The impact of frontloading the provision of patient orientated pharmacy services in the acute medical unit on the same service provision in the first seventy two hours following transfer to a medical ward

A thesis submitted to The University of Manchester for the degree of Master of Philosophy (MPhil) in the Faculty of Human and Medical Sciences

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ABSTRACT

Introduction

A hospital providing acute medical care to adults is now expected to have an acute medical unit (AMU). This is true of health service systems both in the UK and worldwide. Nationally the AMU is modelled as the hub around which acute medical service provision is provided throughout hospital organisations[1]. Problems with medicines are recognised as a contributory factor in a significant proportion of acute medical admissions and pharmacy clinical service provision (for example, medicines reconciliation) is acknowledged as being of value in supporting the attainment of optimal service outcomes. There is, however, little published research that looks at how pharmacy services in the AMU are provided.

Aims

The programme of work has two aims. The first describes how pharmacy clinical service provision differs between the AMU and the medical wards. The second reports the impact of a front-loaded model of clinical service provision onto the AMU upon the subsequent need for pharmacy clinical service in the first 72 hours following transfer to a medical ward.

Method

This work used a cohort method to capture self-reported clinical service activity by pharmacy staff on the AMU and medical wards over three discrete periods of time. Patients moving from the AMU to the wards during the data collection were further investigated to determine the impact of AMU interventions by pharmacy staff on the subsequent need for similar intervention following ward transfer.

Results

The data collected successfully demonstrates that there are quantitative differences in the activity content of pharmacy clinical service provision between the AMU and the wards. Differences were seen with regard to a number of different aspects of service provision and also between the activity of pharmacists and pharmacy technicians. Additionally, data collected described differences in workload factors likely to influence the provision of pharmacy clinical services. Front-loading pharmacy services into the AMU is suggested to have advantages in enabling earlier identification of errors, earlier ordering of medicines, earlier medicines reconciliation.

This is achieved without increasing the overall time spent upon providing services. This intuitively suggests that medicines use is likely to be safer and more effective across the course of the admission.

Conclusions

The findings of this research suggest that the front-loaded model of care has clinical value for patients in terms of the prompt control of risk without detriment to service provision in terms of increased need for input by pharmacy staff. Service provision differs between the AMU and the wards and an understanding of this variation in the context of clinical workload will inform service design and lead to the implementation of service models equipped to attain required performance levels without creating an unsafe or unnecessarily pressurised working environment.

DECLARATION

The University of Manchester

Master of Philosophy Candidate Declaration

Candidate name: Stephen Michael Gillibrand

Student ID Number: 5528932

Faculty: Human and Medical Sciences

Thesis Title: The impact of frontloading the provision of patient orientated pharmacy services in the acute medical unit on the same service provision in the first seventy two hours following transfer to a medical ward

Declaration:

The nature and extent of the candidate's contribution to the submitted publications are as stated below:

Paper 1: Gillibrand SM, Scanlan JC, Tully MP. *Variation in patient-facing clinical service provision by pharmacy staff on an acute medical unit and acute medical wards in a UK teaching hospital*. To be submitted to the International Journal of Pharmacy Practice.

Paper 2: Gillibrand SM, Scanlan JC, Tully MP. *Optimising pharmaceutical care - front-loading pharmacy clinical services onto an acute medical unit*. To be submitted to The Annals of Pharmacotherapy.

The candidate planned and designed the programme of work, collected and analysed the data and wrote the papers. Mary Tully and Justine Scanlan supervised and guided the candidate.

All the work presented in this thesis has been completed whilst the candidate has been a post-graduate student at this University.

None of the work presented has been submitted in support of a successful or pending application for any degree or qualification of this or any other University or of any professional or learned body

I confirm that this is a true statement and that, subject to any comments above, the submission is my own original work.

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DEDICATION

To Karen, Katherine, Thomas, Joseph and Isaac – my circle of strength, founded on faith, joined in love, kept by God.

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About the Candidate

I obtained a BPharm(Hons) from Bradford University in 1988 and then worked for Salford Area Health Authority at Hope Hospital until 1992 as first a basic grade and then a resident pharmacist. Following this, I worked as a community pharmacist until 2001 when I returned to Salford Royal NHS Foundation Trust to manage the out-patient pharmacy. Whilst doing this I completed my Post-Graduate Diploma in Clinical and Health Services Pharmacy at the University of Manchester. Remaining at Salford Royal, since 2004, I have worked as a Clinical Pharmacist specialising in Ageing and Complex Medicine and Clinical Audit.

This research has been conducted part time over a three year period. A one day per week release from work was allowed for the first two years. All other time input has been my own and my third, writing-up, year was self-funded whilst working full-time.

GLOSSARY OF TERMINOLOGY

Acute Medicine

The medical speciality trained to provide coordinated care for acutely unwell adults who are medically rather than surgically unwell.

Acute Medical Unit

A clinical area providing immediate care for acutely, medically (as opposed to surgically), unwell adults. The acute medical unit is managed by Acute Physicians and provides care for up to 72 hours, according to local policy, after which people are discharged or transferred to another ward. Admissions are usually taken from the Emergency Department or by direct GP referral.

Acute Physician

A practitioner of acute medicine. Trained to consultant level in both acute medicine and a sub-speciality, for example geriatric medicine.

Ambulatory Emergency Care

A discrete area within the Acute Medical Unit that provides care for and observation of acutely unwell adults who are expected to be discharged from hospital within 24 hours of admission.

American Society of Health-System Pharmacists

The US national professional organisation for pharmacists and pharmacy technicians

Emergency Department

A clinical area providing for the triage and emergency care of unwell adults and children. Managed by an Emergency Care Consultant Team. Admissions may self-present or arrive by ambulance.

Frontloading

For the purpose of this thesis a concept of concentrating a disproportionate amount of limited staff time into a clinical area to achieve critical pharmacy clinical service interventions promptly following admission to maximise their clinical impact.

General Medical Council

In the United Kingdom, the regulatory body for doctors.

General Pharmaceutical Council

In the United Kingdom, the regulatory body for Pharmacists

General Practitioner

A registered medical professional who specialises in providing community based general medical services.

National Health Service

The healthcare system that operates in the United Kingdom. It is funded through taxation and is largely free at point of care.

Nursing and Midwifery Council

In the United Kingdom, the regulatory body for Nurses and Midwives.

Royal College of Physicians

In the United Kingdom, the professional representative body for doctors

Royal Pharmaceutical Society

In the United Kingdom, the professional representative body for pharmacists and pharmacy technicians

Society for Acute Medicine

A professional association focussing upon how best to provide acute medical services. An aspect of this is the role of healthcare professionals working in acute medicine.

ABBREVIATIONS

AEC: Ambulatory Emergency care

AFC: Agenda for Change

AMU: Acute Medical Unit

ASHP: American Society of Health-System Pharmacists ED: Emergency department

DoH: Department of Health

EPR: Electronic Patient record

EPMAR: Electronic prescribing and medication administration record

EWTR: European Working time Regulations

GP: General Practitioner

NHS: National Health Service

NMC: Nursing and |Midwifery Council

RCP: Royal College of Physicians

RSPGB: Royal Pharmaceutical society

SAM: Society for Acute Medicine

UK: United Kingdom

CHAPTER ONE: LITERATURE SEARCH

1.1 Introduction

Acute medicine is the most rapidly growing medical specialism in the UK. A census in 2010 showed a 27% increase in consultant numbers, nearly five times the average national rate for other medical specialities[2]. The need for this development was part of a paradigm shift in the 2000s in recognising the need for streamlined organisational approaches to patient management from emergency department presentation to eventual discharge in order to optimise both the use of available resources and patient health outcomes. Each of these should in turn be fully integrated with coordinated ongoing care in the community to optimise recovery and reduce unplanned readmissions. Acute Medical Units (AMU), or their synonymous equivalents, are now seen in the majority of UK hospitals that admit people who are acutely medically unwell[3]. This model of care has also been widely implemented beyond the UK across most major national healthcare systems[4].

In order for the AMU to function effectively and achieve its intended service benefits and health outcomes it is critical that rapid access to supporting clinical services, pharmacy included, is available[5]. A major challenge for these services is adapting to the unique service needs of the AMU that arise from its rapid patient turnover rate, patient profile (in terms of both complexity and need) and 24 hour, 7 day per week activity.

Medicines related harm is a contributing factor to a significant proportion of acute medical admissions and further harm due to prescribing and administration errors post-admission are recognised as contributing to sub-optimal outcomes such as prolonged length of stay with its attendant risk of harm from, for example, healthcare related infection or venous thromboembolism[6,7,8]. Intuitively therefore pharmacy has a key role to play in supporting the effective function of the AMU team in providing optimised, harm-free patient care. This has to be achieved however, within the context of the plethora of demands that the hospital service places on its pharmacy service.

1.2 Literature search

To begin our journey to research the provision of pharmacy clinical services into the AMU and their impact a literature search was conducted using the Ovid Medline®, Ovid Embase®, EBSCO CINAHL® and International Pharmacy Abstracts®

databases. The initial search terms applied were 'acute medical unit*' and synonymous terms. This yielded the results shown in table 1 below.

The '*' acts as a truncation indicator for the search engine and it will return results that contain the stated text as a stem. For example 'acute medical unit*' will also return 'acute medical units'.

Table 1: Summary of the number of items identified in the literature search

Search term	Medline	Embase	International Pharmacy Abstracts	CINAHL
Acute medical unit	30	52	1	39
Medical admissions unit	15	24	3	40
Emergency admissions unit	2	3	0	7
Emergency medical unit	6	11	1	12
Acute medical admissions unit	10	13	1	11
Medical assessment unit	14	25	3	38
Acute assessment unit	5	11	0	17
Rapid assessment medical unit	0	1	0	2

The search term 'pharm*' was then added to the above searches to specifically look for papers relating to pharmaceutical activity. Papers identified were subject to an abstract review to assess their relevance to the project. Suitable papers had their references and citations checked for further relevant literature not found in the initial searches. Papers thus identified were reviewed and any content considered relevant to the research was summarised.

'Front-loading' in the context of this study proved difficult to find any references for in the standard databases and therefore a search using the Google® and Google Scholar® search engines was made to try to find publications from a wider range of sources. The Health Management Information Consortium, PyschInfo, Social Policy and Practice, Allied and Complementary Medicine and Econlit databases were also checked but did not yield any relevant papers not found in the initial database searches.

1.3 Strategic and operational guidelines

The need for organisations to implement the use of an AMU to provide acute medical services has been the subject of national guidelines and recommendations since 2002. As a corpus of work they provide a framework for the implementation and operation of AMU based services in UK hospitals. The literature search identified a number of these that are summarised in table 2 below:

Table 2: National guidelines identified during the literature search.

Authoring body	Title	Year	Relevant content
The Royal College of Physicians	The interface between accident and emergency medicine and acute medicine	2002	Provides 19 recommendations regarding the emergency management of people with acute medical illness
	Acute medicines making it work for patients. A blueprint for organisation and training	2004	Provides 23 recommendations regarding the establishment of an acute medical service and how it should dovetail with Emergency and Critical care provision at the same site
	Acute medical care: The right person, in the right setting – First time	2007	Provides guidance upon the best ways to deliver excellence in the provision of acute medical care
	Consensus statement on acute medicine	2008	Provides guidance upon the best ways to deliver acute medical care and what education and training will best support this.
	An evaluation of consultant input into acute medical admissions management in England, Wales and Northern Ireland	2010	Provides audit data on current acute medical service provision and its associated outcomes. Recommendations are made upon how best to model services an required levels of senior medical staffing
	Acute internal medicine and general internal medicine	2011	Provides recommendations upon the provision of acute medical care but also on how general medical care should be modelled to work alongside this
Future Hospitals Commission	Future Hospital: Caring for Medical patients	2013	Provides recommendations for best practice in the establishment of the whole process of care for medical admissions to secondary care. Acute medicine and the AMU are central to the proposed best method of working.

CHAPTER TWO: LITERATURE REVIEW

2.1 Acute medicine

2.1.1 The development of the current situation

The recognition of the need for the model of secondary healthcare provision for the acutely unwell adult that is now known as acute medicine arose from identified deficiencies in the way that acute medical care was being delivered both nationally and internationally in the late 1990s. At that time people with acute medical illness would present to the emergency department either by ambulance or self-presentation. Such attendance was either self-initiated or as a GP referral. Following triage and medical stabilisation emergency department staff would be tasked with facilitating the admission of people with acute medical illness requiring further medical management to a sub-specialist medical ward. This process was associated with a number of problems. The underlying model of care was that the person should be admitted to a bed on a ward where the clinical team would be most able to manage the primary system dysfunction with which the person had presented. For example, a patient with heart failure should be admitted to a cardiology ward, or a patient with chronic obstructive pulmonary disease should be admitted to a respiratory ward. However the multi-morbid nature of many people with acute medical illness frequently requires the simultaneous management of more than one organ system. Thus the team under which the person was admitted might not have had the necessary experience, knowledge and skills to optimally manage the acute phase of illness (such as heart failure and chronic obstructive pulmonary disease without using the support of other teams within the hospital. This situation often led to difficulties in the effective coordination of care and inability to access services at the time when they were most needed in order to provide the person with maximal benefit in terms of both quality of care and health outcome[9]. A major consideration in this poorly coordinated model of care related to how patients moved through the healthcare system and a lack of understanding thereof.

2.1.2 Bed management and patient flow

Up until the late 1990s and early 2000s clinical teams would organise admissions and discharges with little consideration of wider organisational impact upon patient flow. This led to frequent ‘bed crises’ defined by Egan as ’situations in which the emergency demand exceeds the capacity of vacant beds’.[10] Synonymous terminologies are ‘overcrowding’ and ’access block’. Although the risks of hospital

bed occupancy rates above 85% (bed crises 'likely') and 95% (bed crises 'very likely') had been identified by Bagust et al in their 1999 paper[11], bed management was poorly organised in UK hospitals at this time. The challenge of effectively managing both whole organisation and specifically ED overcrowding had been identified as problematic by Lynn and Kellerman in 1991[12], a premise supported by Richardson and Mountain[13] in their analysis of the factors leading to 'access block' in 2009 . More widely a major impact of 'bed crises' at organisational level is in the context of a reduced overall bed capacity that has the consequent potential to perpetuate the bed capacity deficit beyond the initial event. Bagust et al described how a single bed crisis could disrupt patient flow and the consequent provision of optimal care at an organisational level for up to fourteen days after the event.[11] Compounding this the pressure arising from increasing admission rates is adding to the pressure on the healthcare system[14]. One of the potential consequences of a 'bed crisis' for patients is, in turn, a prolonged stay in the Emergency Department which is known to carry an attendant risk of increased morbidity and mortality.[15]

2.1.3 Prolonging an Emergency department stay: the risks

The current UK Emergency Department attendance rate is, nationally, over 60,000 attendees per day[16]. This figure is rising. A delay in transfer from the emergency department to a level 3 critical care unit of more than six hours has been shown to be associated with a 17% increase in length of stay ($P<0.001$); 27% increase in mortality during critical care admission ($P<0.01$) and a 35% increase in overall in-hospital mortality ($P<0.01\%$).[17] Similarly for trauma patients it has been calculated that every three minutes spent in the Emergency Department increases mortality risk by 1%.[18] For medical patients, 30 day mortality rates have been shown to increase from 5%, for those with a length of stay in the emergency department of less than 2.5 hours, to 17% when length of stay rises above nine hours ($P<0.001$)[19]. Additionally for every hour spent in the Emergency Department the risk of an in-hospital adverse event increases by 3%.[20] There is thus a clear need to move patients out of the Emergency Department as promptly as possible once it is clinically safe to do so.

2.1.4 Outliers

The need to release emergency department bed capacity led to people with acute medical illness being admitted to 'any empty bed'. This led to their being put under

the care of a clinical team, often surgical, that was under-skilled to effectively manage their health needs. This was termed ‘outlying’ with such people referred to as ‘outliers’. The health disadvantages of outlying have been described by Stowell et al in 2013. Their study of 238 people with a medical admission to a French hospital in 2010 showed a number of health outcome concerns for this patient group. Length of stay was prolonged by an average of 24 hours (8 days [4-15} vs 7 days [4-13]; $p<0.05$). There was a 60% increase in relative risk of readmission within 28 days (27% vs 17%; $p<0.01$). Finally there was a 21% increase in the relative risk (84% vs 48%; $p<0.05$) of not receiving appropriate venous thromboembolism prophylaxis, a key marker of good hospital medical care. The same group also note that despite being of concern this is an under-researched area of practice[8]. Alameda et al researching a cohort of 243 people admitted with a diagnosis of heart failure in Spain in 2006 similarly reported a 2.6 day (95% CI: 0.6-4.7) increase in length of stay for those outlying on other wards[21]. UK based work by Lloyd et al in 2005 described lower levels of important clinical knowledge by nursing staff caring for outlying acute trauma patients in a 220 participant multicentre study[22]. The adverse outcomes associated with bed crises and outlying have been subject to scrutiny in the press and have been focused upon by the Department of Health in policy derivation under several governments.

2.1.5 Healthcare politics

In response to the rising incidence of ‘bed crises’ discussed earlier, the UK Government introduced the ‘four hour wait’ in the NHS plan of 2000.[23] This mandated NHS Acute Trusts to ensure that 98% of all Emergency Department attendees were admitted or discharged within four hours of triage. The consequence of failing to meet this target would be severe financial penalties for the Trust concerned. Although the concept was criticised as putting pressure on Emergency Department staff within 12 months of its implementation the proportion of people meeting the criteria had risen from 52% to 98.2%. Research into why these remaining people did not meet the criteria indicated that complex older patients and poor patient flow were key drivers for delay. There were nearly 3.8million emergency admissions to NHS acute trusts in 2012/13, representing about 17% of total Emergency Department attendances[24]. This represents a 34% increase on the number of admissions in 2004/5 and shows a faster rate of increase than that of

Emergency Department attendances (22% for the same period). The number of acute NHS beds has fallen by 24% in the same period and nationally acute bed occupancy rates are 88%.[25] The 98% target was reduced to 95% in 2010 and service evaluation started to be measured using a broader spectrum of clinical quality indicators produced in collaboration with the College of Emergency Medicine and the Royal College of Nursing.[26]
These are:

- unplanned re-attendance rate (no more than 5%)
- left without being seen (no more than 5%)
- total time spent in the emergency department (less than 5% of patients spend less than four hours in the emergency department)
- time to initial assessment (less than 5% of patients wait less than 15 minutes)
- time to treatment (median figure of less than 60 minutes)

In conjunction with this, admission avoidance by referral to ambulatory care and consultant involvement in high risk cases were also introduced as additional measures of performance.[27] This move has been disputed as retrograde by the Society of Acute Medicine on the grounds that collected data shows that the four hour wait target improved clinical performance with the majority of cases that breach the four hour target doing so because of non-clinical factors.[28] The idea has subsequently been adopted outside of the UK and literature to support it's positive effects upon performance have been forthcoming[19, 29] . Recent figures from the UK Governments Department of Health show that the NHS is currently achieving a 93.6% rate for Emergency Department attendees to be seen within four hours of presentation (compared to 98.3% five years ago)[16]. Although this is no longer the sole performance measure utilised in assessing emergency department performance it retains a powerful place in the public consciousness and is often reported in the press. Interestingly by 2010/11 the number of patients waiting in an NHS emergency department for more than four hours had fallen by 48% from the figure for 2004/5 representing a reduction of over 300,000 cases per annum in absolute terms.[25] Since 2010/11 however the same figure has risen by 155% in three years and now exceeds the 2004/5 figure by 32%.[25] The argument has been proposed that many of these people are admitted for less than 24 hours and may thus represent

‘inappropriate admissions’ pushed through the system to avoid breaching the four hour target.[30] This has been countered by the suggestion that short stays and rapid discharge may actually represent improved clinical management of patients who would previously been admitted for a longer period.[28]

In addition to these politically mediated clinical targets the implementation of the European Working Time Directive into NHS services in 2009 reduced junior doctor working hours to an average of 48 per week[31]. This was coupled with the introduction of Agenda for Change in 2004 which redesigned non-medical pay arrangements and introduced the infrastructure for more flexible, performance related working practices and remuneration[32]. Both of these initiatives provided further stimulus for service redesign. Between 2004/5 and 2012/13 Emergency Department attendances rose almost 22% from 17.8million to 21.7million.[25] It has been argued that this is in significant part due to the inadequate funding and organisation of facilities to manage acute medical illness within the primary care setting especially outside of ‘office’ hours, leading to a pressurised system with poor patient flow.[33] This is our next consideration.

2.1.6 Community-based healthcare provision

Current thinking upon healthcare organisation promotes integrated hospital and community based services (and ideally include social care as well) in order to optimise health outcomes and resource consumption[34]. Unfortunately the vision for the development of community based care to support this described in ‘Our health, Our care, Our say: a new direction for community services’, has largely yet to be realised with only five years of its timescale remaining[35].

