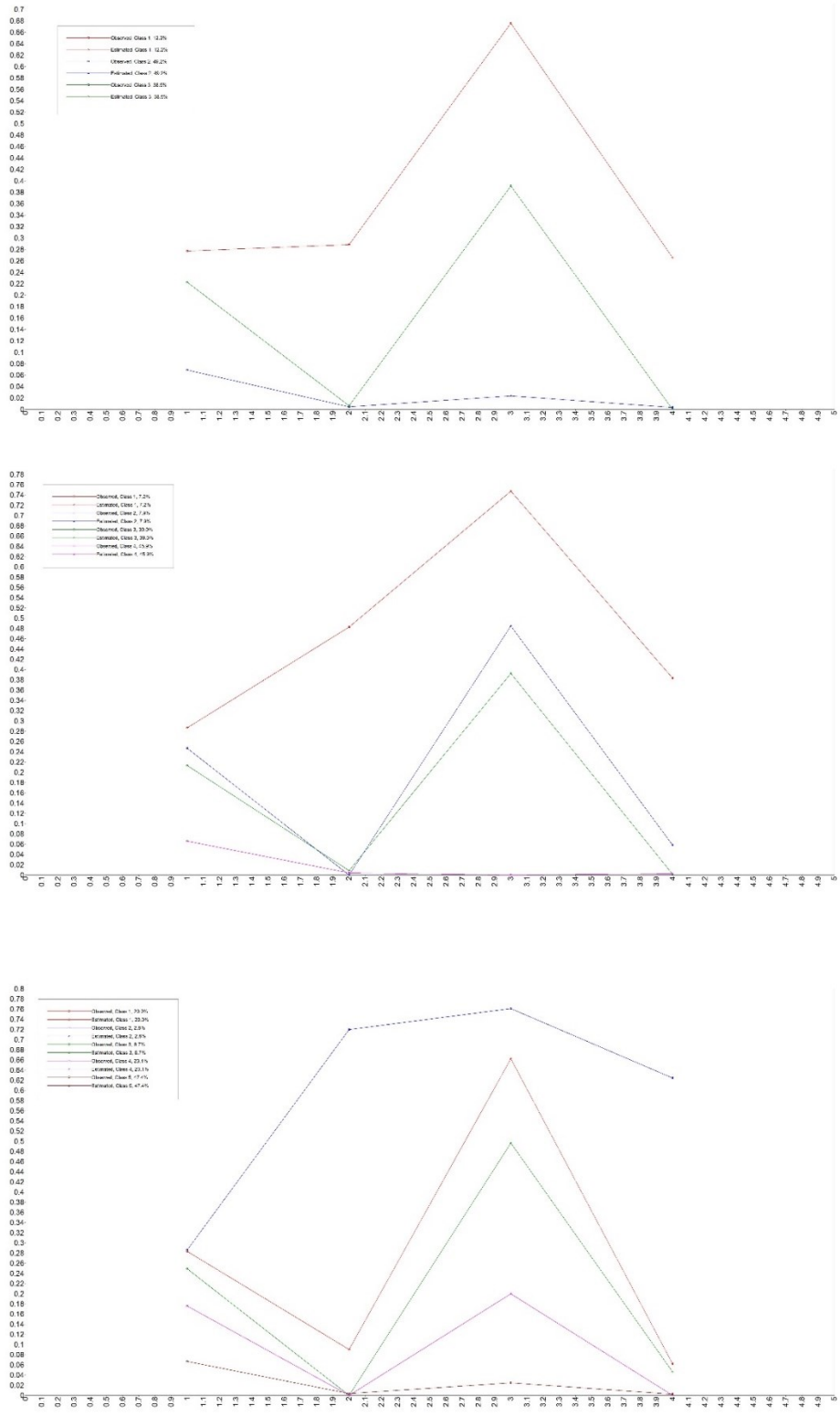
Furthermore, a number of drug subgroups showed a low level of endorsement preventing their examination in crosstabulation analyses. These included:

'hypnotics chloral hydrate', 'melatonin', 'buspirone', 'barbiturates', 'antipsychotic depot injections', 'antimanic drugs', 'lithium', 'monoamine oxidase inhibitors', 'phenothiazines and related drugs for nausea and vomiting', 'hyoscine CNS nausea and vomiting', 'drugs used in status epilepticus', 'drugs used in essential tremor, chorea, tics and related disorders' and 'drugs used in nicotine dependence'.

