University of East Anglia

Optimising Medicine Reconciliation at the Healthcare Interface

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Abstract
Optimising medicine reconciliation at the healthcare interface

By

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Keywords: Medicine/ medication reconciliation, care transition, pharmacist service, discharge communication, medication discrepancies, health interface

Background: Medicine reconciliation (MR) is the process of obtaining and maintaining an accurate, detailed list of all medicines taken by a patient and using this list anywhere within the health care system to ensure that the patient receives the correct medicines. This thesis aimed to design an MR intervention and develop a strategy for its evaluation.

Methods: A health Trust-wide evaluation of the quality of discharge information relative to national guidance for the minimum dataset of information transfer was undertaken to identify the areas of sub-optimal practice. A systematic review informed the content and design of a pharmacy led medicines reconciliation service. A pilot randomised controlled trial was conducted to provide an early indication of the intervention's costs and effects and to inform the design of a definitive trial.

Results: A review of 3,444 discharge summaries in one primary care trust found that 80% had at least one medication discrepancy. On average these were considered to cause moderate patient harm and to take 15 minutes to address. No studies were found to comprehensively assess the cost-effectiveness of pharmacy led medicines reconciliation. Interim analysis of a pilot 24 hour MR service showed that only 20% of errors upon admission were intercepted before discharge in the control group, compared to 98.6% within the intervention arm. The MR service was estimated to contribute to cost savings of almost £3,000 per patient.

Conclusions: The existing process to transfer and process information at the healthcare interface is not optimum. Evidence to demonstrate the cost-effectiveness of pharmacy led MR services is not currently available. Interim analysis of a pharmacy led 24 hour MR service suggests that the service may enhance accuracy and transfer of information and reduce overall health resource utilisation. The pilot MR service will inform the feasibility of large scale evaluation for the cost-effectiveness.

Table of contents

Abstract i
Table of contents ii
List of Tables x
List of Figures xiv
List of Commentary Boxes xvi
List of Appendices xviii
List of Abbreviations xx
University of East Anglia, Norwich, UK xxiii
University of Jordan, Jordan xxiv
Acknowledgements xxv
Dedication xxvi

Chapter 1 Introduction 1
1.1 Background 2
1.2 Healthcare transition in the UK 3
1.2.1 Primary care to secondary care transition 3
1.2.1.1 Planned admissions 3
1.2.1.2 Unplanned admissions 4
1.2.2 Secondary care to primary care transition 4
1.3 Communication deficits at the health interface: hospital admission and discharge 5
1.4 Deficits in information transferred to primary care 6
1.5 Implications of communication deficits at the health interface 8
1.6 Contributing factors to the quality of information transfer at health interfaces 9
1.6.1 Patient related factors 9
1.6.2 Process related factors 11
1.6.2.1 Type of discharge summary 11
1.6.2.2 Type of admission 11
1.6.3 Individual related factors 12
1.6.3.1 Training of healthcare professional 12
1.6.4 System related factors 13
1.6.4.1 Ward speciality 13
1.6.4.2 Variation between hospitals 13
1.6.4.3 Time and day of admission 13
1.7 Medicine reconciliation (MR) 14
1.7.1 Definition 14
1.7.2 Terminology 15
1.8 Initiative for MR implementation 16
1.8.1 MR initiatives in the UK 16

1.8.2 Worldwide MR initiatives 19
1.9 Interventions to improve information transfer at the health interface 21
1.9.1 Pharmacy led MR 21
1.9.2 Multidisciplinary package to implement MR 24
1.9.3 IT based information transfer initiatives 25
1.9.4 The use of a standardised reconciliation document 26
1.9.5 Discharge planning and post discharge follow up 27
1.9.6 Education and training health care staff involved with care transition 27
1.10 Barriers for implementation of medicines reconciliation 28
1.11 A place for evidence 29
1.12 Thesis purpose 31
1.12.1 Conducting a Trust-wide evaluation of information received in primary care 31
1.12.2 Developing and evaluating an innovative pharmacy led MR intervention 34
1.12.2.1 Identifying the evidence base for pharmacy led MR studies 37
1.12.2.2 Development and evaluation of a novel pharmacy MR intervention 38
1.13 Cost-effectiveness 39
1.13.1 Costs 41
1.13.2 Effectiveness 42
1.13.3 Perspective 44
1.13.4 Making decision using economic evaluation 44

Chapter 2 Methods 47
2.1 Quality of discharge information upon hospital discharge: an audit at primary care 49
2.1.1 Audit site 51
2.1.2 Audit tool 52
2.1.3 Data collection 53
2.1.4 Pilot 53
2.1.5 Inclusion and exclusion criteria 54
2.1.6 Audit communication 54
2.1.7 Audit distribution and recall 4 5
2.1.8 Confidentiality 54
2.1.9 Outcomes measurement 54
2.1.9.1 Adherence to NPC minimum dataset 54
2.1.9.2 Discharge discrepancies identification 56
2.1.9.3 Clinical significance of discharge discrepancies 58
2.1.10 Validity and reliability 58
2.1.10.1 Face validity of the audit process and tool 58
2.1.10.2 Quality assurance of the audit data 59
2.1.10.3 Legibility rating agreement 59

2.1.11 Statistical analysis 60
2.2 Pharmacy led medicine reconciliation in hospital care: A systematic review 62
2.2.1 Literature search strategy 64
2.2.2 Software to manage references 64
2.2.3 Inclusion criteria 64
2.2.3.1 Populations and sites 64
2.2.3.2 Intervention type 5 6
2.2.3.3 Study design 5 6
2.2.3.4 Language 5 6
2.2.4 Exclusion criteria 65
2.2.5 Screening and selection 65
2.2.6 Data extraction 66
2.2.7 Outcome measurements 67
2.2.8 Quality assessment 67
2.2.9 Reporting 68
2.3 Medicine reconciliation at the health interface: The MedRec Study 69
2.3.1 Study development 71
2.3.1.1 Study management committee 71
2.3.1.2 Patient and public involvement 71
2.3.1.3 Ethical review and approval 71
2.3.2 Study setting 71
2.3.3 Study communication 72
2.3.4 Patient recruitment and consent 72
2.3.4.1 Inclusion & Exclusion criteria 74
2.3.4.2 Recruitment of patients under the Mental Capacity Act 2005 74
2.3.5 Randomisation 75
2.3.6 Blinding 75
2.3.7 Study groups 76
2.3.7.1 Intervention group 76
2.3.7.2 Control group 7 7
2.3.8 Data management and collection 77
2.3.9 Outcomes measurement 80
2.3.10 Process oriented outcomes 81
2.3.10.1 Identification of medication discrepancies 81
2.3.10.2 Classification of medication discrepancies 82
2.3.10.3 Clinical significance of medication errors 84
2.3.11 Patient oriented outcomes 85
2.3.11.1 Length of hospital stay 5 8

2.3.11.2 Post discharge health resource use 85
2.3.11.3 Health related quality of life 86
2.3.11.4 Mortality 86
2.3.12 Cost-effectiveness 86
2.3.12.1 Cost estimation 86
2.3.12.2 Effectiveness 87
2.3.13 Statistical analysis (the MedRec interim analysis) 88

Chapter 3 Quality of Discharge Information Audit Findings 90
3.1 Audit sample 91
3.2 Adherence to the NPC minimum dataset 95
3.2.1 Adherence to the NPC minimum dataset relating to patient, admission and discharge information 96
3.2.2 Adherence to the NPC minimum dataset relating to medication information 99
3.2.3 Adherence to the NPC minimum dataset relating to therapy change information 99
3.3 Adherence to the NPC minimum dataset between admission and discharge summary types 99
3.4 Adherence to the NPC minimum dataset between hospitals 100
3.5 Adherence to NPC minimum dataset between wards 108
3.6 Adherence to NPC minimum dataset between profession types 108
3.7 Investigating contributing factors to discharge summary adherence to the total NPC minimum dataset 117
3.7.1 Contributing factors to patient, admission and discharge information 117
3.7.2 Contributing factors to medication infromation 118
3.7.3 Contributing to factors therapy changes infromation 118
3.8 Predictors of adherence to the NPC minimum requirements 127
3.8.1 Predictors of adherence to patient, admission and discharge information 129
3.8.2 Predictors of adherence to medication information 131
3.8.3 Predictors of adherence to therapy change information 132
3.9 Effect of ward specialty on discharge summary adherence to the total NPC minimum dataset 134
3.10 Discharge discrepancies 139
3.10.1 Medication discrepancies 139
3.10.2 Factors contributing to medication discrepancies 144
3.10.3 Reconciliation discrepancies 147
3.10.4 Clinical significance of discharge discrepancies 148
3.10.5 Estimated time needed by the GP to confirm necessary action 151
3.11 Additional discharge information 151