Following the publication of the Carson Report in 2000[36] – (a review of GP out-of-hours cover conducted on behalf of the Department of Health), GPs were given the option to opt out providing out-of-hours services from 2004 onwards. This option has been taken up by at least 90% of GP practices. As of 2013 the responsibility for providing out-of-hours healthcare in UK primary care lies with Clinical Commissioning Groups (these replaced Primary Care Trusts, who had held this responsibility since its inception, under the provisions of the Health and Social Care Act of 2012)[37]. The National Audit Office reported in 2014 that it could not provide assurance about the value for money of out of hours services in relation to either performance or integration with the NHS 111or emergency department services[38].

Further to this they specifically note that many societal groups find the way that these services are organised difficult to understand with a consequent tendency to inappropriately access Emergency Department services as an alternative. This point is important in the context of a nearly 22% rise (17.8million to 21.7million) in UK emergency department attendances between 2004/5 and 2012/13[23]. These emergency department attendances by older people are disproportionate in their prevalence to the societal prevalence of this age group. It is therefore important to consider the impact of older people on the provision of acute medical care.

2.1.7 The ageing population

Improving health and social care in the UK since the inception of the NHS in 1948 has seen the proportion of the population living beyond their 65th birthday rise from 52% to 86%[39, 40]. Coupled with this the prevalence of people aged over 85 years in the same population has doubled since 1980[39, 40]. Although societal change has contributed to people in old age being able to live healthier, more content and more productive lives increasing age carries an ever present risk of ill-health that is far more likely to manifest in frailty, disability and complicated co-morbid illnesses in this age group. Older people consume over half of the UK's spending on adult social care and nearly three-quarters of the expenditure on prescribed medicines in primary care[39, 40]. Societally, healthcare in the UK has evolved to focus upon the management of the single-organ morbidities most prevalent in the middle aged strata of society. This is clearly out of step with the current need to optimise care for the complex multi-morbid person who is often in the older age strata[41]. Healthcare research on the common illnesses of older people is known to be lacking whilst the underfunding of this area relative to that seen for cancer and cardiovascular conditions is all too obvious[42]. Older people account for a high proportion of emergency department attendances relative to their prevalence in the general population and are subsequently five times more likely to be admitted to hospital and to stay in for longer[39, 40]. Older people are also more likely to be taking larger numbers of prescribed medicines than their younger counterparts[43]. The National Patient Safety Agency and National Institute for Clinical Excellence reported in 2007 that 80% of persons aged over 75 years took at least one prescribed medicine whilst 36% of the same population were prescribed four or more medicines[44]. Partly as a consequence of this they are more likely to experience medicines related harms and

prescribing errors[45]. When this ensues, older people have been shown to experience worse health outcomes as a result[45]. Polypharmacy and multi-morbidity are two of the factors that significantly contribute to the complex nature of health provision for older people[43]. It is also known however that the way that healthcare in the UK is currently modelled does not address these needs[40]. Although specific data upon acute care of the elderly bed occupancy rate is no longer collected by the National Office for Statistics, it is worthwhile noting that occupancy of these beds was historically about 7% higher than the acute, non-geriatric occupancy rate.[25] Also between 2004/5 and 2009/10 (the final year of separate data collection) the number of general and acute beds (non-geriatric) fell by 8% whilst the number of general and acute geriatric beds fell by 22%.[25] While it is recognised that secondary care geriatric medicine services frequently provide high quality care for the frail older person however extending this quality of care into the community and, in particular, recognising prodromal indicators of incipient frailty over a period of many years is a significant challenge for healthcare providers in the 21st century[46]. It is noted therefore the way that older people impact upon acute medical care. As major consumers of medicines they are, as a group, more likely to experience medicines related harms that may lead to hospital admission or be subject to prescribing errors whilst admitted to hospital.

2.1.8 Prescribed medicines

The prescribing of medication is one of the most prevalent healthcare interventions but is also associated with a high risk of resultant patient harm.[47] Drug/drug; drug/disease, drug/patient reactions have all been identified as possible sources of patient harm. Mirroring this, errors of omission, not prescribing something that the patient should be taking, are also common. Indeed 'medicines incidents' were shown to account for over 72,000 healthcare incident reports to the National Patient Safety Agency's National Reporting and Learning Service in 2007.[45] Furthermore, the EQUIP study, conducted in 2009 at 19 acute Trusts situated in the northwest of England demonstrated a prevalence of 8.9 errors per 100 medicine orders across nearly 125,000 such orders.[7] Further to this, the early stages of a hospital admission, when the patient is acutely unwell and may be most susceptible to harm from the sudden, inadvertent, omission of a regular medication that they were previously taking, has been identified as a high risk time for prescribing errors. The same study

showed a 13.4% prevalence of error for at admission medicines orders compared with a 7.6% prevalence for orders prepared later in the admission.[7]
The central role of pharmacists and technicians in reducing the risk of patient harm by identifying these errors is well recognised.[7, 48 49] Medication errors were estimated, in 2009, to cost the NHS more than £637million per annum and this figure was felt by that research team to be in line with published costings produced for US and European populations.[50] The same team also estimated that on any day some 8,000 NHS beds (6% of the total UK NHS bed capacity) would be occupied as a consequence of an adverse drug event.[50] The analysis of re-admission data by Pirmohammed et al in 2004 demonstrated a 6% avoidable re-admission rate due to preventable adverse reactions to medicines[6]. We have already discussed how bed management is a key factor in maintaining patient flow through the Emergency Department and AMU and it is clear that releasing a significant proportion of this number of beds on any day would have the potential to impact hugely upon organisational patient flow. An additional factor relating to this is the waste of financial resources due to incorrect or non-use of prescribed medicines. The York Health Economics Consortium in conjunction with University College London have demonstrated that some £150million per annum of preventable medicines wastage occurs in primary care alone[51]. Clearly the factors that have driven the development of acute medicine in the UK are also likely to be relevant in other healthcare systems worldwide and these are now considered.

2.1.9 Beyond the UK

Budnitz et al have studied almost 950,000 US emergency department attendances in a 2 year national surveillance programme. This has demonstrated that 2.3% of cases were attributed to an adverse medication event and that the subsequent admission rate for these cases was 16% compared with 6.5% for cases of unintentional injury.[52] Moreover researchers looking at retrospective adverse drug reaction data in the US over a thirty year period found a steady incidence of occurrence and concluded that mortality due to adverse drug reactions was the fourth most common cause of death at the upper confidence limit of their data.[53] This is concerning as the definition of an adverse drug reaction, ‘an appreciably harmful or unpleasant reaction, resulting from an intervention related to the use of a medicinal product’, as given by the World Health Organisation, does not include prescribing, administration or non-adherence

related incidents and thus under reports the types of errors that can occur within healthcare.[53, 54] It is unsurprising therefore that given the similar underlying problems being encountered the concept of acute medicine is not limited to the UK. European, Australasian and South East Asian healthcare systems have all adopted the underlying philosophy of care and have indeed generated a considerable proportion of the research literature relating to this area[4, 55]. In the US and subsequently Canadian health-care systems the model of care that has developed is similar but not identical. Increasing complexity, reduced working hours for trainees and an unwillingness of primary care physicians to leave profitable primary care activity to spend time managing people admitted to hospital has led to the development of the specialism termed 'Hospitalist'[56]. This role differs from that of the Acute Physician in the UK in that the Hospitalist retains overall responsibility for the management and coordination of the patients care throughout their hospital stay and is tasked with overseeing their transfer of care at discharge. Hospitalism is the fastest growing speciality in medicine in the US. Practitioners tend to have a strong position in quality improvement and service development within their organisations[55, 57, 58] As with AMU services elsewhere, literature regarding the outcome benefits of the Hospitalist function are limited, but have been demonstrated in the context of reduced length of stay, reduced healthcare costs and reduced in-hospital mortality[59].

2.1.10 Implementation of the acute medical unit

Current thinking on the present and future modelling of medical services within the secondary care environment in the UK eschews the practice of acute medicine by acute physicians within an 'Acute Hub'[1]. This would be a key area within which the AMU is located. The AMU may also be synonymously known as the Emergency Admissions Unit, Emergency Medical Admissions Unit, Medical Admissions Unit, Medical Assessment Unit, Acute Assessment Unit and Rapid Assessment Medical Unit. For the purposes of this study the term AMU will be used as this is the preferred terminology of both the Royal College of Physicians and the Society of Acute Medicine, the professional body of Acute Medicine. In addition to the AMU it is also suggested that the acute hub should contain an Ambulatory Care Unit providing for the acute management of patients not requiring an overnight stay in hospital. Much of the issue here may lie in encouraging emergency department and AMU teams to work in a more integrated manner that encourages the development of

clinical systems tailored to suit the needs of both specialities[60]. Despite ten years of development in UK hospitals audit work in 2012 showed that across 22 trusts in the northwest of England only 2 of 19 practice standards, benchmarked against Royal College Physicians and Society of Acute Medicine guidelines, achieved 80% attainment. Concerns were raised around facilities, service provision and staffing levels[61]. Given this less than optimal performance in implementing acute medical services what evidence is there to demonstrate health outcome benefits for patients and the organisations providing their care?

2.1.11 Outcomes

Despite global implementation the literature for acute medicine is limited and heterogeneous in structure. Scott et al conducted a literature review from which they concluded that the evidence for the clinical benefit of the AMU was 'positive' in nature[9]. They went on to say however that it was 'difficult ' to draw meaningful conclusions about the outcomes of providing AMU services due to this limited literature base. Byrne and Silke drew similar conclusions following their own literature review[4].

Mortality is the outcome measure of whether a patient dies either during admission or within a specified period post-discharge. In-hospital, all cause, mortality has been shown to fall from 12.6% to 7% ($P<0.0001$) over a four year period and all-cause mortality up to 30 days post discharge from 8.8% to 5.6% ($P<0.0001$) for the same patient group.[4, 62]

Readmission rate, the process measure of the number of unplanned readmissions of patients within a specified time period post discharge, have been reported as unchanged by Moloney et al and Moore et al and as reduced in absolute terms by 7% by Wanklyn et al.[9] It is important to note that this is being seen within the context of increasing patient numbers and increasing co-morbidity, complexity and severity of illness at admission.[4] Consequently the implication is that AMUs are not prematurely discharging people, a balancing concern relating to this model of care.

Length of stay, the process measure of how long a patient stays in hospital following admission, has been shown to be reduced from 6 to 5 days ($P<0.0001$) in an Irish population and from 9.3 to 7.8 days ($P=0.03$) in a cohort of over 3,000 UK acute medical admissions to a single AMU over a 12 month period.[4, 63]

Numbers of patients waiting in the Emergency Department for a bed to be admitted to also fell from a mean average of 14 to 2 (P<0.0001) over a four year period in a study of 33,000 presentations to an Irish Emergency Department. In association with this there was a 30% fall in patients waiting more than four hours in the Emergency Department.[4]

2.1.12 Conclusions

Acute medicine provides the hospital with a conduit through which it should be better able to manage patient care and patient flow during the first 48 to 72 hours of hospital admission[4]. Additionally a clear interface between the emergency department and acute medical functions of the hospital allows for more effective bed-management and patient flow through the latter area[24]. Acute medicine services are provided by acute physicians who, in addition to their clinical skills are trained in the coordination of the care of the acutely unwell medical patient. This may involve in-reach services from multiple other clinical teams medical, therapy and clinical support, including pharmacy[1]. Thus acute medicine is conceptually similar to emergency medicine in being a speciality focussed on all of the needs of people at a particular point of care and not on an organ system, disease type or demographic group. The skill set of the AMU clinical team is therefore in the 'comprehensive assessment and management of the acutely unwell adult who may have multiple organ system deficits'[60]. This contrasts with the other medical specialities used to dealing with acute and chronic single organ system problems. The exception to this is geriatric medicine where the long established 'comprehensive geriatric assessment' model of care provides a similar skill set to that seen in the AMU team[64]. This is an important point as embedded geriatric medicine support has been shown to augment the performance of the AMU given the high proportion of complex elderly patients seen within the patient cohort admitted to the AMU[65]. Acute medicine developed, in part, as a solution to a failing model of care. It has developed from this and is now central to thinking on how best to model the provision of acute care for medical patients in the 21st century. Unfortunately, although standards of practice have been developed the implementation of the concept is often moulded to local need and the service is frequently not able to function as effectively as it was intended.

2.2 Pharmacy clinical services

2.2.1 Introduction

The NHS Constitution gives UK citizens legal rights regarding the quality of care that they can expect to receive whilst under NHS care[66]. This includes specific rights regarding medicines. Professional ethics require pharmacists to 'take action to protect the well-being of patients and the public'[67]. Domain 5 of the NHS Outcomes Framework relates to patient safety and requires that patients are 'treated and cared for in a safe environment and protected from avoidable harm'[68]. It is known that approximately 1 in 20 of people admitted to hospital will be exposed to an avoidable adverse event[69]. Within this group research has shown that older people are more likely to experience adverse events leading to severe harm or death[70]. Although the prescribing, supply and administration of medicines are one of the most common care pathways utilised in secondary care the process is also known to be a common source of error and is consequently attributed as a causative factor leading to many incidents of avoidable exposure to risk and even harm[71]. In order to optimise systematic control of these sources of error the role of the pharmacist is acknowledged to be of key importance.

2.2.2 Economic evaluation of clinical pharmacy services

Clinical pharmacy services have been economically evaluated within a number of healthcare systems. Analysis of the 'All Wales interventions database' using a notional cost model demonstrated a £47million per annum cost avoidance for the NHS across eighteen hospitals[150]. Research from Ireland by Gallagher et al, showed a €708,221 cost avoidance over 12 months in one hospital with a benefit:cost of 8.64:1 (Euro)[151]. US research has demonstrated reduced mortality attributed to clinical pharmacy intervention and benefit:cost ratio of 4.81: 1 (USD)[152,153]. Despite these times of financial pressure it should be noted that both deRijdt and Touchette have separately identified a declining prevalence of this type of research being published[154,155]. Whilst this may reflect clinical pharmacy services becoming more accepted in the mainstream, memory is short and we should not forget Avron's observation of the low visibility and appreciation of pharmacies real value in the wider healthcare system: 'a surgeon who repairs a ruptured AAA is a hero but the pharmacist who prevents a prescribed penicillin being given to a patient with known anaphylaxis is not accorded the same respect'[156].

2.2.3 Pharmaceutical care

There are four key principles underlying the concept of quality management[41].

- Communication
- Teamwork
- Clear processes with assigned responsibility
- Audit to prompt continuous improvement

Pharmaceutical Care, which is best described as 'the responsible provision of drug therapy for the purpose of achieving definite outcomes that improve the patient's quality of life'[72] might be considered to represent the application of these principles to the use of medicines in healthcare. Medicines use forms only one part of the overall management plan for the patient and as such is the responsibility of the whole multidisciplinary team that assumes responsibility for the delivery of this care. Within this team the pharmacist's accountability lies in the provision of quality assurance for the medicines related aspects of the wider management plan. In providing this assurance a clear understanding of the health outcome goals of the management plan, agreed to by the patient following full discussion with the team is essential. These goals should be clearly documented and wherever possible, measurable[41].

In order to deliver effective pharmaceutical care to patients in a particular clinical context it is necessary to implement a robust, overarching, model of pharmaceutical care with a defined structure and associated processes of care provision. It is implicit within this that the model of care that best serves a particular care environment may not be the same as one that works well in another area. With their legal and moral professional responsibility to protect the public from harm resulting from the use of medicines, pharmacists need to very aware of this requirement for the optimised modelling of pharmaceutical care provision[41].

2.2.4 Medicines management

Whilst the health benefits of medicines used safely are clear, so are the risks of harm when such use is not safe[45]. Attendant to this is the significant cost pressure associated with medicines procurement for all providers of healthcare[73]. Thus clinical and cost-effectiveness are key considerations. 'Medicines management' was defined by the Audit Commission in 2001 as 'encompassing the entire away that medicines are selected, procured, delivered, prescribed, administered and reviewed to optimise

the contribution that medicines make to producing informed and desired outcomes of patient care'[74]. Subsequent to this, safe medicines storage and the management of medicines related waste have also come under the umbrella of this terminology[51,75]. Within this wider concept 'medicines governance' focuses upon the control of medicines related safety and risk management issues at both system and local levels to minimise the risk of error and harm[74]. The effective implementation of medicines management processes are underpinned by evidence based medicine in much of their methodology[76]. This has the effect of reducing the incidence of errors relating to the use of medicines at all stages of care and consequently a reduction in patient harm. Audit evidence of robust assurance of effective medicines management strategy and implementation is a key requirement of external inspection bodies such as the Care Quality Commission and the NHS Litigation Authority.

2.2.5 Medicines reconciliation

The Institute for Healthcare Improvement definition of medicines reconciliation is 'the process of identifying the most accurate list of a patients current medicines and comparing them to the current list in use, recognising any discrepancies and documenting any changes, thus resulting in a complete list of medicines, accurately communicated'[77]. The effective implementation of this three stage process is a key factor in assuring that medicines are used safely when patients experience a change in location of care provision, termed a 'transfer of care'.[78]

The World Health Organisation[79], the National Institute of Clinical Excellence[80] and the Joint Commission on Accreditation of Healthcare Organisations[81] have all produced guidance on how medicines reconciliation should be implemented and that, in acute care situations, it should be fully implemented within 24 hours of transfer of care. It is important however to emphasise that medicines reconciliation can and should be conducted at any transfer of care, not just at admission to hospital[77]. In their 2011 guidance document the Royal Pharmaceutical Society report an incidence of up to 70% for patients experiencing medicines errors at transfers of care[82]. The root cause of these incidents is stated to largely lie in poor communication between health care professionals and with patients and their carers. In turn core principles for both individual and organisational good practice regarding medicines at transfers of care are described. Acute hospitals in the UK have local

performance targets with regard to the completion of medicines reconciliation within agreed time frames from admission. Achieving these is often linked to operational performance targets agreed with local service commissioners and carries a significant financial benefit for the organisation concerned. Medicines reconciliation completion is thus a priority for good clinical and financial performance.

2.2.6 Shared decision making and concordance;

It has been described that up to half of all prescribed medicines are not taken as was intended by the prescriber[83]. The consequences of this are sub-optimal health outcomes and financial waste of medicines supplied but not taken[51]. The reasons behind this non-compliance with prescribed treatment are complex but are frequently found to lie in factors such as the health literacy of the person prescribed the medicines and a lack of involvement and understanding of the wishes of the person by the prescriber when making prescribing decisions about their healthcare[84]. This leads to a management strategy that is not well aligned with the patient's own knowledge and health outcome aspirations[85]. This lack of a shared goal is implicit in poor concordance. Concordance is best described as being in informed agreement with treatment plans and it is a key factor in the subsequent adherence of the person prescribed a medicine in actually taking it correctly over the intended duration of treatment[86,87].

2.2.7 Supported self-management and adherence

While shared decision making between prescribers and their patients is a key factor, maintaining the required levels of adherence is a more multidisciplinary task involving making resources available to the person prescribed medicines, when they require them, in terms of both information and advice to support them in the ongoing self-management of the medicines related aspects of their care[88]. Pharmacists, as experts in the use of medicines, are clearly central to the provision of this essential function. Adherence is the terminology for a patient's actual ongoing taking of prescribed medicines in accordance with the instructions provided by the prescriber[86,87]. As mentioned above adherence rates for prescribed medicines are sub-optimal in most non-managed care environments and contribute significantly to poor health outcomes, polypharmacy and medicines wastage[51, 89]. Indeed it has been discussed that sustainably improving medicines adherence would be one of the long term health interventions most beneficial to the greatest number of patients[90]. It

is known that adherence can be improved when medication regimes are designed in conjunction with the patient and aligned with their health outcome aspirations[85]. Additionally ongoing adherence over time requires patient accessible self-management support facilities to provide information and advice when the patient needs them[88].

2.2.8 Medicines optimisation

Using a composite measure comprising:

- Takes the medicine as prescribed
- Experiences no problems from taking the medicine
- Has been given as much information about the medicine as they want

Research has shown that the majority of people fail to take prescribed medicines correctly, even when these are newly prescribed[89]. Of this group, subsequently over a third of these people will fail to correctly adhere to the correct use of their medicines. In at least half of these cases this action will be a conscious, deliberate act. In response to this medicines optimisation, 'empowering people who take medicines to make the most of them' has been socialised by the Royal Pharmaceutical Society of Great Britain[91].

The seven principles of medicines optimisation are:

- A patient-centred approach
- Understanding the patient's experience
- Evidence based choice of medicines
- The safest possible use of medicines
- Making medicines optimisation part of routine practice
- Aligned measurement and monitoring of medicines optimisation
- Improved patient outcomes

Where medicines management is focussed upon the systems and processes that underlie the provision of pharmaceutical care medicines optimisation focusses upon the people who are the recipients of this care and their health outcomes. The rationale for this is in part the argument that a high quality of care is in itself clinically and cost effective as it maximises the value of both financial and human investment in terms of health outcomes for patients and service providers alike[92]. Given the association of prescribed medicines with adverse health incidents leading to hospital admission the AMU is an obvious place where the application of medicines

optimisation will be of particularly high value. While it is intended that medicines optimisation is the responsibility of all healthcare professionals pharmacists should be seen to be available to provide leadership in ensuring that it is being correctly implemented in clinical practice.