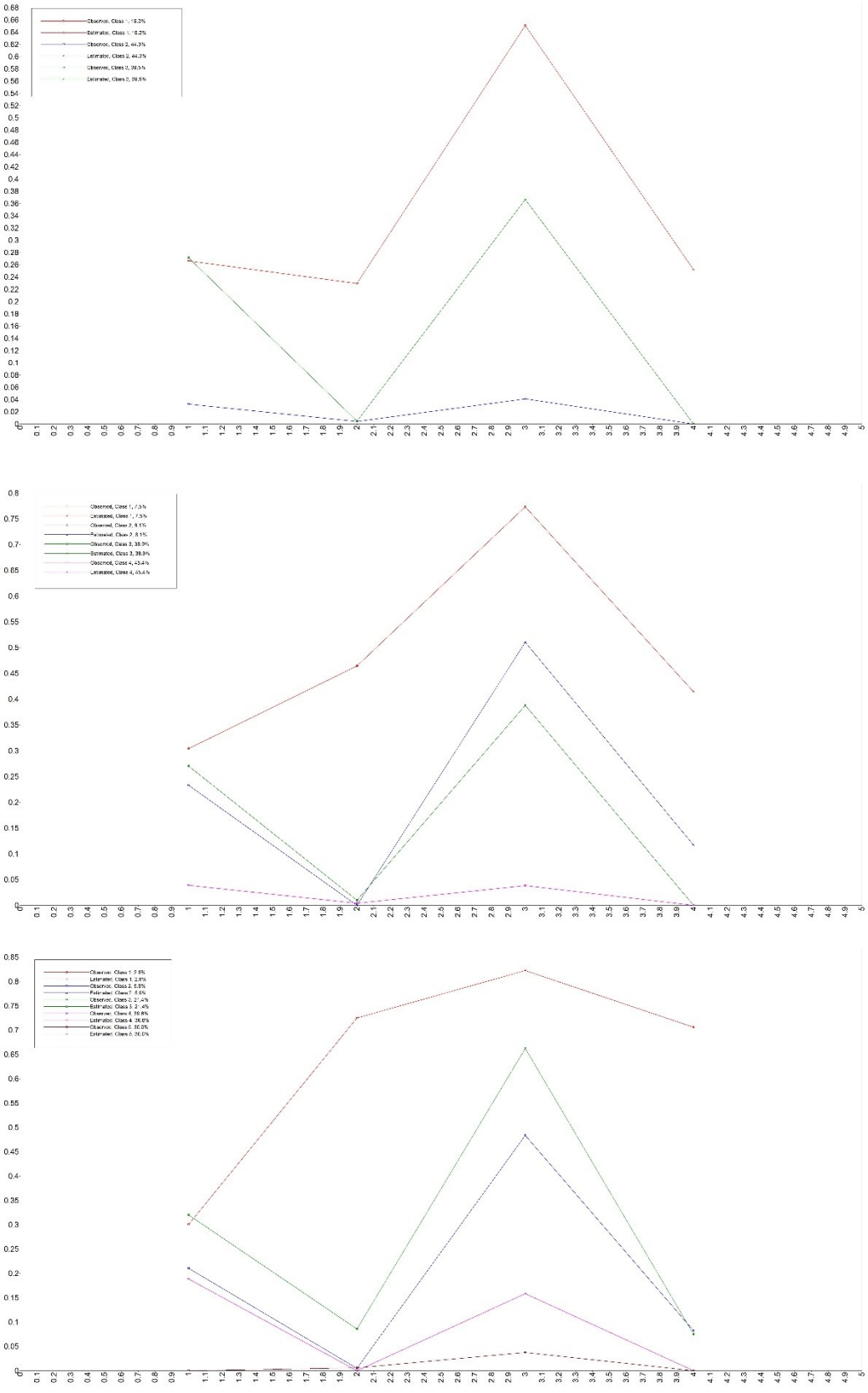
Appendix J: Intermediate Care MAI score change categories for psychoactive medications

BNF drug subgroup	MAI same or worsened	Incomplete improvement	All medicines in this class improved	Missing MAI score at one time point	N/a Not on this medication
Control of the epilepsies	40	-	31	5	456
Antihistamines CNS nausea	17	2	28	6	479
Tricyclic antidepressants	14	-	19	3	496
SSRIs	103	-	20	9	400
Second generation antipsychotics	21	-	7	3	501
Dopaminergic drugs Parkinson's	19	4	3	1	505
Other antidepressants	30	1	3	4	494
Drugs for dementia	26	-	4	-	502