3.11.1 Laboratory results and procedures 151
3.11.2 Adverse drug reactions during hospitalisation and post admission complications 151
3.11.3 Contact details if needed by primary care 151
3.12 Variations in the audit data 152
3.13 Legibility rating agreement 156
3.14 Summary of the main findings 156
3.15 Audit dissemination 157
3.16 Re-audit 157

Chapter 4 Quality of Discharge Information Audit Discussion 159
4.1 Extent of adherence to the NPC minimum dataset 160
4.2 Discharge discrepancies 161
4.3 Predictors of non-adherence to the NPC minimum dataset and discharge discrepancies 162
4.4 Strength and limitations 164
4.5 Implications for practice 165
4.6 Implications for future work 166

Chapter 5 Pharmacy led Pharmacy Led Medicine Systematic Review Findings ... 167
5.1 Literature search 168
5.2 Included studies 169
5.3 Pharmacy led MR 169
5.4 Targeted patient population 172
5.5 Effects of pharmacy led MR 188
5.5.1 Medication discrepancies and the MR pharmacist interventions 188
5.5.2 Clinical significance of medication discrepancies and MR pharmacist interventions 189
5.5.3 Length of hospital stay 199
5.5.4 Readmissions and emergency department visits 200
5.5.5 Health resource use in community 203
5.5.6 Health Related Quality of Life 203
5.5.7 Mortality 203
5.6 Cost associated with pharmacy led MR 203
5.7 Resources needed to implement MR 211
5.7.1 Time commitment 211
5.7.2 Training and education 211
5.8 Quality and design of studies evaluating pharmacy led MR 217
5.8.1 Design bias 217

5.8.2 Selection bias 217
5.8.3 Performance bias 218
5.8.4 Detection bias 218
5.8.5 Selective reporting (Incomplete outcome data) 218
5.8.6 Adequacy of study power & analysis 219
5.8.7 Validity of economic evaluations 219
5.9 Summary of main findings 222

Chapter 6 Pharmacy Led Medicine Systematic Review Discussion 223
6.1 Hospital based pharmacy led MR intervention 224
6.2 Effects of pharmacy led MR 226
6.3 Costs associated with pharmacy led MR 229
6.4 The quality of the evidence of pharmacy led MR 230
6.5 Strengths and limitations 231
6.6 Implications for further research 232

Chapter 7 Medicine Reconciliation at the Health Interface Findings 234
7.1 Patient recruitments 235
7.1.1 Excluded patients 236
7.1.2 Consultee identification 236
7.1.3 Unavailability of the MR Pharmacists or the study researchers 237
7.1.4 Patient declined study participation 239
7.2 Recruitment rate 239
7.3 Feasibility of implementing the MR Process 240
7.4 Feasibility of data collection 240
7.5 Feasibility of data management 240
7.6 Acceptability of the intervention and study process 240
7.7 Follow up rate 241
7.7.1 Death 241
7.7.2 Withdrawal 241
7.7.3 Medicines prescribed to patients in primary care three months post discharge 241
7.7.4 Health related quality of life and Health resource use at 3 months 242
7.8 MR in the control group 242
7.9 Patient characteristics 243
7.10 Outcomes measured 246
7.10.1 Medication errors 246
7.10.2 Clinical significance of medication errors 248
7.10.3 Medication errors in the interventions group 248

7.10.4 Intentional medication discrepancies 249
7.10.5 Post discharge medication changes 249
7.10.6 Length of hospital stay 251
7.10.7 Readmission episodes identified by hospital records 253
7.10.8 Patient self-reported use of NHS and personal and social services (PSS) in hospital 255
7.10.8.1 Readmission episodes reported by patients 255
7.10.8.2 Emergency department visits 256
7.10.8.3 NHS walk in centre 256
7.10.8.4 Outpatients visits 256
7.10.9 Patient self-reported use of NHS and personal social services in community 257
7.10.10 Patient self-reported use of social and informal care 259
7.10.11 Health Related Quality of Life 259
7.10.12 Mortality rate 260
7.11 Resources necessary to implement pharmacy led MR service 261
7.12 Cost estimation 262
7.12.1 Costs associated with pharmacist time 263
7.12.2 Costs associated with doctor time 263
7.12.3 Costs associated with unintentional errors 264
7.12.4 Costs of hospital stay 264
7.12.5 Costs of readmissions 264
7.12.6 Costs of NHS and PSS worker visits 266
7.12.7 Costs of hospital service use 269
7.12.8 Costs of social and informal carer 270
7.12.9 Costs of control MR 273
7.13 Cost-effectiveness of pharmacy led MR 273
7.14 Summary of the MedRec interim analysis findings 276

Chapter 8 Medicine Reconciliation at the Health Interface Discussion 277
8.1 Feasibility of the MedRec study 278
8.2 Initial findings of the MedRec study 281
8.3 Resources necessary to implement pharmacy led MR 285
8.4 Cost-effectiveness of pharmacist-led MR 285
8.5 Strengths and limitations 288
8.6 Implications for the full pilot analysis 291

Chapter 9 Conclusions 294
9.1 Main findings 295
9.2 Lack of collaboration between secondary and primary care providers 296
9.3 Best possible medication history 296
9.4 Optimising resource use for effective MR implementation 297
9.5 Thesis recommendations 298
9.6 Research needs 299
References 301
Appendices 323

List of Tables

Table Title **Page**

Chapter 2

Table 2.1.1 The NPC minimum dataset of information recommended in primary care following patient discharge from hospital 52
Table 2.1.2 Audit scoring criteria 56
Table 2.3.1 The MedRec study data collection process 79

Chapter 3

Table 3.1 Characteristics of the audit sample 93
Table 3.2 Discharge summary adherence to the NPC minimum dataset 95
Table 3.3 Examples of allergies recorded in primary care records 98
Table 3.4 Adherence to patient, admission and discharge information by admission and discharge summary types 101
Table 3.5 Adherence to medication information by admission and discharge summary types 102
Table 3.6 Adherence to therapy change information by admission and discharge summary types 103
Table 3.7 Adherence to patient, admission and discharge details between hospitals 104
Table 3.8 Adherence to medication information between hospitals 105
Table 3.9 Adherence to therapy change information between hospitals 106
Table 3.10 Templates of the primary medium of discharge summary between the audit hospitals 107
Table 3.11 Adherence to patient, admission and discharge details between wards 109
Table 3.12 Adherence to medication information between wards 111
Table 3.13 Adherence to therapy change information between wards 112
Table 3.14 Adherence to patient, admission & discharge details between profession types 114
Table 3.15 Adherence to medication information between profession types 115
Table 3.16 Adherence to therapy change information between profession types 116
Table 3.17 Factors contributing to discharge summary adherence to the total NPC minimum dataset 119
Table 3.18 Factors contributing to discharge summary adherence to patient, admission and discharge information 121
Table 3.19 Factors contributing to discharge summary adherence to medication information 123