2.2.9 Medicines review

Medicines reconciliation is clearly a central aspect of the medicines optimisation process but leading on from this medicines review is also critical[92]. Medicine review has been defined as 'a structured, critical examination of a patients medicines with the objective of reaching an agreement with the patient about treatment, optimising the impact of medicines, minimising the number of medication related problems and reducing waste'[93]. It is described as a seven step process, comprising:

- The identification of the aims and objectives of care
- The identification of essential medicines
- The identification of non-essential medicines
- Determining how well therapeutic objectives are being achieved
- Determining the presence and risk of adverse reactions to medicines
- Determining the cost-effectiveness of current medicines
- Determining the patients concordance with and adherence to treatment[94]

Medicines review helps to bring the shared care and concordance concepts into the optimisation process, whilst also providing a supported self-management function in the support of adherence. Implemented effectively, this process allows problematic polypharmacy, defined by the Kings Fund as 'the prescribing of multiple medications inappropriately, or where the intended benefit of the medication is not realised'[43] to be addressed. Medicines review can take several forms depending upon clinical context and can, with training, be carried out by any healthcare professional in many situations[95]. Where a high level review is required pharmacists are acknowledged to be the most appropriate people to conduct this as part of an interdisciplinary group[95]. A key factor in medicines review is that, in most cases, it should extensively involve the patient to assure joint understanding of health aspirations, shared decision making, concordance and health outcome alignment[95]. Medicines may be de-prescribed[96] as part of this process which can be supported by tools such as the 'Stopp-Start' and 'No Tears' methodologies[97,98].

There is therefore clearly a need for clinical pharmacy services at ward level. Unfortunately however, pharmacists are a limited resource (the UK pharmacy workforce comprises 50,000 pharmacists and 25,000 technicians some one third of whom work in secondary care) within any healthcare setting as their salary bandings tend to make them an expensive resource[99]. This is coupled with limited literature to demonstrate clear outcome benefits from the implementation of pharmacy services. This situation has helped to drive innovation in how pharmacy departments meet the ever increasing demands upon their staff time.

2.2.10 Clinical checking

The provision of a clinical check for prescribed medicines is an essential clinical activity of pharmacists. The check is essentially a risk assessment by the pharmacist of the likely value to the patient of taking the prescribed medicine in the wider context of, amongst other things, their co-existing morbidities, other prescribed medicines and known allergies and intolerances to medicines. Completing this activity is an essential pre-requisite without which the majority of prescribed medicines for individual patient use will not be issued from the dispensary. The activity carries a high impact, in terms of risk reduction and harm prevention, with regard to the prescribing and administration of medicines. As such it represents an essential patient safety intervention. Such clinical checking of prescribed items is the direct responsibility of a pharmacist in any practice environment and represents a considerable proportion of their clinical workload[100,101]. It is distinct from accuracy checking which is an activity also carried out by suitably trained clinical technicians.

2.2.11 Complexity in healthcare

The underlying philosophy of healthcare provision as to how one identifies illness and then seeks to reactively resolve it, has evolved over many years. Thinking is focussed upon rational deduction with care planning purportedly optimised through the micro-management of individual aspects of the continuum of health and well-being[102-104].

This has led to the conceptualisation of a black box model of healthcare provision elucidated in the field of nosokinetics where the input and output of the healthcare system are well measured but there is little understanding of the ‘black box’ of processes and outcomes that occurs between these two points[105].

In attempting to address this knowledge gap the recognition of healthcare as a complex adaptive system has begun to develop. A complex adaptive system is best understood as one in which the individual components of the system are free to act unpredictably but always remain interconnected. This means that any action, however unpredictable, by one component of the system will change the system context for all of its other components i.e. they will adapt to the change[102-104].

Associated with chaos theory, the fuzzy logic of complex adaptivity is well placed to provide new insight into more effective ways of changing systems and thinking to improve the delivery of care[106]. This relates well to how best to manage the multi-morbid patient cohort, frequently frail and frequently prescribed multiple medicines who are encountered on the AMU[107].

Measuring complexity within the healthcare continuum remains imprecise as it is often a context and perspective dependant concept.

2.2.12 Polypharmacy

Whilst the underlying implication of polypharmacy as a descriptor of inappropriate medicines prescribing has been understood for many years it's clinical utility as a measure has been clouded by the increasing use of multiple medicines in the optimal management of relatively common disease. This is compounded in the multi-morbid population by the need to simultaneously manage more than one of these conditions for the same person[94]. Polypharmacy is now commonly split into 'appropriate' and 'problematic' to address this issue. Within this 'hyper-polypharmacy' is understood as the prescription of ten or more medicines with 'polypharmacy' referencing five to nine items[43].

2.2.13 Multi-morbidity

This terminology describes the co-existence of a number of long-term health conditions in the same person. With improvements in healthcare and consequent longevity the societal prevalence of multi-morbidity is increasing. This prevalence is especially marked in the older population who as we have discussed are a major component of the AMU patient population. The management of multi-morbidity is a particular challenge in healthcare provision and one with which the AMU team are all too familiar[108].

2.2.14 Pharmacy technicians

In their progression to recognition as healthcare professionals in their own right pharmacy technicians have also progressed from the dispensary to ward level work. In their case however this was most usually focussed upon medicines ordering, stock control and the dispensing medicines for discharge and resupply. Ever increasing service demands and limited pharmacist numbers coupled with developments in training and education have now led to expanded roles incorporating counselling, accuracy checking dispensed items, drug history taking and full medicines reconciliation. The skills of technicians in fulfilling these roles have been described in a small body of literature. They have been demonstrated to be as effective as pharmacists in conducting these 'extended' roles and shown to be well accepted by the wider clinical team[109, 110]. This 'extended' technician clinical activity has also been shown to realise benefits in terms of quality of care through risk reduction and cost minimisation[111-113]. Devolution of these roles to technicians in turn releases pharmacist time for value-added medicines optimisation inputs such as medicines review that require their clinical analysis and judgement. Additionally non-medical prescribing roles may become more realistically attainable without impairing wider service provision.

2.2.15 Recommended staffing levels

The only published guidelines on pharmacy staffing establishments at ward level are those of the Society of Hospital Pharmacists of Australia.[114] These currently suggest a ratio of thirty beds per pharmacist for general medicine but do not address AMU services. O'Leary et al have used data relating to over 20,000 clinical interventions by pharmacists to 4,600 in-patients in two Australian teaching hospitals in 2006 to argue that this ratio should, in fact, be twenty to one for general medicine and probably ten to one for an AMU due to the rapid patient over.[115] Likewise there is little literature measuring either the processes or outcomes of the activities carried out by pharmacy staff in the AMU environment. This presents a problem as intuitively, concentrating the provision of pharmacy services into the AMU, seems to be the best model of service provision so that medicines reconciliation can be completed as early as is feasible in the admission and any prescribing issues being thus promptly resolved, referred to subsequently as 'frontloading'. Unfortunately, however, finite staffing resources mean that in turn the availability of staff to cover

medical wards is reduced and the concern is that trying to improve the service early on in the AMU may adversely affect service provision later in the course of an admission.

2.2.16 AMU pharmacy services

While admitted to hospital the 'average' patient has been shown to be at risk of being exposed to at least one medicine related error each day.[116] With their specialist knowledge of the safe and effective use of medicines pharmacists have an important role in monitoring this aspect of clinical care during the course of a hospital admission. This is particularly true in an acute, rapidly changing clinical environment such as that which exists on the AMU whence clinicians may be easily distracted from the fine detail of what is happening with prescribed medication by sudden and urgent clinical developments. Patient concordance, that is being in informed agreement, with the choices made by themselves and their clinicians regarding the best pharmacological management of the patient's illness(es) is a critical aspect of ensuring adherence, that is correctly following the agreed management plan, to on-going treatment.[117] This terminology is now preferred to the previous term 'compliance' as this was perceived to imply a greater passivity of the patient in the therapeutic decision making process.[86]

In the acutely unwell lifesaving interventions, including the use of medicines may have to be driven by clinical urgency and discussion with patients is not always possible. Effective medicines counselling by pharmacists to ensure retrospective concordance with on-going changes to medicines regimens is, however, still an essential clinical activity. It helps to ensure that patients realise the benefits of on-going medicines based interventions, both during admission and post discharge. Health outcomes will thus, hopefully, be improved and the cost implications of prescribed medicines not being taken by the patient minimised. Given that it has been shown that up to half of older people prescribed medicines do not take them correctly, this is a key consideration.[118]

The importance of effective and responsive discharge processes in maintaining optimal patient flow within healthcare organisations has already been identified as a key issue in the AMU centred model of care.[60] It has also been shown that adverse health outcomes occur in up to 20% of patients discharged from hospital.[119] In 72% of these cases the adverse outcome is related to a prescribed medicine.[120] The

preparation of medicines for discharge is often cited as a rate limiting step in the discharge process. However a literature review conducted in 2004, found only one published article out of twenty that identified pharmacy-related issues as a major cause of delay in the discharge process.[121] The reality is that no more than fifty per cent of the average time between the clinical decision to discharge and actual time of discharge is taken up by pharmacy activity.[122] The greater majority of the time involved in the process relates to delays in the preparation of the discharge prescription by the medical team.[122] It is thus essential that, as part of a whole-system based solution to optimising discharge processes, pharmacists and technicians are empowered by local operating procedures to facilitate the prompt discharge of patients. This need may arise from either the AMU or medical ward environments. It can often be most effectively addressed by completing the medicines related aspects of the discharge process near-bedside within the AMU or medical ward environment. This then removes from the previous reliance upon a remote central dispensary with its attendant risks of delay. The inclusion of 'dedicated' pharmacists within the clinical team on the AMU is a 'key principle for high quality patient-centred acute medicine'.[5] Audit evidence from 2010 suggests that pharmacy input into AMU services in the UK is largely established. Organisations reported an 84% establishment incidence for a pharmacy service on their AMU (more than twice the number reporting established physiotherapy, occupational therapy or social services establishment); however there is little published evidence to inform decisions upon appropriate staffing levels for either pharmacists or technicians or to describe any clinical benefit derived from their input.[61]

2.2.17 Frontloading of services

For the purposes of this research our definition of 'front loading' will be: 'the concentration of a limited resource (pharmacy staff) to provide a comprehensive service at the beginning of the admission process'. Intuitively this is probably the way forward with regard to service provision to the AMU. Organisationally however, front-loading the pharmacy service to the AMU in this way creates a difficulty in providing a truly effective pharmacy service in the context of the AMU environment. Pharmacy services in the UK are, most commonly, not provided in full on a 24/7 basis to any unit within a hospital. On the AMU therefore, this means that when pharmacy staff

come on duty in the morning they always have a backlog of clinical work, including outstanding medicines reconciliation, to get through for patients admitted to the AMU overnight. This may prevent proper, real time involvement in patient management on the unit and may be particularly disadvantageous in such a fast moving and acute healthcare environment as an AMU. Alternatively, if pharmacy staff do engage with this patient management activity, then the medicines reconciliation work may not be completed in a timely fashion and may still have to be completed post transfer to a medical ward; thus negating one of the supposed benefits of the front loaded service model. Additionally, the way that a front loaded service functions may well need to move away from the currently established model to one that better addresses the unique requirements of the pharmacy service within the AMU environment. The literature in this area is extremely limited with regard to pharmacy. Dutton, et al demonstrated in 2003 that significantly increasing the time spent by a pharmacist on an AMU (68 minutes to 150 minutes $p<0.001$) significantly improved the daily detection rate of on-admission prescribing errors (3.3% to 7.1% $p<0.001$) relating to patients pre-admission medicines.[123] Medical and allied health professional researchers have also shown that conceptually the idea of front loading services can realise healthcare benefits. Richardson et al have shown benefits in an Australian emergency department with an improvement in the proportion of patients being treated within their 'triage threshold time' increasing from 62% to 68% ($P<0.001$) and the percentage of patients waiting for treatment falling from 8.9% to 6.9% ($P<0.001$). Numbers of patients waiting to be seen also reduced on a background of unchanged attendance and subsequent admission rates and no change in patient contact time.[124] This study is particularly interesting as it provides some evidence of the benefit of a staffing cohort structured to the provision of cover by more experienced staff. Pharmacy service models currently often use more junior staff to cover AMUs with more senior staff being allocated to specialist and subspecialist ward areas. A 'front loaded' model using rapid response paramedics to attend older people suffering acute injury at home has shown a reduction in emergency department attendance at the time of injury or in the subsequent 28 days from 87% to 63% ($P<0.001$). Hospital admissions amongst those who did attend the emergency department were also reduced from 47% of cases to 40% ($P<0.001$) and importantly 85% of patients were highly satisfied with the service provided ($P<0.001$).[125] Finally a physiotherapy service to an AMU has shown that frontloading to provide a seven day

additional evening service reduced length of stay by 1.5 days per patient and reduced service response time from 13.7 hours to 2.3 hours.[126] Conceptually, providing an effective AMU based pharmacy service should mean that the cohort of patients subsequently transferred to a medical ward for on-going specialist care should present with a completed medicines reconciliation and all medicines related problems identified and under management. This should in turn mean that pharmacists providing care at ward level will have time freed up to spend upon other patient related activity. What this might be is unclear as there are always a number of unfulfilled activities that might be engaged with that could improve outcome for patients. The ultimate extension of this is moving pharmacy clinical service provision into the emergency department to implement medicines optimisation principles even earlier in the secondary care process. This proof of concept is now supported by the Royal Pharmaceutical Society and educational programmes to upskill a suitable cohort of pharmacy staff to implement the intervention are currently under development.

2.2.18 Conclusions

Acute medicine offers significant scope for improving the clinical management of the acutely unwell adult. Fully realising these benefits however, requires system-wide reform of both policy and practice to put acute services at the centre of care provision within a secondary healthcare organisation. This will ensure that acute services are given the clinical environment that they need in order to flourish and achieve the optimal care that they potentially offer to both individual patients and the wider organisation. It has been shown that a significant part of the workload in any acute medical environment relates to medicines through either direct or indirect mechanisms. Regardless of the cause, the role of pharmacy staff is clearly key to addressing these important safety issues effectively. We still need to understand however, the consequences of the ‘frontloading’ of limited pharmacy staffing resources into acute medical services to achieve these goals. The wider provision of pharmacy services to the medical specialities beyond the acute environment is also important as the same medicines related issues are also prevalent there. Intuitively we believe that the early resolution of medicines related problems during a hospital admission will be beneficial to overall care but there is little or no literature to support or refute this premise. The results of this study will therefore help to inform upon this

paradox by helping to clarify the subsequent benefits to patients later in their admission, of a ‘front loaded’ pharmacy service providing pharmaceutical care whilst they are in the AMU.

CHAPTER THREE: AIMS AND OBJECTIVES

3.1 Aims

The overall aim of the body of work is twofold. First, it aims to understand whether pharmacy clinical service provision differs from that provided on acute medical wards and, second, to determine whether providing these services on the AMU demonstrates any benefit for patients further into their admission. It is hoped that this will stimulate further research into the best way to use pharmacy clinical services to support the practice of acute medicine in reliably achieving optimised clinical outcomes for patients.

The thesis therefore has two interlinked work-streams that combine to achieve these aims, described in the two papers in Chapter Five:

1. (Paper One): To describe variation in practice by pharmacy staff between the acute medical unit and medical wards and to investigate associated workload factors.
2. (Paper Two): To determine whether providing pharmacy clinical services to patients on the acute medical unit has any effect upon their need for similar services on the medical wards in the first 72 hours after transfer.

3.2 Objectives

The objectives of this programme of work are:

1. To understand the background to the current clinical model of practice of acute medicine.
2. To maintain the required standards of research practice with regard to ethical and information governance considerations.
3. To collect clinical activity data relating to the work of pharmacists and pharmacy technicians in providing pharmacy clinical services on the acute medical unit and medical wards at the study site in a sustainable manner to meet the first project aim.
4. To identify from the data in (3) a subset of patients who move between the AMU and the medical wards for further analysis to meet the second project aim.
5. To report how the results of the data analysis inform the project aims and how future research in this area might be targeted.

CHAPTER FOUR: METHODOLOGY

This chapter provides a rationale for the definition of research questions and a description of the means by which the project aims and objectives were realised into a functional programme of work. The operational detail of the method for each work-stream is detailed in the two papers included in chapter five of this thesis.

4.1 Defining the research questions

4.1.1 Paper 1

This study aimed to describe the variation in the clinical inputs of pharmacy staff between the AMU and ward environments and to give context to the second study. In order to achieve this, the following comparisons between these inputs on the AMU and wards were conducted. The data collected in this study would also generate a subset of data for the second study. Data on clinical inputs need to be simple to collect, to minimise the impact of the process on contiguous clinical activity relating to usual practice. This was facilitated by either using the electronic patient record for data relating to workload or otherwise using a form with tick boxes, for data relating to specific activities. Simple timings based on clock times were also employed.

The following data were collected:

1. Average number of inputs per patient. An input was categorised as a period of clinical activity by a pharmacist or a technician focussed upon the needs of an individual patient on a ward or the AMU at any one specific time.
2. Quantitative content of inputs in terms of specific clinical activities such as whether a medicines reconciliation was completed.
3. Proportion of remote compared to ward-based inputs occurring for patients on the AMU and wards, as the hospital used an electronic patient record.
4. Time taken to complete an input for both pharmacists and pharmacy technicians.
5. Time taken to complete input by pharmacy staff who regularly and do not regularly work on the AMU
6. Time taken to complete input by pharmacy staff grouped as professionally qualified more than or less than two years.
7. Time taken to complete an input depending upon whether the input included direct interaction with the patient.

8. Time taken to complete an input for patients at admission, post-admission and discharge.
9. Activity patterns within inputs for both professional groups
10. Time taken to complete an input depending upon whether use of the EPMAR system was involved.

Pharmacy staff frequently report that workload pressure on the AMU is not the same as on the wards. Therefore, this paper will also report upon likely markers of workload pressure that might impact upon pharmacy staff in delivering clinical inputs in both AMU and ward environments. These were defined as:

1. Number of new admissions
2. Total number of patients
3. Number of patients without a completed medicines reconciliation
4. Number of prescribed medicines not clinically checked

These data were collected at the start and end of each visit to give a measure of how this workload pressure impacted upon the clinical effectiveness of pharmacy staff in completing their clinical work.

4.1.2 Paper 2

Using the same data collection method as paper one the key concept underlying this section of the programme of research is 'frontloading' with regard to the modelling of pharmacy staffing resources between the AMU and other medical wards. For the frontloaded model to be clinically valid it needs to realise both process and outcome benefits for both patients and the healthcare provider compared to usual models of care. Because there is variation in the level and profile of pharmacy staffing on the AMU over any twenty-four hour period some people admitted to the AMU are assessed, managed and transferred to a ward with little or no pharmacy clinical service input. The option of a randomised, controlled research method was considered, however it was deemed to be fundamentally unethical to deliberately not provide pharmacy services to a patient cohort. This created a patient population with two self-selected groups. The control group was those people, just described, who have not had pharmacy input. The exposure group was those people admitted to the

AMU who received pharmacy clinical services input before they were transferred to another ward.

Following ward transfer research has shown that most changes to medicines regimens occur within seventy-two hours[127]. Based upon this it was decided that measuring pharmacy clinical service inputs during the first seventy-two hours after the ward transfer from the AMU would provide the data with which to assess the impact of pharmacy clinical service input being provided or not whilst admitted to the AMU. If, following the transfer of the patient from the AMU, statistically significant positive differences between the exposure and control groups, in stated aspects of pharmacy clinical service provision on the wards could be identified, this would be viewed as a vindication of the frontloading approach. Again, however, the data to be collected needed to be simple to collect from the electronic patient record.

On this basis the research questions for the second work-stream were defined as:

Does the provision of pharmacy clinical services on the AMU have a statistically significant association with any of:

1. Reduced time to complete a medicines reconciliation following admission
2. Reduced time between initial post-admission prescribing activity and the completion of a medicines reconciliation
3. Reduced time to detect prescribing errors
4. Time spent in discussion with the patient
5. Reduction of proxy markers of clinical workload for pharmacy staff on the post transfer ward. These proxy markers were, in turn, defined as:
    a. Number of items requiring a clinical check
    b. Number of prescribing errors detected
    c. Time spent providing clinical pharmacy services
    d. Variation in the clinical content of pharmacy clinical service inputs.
6. Reduced mortality during admission
7. Reduced mortality at 7 and 30 days post discharge
8. Reduced readmission rates at 7 and 30 days post discharge
9. Reduced length of stay

It was recognised that the factors affecting measures six to nine are highly complex and that the detection of variation by a relatively small study such as this one would carry a low likelihood of success.