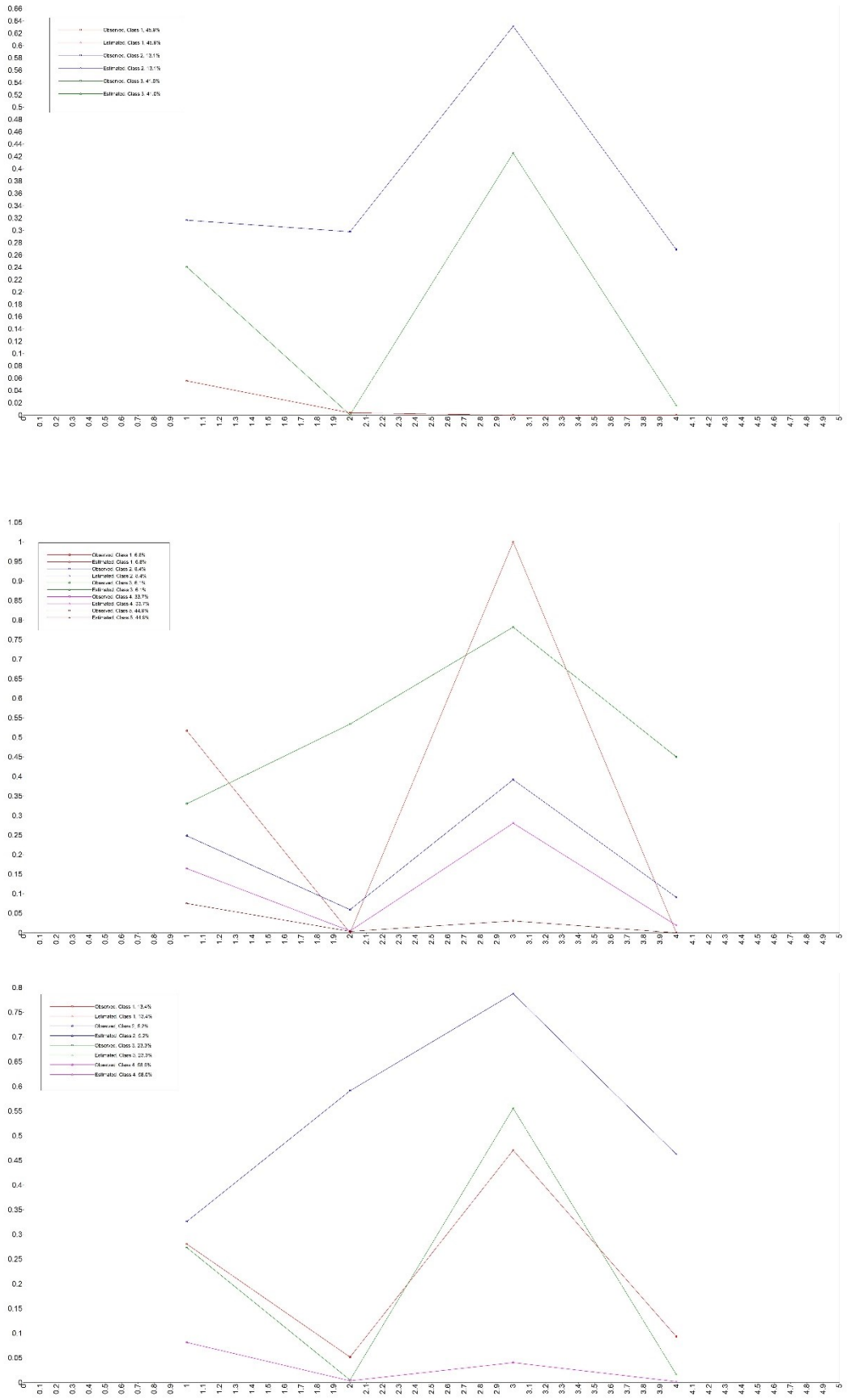
Appendix K: Probability plots for latent class analyses of healthcare utilisation for Waves 1-3



Appendix K- 1: Probability plots for three, four and five class latent class solutions of healthcare utilisation at Wave 1



Appendix K- 2: Probability plots for three, four and five class latent class solutions of healthcare utilisation at Wave 2



Appendix K- 3: Probability plots for three, four and five class latent class solutions of healthcare utilisation at Wave 3

Appendix L: List of publications and conference submissions pertaining to the present thesis

Oral presentations

- Doherty, A., Miller, R., Mallett, J., Shevlin, M., & Adamson, G. (2020) Inappropriate prescribing among older people in intermediate care: prevalence, pharmacist intervention and predictors of improved prescribing. 20th International Conference on Integrated Care, Croatia [*online, Sep*]
- Doherty, A., Miller, R., Mallett, J., Shevlin, M., & Adamson, G. (2020) Healthcare utilisation following pharmacist case management of older people in intermediate care. 20th International Conference on Integrated Care, Croatia [*online, Sep*]

Poster presentations

- Doherty, A., Miller, R., Darcy, C., Friel, A., Mallett, J., Shevlin, M. & Adamson, G. (2020) Medicines optimisation in care homes via pharmacist case management: what is the impact on subsequent healthcare resource usage? Health Services Research and Pharmacy Practice, Cardiff University [online]
- Doherty, A., et al., (2018) Targeting pharmacist case management medicines optimisation outreach services to care homes. 78th International Pharmaceutical Federation (FIP) World Congress of Pharmacy and Pharmaceutical Sciences, Glasgow. Shortlisted for the Hospital Pharmacy Section distinguished poster award.[5]

Published abstracts

- Doherty, A., Miller, R., Darcy, C., Friel, A., Mallett, J., Shevlin, M. & Adamson, G. (2020) Medicines optimisation in care homes via pharmacist case management: what is the impact on subsequent healthcare resource usage?, *International Journal of Pharmacy Practice*, 28, S1, p. 73 74 p. [Health Services Research and Pharmacy Practice, Cardiff University abstract]
- Doherty, A., Miller, R., Mallett, J., Shevlin, M., & Adamson, G. (2020) Healthcare resource usage following medicines optimisation and pharmacist case management within Northern Irish care homes, *International Journal of Pharmacy Practice,* S2, p. 10 [Royal Pharmaceutical Society Science and Research Summit, London abstract]

[5] Service development piece conducted in a complementary dataset. Not presented in the present thesis.