Table 3.20 Factors contributing to discharge summary adherence to therapy change information 125
Table 3.21 Predictors of discharge summary adherence to the total NPC minimum dataset 128
Table 3.22 Effect of discharge summary templates on adherence rate to the total NPC minimum dataset adjusting for number of medicines and discharge summary type 129
Table 3.23 Predictors of discharge summary adherence to patient, admission and discharge information 130
Table 3.24 Effect of discharge summary template on adherence rate to patient, admission and discharge information adjusting for number of medicine and discharge summary type 130
Table 3.25 Predictors of discharge summary adherence to medication information 131
Table 3.26 Effect of discharge summary template on adherence rate to medication information adjusting for age, discharge summary and admission type 132
Table 3.27 Predictors of discharge summary adherence to therapy change information 133
Table 3.28 Impact of discharge summary template on therapy change information.... 133
Table 3.29 Influence of ward specialty on discharge summary adherence to the total NPC minimum dataset 135
Table 3.30 Effect of ward speciality on discharge summary adherence to the total NPC minimum dataset adjusting for number of medicines and type of discharge summary 135
Table 3.31 Influence of ward specialty on discharge summary adherence to patient, admission and discharge information 136
Table 3.32 Effect of ward speciality on discharge summary adherence to patient, admission and discharge adjusting for number of medicines and of discharge summary type 136
Table 3.33 Influence of ward specialty on discharge summary adherence to medication information 137
Table 3.34 Effect of ward speciality on discharge summary adherence to medication information adjusting for age, discharge summary and admission type 137
Table 3.35 Influence of ward specialty on discharge summary adherence to therapy change 138

Table 3.36 Effect of ward speciality on discharge summary adherence to therapy change information adjusting to hospital stay 138
Table 3.37 Distribution of medication discrepancies between admission type, discharge summary type, hospitals, wards and profession types 140
Table 3.38 Medication classes implicated to medication discrepancies 143
Table 3.39 Summary of logistic regression model of factors predicting medication discrepancies 146
Table 3.40 Examples of discharge discrepancies and their estimated risk 149
Table 3.41 Variations in the audit data 153

Chapter 5

Table 5.1 Summary of included studies 172
Table 5.2 Aspects of pharmacy led interventions by study 178
Table 5.3 Features of the MR process by study 180
Table 5.4 Characteristics of included patients by study 183
Table 5.5 Summary of MR discrepancies and MR pharmacist interventions 192
Table 5.6 Summary of readmissions and emergency department visits by study 201
Table 5.7 Scope of costs measured by study 207
Table 5.8 Summary of MR related costs 209
Table 5.9 Time commitment for the MR 213
Table 5.10 Details of MR related training/education 216

Chapter 7

Table 7.1 Reasons for not approaching patients 236
Table 7.2 Details of MR in control group 243
Table 7.3 Baseline characteristics 244
Table 7.4 Baseline health related quality of life measures 245
Table 7.5 Nature of unintentional errors in the control group 247
Table 7.6 Unintentional errors at three months post discharge in the control group 248
Table 7.7 Pharmacist interventions to resolve unintentional errors 250
Table 7.8 Details of suspected outlying data points 253
Table 7.9 Readmission episodes in both groups 254
Table 7.10 Patient self-reported readmissions and readmission duration 256
Table 7.11 NHS and PSS worker visits in community 258
Table 7.12 Health related quality of life measures three months post discharge in both groups 260
Table 7.13 Pharmacist time (minutes) spent on MR upon admission and discharge 261

Table 7.14 Unit costs and assumptions for MR pharmacist time, doctor time, length of hospital stay, unintentional errors and readmissions 262
Table 7.15 Cost associated with pharmacist time commitment 263
Table 7.16 Costs of unintentional discrepancies in the control and intervention groups 264
Table 7.17 Cost related to readmissions in both study groups 265
Table 7.18 Units cost and assumptions related to NHS and PSS worker visits 266
Table 7.19 Costs of NHS and PSS worker visits 267
Table 7.20 Units cost and assumptions for hospital service use 269
Table 7.21 Costs of emergency department in both study group 269
Table 7.22 Cost of outpatient visits 270
Table 7.23 Cost unit and assumptions for social and informal care service use .. 271
Table 7.24 Costs of social and informal care service use 272
Table 7.25 Expenses incurred by patients in the intervention and control groups 273
Table 7.26 summary of costs/saving associated with the intervention and control group 275

List of Figures

Figure title **Page**

Chapter 1

Figure 1.1 The clinical Audit cycle 32

Figure 1.2 Quality-adjusted life-years gained from an intervention 43

Figure 1.3 Cost-effectiveness plane 45

Figure 1.4 Decision for cost-effectiveness compared to the cost- effectiveness threshold 46

Chapter 2

Figure 2.2.1 Pharmacy led MR systematic review screening stages 66

Figure 2.3.1The MedRec study recruitment flow 78

Figure 2.3.2 Medication discrepancy identification in both study groups..... 82

Figure 2.3.3 Medication discrepancy classification 84

Chapter 3

Figure 3.1 Summary of the audit data 92

Figure 3.2 Magnitudes of discharge summaries adherence to NPC minimum dataset 97

Figure 3.3 Comparison of prescribed medicines and medicines implicated to discrepancies 142

Figure 3.4 Duration and titration plan information for antibiotics, clopidogrel, corticosteroids, anticoagulant, analgesic and proton pump inhibitors 144

Figure 3.5 Distribution of medication discrepancies and number of prescribed medicines..... 145

Chapter 5

Figure 5.1 Studies selection and reason for exclusion 171

Figure 5.2 Discrepancies rate per patient by study..... 188

Figure 5.3 Average length of hospital stay by study..... 199

Figure 5.4 Outcomes of risk assessment by bias type..... 217

Figure 5.5 Outcomes of risk assessment by study 220

Chapter 7

Figure 7.1 The MedRec study diagram..... 238

Figure 7.2 Recruitment rate compared to target rate 239

Figure 7.3 Histogram presentation of hospital stay in hours by study group 251

Figure 7.4 Box plot of hospital stay in hours by study group 251

Figure 7.5 Histogram presentation of Log length of hospital stay in hours by study group..... 252

Figure 7.6 Box plot of Log length of hospital stay in hours by study group..... 252

Figure 7.7 Kaplan-Meier survival function of time to readmission 254

Figure 7.8 QALY gained over three months in both groups 274

List of Commentary Boxes

BOX title **Page**

Chapter 1

BOX 1.1 MR steps (IHI, 2005) 14

BOX 1.2 MR process (NPC, 2008) 15

BOX 1.3 NPC minimum dataset 18

BOX 1.4 Areas for key research questions 30

BOX 1.5 Clinical audit steps (NICE, 2008) 33

BOX 1.6 MRC process for the development, evaluation and implementation of complex interventions 34

BOX 1.7 Types of economic evaluation (Drummond, 2005) 40

BOX 1.8 Stages of cost estimation (Drummond, 2005) 41

Chapter 2

BOX 2.1.1 Aim and objectives of the discharge information audit 51

BOX 2.1.2 Method for estimating discharge summary adherence to the NPC minimum dataset 55

BOX 2.1.3 Type of discharge discrepancies 57

BOX 2.2.1 Aims and objectives of pharmacy led MR systematic review 63

BOX 2.3.1 The MedRec pilot study aim and objectives 70

BOX 2.3.2 The MedRec intervention 76

BOX 2.3.3 Assumptions agreed to establish prescriber's intention 83

Chapter 3

BOX 3.1 Modifications to the audit dataset prior ANCOVA-GLM analysis 127

BOX 3.2 Decisions informed by the quality assurance of the audit data 155

BOX 3.3 Recommendations for the re-audit 158

Chapter 4

BOX 4.1 Audit recommendations 165

Chapter 6

BOX 6.1 Features of practice of hospital based MR 225

BOX 6.2 Foremost MR related outcomes measured 225

BOX 6.3 Feature of MR intervention to develop 233

Chapter 7

BOX 7.1 QALY estimation 274

Chapter 8

BOX 8.1 Feasibility of the MedRec study 279

BOX 8.2 Costing strategies planned for the full pilot analysis 287

BOX 8.3 Gains from the interim analysis 293

List of Appendices

Appendix 1 – Literature variation in discrepancy classification, clinical significance and inter-rater agreement assessment