4.2 Epidemiological methodology

It has been described how it was necessary to identify the pharmacy clinical interventions that were or were not conducted on the AMU at the study site and then measure outcomes following ward transfer and across the admission as a whole. This represents a forward moving timeline and clearly capturing this direction of movement in the over-arching methodology will give a more logical and realistic pattern to the data collection and ordering of the factors that may affect the multiple necessary outcome measures required to evaluate the effect of the AMU interventions. Therefore, this work-plan lent itself best to a cohort study method where a pre-defined group of patients had data collected over a pre-defined period of time during their admission. Methodologically the other approach that might be considered would be a case controlled one. This method would have required the identification of one or more outcomes in a group of patients and then tracking back to see what interventions had occurred that might have impacted on the identified outcome. Because of the need for multiple outcome measures to be analysed separately, this latter approach would have been very complex to apply. Also, because much of the data regarding factors such as time spent in completing activities and activity content were not routinely documented, this approach would not have been able to capture much of the data needed to investigate the research questions.

4.3 Other considerations

4.3.1 Surplus data

Because data collection was prospective it was not known in advance which patients were going to be transferred to the medical wards from the AMU. This meant that data was collected for patients not subsequently eligible for inclusion in the second work-stream of the study. This ‘surplus’ data collection presented an ethical concern in terms of the justifiable use of the data collectors time. However, using that data for study 1 and providing a descriptive, supporting piece of work alleviated this concern and assured that the time spent in data collection was not wasted effort.

4.3.2 Measuring complexity

There are several measures for patient complexity commonly used in research[128]. The Charleson Co-morbidity Index is an example of such[129]. There are also a number of scoring systems for patient mortality risk. Of these the Medicines Regime Complexity Index is a comprehensive means of scoring the complexity of medicines regimes from the perspective of the person having to take them[130]. None of these systems, however, capture the 'pharmaceutical complexity' presented by an acutely ill person. This represents a complex interplay of medicines, morbidities and social factors. The lack of such an assessment is currently subject to research by The American Society of Health-System Pharmacists but their work is as yet ongoing and unpublished. The Modified Early Warning Score is a marker used to identify each individual patients level of unwellness[131]. However, it rapidly fluctuates and correlating scores at the point of pharmaceutical interventions proved to be too complicated. It was also noted that the documentation of this score is now much more robust than when the data collection for this work was completed and that in the future it may be better utilised in research. Given these considerations it was thus decided that polypharmacy would serve as the best proxy marker of pharmaceutical complexity for this work[43]. Polypharmacy or the inappropriate prescribing of large numbers of medicines is a major concern particularly for elderly and multi-morbid patients[132]. Regardless of the appropriateness of the medicines prescribed, which is beyond the scope of this work given it's limited timescale, if a patient is taking a lot of medicines their pharmaceutical care is likely to more complex than would be the case for someone prescribed a smaller number of medicines[108, 128]. Nishtala and Salahudeen have described polypharmacy as a proxy for the inappropriate use of medicines following a nine year prevalence review of a cohort of older people[133]. Polypharmacy has also been identified as a proxy for poor health in multi-morbid patients by Haider et al whilst Flaherty et al in 2000 identified polypharmacy as a proxy for risk of hospitalisation in a group of older people[134, 135].

4.4 Limitations

A number of potential sources of bias were relevant to this work. These could potentially affect either or both of the internal validity (data quality) or external validity (wider applicability) of the research. In considering these, methodological controls for their possible impact were implemented.

4.4.1 Selection bias

Data collectors would invariably choose which cases they would and would not interact with and, for the cases that they did interact with, whether they chose to record intervention data. To control for this a 'universal' approach to data collection was adopted. By this it was meant that data collectors did not have to specifically identify for which patients on the AMU or a ward they would collect data. They were simply asked to collect data for anyone with whom they interacted, holding no knowledge of which cases would subsequently be aggregated into the second part of the study. By taking this approach it was anticipated that data collectors would follow a more 'normal' way of working with the intention that cases would not be picked and chosen. Consequently, reporting would merge into usual activity, with the same data being collected for each ward arrival and departure and for each clinical input made within each visit. Each case seen would thus give a truer report of actual practice and decisions to interact or not with particular patients were driven by usual thought processes and not the presupposed requirements of the data collection for the study. The adoption of a universal approach to data collection thus provided a degree of control for this type of selection bias. It also gave a more true to life picture of clinical activity. As regards non-documentation of activity they had undertaken we could only encourage the data collection team to avoid this if at all possible. It has to be recognised however that the first priority of the data collectors in all cases was the provision of a safe clinical service to patients and not to collect data comprehensively. With this important proviso, the establishment of rigorous control was impossible and the existence of this aspect of selection bias has to be recognised as a limiting factor in considering the findings of this work.

4.4.2 Observer bias

Observer bias in terms of the interpretation of situations was an important consideration for this work. Data were collected by multiple persons at different ward locations. The best way to control for this bias was in the design of the data collection tool. This was designed in a tick box format with specific textual descriptions of activities and scenarios. Although this created a form that was at first sight visually complex, this was justified to optimise control of this source of bias (see appendix).

4.4.3 Recall bias

The retrospective recording of data collection was recognised as a problem for this type of research method. Data collectors may make prospective notes of their activity and enter it onto the form retrospectively. This loss of real time data collection can introduce significant recall bias with regard to activity content and time spent carrying out activity. By designing the data collection tool to require only boxes to be ticked it was again hoped to encourage real time activity recording to control the impact of this type of bias.

4.4.4 Loss to follow-up

Although a common problem for cohort studies [136] , lost to follow up was not perceived to be a problem in this work as only patients for whom any data were initially recorded would subsequently be included in the data. All of these patients were processed through the EPR system and thus any additional data would remain available to the research team for all cases.

4.4.5 Confounding factors

Although the pharmacy department at the study site operates a traditional model of ward pharmacy service [137] to most wards and departments it operates a variable staffing model to the AMU over the course of the day and the week. This involves differing numbers of pharmacists and technicians being allocated to the unit in an attempt to anticipate periods of higher workload. This modelling strategy is a key aspect of the frontloaded care model. As such it is important not to overlook the effect of this in how the study data was collected. In conjunction with this pharmacists were not only allocated to the AMU during their working day, they also had other ward commitments that varied from day to day, dependent upon departmental leave and sickness absence. Whilst the departmental rostering system used does not require a pharmacist to physically work between two wards simultaneously, there is nothing to stop other wards from contacting a pharmacist by pager whilst they are nominally working on the AMU. This would potentially reduce their opportunity to be maximally effective in their work upon the unit.

This workload may be first, real, in terms of the physical volume of patients requiring pharmacy services for any measured unit of time and also their associated complexity in terms of their individual pharmaceutical service needs. For example

elderly patients or renal patients are often particularly complex. Second, workload may be a perceived problem rather than an actual one. [138] Examples of this might be; staff approaching the end of a shift, staff working alone or staff covering the AMU who are unfamiliar with it. Additionally, staff covering the AMU in conjunction with either, other unfamiliar wards or a number of other wards, may find a numerically average or 'normal' level of service need on the AMU to be psychologically more challenging than they might appear to a neutral observer. This may have a consequent effect upon clinical performance that may be manifest by reduced rates of medicines reconciliation completion or interventions. This perceived extraneous workload was likely to contribute to the prevalence of selection bias as described above.

4.5 Endpoints

Because length of stay is never completely predictable a complete study of pharmaceutical intervention throughout an admission would be very resource intensive and the value of the data in the context of the time spent collecting it might not be justifiable in terms of that resource consumption. Intuitively the greatest amount of pharmaceutical intervention is thought likely to occur in the first seventy two hours following transfer as this has certainly been shown to be when the greatest proportion of prescribing errors have been suggested to occur. [127] The limited time resources available meant that it was necessary to implement an artificial rather than natural endpoint to the study with regard to data collection. Despite this hard outcome data could still be obtained for the whole admission period from the electronic patient record system accepting some loss to follow up of patients still admitted at the point when data collection ceased. Clearly the availability of the electronic patient record would mean that retrospective identification of every endpoint would be theoretically possible but the value of the data obtained would rapidly diminish in value against the time investment in following up all of the cases.

4.6 Data collection

4.6.1 Background information

The AMU at the study site is a thirty seven bedded unit that is open to admissions 24/7. Using the study site's EPR system it was possible to determine the patient flow

through the AMU over a seven day period and link this with current pharmacy staffing levels on the AMU (tables two and three below). As a sense check the forty four per cent admission rate agrees almost exactly with data from the AMU regarding their admission rate over the current financial year.[139]

Table 1: AMU pharmacy staffing levels and unit activity: weekday

Weekday over one week						
Time	Pharmacist	Technician	EAU admissions	AAA admissions	EAU discharges	AAA discharges
0900-1100	3	2	4	3	6	6
1100-1300	1	2	7	6	13	10
1300-1400	1	1	9	7	10	2
1400-1530	1	2	2	7	9	3
1530-1600	2	2	10	6	2	3
1600-1700	1	2	4	8	10	2
1700-1830	1	0	11	17	7	11
1830-0900	0	0	83	36	15	25

Table 2: AMU pharmacy staffing levels and unit activity: weekend

Weekend over one week						
Time	Pharmacist	Technician	EAU admissions	AAA admissions	EAU discharges	AAA discharges
1030-1230	1	0	1	4	1	3
1400-1700	1	0	7	5	9	2
1700-1030	0	0	31	22	6	15

Although the data in tables three and four only related to a one week snapshot of activity on the AMU, an interesting point is apparent. There is a significant accumulation of admissions during the periods of no pharmacy service provision, meaning that when pharmacy staff come on shift, they usually face a considerable backlog of work.

4.6.2 Overarching strategy

Although the study site has a well- established electronic patient record with an integrated electronic medicines prescribing and administration recording system it was identified that this would only have limited utility as a source of data for the project. This was because the model of working practice followed by pharmacy staff

providing clinical services throughout the hospital did not entail the regular documentation of their clinical activity in the EPR.

Pharmacy clinical service provision has evolved around the paper medicines chart. This has historically served as the medico-legal record of pharmacists activity in the health record – with the documentation of clinical checks and endorsements being made directly onto the chart. Pharmacists also recorded entries in the main health record, largely in support of verbal interactions with medical and nursing staff over medicines issues that required action and also as a record of counselling interactions with patients and carers over their medicines. While the requirement for clinical checking has always been absolute for medico-legal reasons other endorsements on prescription charts and clinical notes in the health record have always been at the discretion of the individual practitioner with regard to accepted good practice. This way of working has carried over into the adoption of electronic health records. In comparison with the other allied health professionals, particularly physiotherapy and occupational therapy, pharmacy staff do not routinely document 'daily notes' recording their activities with individual patients. Because working practices have evolved without the inclusion of this activity attempts to introduce it are frequently met with resistance. Staff will cite 'not having time to do it' despite the benefits that this type of documentation can bring in terms of a contiguous record of daily patient management activity. This leads to a particular problem for researchers of pharmacy practice as there is no robust database in the healthcare record that they are able to utilise and such activity data always has to be collected specifically for the purposes of the research project in hand. This has an obvious disadvantage in that pharmacy staff will always be cognisant of the data collection and this may affect their behaviours in clinical practice, thus introducing a source of bias into any data that is collected.

Given these considerations it was always apparent that the activity data component of the required research data would have to be collected specifically for the purposes of the study. The first option for this would be for data to be collected by independent observation of clinical practice. This was rejected for several reasons. First, the logistical pressure on the pharmacy department to facilitate observers would effectively double the number of staff allocated to any ward at any time and this would be unsustainable and adversely impact on patient care. Second, as alluded to

above, observed practice would be ‘alien’ to the observed and modified behaviours in clinical practice would likely be prevalent with a consequent effect upon the validity of the data collected as a true picture of clinical practice. Third, it was felt that this would prove to be limiting to the study in terms of the volume of data that it would be possible to collect in the time available.

The second option was for self-reporting of clinical activities. This had the advantage that although there was still a time pressure through the need to physically write down the record of clinical activity there was no extra staffing allocation required. It was also thought that once settled into the data collection the unobserved nature of this method might lead to more ‘normal’ clinical behaviours and thus a truer picture of practice would be captured in the data.

Although the EPR system was discounted for the core data collection it was noted to be a valuable source of additional, relevant data about patients whose clinical inputs were subsequently included in the study. As such a specific data collection strategy was designed to capture which data would need to be collected. Because of the limited reporting functionality of the study sites EPR system data had to be manually retrieved for each included person.

4.6.3 Data collection tool

The time constraints of the project meant that electronic data collection solutions were not considered to be an option as the time taken to develop a data collection tool and the cost of purchasing sufficient suitable data collection devices would have been prohibitive. Subsequent to this work, the study site has put considerable investment into tablet computing devices for use in a variety of situations including data collection for researchers but this was not available to us when we carried out our work.

Audio recording of activity for later playback and analysis was discounted because the complexity of analysing what would be a relatively unstructured data source would consequently limit how much activity could be looked at in the time available. The detail that can be found using this methodological approach was understood but as this is such an under researched area it was thought that a broader data collection to give an overall picture would be more appropriate as an initial investigational approach.

We were thus limited to paper based data collection. This method was noted to have some advantages. By producing a tick box, data collection tool coupled with training of the data collectors, we were able exert some control over inter-operator variation in interpreting activities. The forms were highly portable and could stay with the member of staff at most times thus encouraging real time data recording. This method also allowed data collection across a number of wards and the AMU to take place. It was felt that the volume of data would thus provide some 'normalising' effect and reduce the impact of outlying data.

4.6.4 Form design

The team thus designed a paper based data collection tool. As mentioned above the basic premise was to make it a tick box design to prevent data collectors having to provide interpretation of activity. Using personal knowledge and peer review clinical activities were put into the form which was deliberately kept at the size of one sheet of A4 paper in a landscape orientation. Staff were also required to record some demographic information about their clinical experience. The form was designed so that activities on multiple wards could be recorded on one sheet thus limiting the number of forms that individuals were required to manipulate at any given time.

A pilot study was conducted across all of the study wards on one day using the first draft of the data collection form. This gave the opportunity to familiarise the data collectors with the paperwork and to get feedback regarding the 'workability' of the form design in real life. Fresh forms were provided for each day's activity recording to control for the risk of data loss if forms were mislaid. A second, similarly sized, form was also designed to allow data about workload levels on the ward at the time of clinical visits to be collected at each visit. Spreadsheets were designed using Excel 2010 to allow recording of the information taken from the EPR system and subsequently for aggregation of all of the data from the paper forms.

4.6.5 Sampling and data collection strategy

The selected data collection method was acknowledged to be very labour intensive for the pharmacy staff involved and would have to be carried out in addition to usual clinical activities. The immediate concern here would be data collection fatigue with a consequent drop off in recording over time. Additionally it was recognised that the conversion of paper data collection into an electronic format would be a significant

workload pressure for the primary researcher. It was thus decided that data collection would be limited to two week blocks separated by a sufficient period to allow the collection of EPR data for cases to be included in work-stream two and for subsequent data manipulation to be completed. Knowing the required sample size (Paper 2, page 5) and unit activity levels (tables 3 and 4) it was decided that three data collection periods would be sufficient to aggregate enough cases. In reality, this equated to three data collection periods between July and December 2013, the third of which was terminated early as sufficient cases for work-stream two had been identified. As already discussed, the data was collected in addition to the usual working activity of the data collectors. From this data specific inclusion criteria would then be applied to identify cases suitable for inclusion into the second work-stream. These criteria were that data collected on pharmacy staff input occurring more than 72 hours post-transfer were excluded. Additionally cases were also excluded if:

- They had not been admitted to the AMU prior to admission to the ward.
- They had already been admitted to the AMU before the first data collection day of the data collection period.
- They were discharged directly from the AMU or transferred to a non-study ward.

4.7 Data management

A clear data management strategy was essential for the project owing to the large volume of data collection forms that were generated and the need to aggregate data from these and from the EPR system.

At the end of each data collection period all of the paper based data sheets were transcribed into an Excel 2010 spreadsheet for further manipulation. Three spreadsheets were created for each period – one for the activity data, one for the ward workload data and one for the EPR data for the patients included into the second study.

4.8 Statistical analysis

Although the crude data were aggregated and manipulated using Microsoft Excel 2010, it was recognised that the statistical analysis functionality within that programme was not regarded as being sufficiently robust for the meaningful analysis

and reporting of data for academic purposes. Data was thus transferred from Excel into IBM SPSS v22 for further analysis.

Simple statistical tests of averages both parametric (Students t-test) and non-parametric (Mann-Whitney U-test) were applied depending upon the distribution pattern of the dependant variables involved.

The alpha level for the probability of incorrectly rejecting the null hypothesis was set as 0.05 (5%). This is standard scientific practice based upon the work of Fisher[140]. It is similarly standard practice to declare the alpha value before testing the data as asserted by Neyman and Pearson[141]. The beta level was set at 0.2 to give a statistical power of 80% chance of incorrectly accepting the null hypothesis.

A linear regression model was used to measure the effect of providing pharmacy clinical services on the AMU upon total pharmacy service time in the first 72 hours following ward transfer. Use of this model allowed correction for the factors most likely to confound the effect of this service provision. Regression analysis is, by consensus, not dependent upon the distribution pattern of the dependant variable. Because the dependant variables were all measures of time a linear regression model was chosen for the purpose of multivariate analysis.

4.9 Ethical considerations

A project specification document was prepared before any data collection was attempted. This fully described the aim of the study, the data collection and management strategies and the data sources. This was submitted to the NHS Research and Development team at the study site for assessment. Their decision was that the study constituted service evaluation and would not require formal ethics committee approval from either the NHS or the University.

4.10 Resource consumption

The research required time input from the members of the research team, the statistical advisor and the data collectors. Paper was needed for the data collection forms. The rest of the work was conducted using a laptop computer which carried its own acquisition cost, although it would be part of the University laptop ‘stock’ in the future thus offsetting this to an extent. Electricity and ink were other necessary consumables.

4.11 Communication strategy

It is essential that for NHS funded research to be justifiable the results need to be fully communicated in the public domain. The proposed strategy for this communication was to produce two research papers for publication and to take the results to a number of relevant conferences in poster/oral presentation format as agreed with the conference organisers. To facilitate this, the thesis is being presented in alternative format with the completed papers in a format ready for publication included in the body of the thesis.

4.12 Information governance

The only patient identifiable information that was collected at any time was the hospital number. This was considered to be essential as it allowed the later linking of data from a number of collection sources for analysis purposes. Following initial data collection knowledge of the true hospital number was not necessary for the completion of our research. With this in mind, at the point where data was transcribed from paper to electronic format, the hospital number was mathematically manipulated to generate a number that while unique to that person bore no resemblance to the actual hospital number but retained the functionality for data linkage. From this point all data was completely unidentifiable. Further to this, information detail such as ward locations, although not technically patient identifiable, were also numerically coded for completeness. Paper forms were securely retained and all computer activity was conducted on appropriately encrypted NHS or University of Manchester laptop devices.

CHAPTER FIVE: RESEARCH PAPERS

PAPER ONE

To be submitted to: the International Journal of Pharmacy Practice

Variation in patient-facing clinical service provision by pharmacy staff on an acute medical unit and acute medical wards in a UK teaching hospital

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Abstract

Introduction

The acute medical unit (AMU) is a key component in the management of the acutely unwell patient in many healthcare models. While there is some literature describing the patient benefits of an AMU and the operational features that optimise them, there is little published regarding clinical activity by pharmacy staff in this environment.

Aim

To describe quantitatively differences in the clinical activity of pharmacy staff between the AMU and medical wards of a UK teaching hospital.

Method

Pharmacy staff self-reported patient-facing clinical activity and pending workload over three discrete cycles of data collection. Data were collected on the AMU and seven medical wards. Activity was described in terms of inputs and activities. Each input described a single period of clinical activity by a pharmacist or technician focussed upon one patient. Each input could contain one or several activities. These represented the individual components of clinical service provision.

Analysis

Fewer inputs in total were completed for each patient on the AMU than on the wards. Each contained more activities and took longer to complete. Pharmacists spent less time on each input than technicians on the acute medical unit but longer on the wards. Less experienced staff spent longer on each input in both locations. ‘Pending’

workload for pharmacy staff on the AMU was greater than on the wards. An estimation of staffing levels to achieve clinical effectiveness was provided.

Conclusions

Pharmacy staff appear to work differently on the AMU than they do on medical wards. This may be due to a limited opportunity to work with the patient and workload pressure. Experienced staff may complete work more efficiently. The rapid turn-over and complexity of the patients means that clinical pharmacy service provision may need to be tailored to the particular needs of the AMU.