Appendix 2 – Discharge information audit tool

Appendix 3 – Discharge information audit guidance

Appendix 4 – Discharge information reconciliation sheet

Appendix 5 – Multiple regression and logistic regression assumption check

Appendix 6 –Pharmacy led medicine reconciliation systematic review research strategies

Appendix 7 – Pharmacy led medicine reconciliation review screening tools

Appendix 8 – Pharmacy led medicine reconciliation review extraction tool

Appendix 9 – Pharmacy led medicine reconciliation review risk assessment tool

Appendix 10 – Medicine Reconciliation at the health interface patient information leaflet

Appendix 11 – Medicine Reconciliation at the health patient informed consent form

Appendix 12– Medicine Reconciliation at the health interface consultee information leaflet

Appendix 13 – Medicine Reconciliation at the health interface consultee declaration form

Appendix 14 – Medicine Reconciliation at the health interface medicine reconciliation pharmacist time recording form

Appendix 15 – Medicine Reconciliation at the health interface control medicine reconciliation form

Appendix 16 – Medicine Reconciliation at the health interface three month health related quality of life and health resource use questionnaire

Appendix 17 –Summary of auditors' comments on discharge information audit

Appendix 18 – Pharmacy led medicine reconciliation systematic review description of risk of bias assessment

Appendix 19 –Medicine reconciliation at the health interface data collection and recruitment barriers

Appendix 20 – Amendments suggested for the MedRec database

Appendix 21 - Details of unreturned health related quality of life and resource use questionnaires

Appendix 22 - Examples of medication errors identified by the MedRec interim analysis

Appendix 23 - Examples of intentional discrepancies

List of Abbreviations

ANCOVA-GLM	-	Analysis of Covariance- Generalized Linear Model
CEAC	-	Cost-effectiveness acceptability curve
CI	-	Confidence interval
GP	-	General Practitioner
ICER	-	Incremental Cost-Effectiveness Ratio
IQ	-	Interquartile
IT		Information technology
MedRec study	-	Medicine reconciliation at the health interface study
MR	-	Medicine Reconciliation
NHS	-	National Health Services
NICE	-	National Institute for Health and Care Excellence
NPC	-	National Prescribing Centre
NPSA	-	National Prescribing Safety Agency
PI	-	Principal Investigator
PSS	-	Personal Social Services
QALY	-	Quality-Adjusted Life Year
SD	-	Standard deviation
UEA	-	University of East Anglia
UK	-	United Kingdom
USA	-	United states of America
VAS	-	Visual Analogue scale

Initials

AB	-	Amanda Bale
BC	-	Brit Cadman
DB	-	Debi Bhattacharya
DW	-	David Wright
EH	-	Eman Hammad
GB		Garry Barton
IN	-	Ian Nunney
JD	-	James Desborough
KH	-	Kellie Hempstead
RH	-	Richard Holland

Glossary of UK health organisation/ terms used in this thesis

NHS	NHS England is an independent body aims to improve health outcomes for people in England, oversee the operation of clinical commissioning groups, allocate resources to clinical commissioning groups and commission primary care and specialist services
Acute care trust	Management structure for hospitals or group of hospitals that are commissioned by primary care trust to provide acute health care
Care Quality Commission	The authority to regulate all health and adult social care services in England.
Foundation hospital trust	An independent legal management structure for highly performing hospitals with unique governance arrangements, it is self-standing, self-governing organisations and have financial freedoms.
GP	The doctor who practice in a primary care environment (primary care practice)
Medical Research Council	A publicly funded government agency responsible for coordinating and funding medical research in UK. It is one of seven Research Councils in the UK and is answerable to, although politically independent from, the Department for Business, Innovation and Skills.
National reporting and learning service/ NPSA **	The division collects confidential reports of patient safety incidents from healthcare staff across England and Wales
National Service Framework	The policies set by the NHS in the UK to define standards of care for major medical issues such as cancer, coronary heart disease, mental health and diabetes. Those polices are defined for some key patient groups including children and older people
NICE	Special health authority that makes recommendation on which treatment should be used in NHS on the basis of their cost-effectiveness
NICE Technology Appraisal Committee	A standing advisory committee of NICE, Including people who work in the NHS, people representing patient and carer organisations, lay members, people from relevant academic disciplines and the pharmaceutical and medical device industries
NPC	The organisation responsible for helping the NHS to optimise its use of medicines.

Primary care practice	The team of GPs and staff such as practice nurses, practice pharmacists, and receptionist who provide primary health care
Primary care trust	Primary care is the first point of contact for most people and is delivered by a wide range of independent contractors, such as GPs, dentists, pharmacists and optometrists. NHS walk-in centres.
Secondary care	The health service provided by medical specialists who generally do not have first contact with patients and usually delivered in hospitals
Department of Health	The division responsible for strategic leadership of both the health and social care systems, but no longer the headquarters of the NHS, nor it directly manage any NHS organisations.
The Royal Pharmaceutical of Great Britain	The regulatory and professional body for pharmacists and pharmacy technicians in England, Scotland and Wales.

From NHS.choice. Available at: http://www.nhs.uk/NHSEngland/thenhs/about/Pages/authoritiesandtrusts.aspx.
**National Patient safety agency available at : http://www.npsa.nhs.uk/corporate/about-us/what-we-do/nrls/

University of East Anglia, Norwich, UK

Norwich is situated in the county of Norfolk, in the east of England. The city has a rich historical background. During the 11th century, Norwich was the largest city in England after London.

Norwich, alongside the rest of the British Isles, experiences a temperate maritime climate, and as such does not endure extreme temperatures, and benefits from fairly evenly spread rainfall throughout the year. Some call Norwich the city of sun compared to the rest of UK cities.

Norwich is a very beautiful city with fascinating landscape views, delightful riverside walk and lake. There are also museums, magnificent cathedrals, cobbled streets, half-timbered houses. Norfolk is a beautiful county; famous for Norfolk Broads. These offer uniquely beautiful unspoilt coastline, nature reserves and amazing wildlife.

The University of East Anglia (UEA) was founded in 1963; UEA will celebrate its 50th anniversary in 2013 over the weekend of 28-29 September 2013.

UEA School of Pharmacy was founded in 2003 and has quickly risen to become one of the top pharmacy schools in the UK which was nominated number one in the Guardian University Guide (2013). In the 2008 Research Assessment Exercise, UEA came 6th overall, top of the new schools of Pharmacy in the UK.

Most recent, UEA is ranked 5th in the UK for the impact of its research in the 2013 Leiden ranking of universities and the Top UK University by the Times Higher Education Student Experience Survey 2013.

University of Jordan, Jordan

Eman A. Hammad, the author of this thesis is from Jordan.

Jordan is a small country in the Middle East but captures one's heart the minute they get to see the mesmerising beauty and contrasts of the country as it is a well-travelled bridge between sea and desert. Jordan has grown into a modern nation that has enjoyed a remarkable measure of peace and stability. Jordanians are friendly and open their hearts before homes to visitors.

Jordan is mostly known to westerners for its famous ancient Nabataean city of Petra, carved from the rock over a thousand years.

The main duties of community pharmacists in Jordan involve dispensing; the duties of hospital pharmacists mainly consist of administrative tasks with dispensing activities principally left to pharmacy technicians. In recent years the role of clinical pharmacist has been increasingly recognised and the need for pharmacy profession to develop and strive to adopt a more central role in patient care and health policy making is well recognised by health care and education bodies in Jordan. This can be achieved by devising undergraduate and postgraduate programmes that yield pharmacists with clinical, communication and research skills.

University of Jordan (UJ) is the leading university in Jordan and one of the most prestigious in the Arab World. UJ/ School of Pharmacy enjoys respectable reputation for research and innovation; staff at the faculty continually strive for excellence in their learning, teaching and research. The School actively promotes opportunities to allow students to add new skills and experiences that can be shared with future students and translated into pharmacy research that take the profession of pharmacy in Jordan forward; herein the author of this thesis was funded to do her PhD.

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"And their last prayer is praise and gratitude to Allah, the Lord of all the worlds"

Holy Quran Chapter 9:10

I owe my most gratitude to Allah; for blessing me and helping me to come to achieve my PhD dream.