Keywords

Pharmacy, Acute Medicine, Acute Medical Unit

Introduction

The Acute Medical Unit (AMU) is an environment where physicians can lead the management of acutely unwell medical patients for up to 72 hours after hospital admission.[1] It is a key component in the modelling of acute medical care in a number of healthcare systems worldwide and there is literature to suggest that this implementation has led to better patient health outcomes.[2] Additionally, researchers have been able to describe operational features such as the availability of clinical support services including pathology, radiology, therapy and pharmacy, that may optimise the performance of the AMU in achieving these outcomes.[3]

A key intervention at admission is the completion of an accurate medicines reconciliation in order to inform effective medicines optimisation and minimise the risk of harm by either commission or omission of medicines.[4, 5] Medicines reconciliation is an acknowledged patient safety intervention that it is recommended be completed within 24 hours of hospital admission.[5, 6] Pharmacy staff have been shown to be more clinically effective at completing this activity than either medical or nursing colleagues.[7]

Completing medicines reconciliation and other pharmacy clinical activity in an AMU, with its environment of rapid turnover of frequently complex patients, presents a particular challenge for pharmacy service providers. The staffing requirement to achieve performance measures such as timely medicines reconciliation, error resolution and safe pharmaceutical transfer of care from the AMU either home or to other ward locations, impacts upon staffing availability for other clinical areas.

Intuitively, the sooner that medicines reconciliation is completed after admission, the greater its patient safety impact is likely to be. Committing resources to ‘frontload’ pharmacy services into the AMU to achieve this requires an understanding of how pharmacy staff work within the AMU environment and whether this is any different from how they work on the medical wards. Understanding this would inform the modelling of services that give pharmacy staff the infrastructure to achieve the previously stated performance outcomes in a safe and sustainable way.

Literature describing pharmacy activity on the AMU is limited. In order to begin to inform this decision making process, this study aims to describe the quantitative

differences in patient-facing clinical service provision between the AMU and medical wards by pharmacy staff.

Method

Data were collected at a 700 bedded, inner city teaching hospital located in the northwest of England. The units involved were the AMU (56 beds, 20 ambulatory care) and the seven medical wards (169 beds in total) with the highest proportion of their admissions arising from the AMU. These were determined by analysing admission data for a four week period prior to data collection. The study site has a well-established, fully integrated, electronic patient record. Data collection was completed by any pharmacist or pharmacy technician working on any of the study wards during any of the data collection periods. A power calculation suggested that 210 eligible cases were sufficient for the detection of a five minute difference in total pharmacy service time per patient between the AMU and wards with 90% power at a two-sided 5% significance level. Three discrete data collection periods (two of fourteen and one of eleven days) were used over a six month time frame.

Contextual data were collected as to the job role, experience, employment duration and grade of each data collector. The allocation of pharmacy staff to the study wards during the data collection cycles was carried out as part of the normal departmental rota-setting procedure, determined by skill mix and annual leave. The investigation team had no part in this process. A piloted data collection form (see Appendix 1) was used to self-record daily clinical activity in the form of units termed ‘Periods of clinical input’ (input). Each input related to one patient, one data collector and one ward at one time. For example, all care given to patient x, by pharmacist y, on date z, on the AMU, was classed as a single input.

Each input contained one or more ‘individual activity types’ (activity) depending on the care the patient received, such as completing a medicines reconciliation, speaking to a doctor about a prescription and using the electronic patient medicines administration record (EPMAR) system to record information. Activities such as clinical checking and prescribing errors were counted, as well as a record of the total time spent completing the input and within that, how long was spent in direct communication with the patient. Clinical checking was defined as an action carried out by a pharmacist to confirm the validity of a prescribed medicine for an individual

patient. Prescribing errors were defined as any prescribing activity of commission or omission that resulted in a patient not being prescribed the medicines regimen that should have been prescribed and included the unintended omission of pre-admission medicines. This was judged by the data collector. The stage of the admission and whether it was a regular ward for the data collector were recorded. Whether clinical services were delivered for patients during a combined pharmacist and technician (joint) or single professional group (solo) visit was also documented.

Data were collected on 'pending' workload on the ward at the time that the inputs were completed. This data comprised the number of patients on the ward, new admissions, patients without a completed medicines reconciliation and prescribed items not yet clinically checked. These were documented by the data collector at arrival on the ward and at departure to provide a measure of clinical effectiveness in addressing the overall pending workload.

The only patient identifiable information collected was hospital number, which enabled all inputs provided by multiple staff or on multiple days for an individual patient to be linked together. This was anonymised by mathematical manipulation at the [point of transcription from the paper data collection forms to electronic format. The project was deemed to be a service evaluation by the research and development team at the study site. As such, formal ethical approval was not required.

Data were initially managed in Microsoft Excel 2010 and statistical analysis was completed using IBM SPSS v22. Comparisons between AMU and ward activities were made using independent t-tests. For analysis, inputs were grouped according to whether they were completed on the AMU or a medical ward.

Results

Data were collected on 1028 inputs for 564 patients (mean=1.8 per patient; sd=1.1) on the AMU and on 5164 inputs for 1052 patients (mean=4.9 per patient; sd=4.3) on the seven medical wards. The mean number of activities per input was greater for the AMU (3.2 per input; sd=2) than the wards (2.3 per input; sd=1). Ward inputs completed remotely (i.e. those that were done on the EPMAR when the data collector was not on the ward), accounted for eleven percent of ward based clinical activity but less than one percent of AMU activity. Remote inputs also took less time

(mean=5.3; sd=4.9 minutes) than those where the data collector was on the ward (mean=6.9; sd=7.5 minutes); $p<0.05$.

Each input completed by a pharmacist on the AMU took an average of 12.1 (sd=10.1) minutes and was significantly ($p<0.05$) longer than the 7.4 (sd=7.8) minute average on the wards. The same was true for pharmacy technicians (14.6; sd=11.4 vs 5.0; sd=5.6 minutes; $p<0.05$). Pharmacists spent significantly less time completing each input on the AMU than did pharmacy technicians (12.1; sd=10.1 vs 14.6; sd=11.4 minutes; $p<0.05$). Conversely, pharmacists spent longer than technicians completing each input on the wards (7.4; sd=7.8 vs 5.0; sd=5.6 minutes; $p<0.05$).

Each input completed on the AMU by pharmacy staff who worked on the unit regularly took an average of 14.2; (sd=10.6 minutes), which was significantly longer than the time taken by non- regular staff (11.5; sd=10.2 minutes; $p<0.05$). Completion of an input by pharmacy staff qualified for less than two years took significantly longer on both the AMU (18.5; sd=11.1 vs 12.0; sd=10.1 minutes: $p<0.05$) and the wards (11.1; sd=9.6 vs 6.2; sd=6.9 minutes; $p<0.05$) than if a input was completed by a more experienced member of staff.

The inclusion of interaction with the patient increased the average time spent on an input on both the AMU (19.5; sd=10.9 vs 8.8; sd=7.8 minutes; $p<0.05$) and the wards (17.2; sd=9.8 vs 5.4; sd=5.7 minutes; $p<0.05$). On the AMU, 358 (35%) of inputs were documented as including direct interaction with the patient. This compared to 595 (12%) of inputs completed on the wards. When patient interaction was documented as being considered necessary, pharmacy staff spent an average of 5.5; sd=3.7 minutes upon such activity on the AMU compared with 6.4; sd=3.7 minutes on the wards ($p<0.05$).

On the AMU, pharmacy staff spent significantly longer completing initial post-admission inputs than follow up or discharge inputs (14.4; sd=10.9 vs 9.7; sd=9.6 vs 9.7; sd=6.8 minutes; $p<0.05$). On the wards, discharge inputs required significantly more pharmacy staff time than either initial or follow up inputs (14.6; sd=9.2 vs 13.0; sd=9.7 vs 4.4; sd=4.3 minutes; $p<0.05$).

The inclusion pattern of individual activities within the inputs indicated that there was variation in the content of work of both pharmacists and pharmacy technicians

between the AMU and the wards. Pharmacists working on the AMU most frequently reported medicines reconciliation and clinical checking activities within the content of their inputs. This contrasted with the wards, where pharmacists most frequently recorded clinical checking and monitoring activities in their inputs. AMU pharmacy technicians most commonly reported medicines reconciliation and dispensing activities in their inputs compared with ward pharmacy technicians who most commonly reported ordering and error intervention activities. Use or not of the EPMAR system showed no difference in the average time spent on a single input.

In terms of workload, the average number of new admissions at the start of a clinical visit was significantly greater (15; sd=9 vs 2; sd=3 $p<0.05$) on the AMU than the wards. The average number of current in-patients (34; sd=3 vs 23; sd=2; $p<0.05$) was also greater on the AMU at the start of a clinical visit. Pharmacy staff found a significantly greater number of patients requiring the completion of a medicines reconciliation (19; sd=7 vs 1; sd=1 $p<0.05$) when arriving on the AMU than on the wards. Over the duration of a clinical visit to the AMU, a 27% average reduction in the number of patients requiring the completion of a medicines reconciliation was seen (19 reduced to14 patients not reconciled). This compared to 100% reduction (i.e. all outstanding medicines reconciliations were completed) over the course of a ward visit. At the start of a visit to the AMU, pharmacy staff also found an average of 186 (sd=53) prescribed items requiring a clinical check. This was significantly ($p<0.05$) greater than that found on the wards 36; (sd=18). Over the course of a visit to the AMU, the number of unchecked items was reduced by an average of 18% (186 reduced to 152 items not checked), compared with 42% (36 reduced to 21 items not checked) for a ward visit. From this, we can extrapolate that a medical ward generates 1.5 new prescription items per bed per day, while the same figure for the AMU is 5.2 new items per bed per day (different by a factor of 3.5). If a ward gets a nominal 4 hours of pharmacy service time per day (divided between pharmacist and technician), this equates to 0.2 hours per bed per day which appears to achieve clinical impact in terms of staying on top of workload. If we multiply the AMU prescribing rate factor by this nominal figure (3.5 x 0.2) and factor in that during the study AMU inputs took 1.9 times (12.5 vs 6.7 minutes) longer than on the wards we get a requirement for 1.3 hours of pharmacy service time per bed on the AMU. This

works out at 48 hours of staff time needed per day in order to provide a full clinical service to the 36 AMU beds during the day shift.

Discussion

The data describes people admitted to the AMU receiving nearly three times fewer number of inputs than do those admitted to the medical wards. Despite this the activity content of each input is greater on the AMU. The ability to work remotely is one, purported; advantage of an EPR system and our data shows that such activity results in inputs being completed in a shorter time than during a physical ward visit. Both groups of pharmacy staff spent longer completing inputs on the AMU than the wards. Pharmacists spent less time than technicians completing inputs on the AMU, but more time on the medical wards. Regular AMU staff spent longer on inputs on the AMU than did non-regular staff, less experienced staff spent longer on each input in both environments. Differences in the underlying workload between the AMU and the wards are apparent. These are likely to need to be considered carefully in designing service provision.

This study has a number of limitations. Methodologically, the weaknesses of self-reporting as a mechanism for data collection have been described.[8] Data collection was conducted synchronously with usual clinical activity and was thus subject to fluctuation depending upon how busy the data collectors perceived that they were. The data collection forms were designed to control variation in how data were reported. However, this could not be entirely eliminated in a study of this type particularly with regard to the time spent upon activities. The study was also limited by only collecting data at one site and it should be noted that this is one of the largest, busiest, AMUs in the region. Consequently external validity and generalisability may be contended to be limited however, the workload factors encountered are the same as those seen on any other unit and thus variation is more likely to be a factor of scale and proportional volume than in contextual content. It was considered that the effect of these limitations would be to reduce the likelihood of statistically detecting variation between the two clinical locations and that therefore any variation that was actually observed would be more likely to be meaningful.

The fact that pharmacy service intervention on the AMU seems to be limited to single or at the most two inputs, that usually included either a partial or full medicines

reconciliation, may have accounted for much of the practice variation seen between the two areas. The pressure to complete medicines reconciliations for patients staying in and discharges for those going home appeared to occupy the majority of the time available to the pharmacy staff working on the AMU. In contrast, on the wards, where activity is spread over several inputs over several days, with the medicines reconciliation already having been completed on the AMU, it is understandable that pharmacy staff have much more opportunity to get involved in treatment monitoring and other activities. Similarly, the need to converse with the patient might be lessened with this differing activity profile. Indeed, interaction with the patient significantly increased the time spent on an input; however, relatively few inputs were documented as including such interaction. Input activity on the AMU was more likely to involve patient interaction than on the wards. Inputs relating to admission were the most demanding of pharmacy staff time on the AMU, whereas discharge input activity was the most labour-consuming activity on the wards.

Local practice is that whilst working on the wards, pharmacists and pharmacy technicians at the study site carry out quite traditionally demarcated roles, with the technicians focussed upon organising the supply of items that had been clinically checked by the pharmacists. On the AMU, however, the technicians have an additional role in completing drug history taking and ordering activity is more evenly allocated between both professional groups. The process of work at admission is drug history - reconciliation - clinical checking of prescribed items/error resolution – necessary ordering. Pharmacists either complete the whole process themselves or a technician completes the drug history and then the pharmacist completes the reconciliation. The value of technicians in medicines history taking and medicines reconciliation has been described[9, 10]. Technicians have also been demonstrated to be well accepted by the wider clinical team and to be as effective as pharmacists in completing this type of work[11-13].

Professional experience may enable staff to complete clinical activity in a more time efficient manner.[14] They may also be more likely to avoid error through broader knowledge and more effective communication.[14] In the AMU, where there is workload and time pressure to carry out work promptly for a complex patient cohort, the use of more experienced staff may thus offer advantages in terms of clinical effectiveness. This reflects what is also known about medical staffing.[15] Clinical

practice in pressurised environments is recognised as being tiring for staff and they may become more prone to errors and burn-out.[16] Experience may help staff to cope with these pressures more effectively but is not a substitute for well-planned staffing rosters and vigilant workload monitoring.[17]

Patient-facing clinical pharmacy services are likely to be most effective in their impact when delivered proactively, as part of a coordinated multidisciplinary clinical service. It is apparent that on the AMU, however, the pharmacy service is constantly trying to catch up with a backlog of clinical work. This may restrict the opportunity to provide truly proactive care and makes it more likely that medicines errors may reach the patient and effect harm. This need to catch up may be due to a number of reasons including the patient not being seen at all, inconsistent task completion and the ineffective actioning of identified issues. The likelihood of any of these occurring will be greater if staff are feeling 'pressured' into completing medicines reconciliations and discharges to catch up with a perceived service deficit. Ward level impact on workload, as evidenced by the reduction in the number of unchecked prescribed items for those patients seen, is clearly much greater than on the AMU. This suggests that pharmacy staffing levels may be better attuned to workload and that staff consequently have the opportunity to interact with the wider clinical team in a more real time fashion.

There is a clear need for the pharmacy profession to look more widely at how clinical services are provided in the acute medical environment to provide some consensus on how best to model such services. The workload data describes a difference between the AMU and the wards in terms of the amount of outstanding work facing pharmacy staff at the start of a clinical visit. It also suggests that the design of the pharmacy service may have limited clinical effectiveness in impacting upon the overhead of workload on the AMU. Beyond the attendant risks to patient care of work not being completed, the risks to staff must also be considered. Workplace stress, defined by the UK Health and Safety Executive as 'an adverse reaction to excessive pressure or other demands experienced at work', has recognised psychological and physical detriments to employees.[18] It also adversely affects organisational performance through a number of mechanisms including reduced productivity.[19] This in turn creates a cycle with a further reduction in the amount of work that is completed.[19] The Chartered Institute of Personnel and Development

identify workload volume as one of the top five sources of work stress[20]. The ability to psychologically detach from work has been associated with improved affect coupled with a decrease in perceived fatigue.[21] This is clearly beneficial for staff in terms of wellbeing. Higher workload levels have in turn been shown to reduce this ability to effect the psychological detachment process.[21] The literature upon workplace stress in pharmacy is mainly focussed in the community sector where dispensing errors, including criminal prosecutions, have been linked, in part, to work stress.[22] The impact of clinical workload upon hospital clinical pharmacy service provision is not the subject of a great deal of published literature[23] Ladds described in 2012 a remodelled service that was able to flex staffing allocations according to daily workload variations.[24] There is little literature describing how the clinical activity of pharmacists and technicians differs and even less regarding their specific activities on the AMU. This research suggests that these differences do indeed exist. Given the observed differences in underlying workload, stress associated with this workload may need to be considered in planning safe and effective service delivery. The staffing figures generated in the described model may seem excessive but should be considered in the context that safe prescribing of medicines, which begins almost immediately following admission, requires a completed medicines reconciliation to provide essential, underpinning knowledge. Achieving medicines reconciliation with real clinical timeliness beyond the nominal 24 hour target that is often worked to, introduces the need for greater frontloading of services to attain this target. Planning pharmacy services for an AMU needs to take account of the operational profile of the AMU and consequent need for greater pharmacy staff time per bed than is needed for a more ‘standard’ medical ward, in order to achieve an effective service. While pharmacy service input to the AMU at the study site is frequently allocated in two to three hour sessions, the published guidance for medical staff is that when they are working on an AMU it should be their sole area of work in order to facilitate effective clinical function.[25] This is a learning point for service planning as it may contribute to reduced clinical effectiveness on the part of pharmacy staff. Additionally the use of more experienced staff familiar with the AMU environment is likely to be more clinically effective.

The Society for Acute Medicine has described five aspects that it regards as core features of the model of nursing care for the AMU[26]. These comprise: emergency

care/stabilisation; assessments and related actions; admission and general care; ward rounds/reviews/progress chasing/referrals and follow-up; coordination/discharge and transfer. They further state that expecting individual nurses to provide care across all five aspects of the model of care in a single shift will lead to underperformance and compromise quality of care.[26] It is suggested that teams work with a small group of patients and then divide activity amongst the team with an effective communication strategy being key to the overall coordination of care.[26] It is further suggested that the nurse to care assistant ratio for an AMU should be 3:1 due to the high demand for skilled interventions.[26] The Society, with regard to medical staff, state that whilst they are deployed on the AMU they should not be allocated to other clinical activities and rostered onto the AMU for regular basis for at least four hours at a time to facilitate effective working.[25] Whilst direct comparison between professional groups is not possible in terms of job roles and skills, there are considerations here that might be relevant in deciding how the proportion of 'experienced' pharmacist time needs to be reflected in the skill mix. Junior pharmacists and technicians cannot just replace experienced pharmacist time on the AMU even where the technicians are involved in the medicines history taking and reconciliation processes. Our recommendation is that in designing AMU clinical pharmacy services emphasis should be placed upon the presence of experienced pharmacists supported by senior technicians skilled up in medicines history taking and reconciliation. Additionally a training cohort of junior pharmacists and technicians small enough to be involved in an effective AMU training programme that does not affect the delivery of the wider clinical service should be instituted. Service provision has been calculated for the 'core' AMU beds during the day. Covering extended hours for the AMU or any service provision to the embedded ambulatory care unit would require staffing in addition to that quoted.

Conclusion

The AMU is a highly complex area and careful consideration of skill mix is required to optimise the benefits of front-loading pharmacy services with particular regard to staff experience and shift patterns. Pharmacy technicians are able to be fully involved in such service provision as part of a balanced pharmacy team. This research provides some insight into how pharmacy service provision on the AMU may vary from that provided on medical wards. However, service planning needs to

take account of the nature of the AMU working environment and ensure that staff are adequately equipped and supported to provide the most reliable and effective service to both the wider clinical team and most importantly the patient.

Author contributions

The research was conceived by SG, JS and MPT. The research was designed and developed by SG supervised by MPT and JS. SG collected and analysed the data and wrote the paper supervised by MPT and JS.

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Conflicts of interest

The authors declare no conflicts of interest.

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PAPER TWO

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Optimising pharmaceutical care - front-loading pharmacy clinical services onto an acute medical unit

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Abstract

Introduction

Models of care for acutely unwell medical patients have evolved within a healthcare environment of escalating service demand and limited resources. Targeting resources to provide optimal health value for patients and providers is a key, strategic requirement. Reconciliation and optimisation of medicines are recognised patient safety interventions. Despite little published literature, intuitively, providing such services promptly after admission maximises their impact.

Aim

To compare how the provision of pharmacy services to patients in the first 72 hours on a medical ward differed if patients had received pharmacy interventions prior to transfer on the AMU.

Method

Pharmacy staff self-reported data about their clinical activity on the AMU and medical wards at a UK hospital. Data were described in terms of inputs and activities. An input represented a discrete period of clinical activity by pharmacy staff focussed upon the needs of one patient. It could comprise one or several activities, each an individual aspect of the content of an input. Following data collection, patients were allocated to exposure or control groups based upon whether they had received clinical pharmacy input on the AMU.

Analysis

The exposure group showed a significantly shorter time from admission to completion of a medicines reconciliation. Post ward-transfer, prescribing errors detected and prescribed items requiring a clinical check were significantly less. Pharmacy service time expended post ward-transfer was less for the exposure group but total service time during the admission was unchanged. Fewer inputs, containing fewer activities, were provided to the exposure group. The exposure group had a longer stay on the AMU but overall length stay was unchanged. Regression modelling demonstrated a significantly reduced total pharmacy service provision time following transfer to a medical ward following AMU service input.

Conclusions

Front loading pharmacy services onto the AMU enabled prompt medicines reconciliation and clinical review. This may be associated with reduced risk of patient harm secondary to medication errors. Medicines related workload was reduced for ward staff but overall service time was unaffected.