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To the girl who had a dream and more courage than she knew…

For she comes to realise that every prayer is answered, and a heart filled with hope might be frail but hard to restrain

….

Chapter 1

Introduction

1.1 Background

With medication usage increasing by 4% each year it is the primary healthcare intervention used in western society, in 2011 it was estimated that an adult is prescribed an average of 18 items under the UK National Health Service (NHS) per year.[1] In June 2012, the National Reporting and Learning Services / National Patient Safety Agency (NPSA) in England and Wales identified adverse drug events as the second most common type of patient safety incident and therefore effectively managing the way that medicines are prescribed, dispensed and administered is central to patient safety. [2]

Whilst the number of hospital admissions in England has grown by more than 60% from 11 million per year to 17.5 million over the past 10 years, the number of hospital beds has increased to accommodate only 5% of these admissions. Consequently, the average length of hospital stay over the past five years has reduced significantly and the median length is currently one day.[3, 4] The increase transition of patients between primary and secondary care provides an increased opportunity for medication errors. Between 2003 and 2007, the NPSA reported 7,070 medication errors involving admission and discharge resulting in two fatalities and 30 errors which caused severe patient harm.[5] Additionally, between 2006 and 2009, the NPSA received reports of 27 deaths, 68 severe harms and more than 21,000 patient safety incidents related to omitted and delayed medicines upon admission.[6] Noting that the NPSA reporting scheme is a voluntary system, it is likely that these figures potentially underestimate greater rates of patient harm.

The Institute of Healthcare Improvement, based on reports from hundreds of organisations around the world, concluded that poor communication of clinical information at the health interface is responsible for almost 50% of all medication errors and up to 20% of averse drug events.[7] It is also estimated that one in five patients suffer an adverse event at discharge, of which 72% are related to medicines.[8] Additionally, the World Health Organisation highlighted the increased risk of preventable morbidity at the health interface.[9]

In the UK, the Audit Commission in 2001 reported that 12% of adverse drug events upon hospital admission were related to medicine use.[10] It is also estimated that each adverse event increase hospital stay by 8.5 days on average and the total cost of hospital admissions related to preventable medication errors is half of a billion pounds each year.[11] Additionally, within an increasingly litigious society, the NHS Litigation Authority reported that the payment for clinical claims is rising substantially each year. In 2011/2012 the NHS payment for clinical claims in total was estimated over than one billion.[12]

As a result of increases in the use of medicines, number of hospital admissions, number of medication errors and the public desire to pursue compensation, it has become ever more necessary to minimise errors occurring at healthcare interfaces and to identify areas for improvement in the current practice of care transition.

1.2 Healthcare transition in the UK

There are two main transfer points where errors can be introduced; one is on admission from primary to secondary care and the other is upon discharge from secondary to primary care.

1.2.1 Primary care to secondary care transition

1.2.1.1 Planned admissions

A patient admission to the hospital can be planned or unplanned. Planned admissions might be an outpatient, admitted as day care or inpatient case. As an outpatient, the patient goes to the hospital for an appointment to see a specialist without staying overnight. As a day case, the patient will be given a hospital bed for a test or surgery, but will not stay overnight; this can include treatments such as minor surgery, dialysis or chemotherapy. Meanwhile, as an inpatient the patient stays in hospital for one night or more.

With planned admissions, the patient is often involved in the decision regarding the receipt of treatment in hospital. The decision is mutually agreed with the patient's primary care doctor who will be termed the general practitioner (GP). Patients might have a referral letter from their GP which contains information about the patient's regular medicines, co-morbidities, and known allergies. The letter might also include a full list of medicines the patient is taking and the contact details of the GP or the nurse who is responsible for the patient's care in the primary care practice. Additionally, the patient may bring their own medicines with them or a copy of their repeat prescription.

Traditionally, information upon admission is obtained by junior doctors, also called foundation year doctors, who have limited experience and knowledge of medicines and frequently this process is undertaken unsupervised.[13, 14]

In some hospitals patients attend a pre-admission clinic which may include an appointment with a nurse or doctor, or a telephone assessment. This might also include a pharmacist who obtains information on the patient's medication history and ensures the patient receives clear instructions on medicines to discontinue before admission.

1.2.1.2 Unplanned admissions

Unlike planned admissions, the amount and quality of information available in the case of unplanned admissions is less predictable. Patients frequently access the accident and emergency departments with serious injuries or illnesses; this occurs more frequently out of working hours.[3] Therefore, no information may be available with the patient and neither the GP nor the community pharmacist might be available to contact.

In some emergency departments, a pharmacy post is funded to provide services including medication history and patient own drugs review; however, in others there is limited or no pharmacy input.[15] Similarly, in some hospitals a dedicated pharmacist is employed in the medical assessment units; through which a sizable proportion of patients are admitted. The pharmacist is available to quality assure the information collected on admission; nevertheless, not all admissions go through the medical assessment units and might occur outside normal working hours.

1.2.2 Secondary care to primary care transition

The quality of discharge information can depend on the quality of admission information, i.e. if errors were introduced at the admission stage they are likely to continue upon discharge.[16, 17] Each hospital has its own discharge policy which should comply with the guidance published by the Department of Health in 2003. The guidance emphasises the importance of involving patients and their care providers in hospital discharge planning and ensuring effective handover of care.[18]

Upon discharge from hospital, a discharge summary is produced by the secondary care team summarising the key clinical information related to the patient's hospital stay. Ideally, this includes details of the presenting diagnosis, procedures carried out, medicines changed, started or stopped.[19] Discharge summaries can be handwritten or produced in an electronic pro-forma; either type might be faxed, posted, emailed or hand delivered by the patient to the primary care practice.

As is the case with admissions, the responsibility for preparing lists of discharge medicines lies principally with junior doctors. A new post has been funded in many hospitals for a discharge coordinator who is often from a nursing background. The discharge coordinator is responsible for providing a single communication point for all health professionals involved in patient care. The consultant in charge and the discharge coordinator might support junior doctors.[20] Increasingly, a pharmacist is available also to clinically check discharge prescriptions; however, such a service is available in only three quarters of UK trusts and mostly during normal working hours only.[21]

Following discharge, patients visit primary care practices for follow up, assessment of treatment progress and obtaining medicines supplies. Once a discharge summary is received by the primary care practice, information from secondary care should be critically reviewed and incorporated in the GP held patient record. As such, all changes occurring during hospital stay are continued as intended by the hospital team. Ensuring continuity of care between health providers at both sides of the health interface is central for patient safety; breakdown in communication might result in duplicated medicines or continued medicines which might be incompatible with the patient's condition.[19]

1.3 Communication deficits at the health interface: hospital admission and discharge

Several NHS reports and a number of UK studies highlight that admission and discharge information is often incomplete and inaccurate.

The audit commission highlighted in 2001 that almost one third of patients receive incorrect medicines or have incomplete medicines recorded on admission and outlined considerable costs related to patient own drugs that brought upon admission but thrown away or left behind upon discharge.[10]

Gray et al. reviewed 736 medicine charts over three months in an acute medical assessment unit in a large teaching hospital in the east of England in 2007 and found that 45% of charts included at least one prescribing error. A total of 265 prescribing errors were identified of which 15.9% were omissions and 13.2% were incorrect additions of medicine.[22] Additionally, the NPSA published a report in 2010 highlighting the harm caused by omitted and delayed medicines upon hospital admission. Omission of regular medicines was the predominating error and often contributed to delays in patients receiving their medicines.[23]

Studies have highlighted that a gold standard medicines list is frequently not available when patients transfer between care settings. A study in the northwest of England in 2004 conducted by Collins et al. reviewing 126 medical and 51 surgical patients highlighted the need for better documentation of medication histories. One hundred and two (16%) inpatient medicines were not documented in medical notes and 40% of medicines were omitted. Collins et al. reviewed different sources of patient information and found frequent discrepancies between what is are actually taken, reported by the patient, documented on the hospital medical notes and the primary care records.[24] In 2010, a similar investigation repeated in the same institution reported similar findings. Further insights, however, were reported on the type of discrepancies identified within each source of patient information. Discrepancies were most frequently attributable to unintentional omissions by the hospital team, those accounted for 119 (42%)

discrepancies. Additionally, for 28 patients, the GP held list of medicines was found inaccurate and inadequate which accounted for 119 discrepancies. Of those discrepancies 30% were medicines described to be used “as directed” where ideally full directions should have been included and so the hospital doctor required further contact for clarification.[25]

Allergy information is often insufficiently documented in patient records; Collins et al. reported that allergy information was incorrect or incomplete for 41% patients. For 29% patients, allergy status boxes were left empty and for 71% patients allergy was noted but with no description of the nature of reaction.[24] Similarly, allergy information was also missing or inaccurate on 13% of medication charts reviewed by Gray et al.[22]

An audit of 56 trusts reported by the clinical directorate of the East and South East England Specialist Pharmacy Services in 2010 included 3,3120 patients; the average number of errors per discharge review consisting of five or more medicines was 1.32 errors. A total of 11,366 unintentional discrepancies were identified of which 73% concerned omitted medicines and 14% were for wrong doses.[26]

In addition to omissions and inaccuracies of information, legibility may compromise the effectiveness of discharge communication. However, this has been only evaluated by a small report in Nottinghamshire in 2007; a comparison of 30 handwritten and 30 electronic discharge summaries considered 12 (40%) were illegible.[27]

These findings from UK reports are of note, however, they are mostly of relatively small size, based on a single site and with considerable confounding and methodological limitations. There is no robust UK, large-scale evaluation of the quality of information transferred at the health interface.

Similar to those reported in the UK, deficits within information transfer have been reported in USA and Canada. These were generally of larger, multiple site evaluations, though they had similar methodological limitations.[28-31] In line with the figures from the USA and Canada, studies from Europe and Australia have highlighted similar issues.[32-37] This suggests that deficits with information transfer is a worldwide growing challenge across health interfaces and health systems of different workflows

1.4 Deficits in information transferred to primary care

Maintaining continuity of care has showed a significant association with improved patient outcomes and health resource utilisation.[38, 39] Unless an accurate and complete medicines list is obtained upon admission, omissions and unintentional changes will persist until discharge. [16, 17]

Studies evaluating the quality of information received in primary care have highlighted that discharge summaries were often missing essential information. Of 569 discharge summaries audited in Australia in 2001, 36.4% were found to contain information which did not accurately reflect the information recorded in hospital notes.[36] Additionally, GPs require comprehensive information following patient discharge to ensure appropriate post discharge management and continuity of healthcare. One hundred and forty nine out of 465 Dutch GPs responded to post questionnaire in 2010 enquiring about the information needed on discharge medication, both regarding content and timing of discharge information. Up to 88% of respondents wished to receive full information about medicines stopped and changed during hospital admission and appreciated clinical pharmacist advice to inform the post discharge care decision.[40]

The availability of complete information can help to optimise patient post discharge care; in Canada, a study aimed to determine if the availability of discharge summaries at the next health provider visit would decrease the risk of hospital readmission. From 888 patients discharged in 2002, a discharge summary was available for only 12.2% of 4,639 post discharge outpatient visits and 27% of these patients were urgently readmitted to hospital. Patients who were seen by a doctor who had received the discharge summary trended towards a decreased risk of readmission, relative risk [95% CI] = 0.74 [0.50 to 1.11] ($p>0.05$).[39]

The timeliness of information transfer is also pertinent for continuity of post discharge care. An Australian study conducted in 2011 estimated that over 70% of patients visit their GP within one month of discharge and 25% visit their GP within 4 days of discharge.[41] Discharge summaries, therefore, ideally need to reach primary care practices within this timeline, however, a Canadian study in 2002, showed that 542 (68.4%) patients had no discharge summary available at the time of their GP visit post discharged. In 20% of cases this was because discharge summaries were not generated on time and in 50% they were not sent at all.[42] Similarly, in the Netherlands in 2010, 25% of GPs experienced delays in discharge information and preferred to receive information on the day of discharge because they were consulted by patients or family immediately after discharge.[40]

In the UK, the Care Quality Commission in 2009 published the results from a survey of 12 primary care trusts and highlighted persistent omissions of information related to the medicines prescribed upon discharge. GPs reported that information on allergies was infrequent and contact details for enquiries even more rare.[19] The report also outlined concerns around the timeliness of discharge summaries with only 53% of the 12 reviewed trusts reporting that discharge summaries were received in enough time to be of use for

patient post discharge management.[19] However, the development of computer technology has expedited the production and transfer of electronic discharge summaries and resolved legibility issues.[43]

1.5 Implications of communication deficits at the health interface

The clinical impact of information deficits at the health interface have been evaluated by a number of studies using various tools, but few adopted validated approaches.[31, 32, 35] In the UK and worldwide, the proportions of discrepancies causing moderate to serious harm or patient discomfort have ranged between 10% and 50%.[31, 34, 44, 45] Variances can be explained by the variations in discrepancy definition, identification and study settings. Studies also differed in the methods used to assess severity in terms of the tool used, number of raters and degree of agreement. Appendix 1 summarises the variations in worldwide MR literature with respect to discrepancy definition, classification, clinical significance and inter-rater agreement assessment.

The only large scale UK evaluation of the clinical significance of MR related discrepancies was reported by the clinical directorate of the East and South East England Specialist Pharmacy Services in 2011.[44] This audit consisted of 30 acute trusts and reviewed 3,091 medicines; 4,041 discrepancies were identified. Across care areas, 30% to 52% were considered of moderate or significant potential to increase treatment length or to cause non-permanent harm to the patient. The severity of discrepancies was assessed using a non-validated tool developed by the NPSA in 2008. The development of the NPSA matrix was supported by background guidance along with findings from local workshops.[46] No details were also reported regarding assessment of the variability and agreement between auditors.

Medication discrepancies also contributed to increased risks of rehospitalisation. In a USA study of 375 patients, 14.3% with a medication discrepancy were re-admitted to hospital within 30 days of discharge compared with only 6.1% of patients with no discrepancy ($p=0.04$).[47] This was also consistent with the findings from a small UK study in 2008.[48] Communication gaps within discharge information for 108 patients readmitted within 28 days in the East Midlands in 2008 we identified frequent occurring in two-thirds of discharge documents. Twenty two (54%) of readmissions were of patients with at least one communication gap upon discharge.[48]

Discharge summaries lacking information not only pose a risk to the patient but also create ambiguity in prescribing and therefore cost implications. These might include continuation of unnecessary prescribing or the need for GPs to spend time acquiring necessary information from the hospital team using alternative media. This has been

outlined as a concern by the Care Quality Commission report on managing patients after discharge in 2009.[19] Additionally, without comprehensive and timely notification about patient treatment during and post hospitalisation GPs might feel unable to continue patient care and maintain clinical responsibility.[49, 50]

Whilst, studies have highlighted the implications of admission and discharge information deficits, little has been reported on the quality of information transferred to primary care. There is little indication of the magnitude of discharge discrepancies that are translated into primary care; neither the outcomes of discrepancies nor the actual patient harm perpetuated post discharge. Additionally, little is known about how primary care practices process discharge team recommendations.

1.6 Contributing factors to the quality of information transfer at health interfaces

Factors that may influence the quality of communication at health interfaces may be patient related such as age, complexity of care and medicines regimen. They can also be related to the process of obtaining or communicating information, such as the discharge summary template and whether the document used to transfer information is handwritten or electronic. Additionally, the time available to collect and communicate information can influence accuracy and completeness of information depending on whether the admission or discharge was planned or unplanned or occurred out of working hours or at weekends. Variations may also be related to the professional involved, such as the medical training of the person obtaining medication history or completing discharge summary. Workload and ward workflow might vary between care areas and hospitals and thus it might contribute to variation in the transferred information.