Keywords

Pharmacy, Acute Medicine, Acute Medical Unit

Introduction

The development of acute medicine as a recognised specialism over the last ten years has been a key factor in a paradigm shift regarding the best way to manage the acutely unwell medical patient in secondary care.[1] Specialist management by acute physicians in an acute medical unit (AMU) environment is now viewed, not only nationally, but also worldwide across a variety of healthcare models, as the best way to optimise outcomes for these patients during the first 48 to 72 hours of their hospital admission.[2] In order for the best outcomes from this model of care to be realised it is necessary for the AMU team to have strong clinical support from both diagnostic and allied health services, including pharmacy.[3] Medicines reconciliation, (identifying a patient's medication history pre-admission and ensuring that all items are correctly prescribed or any alterations properly documented), and associated clinical checking of prescribed medicines are both activities with a high patient safety impact[4]. Medicines reconciliation has been identified as a key medicines safety intervention by the World Health Organisation[4], the National Institute of Clinical Excellence[5] and the Royal Pharmaceutical Society. Both medicines reconciliation and clinical checking activities have been shown to be best performed by pharmacy staff[6] and, intuitively, the earlier that they are performed after admission the greater their value might be. Further value may be gained by the availability of pharmacy services in providing medicines optimisation and patient counselling support on the AMU.[7]

AMU bed occupancy rates are typically as great as those seen across general acute beds and are, in turn, coupled with a more rapid patient turnover and considerable case complexity. Providing pharmacy services in an environment with this continuous pattern of activity is challenging for pharmacy managers, given limited staffing levels and competing service demands. There is currently little published literature researching the effect of 'front-loading' pharmacy services into the AMU. Front-loading, in this context, describes the concentration of pharmacy staff into the AMU to provide input early in the course of an admission.[8-10] This study is the first to address this knowledge gap and explore what effect providing pharmacy services on the AMU subsequently has upon the delivery of such services in the first 72 hours following transfer of care from the AMU to a medical ward. The aim of this research was to compare whether the provision of pharmacy services to patients in their first

72 hours on a medical ward differed if they had received pharmacy interventions on the AMU prior to ward transfer.

Method

The study uses a cohort design with pharmacy staff self-reporting their clinical activities on the AMU and associated medical wards. This approach allowed us to collect data efficiently while controlling the impact of data collection upon the daily clinical activities of the staff involved.

The study site was a 700 bedded NHS teaching hospital located in an inner city area of northwest England with recognised deprivation and public health problems. There was a well-developed, integrated electronic patient record and electronic prescribing and administration system in operation. Data collection was completed on the AMU (36 beds) and the seven acute medical wards (24 or 25 beds each) that took the highest proportion of their admissions directly from the AMU.

Patients were potentially eligible for the study if any data were collected relating to their care by pharmacy staff on the AMU or the wards during one of the data collection periods. The exposure group contained those patients transferred from the AMU to a ward, where they stayed for up to 72 hours, and who received documented pharmacy staff input while on the AMU. The control group contained those patients transferred from the AMU to a ward, where they stayed for up to 72 hours, but who did not receive such documented pharmacy input on the AMU. In usual practice, patients who did not get pharmacy services in the AMU were those admitted and transferred during hours when a pharmacy service was not provided or workload prevented the pharmacy team from getting around to seeing them before they were transferred.

Data collected on the pharmacy staff input occurring more than 72 hours post-transfer were excluded. Patients were also excluded if:

- They had not been admitted to the AMU prior to admission to the ward.
- They had already been admitted to the AMU before the first data collection day of the data collection period.
- They were discharged directly from the AMU or transferred to a non-study ward.

Data were collected by any pharmacist or pharmacy technician working on the study wards during the three data collection periods, over six months. The allocation of staff to wards was carried out as part of the normal departmental rota setting procedure, determined by annual leave and required skill mix. The investigation team had no involvement in this process. A power calculation suggested that 210 eligible cases were sufficient for the detection of a 5 minute difference in pharmacy service time per patient between the exposure and control groups with 90% power at a two-sided 5% significance level. The staff collecting the data were not made aware as to which patients would subsequently meet the inclusion criteria for the study and would thus not be inclined to alter their usual practices for particular cases.

Two data collection periods spanned fourteen consecutive days running Saturday to Friday. Data were collected on the AMU from day 1 to 11 and on the wards from days 1 to 14. This allowed for a 72 hour transfer time for patients leaving the AMU on day 11. The third data collection period was truncated at day 11, when data were collected on the required number of eligible cases.

A piloted form was used by pharmacy staff to self-record their ward-based clinical activity. Each data unit collected about an individual patient at a specific ward location were defined as a 'period of clinical input' (input). Thus, all care given to a specific patient by a specific staff member on a data collection day, on a particular ward, was classed as a single input. The content of this input included one or more 'individual activity types' (activity) depending on the care the patient was given, such as completing their medicines reconciliation, or speaking to a doctor about treatment. Data were collected on the total time spent on the input and within this; the time spent in direct communication with the patient, item counts for clinical checks done and prescribing errors identified. The identification of prescribing errors was subjectively judged by the data collectors and included unintended omission of pre-admission medicines.

Further data regarding the admission were extracted from the electronic prescribing record (EPR) system for patients meeting the inclusion criteria (see Table 1). This included outcome data such as mortality and incidences of readmission. The number of prescribed pre-admission medicines was grouped as 0-4, 5-9 or 10+ items as used by Evans et al and used as a proxy for pharmaceutical complexity[11]. Duration

of admission was measured from a zero point of the electronic time stamp for admission to the AMU on the study site EPR system as recorded by the AMU staff. The project was deemed to be a service evaluation not requiring formal ethical approval by the research and development team at the study site. The hospital number was used to track patients between wards during data collection and then converted to a unique patient identification number to enable linkage of data from the AMU and wards. The data were initially entered into Microsoft Excel 2010 to facilitate data management and analysed using the IBM SPSS v22 statistics package. Comparisons between the exposure and control groups were made using either t-tests or Mann-Whitney U-tests, depending upon whether the data were normally distributed. A linear regression model was used to determine the predictive value of the independent variables:

- Exposure to pharmacy services on the AMU
- Number of regular medicines being taken pre-admission
- Admission unit length of stay
- Admission during hours of pharmacy AMU service provision

on total pharmacy service time during the first 72 hours post transfer to the ward. The independent variables contained within the model were those judged by the research team to be the most likely to impact upon each of the dependant variable.

Results

Overall 564 patients were admitted to the AMU during the study period and 278 patients were eligible for inclusion; they had received 1019 inputs comprising 2613 activities. Comparison of pre-admission demographics (Table 1) showed that the two groups were well matched for any likely confounding variables. Independent t-tests showed no significant differences between the groups for any of these variables. Analysis of mortality during admission and both mortality and readmission at 7 and 30 days post discharge demonstrated no significant differences between the two groups. Similarly the was no significant difference in overall length of stay between the groups.

Post-admission, patients in the exposure group (Table 2) had a significantly longer stay on the AMU but a similar duration of ward stay and correspondingly similar overall length of stay (24.3 (IQR=25.5) vs 10.5 (IQR=15.5) hours; $p<0.05$). The

average period of data collection for both groups was 2.8 days. There was a significantly shorter time between admission and when a post-admission medicines reconciliation was completed in the exposure group (14.8 (IQR=15.9) vs 34.1 (IQR=30.0) hours; $p<0.05$). The time between first prescription of a medicine and a medicines reconciliation having been completed was also significantly shorter (11.2 (IQR=17.1) vs 30.5 (IQR=29.2) hours; $p<0.05$).

Analysis of the activity profile across the two groups showed a significantly greater number of inputs having been completed for the exposure group (n=521 vs 498; $p<0.05$) but significantly fewer activities (n=1204 vs 1409; $p<0.05$). This translates as one extra activity for every two inputs completed for each exposure group patient. People in the Exposure Group received significantly less staff time per input regardless of which activity type it included. For example, the inclusion of a clinical checking activity in an input required 8 (IQR=18) vs 12 (IQR=24) minutes; $p<0.05$.

There was a significant difference between the exposure and control groups in the number of prescribing errors (n=123 vs 232; $p<0.05$) and errors of omission (n=70 vs 119; $p<0.05$) detected following ward transfer. For the whole data collection period however, no significant difference was seen, suggesting that errors and omissions were being identified earlier in the admission for the exposure group. The number of items requiring clinical checking post-transfer, a possible marker of pharmacist workload on the ward, were significantly fewer in the exposure group than the control group (n=986 vs 1362; $p<0.05$). Again, over the whole data collection period, there was no difference between the groups, suggesting the same amount of clinical checking was being carried out, but earlier, for the exposure group.

The average total pharmacy service time during the first 72 hours after ward transfer was significantly less for the exposure group (18 (IQR=27) vs 33 (IQR=30) minutes; $p<0.05$). The average total pharmacy service time during the whole admission was similar between the groups however.

The results of the linear regression analysis (Table 3) indicated that exposure to pharmacy services on the AMU significantly predicted a reduced time taken to provide clinical pharmacy services on the wards, during the first 72 hours post-transfer from the AMU (B= -18 minutes; LCI= -24.5, UCI= -11.4; $p<0.05$). Being prescribed more than 5 medicines pre-admission, a proxy marker for case

complexity, predicted a longer service time (B=1.903 minutes; LCI= 1.3, UCI= 2.506; $p<0.05$). The R^2 was 0.203 for the model.

Discussion

Our research was successful in demonstrating that pharmacy clinical service provision during the first 72 hours after transfer of care from the AMU to a medical ward was different if pharmacy clinical services were provided to the patient on the AMU prior to transfer to the ward. The results show a significantly shorter time from admission to completion of medicines reconciliation in the exposure group. Post-transfer of care, the number of detected prescribing errors was significantly less in the exposure group. Although significantly less time was spent in caring for the exposure group post transfer, there was no difference between the groups in overall pharmacy service time from admission to 72 hours post transfer. Post transfer, pharmacy staff also provided the exposure group with significantly fewer inputs each of which contained fewer activities. They were, however, able to commit more time to each input and activity. There were significantly fewer items requiring a clinical check, a surrogate marker of workload for pharmacy staff, in the exposure group post transfer. Although the exposure group had a longer initial stay on the AMU there was no difference in overall length of stay in hospital. Linear regression analysis demonstrated that, correcting for other factors, providing pharmacy services on the AMU was associated with a significant reduction in the time spent on pharmacy service provision in the first 72 hours post transfer of care from the AMU.

Accurate medicines reconciliation is known to be an effective means of preventing and detecting prescribing errors.[4, 5] It also underpins the medicines optimisation process assuring that each person is prescribed an effective and safe medicines regimen.[7] It is also known that pharmacy staff are the most effective group in completing this clinical activity, in comparison to doctors and nurses[6]. Early patient exposure to pharmacy services post admission means that, in addition to completing a medicines reconciliation, pharmacy staff can provide clinical evaluation of medication thus reducing actual and potential harm due to prescribing errors. This may in turn benefit the wider healthcare organisation both in helping to control length of stay and reducing litigation risk.

From a pharmacy service perspective front-loading services onto the AMU has a significant impact upon limited human resources. It is important therefore that the time spent in working with patients on the AMU is recouped over the rest of the admission, and that there is no duplication of effort. Our data suggests that this is achieved and that overall total pharmacy service time for an admission per patient is unaffected. We would thus recommend that the risk reduction associated with the earlier completion of medicines reconciliation justifies the front-loading intervention. Additionally, by reducing unresolved errors and clinical checking workload, ward pharmacy service provision can be focussed upon other clinical activities, such as end of stay transfer of care management, without adversely increasing overall service provision time. This would in turn mean that implementing a front-loaded AMU service would present an opportunity for a wider review of the way that pharmacy services are implemented across an organisation to ensure that service provision is fully optimised.

The causality of length of stay, readmission and mortality is complex and rarely attributable to a single factor.[12] However, multi-morbidity[13] and polypharmacy[14] are known to be associated with all three.[15] Because of this complexity it would not be unexpected that no differences in any of these measures would be observed between the groups. Importantly however, this also provides no evidence that front-loading pharmacy services onto the AMU has a detrimental effect upon patient outcomes.

Noticeable in our data is the limited time that is reported as being spent in face to face contact with the patient. Given the importance of patient involvement in the medicines reconciliation process and the need for effective medicines counselling to optimise concordance and adherence, this is concerning. Patients increasingly report 'depersonalised' healthcare[16] and the advent of electronic management systems may encourage staff to focus upon these sources of information to increase efficiency or achieve performance targets with the limited time available to them.[17] Similarly the focus upon improving patient flow is often implemented asynchronously between services. A common example of this is that patients will be transferred from the ward to a discharge unit immediately after having their breakfast to free up the bed for a new admission. However the pharmacy team have not been given the opportunity to prepare the discharge medication and counsel the patient before this

transfer occurs. This then makes it much more difficult for the completion of an effective medicines service at discharge. This increasingly leaves the patient isolated from pharmacy staff, limiting the opportunities for ad hoc yet effective counselling. This is an area that requires further research.

The study has a number of limitations. First, data were collected using a self-reporting method. This has recognised advantages in allowing large amounts of data to be collected over a relatively short period of time but is also associated with a number of sources of potential bias[18]. Second, data collection was completed in addition to usual workload and was thus subject to workload related effects upon how comprehensively it was collected at any given time. Third, data collection was intended to be carried out prospectively. However, staff may have used their own note taking processes and retrospectively transcribed them onto the data collection forms which may have introduced some recall bias. Furthermore, over the course of the data collection cycle it is also possible that data collection fatigue may have affected performance in recording activities. Additionally while the data collection forms were designed to minimise interpretation by the data collector the decision about how to classify activities within the given options still retained an unavoidable degree of subjectivity. Similarly the recording of time was entirely under the control of the data collector. It is likely, however, that the effect of these methodological weaknesses would be to reduce the likelihood of statistically detecting differences between the exposure and control groups. Hence if differences are detected between the groups, their credibility as true variations is strengthened. We acknowledge that single site data collection also constitutes a limitation and that the fact that the study site is one of the largest, busiest AMUs in the UK, using a well-established electronic patient record, may restrict the external validity and hence the generalisability of our findings. However the fundamental activity and working environment is similar to that seen on any other AMU and comparison between units is actually valid in the context of scale adjustment for number of beds.

Research into the impact of workload pressure upon hospital pharmacy staff is limited and focussed mainly upon dispensary activity by pharmacists in community settings. Patient-facing clinical activity at ward level is much less researched. Within the available literature workload has been identified as a risk factor for increased dispensing error rates and perceived job stress.[19] Workload has also been shown to

reduce pharmacists' detection of prescribing errors.[20] Additionally, although the effects of pharmacy service provision on the AMU are not well reported in the published literature, there is more work regarding prescribing errors.[21, 22] These are a recognised marker of risk for adverse drug events which in turn risk patient harm and may prolonged length of stay. Controlling these errors early during a hospital stay should, intuitively, reduce the chance of progression to actual harm and improve the overall quality of pharmaceutical care received. This study suggests that front-loading pharmacy services onto the AMU enables prompt medication reconciliation and the optimisation of prescribed medicines. Following ward-transfer, less pharmacy staff input is needed in the next 72 hours on the ward and patients are exposed to fewer prescribing errors, probably because they have been corrected more quickly. By minimising the risks of harm associated with prescribed medicines in this way, it could be hypothesised that a contribution would be made to a shorter length of stay. Further work would be needed to investigate this explicitly.

Conclusions

The hypothesis that front-loading pharmacy services onto the AMU realises early benefits for patients with regard to controlling their exposure to medicines related risk is verified by this research. This benefit could be achieved in a time neutral fashion with the extra AMU input being recouped in reduced service time following ward transfer.

Author contributions

The research was conceived by SG, JS and MPT. The research was designed and developed by SG supervised by MPT and JS. SG collected and analysed the data and wrote the paper supervised by MPT and JS.

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Conflicts of interest

The authors declare no conflicts of interest.

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Tables

Table 1: Study group pre-admission demographics

	Exposure Group	Control Group
Cases (n)	159	119
Age in years (mean, range)	70 (16-101)	73 (35-100)
Aged over 79 years (n,%)	57 (35)	44 (37)
Aged under 50 years (n,%)	22 (14)	10 (8)
Female gender (n,%)	91 (57)	60 (50)
Male gender (n,%)	68 (43)	59 (50)
MDS user (n,%)	60 (38)	32 (27)
Care home resident (n,%)	24 (15)	13 (11)
Local postcode (n,%)	145 (91)	104 (87)
Number of prescribed regular pre-admission medicines (mean, range)	14 (0-29)	13 (0-32)
Prescribed 10 or more regular medicines (n,%)	79 (50)	59 (50)
Prescribed between 5 and 9 regular medicines (n,%)	52 (33)	45 (38)

Table 2: Study group post-admission demographics

	Exposure Group	Control Group
Admission during hours of full pharmacy service	34	34
Ward transfer during hours of full pharmacy service	42	26
Median AMU length of stay (hrs) (IQR)*	24.3 (25.5)	10.5 (15.5)
Median time admission to first medicine prescribed (hrs) (IQR)	1.5 (2.6)	1.0 (2.4)
Median time admission to medicines reconciliation (hrs) (IQR)*	14.8 (15.9)	34.1 (30.0)
Median time first medicine prescribed to medicines reconciliation (hrs) (IQR)*	11.2 (17.1)	30.5 (29.2)

*Independent samples Mann-Whitney U tests showed statistical significance (p=0.05)

Table 3: Linear regression results

Independent variable	B	P-value	95% Confidence intervals	
			Lower	Upper
Exposure to pharmacy services on the AMU	-17.968	<0.05	-24.511	-11.425
Number of prescribed regular medicines pre-admission	1.903	<0.05	1.300	2.506

R^2_{adj} for the regression model was 0.203

CHAPTER SIX: SUMMARY OF RESULTS

6.1 Paper 1: Variation in patient-facing clinical service provision by pharmacy staff on an acute medical unit and acute medical wards in a UK teaching hospital

The data described people admitted to the AMU receiving nearly three times fewer number of inputs than do those admitted to the medical wards. Despite this the activity content of each input was greater on the AMU. The ability to work remotely is one, purported; advantage of an EPR system and our data showed that such activity resulted in inputs being completed in a shorter time than during a physical ward visit. Both groups of pharmacy staff spent longer completing inputs on the AMU than the wards. Pharmacists spent less time than technicians completing inputs on the AMU, but more time on the medical wards. Regular AMU staff spent longer on inputs on the AMU than did non-regular staff, less experienced staff spent longer on each input in both environments. Interaction with the patient significantly increased service provision time but was noted to have a lower than expected prevalence in the overall data. Admission related inputs took up the greatest proportion of pharmacy service time on the AMU in contrast with the wards where discharge inputs were the most time consuming. Variation was observed in the content of workload patterns between pharmacists and technicians. Locational variance was also observed for both staff groups. Differences in the underlying workload between the AMU and the wards are apparent. The impact of pharmacy clinical services upon outstanding workload was observed to differ significantly between the AMU and wards. An estimate of an ideal staffing level based upon the collected data was provided.

6.2 Paper 2: Optimising pharmaceutical care - front-loading pharmacy clinical services onto an acute medical unit

The results show a significantly shorter time from admission to completion of medicines reconciliation in the exposure group. Post-transfer of care, the number of detected prescribing errors was significantly less in the exposure group. Although significantly less time was spent in caring for the exposure group post transfer, there was no difference between the groups in overall pharmacy service time from admission to 72 hours post transfer. Post transfer, pharmacy staff also provided the exposure group with significantly fewer inputs each of which contained fewer activities. They were, however, able to commit more time to each input and activity. There were significantly fewer items requiring a clinical check, a surrogate marker of

workload for pharmacy staff, in the exposure group post transfer. Although the exposure group had a longer initial stay on the AMU there was no difference in overall length of stay in hospital. Linear regression analysis demonstrated that, correcting for other factors, providing pharmacy services on the AMU was associated with a significant reduction in the time spent on pharmacy service provision in the first 72 hours post transfer of care from the AMU.

6.3 Additional results

Table 5: The effect of carrying out a particular activity upon the total time spent by a Pharmacist in completing the corresponding period of clinical input

Pharmacists		EAU inputs (n=869)			Ward inputs (n=3710)		
Type of activity contained in input		Number of inputs recorded (n)	Mean number of activities in each input (n)	Mean time spent working during each input (mins)	Number of inputs recorded (n)	Mean number of activities in each input (n)	Mean time spent working during each input (mins)
Medicines Reconciliation	Present	405	5	17.2	328	5	17.1
	Absent	464	2	7.7	3382	2	6.5
	%Present	**46.7**			**8.8**		
Clinical checking	Present	610	4	14.0	2480	3	8.3
	Absent	259	2	7.6	1230	2	5.6
	%Present	**70.2**			**66.8**		
Error intervention	Present	152	5	19.5	680	4	11.0
	Absent	717	3	10.5	3030	2	6.6
	%Present	**17.5**			**18.3**		
Monitoring therapy	Present	97	5	17.1	1863	3	7.1
	Absent	772	3	11.5	1847	2	7.8
	%Present	**11.1**			**50.2**		
Counselling/Communicating	Present	231	5	15.9	550	4	13.2
	Absent	638	3	10.8	3160	2	6.4
	%Present	**27.4**			**14.8**		
Information gathering	Present	449	4	15.2	2216	3	8.0
	Absent	420	2	8.8	1494	2	6.5
	%Present	**51.7**			**59.7**		
Accuracy checking	Present	70	3	11.0	210	3	14.2
	Absent	799	3	12.2	3500	3	7.0
	%Present	**8.1**			**5.7**		
Ordering	Present	243	5	14.9	602	4	10.1
	Absent	626	3	11.0	3108	2	6.9
	%Present	**28.0**			**16.2**		
Dispensing	Present	28	5	15.1	72	4	19.6
	Absent	841	3	12.0	3638	3	7.2
	%Present	**3.2**			**1.9**		

Table 5 details the effect of carrying out a particular activity upon the overall time spent upon the period of clinical input by the pharmacist. Thus, for example, completing a medicines reconciliation increases the average time spent from 7.7 minutes to 17.2 minutes. Comparative values for the AMU and wards are provided.