1.6.1 Patient related factors

Patient age can influence the risk of experiencing a discrepancy. Perren et al. evaluated 577 consecutively selected discharge summaries in Switzerland in 2008. The study reported that discrepancies were significantly more frequent in females who were also significantly older than men plus patients prescribed more medicines.[32] No regression was undertaken in order to estimate the relative effects of these different predictors. Unroe et al. in USA in 2010, [32] used multivariate logistic regression analysis to investigate factors associated with admission and discharge discrepancies. The study reported age to be a significant predictor of discrepancies.[29] Given that the average life expectancy of females is longer than males, it is likely that age is the predictor of discrepancy frequency and not sex as suggested by the Perren et al. study.

Conversely, Pippins et al. found patients older than 85 years had fewer discrepancies.[28] This might be unintuitive, as with increased age patients might be prescribed more

medicines and this imposes greater pressure for communication and opportunity of more errors. However, this effect persisted when Pippins et al. adjusted for number, class of medicines and the source used to obtain pre-admission medicines lists. A possible explanation might be that older patients aged over 85 tend to be in relatively good general health status, i.e. prescribed less medicines and able to self-manage their medicines. Additionally, they might have been prescribed the same medicines for many years, thus, both the patient and carer are well familiar with medicines prescribed. This might suggest that the actual association seen between risk of discrepancy and age in the earlier studies is actually related to the influence of an increased number of prescribed medicines. Consistent with this assertion is a study of 120 consecutively selected patients with a mean (SD) age of 82.3 (6.8) in a geriatric outpatient clinic in the Netherlands in 2009 which identified an increased risk of medication discrepancies with an increased number of prescribed medicines but not with age.[51] This is also in concordance with other reports.[16, 30, 32, 35, 52-54] Add to this, a recent retrospective review of 199 discharge documents from patients admitted to an acute geriatric department in Belgium estimated 47% increase in the likelihood of discrepancies for every additional medicine.[55] Those studies might be insightful, however none of them evaluated patients identified via random selection and thus their conclusion might be biased by unknown confounding factors.

An increased risk of discrepancy might actually reflect the increased complexity of patient care; Pippins et al. found that patients who had six or more medicines changed during their hospital stay were over three times more likely to experience medication discrepancies.[28]

Similarly, the type of prescribed medicines could give an indication of care complexity; cardiovascular medicines were most often associated with discrepancies.[28, 29, 56] Those patients are most often elderly and acutely ill; additionally these medicines are the most frequently prescribed class of medicine.[1] Other classes have also been implicated in discrepancies such as medicines for the central nervous system ,[31, 33] gastrointestinal [54] and respiratory. [31, 33] Over the counter purchased medicines and vitamin supplements were similarly associated with discrepancies in a number of reports.[28, 29, 31, 33] Of these studies, only Unroe et al. and Pippin et al. evaluated the association between discrepancies and medication classes whilst taking into account confounding factors related to patient and regimen complexity. Unroe et al. defined a medicine as “high risk” if listed in the North Carolina Narrow Therapeutic index;[57] using univariate logistic regression, patients prescribed one or more of these medicines were at considerably higher risk of experiencing a medication discrepancy, odds ratio [95%CI] = 63.1 [7.93–502.45] ($p<0.001$). Pippins et al. defined the five most “high risk medicines” prescribed with the greatest frequency in the study site as gout medicines, muscle relaxants, lipid

lowering agents, antidepressants and respiratory medicines. Four or more of these "high risk medicines" at admission increased the odds of a higher number of discrepancies by three times ($p < 0.05$). This association between high risk medicines and discrepancies may simply be because they are commonly prescribed or due to being associated with complex regimens. [1, 58] However, in the case of over the counter medicines and vitamins or supplements, this might be because they are perceived as safe, with minimal risk of adverse event and thus less attention paid to accuracy.[59]

1.6.2 Process related factors

1.6.2.1 Type of discharge summary

Historically, discharge summaries were handwritten and thus their legibility presented a potential for errors. Reports have estimated that 40% to 75% of handwritten discharge summaries were completely or partially illegible.[27, 60] As might be expected, handwritten discharge summaries were associated with an increased risk of medication discrepancies.[35] However, with advances in computer technology, the use of electronic discharge summaries has evolved and thus the relevance of legibility is diminishing.[43]

Despite electronic discharge summaries removing the issue of legibility and allowing faster and uniform recording of clinical information,[60] evidence is emerging that errors yet can be introduced with the use of IT systems.[61, 62] Thus, electonic discharge summary are subject to the same transcription issues as handwritten discharge summaries.[43, 61, 63] In line with this, an Australian study reviewing 245 discharge summaries in 2008, identified nearly twice as many errors and omissions in electronic compared to handwritten discharge summaries.[64] A larger evaluation conducted by the same author in 2010, reviewed 966 handwritten and 842 electronic discharge summaries, the study aimed to gain further insight in to the nature of errors introduced by electronic discharge communication. The authors found no new types of error introduced by electronic discharge summaries with both types exhibiting similar nature and extent of errors.[63] However, neither of these studies adjusted for possible patient or process confounders.

1.6.2.2 Type of admission

For planned admissions, it might be expected to have more comprehensive information. Patients can be asked to bring certain information with them and the GP can help with the process by providing a letter or a list of repeat medicines. Whereas, with unplanned admissions obtaining information in a timely manner can be challenging and the amount and quality of information can vary. There is, however, limited evidence to support this hypothesis. The UK wide audit conducted by the East and South East England Specialist Pharmacy Services in 2011 reported more errors being associated with unplanned

admissions in medical areas, but equally highlighted errors in planned surgical admissions.[44] These comments should be only taken as a guide as they are not supported by regression analysis and there were incomplete data related to a number of planned and unplanned care areas. Another large study conducted by Bell et al., reviewed 1,402 medicine charts of patients discharged from intensive care units in Canada. The study identified patients admitted via emergency department at 1.4 times more risk of unintentional discontinuation of pre-admission medicines.[65] However, this was not statistically significant and patients might have been at increased risk of errors due to the complexity of their presentation which was not adjusted in the regression model. Therefore, further investigation is needed.

1.6.3 Individual related factors

1.6.3.1 Training of healthcare professional

While discharge information depends on the information collected upon admission, it may also be dependent on the training and skills of the person collecting the information upon admission and preparing the discharge summary.

A UK study in 2009 reviewed 124,260 medication orders across 19 hospitals in the northwest of England; the aim was to explore the types of errors made by foundation doctors in their first year of training. Foundation doctor training level was identified as a contributing factor to increased risk of prescribing error.[13] A later smaller study but still of considerable size, reviewed 7,920 medication orders for 1,038 patients over four weeks in the same region. This also identified foundation doctors as a significant predictor of prescribing errors; odds ratio [95% CI] = 2.54 [1.08, 5.99] $p = 0.03$.[66] This was also indicated by other studies, although of smaller scale, in USA and Europe.[28, 45]

In contrast to the above, an Australian study retrospectively evaluating 1,808 discharge summaries reported that medication errors were similar among doctors of various training levels ranging from one year up to three years post-graduate training.[63] There is therefore lack of clarity regarding the effect of practitioner training and experience on the quality of discharge summary produced.

Studies also assessed variances that could arise from differences in training level of professional implementing MR at admission. Those studies compared medication histories elicited by various professionals and highlighted that medication histories obtained by pharmacists were more accurate and comprehensive compared to those obtained by doctors or nurses.[14, 67-69] However, these are of small size, non-blind and of retrospective observational design. Thus such conclusions might have been biased in favour of pharmacist obtained histories.

Therefore, further exploration of the effect of profession type across different workflows and specialities is necessary. This should be of large and robust design accounting for potential confounders.

1.6.4 System related factors

1.6.4.1 Ward speciality

The complexity of patient care, workload and staff responsibilities differs between wards. These variances may contribute to the observed differences between wards with respect to the quality of transferred information. The study conducted by Unroe et al. evaluated three wards including general surgery, general medicine and cardiology. General surgery patients experienced more medication discrepancies and of these more were considered of high risk for patient harm compared to cardiology and general medicine wards; odds ratio [95% CI] = 3.31 [1.4-7.87] (p=0.007). However, surgical patients in the study had higher rates of medicines changed compared to the other wards investigated. It is also of note that besides confounding effects, these conclusions are limited by the inclusion of only three wards in the evaluation. Therefore, further evaluation of ward speciality influence on the quality of information is demanded.