The proportion of inputs containing the particular activity are also indicated.

Table 6: The effect of carrying out a particular activity upon the total time spent by a Technician in completing the corresponding period of clinical input

Technicians		EAU PCIs (n=159)			Ward PCIs (n=1454)		
Type of IAT contained in PCI		Number of PCIs recorded (n)	Mean number of IATs in each PCI (n)	Mean time spent working during each PCI (mins)	Number of PCIs recorded (n)	Mean number of IATs in each PCI (n)	Mean time spent working during each PCI (mins)
Medicines Reconciliation	Present	80	3	20.7	11	5	9.4
	Absent	79	1	8.5	1443	2	5.0
	%Present	**50.3**			**0.8**		
Clinical checking	Present	0	0	0	1	8	17
	Absent	159	2	14.6	1453	2	5.0
	%Present	**0**			**0**		
Error intervention	Present	0	0	0	279	3	2.6
	Absent	159	2	14.6	1175	1	5.6
	%Present	**0**			**19.2**		
Monitoring therapy	Present	0	0	0	144	2	2.2
	Absent	159	2	14.6	1310	2	5.3
	%Present	**0**			**9.9**		
Counselling/communicating	Present	19	4	14.4	36	3	8.2
	Absent	140	2	14.6	1418	2	5.0
	%Present	**11.9**			**2.5**		
Information gathering	Present	39	4	17.7	720	2	5.7
	Absent	120	2	13.6	734	1	4.4
	%Present	**24.5**			**49.5**		
Accuracy checking	Present	10	1	4.8	19	2	6.6
	Absent	149	2	15.3	1435	2	5.0
	%Present	**6.3**			**1.3**		
Ordering	Present	15	3	21.3	1137	2	3.6
	Absent	144	2	13.9	317	1	10.4
	%Present	**9.4**			**78.2**		
Dispensing	Present	63	1	8.6	169	2	14.9
	Absent	96	3	18.6	1285	2	3.7
	%Present	**40.0**			**11.6**		

Table 6 details a similar data content to table 5 except in this case for pharmacy technicians rather than pharmacists.

Table 7: The effect of interacting with a particular group upon the total time spent by a Pharmacist in completing the corresponding period of clinical input

Pharmacists		EAU inputs (n=869)			Ward inputs (n=3710)		
Type of activity contained in input		Number of inputs recorded (n)	Mean number of activities in each input (n)	Mean time spent working during each input (mins)	Number of inputs recorded (n)	Mean number of activities in each input (n)	Mean time spent working during each input (mins)
Interaction with medical staff	Yes	224	4	16.7	1103	3	11.5
	No	645	3	10.5	2607	2	5.7
	%Yes	**25.8**			**29.7**		
Interaction with nursing staff	Yes	224	4	14.3	490	3	14.3
	No	645	3	11.4	3220	2	6.4
	%Yes	**25.8**			**13.2**		
Interaction with another pharmacist	Yes	65	4	18.4	198	3	12.9
	No	804	3	11.6	3512	3	7.1
	%Yes	**7.5**			**5.3**		
Interaction with a technician	Yes	189	3	11.4	275	3	13.1
	No	680	4	12.3	3435	3	6.9
	%Yes	**21.7**			**7.4**		
Interaction with a pharmacy ato	Yes	10	5	19.5	30	3	9.6
	No	859	3	12	3680	3	7.4
	%Yes	**1.2**			**8.1**		
Interaction with internal staff group	Yes	9	6	22.2	121	3	8.6
	No	860	3	12	3589	3	7.4
	%Yes	**1.0**			**3.3**		
No interaction with anyone	Yes	179	2	5.3	1710	2	4
	No	690	4	13.9	2000	3	10.3
	%Yes	**20.6**			**46.1**		
Interaction with the patient	Yes	284	5	19.4	502	4	18.2
	No	585	3	8.6	3208	2	5.7
	%Yes	**32.7**			**13.5**		
Interaction with a carer or relative	Yes	38	5	23.7	61	4	17.6
	No	831	3	11.6	3649	3	7.2
	%Yes	**4.4**			**1.6**		
Interaction with GP surgery	Yes	138	5	17.9	81	4	17.8
	No	731	3	11	3629	3	7.2
	%Yes	**15.9**			**2.2**		
Interaction with external staff group	Yes	10	6	23.6	35	4	14.5
	No	859	3	12	3675	3	7.3
	%Yes	**1.2**			**0.9**		

Table 7 details the impact of interacting with other staff and public groups upon time spent completing periods of input. This data relates to the activity of pharmacists.

Table 8: The effect of interacting with a particular group upon the total time spent by a Technician in completing the corresponding period of clinical input

Technicians		EAU inputs (n=159)			Ward inputs (n=1454)		
Type of activity contained in input		Number of inputs recorded (n)	Mean number of activities in each input (n)	Mean time spent working during each input (mins)	Number of inputs recorded (n)	Mean number of activities in each input (n)	Mean time spent working during each input (mins)
Interaction with medical staff	Yes	3	2	11.7	10	2	11.1
	No	156	2	14.7	1444	2	5
	%Yes	**1.9**			**0.7**		
Interaction with nursing staff	Yes	25	1	8.4	156	2	9.1
	No	134	2	15.8	1298	2	4.5
	%Yes	**15.7**			**1.1**		
Interaction with another pharmacist	Yes	103	2	15.2	215	2	13.7
	No	56	3	13.6	1239	2	3.5
	%Yes	**64.8**			**14.8**		
Interaction with other technician	Yes	18	1	6.7	14	2	11.6
	No	141	2	15.6	1440	2	5
	%Yes	**11.3**			**1.0**		
Interaction with a pharmacy ATO	Yes	0	0	0	5	2	14.2
	No	159	2	14.6	1449	2	5
	%Yes	**0**			**0.3**		
Interaction with internal staff group	Yes	2	4	30	23	2	7
	No	157	2	14.4	1431	2	5
	%Yes	**1.3**			**1.6**		
No interaction with anyone	Yes	1	1	10	1038	2	3.2
	No	158	2	14.6	416	2	9.7
	%Yes	**0.6**			**71.4**		
Interaction with the patient	Yes	74	3	19.8	93	2	11.5
	No	85	1	10.1	1361	2	4.6
	%Yes	**46.5**			**6.4**		
Interaction with a carer or relative	Yes	11	3	29	3	3	19
	No	148	2	13.5	1451	2	5
	%Yes	**6.9**			**0.2**		
Interaction with GP surgery	Yes	26	3	25.3	7	3	16.1
	No	133	2	12.5	1447	2	5
	%Yes	**16.4**			**0.5**		
Interaction with external staff group	Yes	9	3	32.7	0	0	0
	No	150	2	13.5	1454	2	5
	%Yes	**5.7**			**0.0**		

Table 8 details a similar data content to table 7 except in this case for pharmacy technicians rather than pharmacists.

Table 9: The impact of time of day upon average workload and time spent completing it by Pharmacists

		Mean number of activities in the period (n)	Mean time spent working during the input (mins)
EAU	0800-1300	3	12.3
	1300-1730	3	12.2
	1730-2000	4	10.8
Wards	0800-1300	3	7.5
	1300-1730	2	7.3
	1730-2000	2	5.6

Table 10: The impact of time of day upon average workload and time spent completing it by Technicians

		Mean number of activities in the period (n)	Mean time spent working during the input (mins)
EAU	0800-1300	2	17.0
	1300-1730	2	13.7
	1730-2000	2	10.8
Wards	0800-1300	2	5.3
	1300-1730	2	4.9
	1730-2000	0	0

Table 11: Impact of point during stay on average workload and time spent completing it by pharmacists

		Mean number of activities in the period (n)	Mean time spent working during the input (mins)
EAU	Admission	4	14.1
	In-patient	2	6.6
	Discharge	3	10.4
Wards	Admission	5	15.1
	In-patient	2	4.7
	Discharge	3	14.6

Table 12: Impact of point during stay on average workload and time spent completing it by technicians

		Mean number of activities in the period (n)	Mean time spent working during the input (mins)
EAU	Admission	4	30.7
	In-patient	3	18.5
	Discharge	1	8.0
Wards	Admission	3	5.1
	In-patient	2	3.5
	Discharge	1	14.9

Table 9 details how the time of day affected the activity content of each input and the time spent on each input by pharmacists. Table 10 conveys the same information for technicians. The impact of when the input occurred during the continuum of care is displayed in Table 11 for pharmacists and table 12 for technicians.

Table 13: Comparison between the two study groups of time spent on inputs and activities following ward transfer

	Control group (n=119)						Exposure group (n=159)					
	Number of patients	Sum of inputs containing the type of activity	Mean number of inputs containing the type of activity per patient	Total time spent on inputs containing the type of activity	Mean time per patient spent on inputs containing the type of activity	Mean time spent on each input containing the type of activity	Number of patients	Sum of inputs containing the type of activity	Mean number of inputs containing the type of activity per patient	Total time spent on inputs containing the type of activity	Mean time per patient spent on inputs containing the type of activity	Mean time spent on each input containing the type of activity
Type of activity contained in input:												
Medicines Reconciliation	119	112	0.9	1910	16.1	17.1	159	30	0.2	493	3.1	16.4
Clinical checking	119	255	2.1	3105	26.1	12.2	159	267	1.7	2183	13.7	8.2
Error intervention	119	117	1.0	1385	11.6	11.8	159	92	0.6	798	5.0	8.7
Monitoring therapy	119	171	1.4	1924	16.2	11.3	159	185	1.2	1137	7.2	6.1
Counselling/communicating information	119	62	0.5	1114	9.4	18.0	159	45	0.3	565	3.6	12.6
Information gathering	119	282	2.4	2982	25.1	10.6	159	294	1.8	2229	14.0	7.6
Accuracy checking	119	28	0.2	385	3.2	13.8	159	21	0.1	280	1.8	13.3
Ordering medication	119	178	1.5	1477	12.4	8.3	159	208	1.3	1459	9.2	7.0
Dispensing	119	22	0.2	362	3.0	16.5	159	19	0.1	254	1.6	13.4
Interaction with:												
Medical staff	119	145	1.2	2129	17.9	14.7	159	122	0.8	1224	7.7	10.0
Nursing staff	119	71	0.6	1210	10.2	17.0	159	68	0.4	967	6.1	14.2
Pharmacist	119	48	0.4	806	6.8	16.8	159	36	0.2	482	3.0	13.4
Pharmacy Technician	119	25	0.2	385	3.2	15.4	159	26	0.2	367	2.3	14.1
Pharmacy ATO	119	5	0.0	103	0.9	20.6	159	5	0.0	52	0.3	10.4
Other Study Site staff group	119	11	0.1	113	0.9	10.3	159	6	0.0	54	0.3	9.0
No-one	119	196	1.6	781	6.6	4.0	159	281	1.8	1122	7.1	4.0
Patient	119	123	1.0	2262	19.0	18.4	159	52	0.3	883	5.4	17.0
Carer/Relative	119	10	0.1	172	1.4	17.2	159	4	0.0	56	0.4	14.0
Primary care practitioner	119	13	0.1	262	2.2	20.2	159	6	0.0	165	1.0	27.5
Non Study Site Hospital practitioner	119	7	0.1	113	0.9	16.1	159	4	0.0	70	0.4	17.5

Table 13 presents aggregated data for pharmacists and technicians for the cases included in part 2 of the research. It summarises the impact of particular activities

and interventions with other staff upon the time spent conducting inputs in both the control and exposure groups following transfer to the ward from the AMU.

CHAPTER SEVEN: DISCUSSION

7.0 Discussion

The data collected successfully demonstrates, in paper 1, that there are quantitative differences in the activity content of pharmacy clinical service provision between the AMU and the medical wards that most frequently admitted patients from the AMU. These differences were seen with regard to a number of different aspects of service provision and also between the activity of pharmacists and pharmacy technicians. Additionally, the data collected also described differences in workload factors that might have an influence upon the way that pharmacy clinical services are delivered. A coherent understanding of service delivery and workload upon the AMU and how this differs from the medical wards is argued to be essential for the planning of the future delivery of these services in this clinical environment.

The aim of the paper 2 was to determine whether frontloading the provision of pharmacy clinical services onto the AMU led to any quantitative differences in pharmacy clinical service provision in the first 72 hours following ward transfer from the AMU and if any associated patient outcome benefits were demonstrable. In overall terms the data subset demonstrated that front-loading reduced pharmacy input time following ward transfer without increasing total input time across the whole admission. Additionally prescribing errors were detected earlier in the admission, medicines reconciliations were completed more promptly and more prescribed items received a more prompt clinical review by a pharmacist.

7.1 Limitations

7.1.1 Internal validity

Maintaining the internal validity of the data collected during this research was given considerable consideration at the design stage of the project and has already been described in chapter three of this thesis. As discussed there are very likely to be aspects of selection bias in the data will that need to be considered in interpreting the findings. These will be in significant part due to workload pressure and workload fatigue. Data collection was conducted alongside normal work activity in a very busy acute environment. It is thus highly likely that data collection omission will have occurred and that we will not have a full picture of activity. It is contended that collecting data across a number of wards over several activity periods will, to a certain extent, correct for this. It is also likely that these omissions of collection would tend to make findings between the two groups more similar and in fact, reduce the

likelihood of detecting significant differences between them. Thus if, as in fact happened, differences were detected it gives them greater credence as being true representations of real variation.

The structure of the data collection process, using clearly defined descriptors to control for interpretation on the part of the data collector and the use of a highly portable means of data collection to encourage real time activity recording mean that the study should be realistically repeatable in other healthcare environments. The use of paper based health records would however, as already discussed, add considerably to the time impact of the work.

7.1.2 External validity

It is important that research methods maximise the external validity of the data that is collected. It is acknowledged that the study site has one of the largest and busiest AMUs in the UK and that it utilises a well-developed electronic prescribing and administration system in addition to a highly evolved, for the UK healthcare environment, electronic patient record. Additionally local internal understanding of how to best operate the AMU service in the most effective way is still an evolving process. Given this background the external validity of the data for other healthcare providers may be contended. In response to this our argument would be to assert that, given the paucity of existing literature on the subject, the results of this research are still of great interest to the wider health community, particularly in acute medicine and for those implementing and developing pharmacy services in acute medicinal environments. It is acknowledged that a multi-site study would be theoretically preferred from a generalisability perspective however the need for local knowledge acquisition in conjunction with the time constraints placed on the research favoured our chosen model of a single site investigation.

7.2 Contribution to knowledge

This work has achieved its overarching aims in providing data relating to an under-researched aspect of pharmacy practice that is of increasing importance in planning and developing future clinical services. The findings from paper one describe how practice in the AMU differs from that on the medical wards and important factors that need to be considered in conjunction with this. Additionally the differences in the workload facing pharmacy staff in both locations are described. These workload

issues are one factor that requires consideration in the understanding of these services and also in planning future developments. Paper two takes a subset of this data and evidences the advantages of frontloading pharmacy resources into the AMU to complete initial clinical interventions as promptly as possible after admission.

As discussed, the AMU is an integral feature of clinical service provision in most hospitals providing acute medical care across the majority of international healthcare systems. Providing such acute medical services effectively relies upon pharmacy services as a key factor in their delivery. Prompt medicines reconciliation in turn leads to safer prescribing, more effective medicines management and optimisation. This has ultimate benefit for patients in terms of harm reduction and risk control. Despite this little literature has been published that has sought to research the role of pharmacy services in the effective function of the AMU. To this end, this research should be of benefit in provoking further investigation of this area of practice. This might include ideas such as a qualitative understanding of why pharmacy staff work in the way that they do, what other healthcare professionals and patients want from the pharmacy service and how pharmacists work with non-medical prescribers in acute medical settings.

7.3 Methodological critique

From the outset of this research it was clear that within the relatively small body of published literature relating to acute medicine the fraction that related to the provision of pharmacy clinical services in the acute medical environment was miniscule. Given the key role of acute medical services in 21st century healthcare provision and that the effective and safe use of medicines or lack of it is so integral to causes of acute medical admissions and then the provision of harm free care this is concerning. This lack of literature is also evidenced by the limited reference to the provision of pharmacy services in any of the major guidance documents published on the subject of acute medicine and how best to provide such services within the hospital environment. The absence of a ‘gold-standard’ understanding of how best to provide pharmacy clinical services in the AMU environment leads to the conclusion that such services are probably being developed on an largely reactive, ad hoc basis according to local service demands and staffing levels. This model of service development may lead to poor communication of best practice between providers with a consequent detriment to the quality of care delivered to patients.

Methodologically it has been explained why a randomised controlled approach to this type of work would be unethical in a healthcare system where the provision of an integrated clinical pharmacy service is well established. This should not however discourage the consideration of this approach in an environment where such establishment is not pre-existent. Indeed such an environment might provide an ideal means to research a stepwise introduction of pharmacy clinical services to contribute to a clearer knowledge of service development outcomes. In conducting this research one of the biggest obstacles to the integrity of the data in being truly representative of practice was the lack of documentation of clinical activity in the electronic patient by pharmacy staff. If such information had been available, perhaps in a structured format, retrospective data capture would have been possible. This would have had the advantage, given the electronic prescribing system, of the option of a larger data sample less affected by bias as the note keeping would have been conducted as a more routine activity. The value of the electronic patient record in conducting this research cannot be underestimated. The time saved in data collection over not having to review individual paper-based case notes was considerable and indeed without it may have rendered this work untenable to conduct. Despite this there are always considerations for how the availability of data for research might be optimised within any system. While the development of the electronic patient record is very advanced within the context of the NHS in the UK the development of flexible, user-friendly data extraction modalities is much less well developed. Whilst there are always understandable information governance considerations about data access this is an area where academia and healthcare providers might work together in system development to improve the quality of future healthcare research.

As a function of the time available to conduct this research there was a focus on a quantitative approach to data collection. In conjunction with the selected cohort method this allowed for the collection of a relatively large amount of data in the limited time available. This was felt to be important to avoid the risk of being left with a small data sample that would be of limited value in subsequent analysis or explanation. Beyond this proviso however, it is recognised that additional qualitative research of the motivations and thinking underlying the quantitative findings of the pharmacy staff involved would be of immense value in providing a deeper

understanding of this area of practice. An obvious extension of this line of thought would be a more robust qualitative understanding of the perspectives of other groups of healthcare professionals, particularly medical and nursing with regard to the way that pharmacy clinical services are provided. Patient and carer perspectives would also be an invaluable source of information in enhancing knowledge and understanding of how best to provide pharmacy clinical services in the AMU environment.

The lack of a validated clinical scoring system for pharmaceutical complexity in acute illness has already been mentioned and its potential utility in this type of research should one be developed cannot be underestimated. The balancing act between frontloading services and maintaining service levels elsewhere is a constant source of difficulty in the effective planning and development of pharmacy clinical services. A potential solution to this would be to target service provision with a focus on individual patient need i.e. provide the services to the patients who will benefit most from the service investment. To provide a research base to support this approach it is essential to be able to 'score' patients to an individual level to determine the outcomes of service interventions. We in fact, utilised polypharmacy as a proxy marker for pharmaceutical case complexity. This decision was made as there is no currently validated measure for this, although it is noted that this is an area currently being researched by the ASHP in the US. Our choice of proxy marker is supported by the linear regression model which demonstrated that increasing numbers of prescribed medicines pre-admission correlated with and increasing need for pharmacy service time following ward transfer.

The rapid patient turnover seen on the AMU makes it unsurprising that the opportunity for pharmacy clinical service provision is more limited than it is on the wards. On this basis it is interesting to speculate that the way that pharmacy staff work on the AMU is being modelled on a limited opportunity to complete a complex multifactorial clinical intervention (medicines reconciliation) whilst ward working is modelled around multiple opportunities to complete clinical interventions that each have a narrower individual scope. The ability to work remotely whilst still having full access to clinical information is promoted to be a major advantage to clinical staff of all professions of having a well-developed and fully integrated electronic patient management system. A balancing disadvantage of this however, is that a culture of

‘silo working’ becomes engendered. Staff complete much of their activity in professional isolation with the attendant loss of much of the advantage of multidisciplinary team working. This risk is enhanced by resource issues in the information technology infrastructure that exist at ward level within the study site. Intuitively, the ability of staff to access the electronic patient management system is dependent upon their availability of access computer hardware. At ward level this is a scare resource with nursing, medical, administrative, allied health professional and pharmacy staff all competing for such hardware resources. This tacitly encourages staff to seek alternative access points off the ward to enable them to maintain their required workflow through the day. We have already discussed how the opportunity for the completion of pharmacy clinical services activity is more limited in per-patient terms on the AMU than it is on the wards. The variation on the wards is more likely an artefact of the more clearly differentiated clinical roles of the two staff groups with the ordering focussed tasks of the technicians being relatively mechanical and thus quicker to carry out.

Post-admission inputs will predominantly relate to the completion of medicines reconciliation, the complex, time consuming nature of which has already been discussed. AMU discharges however, are commonly relatively simple as they relate to patients not requiring either prolonged or complex management, who are sent home with simple medicines interventions such as antibiotics or short course oral corticosteroids or indeed no changes to regular medicines. This will contrast with the wards, where discharges following more complex in-patient management are likely to include more significant changes to medicines regimes that are likely to be intended to be sustained over the longer term.

It might be suggested that more rapid transfer off the AMU was indicative of being ‘less’ ill or ‘less’ complicated. However given that the subsequent length of ward stay for these cases was actually shown to be longer would suggest that, in fact, this was not generally the case. If in fact the AMU patients in the exposure group were more ill then their tendency towards a shorter length of stay would indicate an outcome advantage due to their initials AMU management which is again an area for possible investigation in the future. Logic suggests that for pharmacy service input on the AMU to realise maximal outcome benefits for patients it would be necessary to have a service structure in place that allowed rapid access to pharmacy services following

AMU admission. It may also be that, as medicines reconciliation is the predominant focus of early pharmacy services intervention, if that activity were also able to be completed by other groups of healthcare professionals to a similar standard to pharmacy staff potential outcome advantages might also be better realised for the patient and whole system alike. Literature has already reported that pharmacists do in fact reconcile medicines more effectively than other groups and this identifies a clear opportunity for educational intervention for other professions and further research[142, 143]. This may, in turn, lead to an overall service time saving following ward transfer. This is important because a concern with the frontloading of services is whether duplication of work occurs between the AMU and the wards. There was no evidence to suggest that this was the case although it should be noted that the constant movement of patients on and off of the AMU is an important consideration when analysing this aspect of the functionality of the unit. Indeed pharmacy staff working on the AMU appear to have to deal with a much greater volume of work relating to new admissions than do pharmacy staff working on the wards. This in turn suggested that staffing models that work effectively on the wards may not do so, on the AMU, without careful extrapolation to account for this greater workload pressure.

A further factor that impacts upon the effectiveness of the pharmacy service on the AMU is the pressure created upon the system by the ambulatory care unit. Whilst this is a recommended part of an AMU service it is frequently not funded for pharmacy clinical service provision due, in-part, to the short stays of the patients allocated to it[144]. Unfortunately however, whilst rapid patient assessment and discharge is often possible, a component of this is still frequently a new or dose adjusted medicines regimen for the patient. This in turn requires medicines reconciliation and review and a discharge prescription to be dispensed, followed by the need for patient counselling to be conducted prior to discharge. These tasks fall on the pharmacy staff covering the AMU thus diluting their clinical effectiveness in providing a service to the part of the unit where they are actually funded to be.

7.4 Implications for pharmacy

Whist the staffing model for the AMU at the study site at the time of data collection included a core of one senior pharmacist, one junior pharmacist and one and a half whole time equivalent pharmacy technicians, this was supplemented by additional

pharmacist time allocated in blocks of between two and four hours each day. Within this there was minimal continuity of the actual staff involved in this aspect of service provision from day to day. This was partly due to AMU coverage having to be worked in around the rest of the pharmacy department's clinical responsibilities and also that AMU working was not a preferred activity of the majority of the staff. This pattern of sporadic cover has been described in the literature as not being conducive to the effective function of the AMU with regard to medical staff but has not been researched for pharmacy staff. Guidance for medical staffing is that doctors allocated to the AMU should, to the greatest possible extent, only work in that environment whilst rostered to it. This recognises the importance of focussing on the needs of the acutely unwell patient cohort and the need to be in control and organised in managing the workloads associated with a high turnover clinical environment. It is both technically and psychologically difficult for healthcare professionals to enter into a complex clinical environment and provide coherent clinical services using a sequence of short patient and service contact footprints. On this basis and because of the different nature of the work encountered on the AMU compared to the wards. It may be that peripatetically allocated staff struggle to adjust to short periods of markedly different working requirements and that this subsequently affects how long they are able to spend working on inputs. This working pattern also makes it difficult for staff to take ownership of clinical care and follow through outstanding actions. An additional consideration here is that the staff who are working on the AMU on a regular basis have to maintain some understanding and coordinating role with regard to the activities of their colleagues. An for example of his might be with regard to ensuring that outstanding clinical issues are effectively followed up or handed over. It is interesting to consider how rostered handover time at the beginning and end of clinical sessions on the AMU would help to address this issue.

The fundamentally complex nature of the patient cohort on the AMU carries an attendant requirement for complex decision making on the part of clinical staff involved in their care. The high turn-over nature of the unit adds a considerable and significant time pressure to this process. Clinical experience will logically better equip clinical staff to manage these competing factors in a clinically effective and efficient manner (explicitly we did not measure the quality of the work carried out). Confounding this however is that more experienced staff, because of the more

complex nature of their job roles, are more likely to have a greater number of competing pressures for their time, both clinical and non-clinical. Additionally, as a group, more experienced staff may have a self-perceived identity in terms of what they see to be their clinical role within the organisation. This may lead to a resistance or reduced motivation to be involved in a technically ‘difficult’ clinical area that is not perceived to be their area of responsibility nor one in which they have an invested clinical interest. Conversely, less experienced staff who generally follow a more flexible, rotational working pattern across a number of clinical areas, may not exhibit these behaviours. The result of this situation might be that it becomes ‘easier’ to roster the more compliant, but less experienced, staff cohort onto the AMU even though this carries the attendant risk that these junior staff are actually not the most suitable group to be so allocated. This scenario additionally brings into consideration how well less experienced staff cope with the workload stresses of the AMU. This is an important consideration for overall system performance.

7.5 Implications for patients

The importance of effective engagement and communication between healthcare professionals and their patients in medicines optimisation activities has already been discussed and it is central to the effective delivery of many facets of the pharmacy clinical service. Similarly, it is vitally important that patients are, to the greatest possible extent, involved in decision making about their medicines and that they fully understand and agree with changes made to their medicines regimens during any hospital admission. In acknowledging this there is an overriding concern that with the introduction of electronic patient management systems and coupled with an increasing clinical workload, there is actually now less interaction between health care professionals and their patients. This problem is not limited to pharmacy and is subject to initiatives to address this in both the medical and nursing fields. The results observed in our data suggest that levels of engagement between pharmacy staff and patients may similarly be less than might be expected to be optimal for the effective all round delivery of clinical services. It is important to note however that many frequently occurring activity types, such as ordering, will not usually require patient interaction. Additionally errors were seemingly being detected more quickly after admission than as the case in the exposure group. This has a clear outcome benefit for patients in that the earlier this type of error is detected the less the risk

that it will progress to cause actual harm to the patient. Errors also represent workload pressure and the fewer of these that need to be sorted out at ward level will release time for pharmacy staff to pursue other clinical activities. Similarly, clinically checked items on the AMU would be indicative that medicines were subject to pharmaceutical review and ordered more promptly after admission than in the control group. This would reduce the risk of medicines being unavailable with the attendant risk of dose omission.

7.6 Implications for Service Planning

The frontloading of pharmacy services onto the AMU represents a significant staffing pressure for a pharmacy department. This work suggests that in planning for an AMU service the simple adoption of a model 'that's works' on the wards will probably not provide sufficient service capacity to cope with the unique workload pattern of the AMU. Providing services for a restricted period of the day or week will generate its own problems as catching up will disrupt the ability to provide a prompt proactive service. Staffing using a short spell rota model is at odds with the research as to what works best for medical staff[145, 146]. This clearly needs to be researched but, in the absence of that data, extrapolation from the medical model would seem to be a sensible approach. More experienced staff probably process patients in a more time efficient fashion. Given the complex nature of the AMU the use of high proportions of junior staff is probably not the best way to work and again is at odds with the way that staffing models for other healthcare professions are organised. Pharmacist to bed ratio information is very lacking in the literature. However what there is supports our argument that ward models of care are not necessarily transferable to AMUs. The suggested modelling of the AMU does not incorporate the distinct ambulatory care service that is provided within the AMU at the study site. These patients are turned around within 24 hours but are very labour intensive as medicines reconciliation and similar are still needed but additionally prompt discharge intervention is also required. It is suggested that ambulatory care activity should be separated from the core AMU service and staffing planned independently to avoid effecting a detrimental impact upon the timely provision of services on the rest of the AMU. Similarly AMU's may include a dedicated unit for complex (usually older people) cases. We have discussed earlier the unique challenges presented by complex care and again staffing this facet of the overall AMU service needs to be

planned in its own right to avoid impact upon the core AMU service. It has been shown that AMU workload builds up in the absence of pharmacy cover and with the advent of 24/7 working it is suggested that the AMU is one of the first areas where serious consideration of that level of cover should be applied. It is assumed that in achieving ideal staffing, it would be necessary to take this time out of that currently allocated to other service activity. Given how central AMU operation is to overall organisational function, redesigning AMU pharmacy services would be best conducted as an exercise as part of a complete service review even in the presence of dedicated funding.

Within the AMU environment the workload content for Pharmacists and clinical technicians overlaps considerably with medicines reconciliation, counselling and ordering prevalent activities. Prescribing activity and formal medicines review are currently less common. These first three activities are within the skill-set of specifically trained clinical technicians. Given that the AFC banding of pharmacists providing clinical services is usually between 6 and 8A in this environment the wider use of technicians who are typically banded at AFC5 would potentially represent a favourable intervention with regard to cost effectively increasing the clinical pharmacy staffing cohort so long as working practices and pharmacist numbers remained in alignment with the needs of the overall service skill mix[31].

The Francis report has called for a patient need rather than a system focus in the way that the healthcare workforce is modelled and the UK Audit Commission has described how innovation in the modelling of the NHS workforce could realise a potential cost benefit of over £300million per annum[157,158]. Despite this many NHS staffing models are still based upon a demand-utilisation model[159]. Typically staffing will be modelled upon average periods of service demand. Applying such general models to clinical areas with higher throughputs of patients with a greater acuity will have a propensity to lead to understaffing relative to demand for considerable periods. This is likely to adversely impact upon both quality of care and patient experience as well as staff morale[160].

Part of the problem here is ‘silo thinking’ by individual professions who may be motivated to protect their perceived ‘own’ interests. The NHS is a unique working environment with little legally binding legislation with regard to staffing numbers and

skill mix[159]. As such there are limited barriers to the adoption of a whole system thinking approach that addresses the skills and abilities of all of those within it to deliver the right care in the right place at the right time, regardless of profession. This may ultimately stimulate the innovation needed to start to resolve this long-standing barrier to truly effective care provision within the financial constraints of the economic reality of 21st century healthcare provision.

The Carter Report has identified a suite of 'system-wide' changes including resolving variation in staffing numbers, deployment and skill-mix as being key to addressing cost efficiency needs in its hospital pharmacy and medicines optimisation domain[161]. This may include the utility of pharmacists as prescribers and clinical technicians in medicines administration to alleviate workload pressure from recruitment issues affecting medical and nurse staffing[161].
This echoes the issues raised by the Royal Pharmaceutical Society in its report on implementing seven day services in hospital pharmacy. These include skill-mix review, efficient and relevant working practices, enhanced roles within clinical competencies, generalist not specialist advanced training, prevalent senior clinical involvement at all times in all aspects of service provision, triage and patient involvement. There is also guidance to specifically target services to complex patients at both admission and discharge[162].

The alignment and streamlining of skill mix is a recurring theme. Experienced pharmacists with prescribing training may be better able to fulfil many of the prescribing activities currently undertaken by junior doctors both in terms of reducing risk of harm and completing such tasks in greater alignment with the needs of the wider service[163]. This would likely benefit both the admission and discharge processes. Controlling the cost of this service development might be mitigated by the training of clinical technicians to carry out 'clinical checking' where a pharmacist has been involved in prescribing but raises concerns about utility in effectively and reliably challenging perceived errors.
Making this work would require prescribing pharmacists with the generalist knowledge and skills to effectively embrace the clinical demographic of the AMU. This mirrors the generalist approach of both the acute physician and geriatrician and perhaps training approaches for pharmacists might be evidenced thus.

7.7 Implications for future research

This study suggests that front-loading pharmacy services into the AMU may have advantages in enabling the earlier identification of errors, earlier ordering of medicines and earlier medicines reconciliation. This is achieved without increasing the overall time spent upon providing services. This intuitively suggests that medicines use is likely to be safer and more effective across the course of the admission. An obvious progression of thought based upon this finding is that frontloading even earlier into the admission process i.e. the Emergency Department might realise even greater benefits. The presence of a pharmacy service in the Emergency Department is relatively uncommon in the UK but more so in other countries[147] and is accepted by the wider healthcare team[148]. We have identified that medicines related interventions begin in the peri-admission period (or pre-admission if brought in by ambulance). Medicines reconciliation is known to influence the safe use of medicines and thus the sooner it is done the earlier prescribing clinicians will have full information to utilise in making safe and effective prescribing decisions for their patients. It is noted that considerable investment is now being made in this area nationally and the Royal Pharmaceutical Society has a stated aim of facilitating a pharmacy presence in emergency departments[149]. Once a validated tool for assessing pharmaceutical complexity is developed research into targeting services to the groups of patients most likely to gain the most benefit from the activity would be warranted. We have discussed at length that limited staffing resources impact upon the capacity to frontload and perhaps focussed frontloading might present an alternative paradigm that that might be more achievable in practice. Educational interventions to improve the effectiveness of non-pharmacy staff in conducting medicines reconciliation should also be an area of investigation. This might meet with resistance form staff who feel that they already have enough to do however given that is such a critical safety intervention cultural remodelling may be warranted. Given that this work suggests that the basic frontloading premise is a valid approach, multisite studies to strengthen the external validity of this finding might be conducted. The data reported here is quantitative in content. A greater depth of understanding of the subtleties affecting patterns of clinical activity would be achieved by qualitative investigation of this subject. Similarly better understanding of the impacts of factors such as workload and stress might be gained. Research to support the clinical value of both current pharmacy practice and that of extensions to services is vital for the

future development of the profession. Acute medicine represents an area of practice research with huge interdisciplinary engagement and relevance. As such it has much to recommend it as a focus area for such outward facing investigation.

As far as support for the methodology of future research is concerned this work has obviously relied greatly on the best efforts of the data collectors to honestly and accurately record their activity. As discussed this approach is always going to be flawed and incomplete and because of the workload involved in collecting the data only able to report on small samples of the total body of clinical service provision activity that takes place. In order to obtain more robust and extensive data samples in the future it is essential that electronic patient records are in place but critically that pharmacy clinical activity is documented in a structured and retrievable form. This latter point is important as an electronic patient record provides a potentially invaluable database of research data collected real time across the whole patient population. Unfortunately the development of the infrastructure to interrogate and report out of this data is not generally a high priority in current systems. This needs to be addressed with obvious consideration for appropriate information governance

I have already discussed that a significant proportion of people admitted to the AMU will, in addition to, or as part of, their acute reason for admission, be frail, elderly, multi-morbid with long term conditions and have exposure to polypharmacy and or high risk medicines. The requirements for pharmacy input for these patients are significant however identifying them can be difficult.

Whilst clinical risk scoring systems such as MEWS have been developed and extensively validated they have no medicines related component to them and thus limited value to pharmacy teams beyond identifying who is most ill which does not necessarily correlate with greatest need for pharmacy services[164].

The MRCI has been developed and validated to assess complexity in medicines regimens but it is probably too complex to apply as a wider screening tool and also lacks a clinical factors component[165]. This gap has been identified as a priority by the ASHP who have commissioned the University of Florida to develop and validate such a tool by 2016[166]. Once socialised it will be interesting to explore the external validity of the tool outside of the US healthcare system.

The principles of right care, right time, right place with a limited staffing resource necessitate targeting interventions where they are most needed[167]. The triage process is well established in emergency care but remains little explored in pharmacy. An Australian healthcare provider has developed a system of technician triage for pharmacists review based upon a brief patient assessment form[168].
In the UK Scottish teams in Tayside and Glasgow have worked upon developing a triage system based upon pre-agreed criteria. This is applied at admission to the AMU and then determines the frequency of pharmacy intervention to be implemented[169],[170]. Anecdotally the pharmacy team on the AMU at the University Hospital of South Manchester NHS Foundation trust also applies such a triage system to guide how clinical pharmacy services are implemented[171].

The increasing use of electronic patient management systems has the advantage of making real time patient information available to pharmacy staff. Access to this information may help in planning and organising pharmacy clinical services workload. Unfortunately current systems frequently lack a pharmacy orientated interface meaning that data utilisation may be considerably more difficult than is ideal. Once these issues are overcome this data stream should be a powerful tool in aligning clinical activity more closely to actual patient need. In making the most effective use of staff in providing focussed models of service this data may be best utilised in conjunction with aspects of methodologies such as quality improvement and lean to develop standardised methods of service delivery across the organisation[172,173].

CHAPTER EIGHT: CONCLUSIONS

Conclusions

The AMU sits at the heart of the model of care for acutely medically unwell adults. It typically has a unique workload profile comprising a rapidly turning over patient population a significant proportion of whom are clinically complex. The complexity of these cases frequently relates, in a significant part, to health issues relating to medicines. It is essential therefore, that pharmacy clinical services are effectively embedded into the working model of the AMU to assure that these issues receive optimal attention and that the attendant risks of harm associated with them are controlled. This programme of work uses data collected from real time clinical practice to describe how pharmacy clinical service provision is different on the AMU from the general medical wards. These differences inform decision making about how pharmacy services to the AMU might be might be modelled and the factors that need to be considered in doing this. It is also clear that service models that work effectively in a medical ward environment may not be so effective if applied to an AMU. Innovative, flexible service provision that puts the patient at the centre of activity is important to optimise the use of limited staffing resources. In order to cope with the workload of the AMU a frontloaded model of pharmacy staffing may be considered as an approach. Although this may create staffing pressures the research presented in this thesis demonstrates that it achieves positive benefits in controlling risk without overtly increasing the time spent on overall service provision across an admission. The interface of acute medicine and pharmacy clinical service provision is an under investigated area of practice research that requires better understanding. This research provides initial steps towards this aim and will hopefully encourage further investigation to deepen understanding and to further improve and develop pharmaceutical care provision in this key area of clinical practice.

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APPENDICES

Appendix 1: data collection form

Your name					Day			Date	

	Demographic detail of patient			Person initiating activity (see frontsheet)	Your location		Stage of admission			Where does the need for the activity arise from				Activity details (as many as apply)										Who did you interact with in carrying out this activity (as many apply)												Methods of interaction (as many apply)						Outcome details									
																								SRFT STAFF							NON-SRFT STAFF																							
	Ward	Hospital number	Time started (hh:mm)		Patient's current ward	Remote location	Admission	In-patient	Discharge	Patient's current ward	Previous ward/unit	Primary Care	Other Secondary Care	Drug History	Medicines reconciliation	Clinical checking	Error intervention	Monitoring therapy	Counselling/communicating information	Information gathering	Accuracy checking	Ordering medication	Dispensing	Medical	Nursing	Pharmacist	Pharmacy Technician	Pharmacy ATO	Other SRFT staff group	No-one	Patient	Carer/Relative	Primary care practitioner	Non SRFT Hospital practitioner	EPR system	Verbal	Written	Telephone	Fax	email	Actual time that you spent directly working on the activity (minutes)	Actual time spent FACE TO FACE with the patient whilst working on the activity (minutes)	Goal achieved nothing further to do	Follow up required	Number of items clinically checked	Number of items accuracy checked	Number of items ordered	Number of items dispensed	Number of medicine related errors detected	Number of EPR items amended
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Appendix 2: workload collection form

Name				Day			Date		

Ward visited	Regular ward	Visit type		Time ward visit started (hh:mm)	Number of new admissions since last visit	Number of patients on ward		Number of patients without a completed medicines reconciliation		Number of prescribed items not clinically checked		Number of prescribed items without an order date		Number of prescribed items not administered as unavailable	Time ward visit finished (hh:mm)
		Physical	Remote			On your arrival	On your departure	On your arrival	On your departure	On your arrival	On your departure	On your arrival	On your departure		

Contracted working hours today (hours)		Allocated dispensary time today (hours)		Allocated teaching time today (hours)	
Actual hours worked today (hours)		Allocated meetings time today (hours)		Allocated clinic time today (hours)	