1.6.4.2 Variation between hospitals

Hospitals vary with respect to medicines management practice, staff and resources which may explain some of the differences in the extent and quality of information communication.[70] There is, however, limited evidence regarding the extent to which quality of transferred information varies between hospital types such as teaching, community or specialist care hospitals. Bell et al. found patients from an academic hospital were at a lower risk of errors with an adjusted odds ratio [95% CI] of 0.70 [0.49 to 1.0] ($p<0.05$). Withstanding that the study adjusted for confounding factors related to type of admission, complexity of patient presentation and regimen, with the small number of hospital studied (n=3) these conclusions are highly limited. Wider evaluation of hospitals of different workflows with their representative patient population and ward specialities is of need.[65]

1.6.4.3 Time and day of admission

It might be expected that the completeness and quality of information could be influenced by other factors, such as the time and day of admission. Fewer staff are available at weekends and out of hours admissions, plus there is limited access to primary care and community pharmacies. Thus errors can be introduced; however, limited evidence is available to support this hypothesis.

Overall, the transfer of clinical information at the health interface is a multi-factorial process. The relationships between factors and the quality of communication at the health interfaces are unclear and subject to confounding effects. Careful and robust investigation of these factors in a UK context through a wide scale evaluation might enhance understanding of contributors and predictors of communication deficit plus substandard as well as outstanding practice.

1.7 Medicine reconciliation (MR)

1.7.1 Definition

In response to concerns about patient safety at health transitions, medicine reconciliation (MR) was proposed as a solution.[7] The definition of MR has been widely discussed among health professionals; the Joint Commission which is a USA based non-profit organization that accredits health care organizations, defines MR as the process of comparing the patient's medication orders to all of the medicines that the patient has been taking. MR should be performed at every transition of care which includes changes in setting, service, practitioner or level of care.[71] According to the Joint Commission, the MR process comprises five steps 1) develop a list of current medicines; 2) develop a list of medicines to be prescribed; 3) compare the medicines on the two lists; 4) make clinical decisions based on the comparison and 5) communicate the new list to the next care provider and to the patient.[71] The Institute of Healthcare Improvement described three steps for MR: verification, clarification and reconciliation as summarised in BOX 1.1.

The UK National Prescribing Centre (NPC) developed a similar definition and describes MR in two stages; and adopts the 3C approach: collecting, checking and communication.[72] The MR process as described by the NPC is presented in BOX 1.2.

BOX 1.1 MR steps defined by the institute of healthcare improvement [73]

- **Verification**

The first step involves collecting of medication histories.

- **Clarification**

Secondly, ensure that medicines and doses are appropriate

- **Reconciliation**

Thirdly, document all changes in inpatient medicine orders or charts

This process starts when the patient is admitted to the hospital, continues whenever the patient is transferred to a different level of care, and occurs again when the patient is discharged from the hospital.

1.7.2 Terminology

Whilst MR is currently clearly defined in the literature, historically there have been variations within MR terminology. The growing literature over the past decade employed a wide range of terms describing the MR process such as history taking,[24, 74-76] discharge planning[77-79], prescribing checking,[58, 80] care transition/continuity,[81-84] medication management,[85] and assessment.

BOX 1.2 NPC MR process[72]

- **Basic reconciliation (stage 1)**

Basic reconciliation involves the collection and accurate identification of a patient current list of medicines. E.g. of basic MR would include medication history taking in secondary care upon admission.

- **Full reconciliation (stage 2)**

Full reconciliation involves taking the basic reconciliation information and comparing it to the list of medicines that was most recently available for that patient. In addition, it involves identifying any discrepancies between the two lists and then acting on that information accordingly.

The NPC "3Cs approach" includes: Collecting, Checking and Communicating

- **Collecting**

The 'Collecting' step involves taking a medication history and collecting other relevant information about the patient's medicines which can be collected from a range of different sources.

Medication history should be collected from the most recent and reliable source. Where possible, information should be cross-checked and verified by multiple sources. The person recording the information should always record the date that the information was obtained and the source of the information. Where there appears to be a discrepancy between what the patient is currently prescribed, and what the patient is actually taking, this should be recorded too. Where they can be established, the reasons for any variation should be recorded too.

- **Checking**

The 'Checking' step involves ensuring that the medicines and doses that are now prescribed for the patient are correct.

- **Communicating**

Communicating' is the final step in the process, where any changes that have been made to the patient's prescription are documented to the next care provider.

1.8 Initiative for MR implementation

1.8.1 MR initiatives in the UK

Driven by the increased focus on promoting patient safety across all NHS health settings,[86, 87] in September 2000, the Department of Health published *Implementing the NHS Plan: A programme for pharmacy in the NHS hospitals*. Pharmacy services were suggested to be re-engineered and recommendations were placed to extend the clinical pharmacist role to mediation history taking.[88]

The National Service Framework for older people in 2001 outlined that more than 15% of hospital admissions are related to problems with prescribed medicines and 50% of older people are not taking their medicines as intended upon admission. Therefore, the report set standards to ensure a system is in place to specifically manage admissions of older people. The system aimed to enforce safe prescribing, medicines review and accurate documentation of medication history. In addition, the National Service Framework highlighted a need for improved communication between hospital and community health professionals following discharge.[89]

With a similar focus on ensuring appropriate and safe medicine prescribing upon admission, the audit commission in 2001 published *A Spoonful of Sugar Medicines Management in NHS Hospitals.* Pharmacists' involvement in taking medication histories and ensuring the accuracy of admission information was emphasised.[10] In 2003, the Royal Pharmaceutical Society of Great Britain also published guidelines for medicine management during admission and discharge.[90, 91]

The NPSA in 2007 published the *Fourth Report from the Patient Safety Observatory* recommending seven actions to improve medicine use and safety of which was the accurate and complete documentation of patients' allergy status.[92] This was followed by national guidance for MR implementation published in collaboration with the National Institute for Health and Clinical Excellence (NICE). The NICE guidance *Technical patient safety solutions for medicines reconciliation on admission of adults to hospital* recommended MR implementation for all admitted patients and identified pharmacists as the key provider of MR.[93] In 2008, the NPC further developed the NICE/NPSA recommendations by recommending MR for all patients upon discharge, admission and ward transfer. This was recommended within 24 hours of admission and two working days following discharge. This guidance *Medicines Reconciliation: A Guide to Implementation* stipulated the minimum dataset of information that should be communicated at all care transitions points. The NPC minimum datasets are summarised in BOX 1.3.[72]

In February 2010, The *Rapid Response Report: From reporting to learning* was issued by the NPSA in response to patient safety incidents, it outlined immediate actions to be taken by NHS organisations to minimise risks of omitted and delayed medicines in hospital and that all staff should be involved in the change.[6]

More recently in 2011, the Royal Pharmaceutical society produced guidance for medication history taking and emphasised the pharmacist role in obtaining medication information from different sources and confirming information with the patient or patient's carer. In addition, greater care was recommended for obtaining information on medicines taken as required and recently stopped.[94] A year after, the report *Keeping patients safe when they transfer between care providers: getting the medicines right* was published by the Royal Pharmaceutical society. This report recommended implementation of information technology (IT) systems in hospitals and primary care practices to ensure effective transfer of the key content of medicines records required for patient care. Community pharmacists were also recommended to be involved in the process of information transfer between primary and secondary care. Taking the MR process forward, the report recommended that clinical records should be structured in a nationally agreed format to assist interoperability and information transfer between settings.[95]

BOX 1.3 NPC minimum dataset

- **Suggested minimum dataset required in primary care**

To be able to reconcile medicines in a primary care setting, it is suggested that the minimum dataset of information available to GPs should include:

- Complete and accurate patient details i.e. full name, date of birth, weight if under 16 years, NHS/unit number, consultant, ward, date of admission, date of discharge
- The diagnosis of the presenting condition plus co-morbidities
- Procedures carried out
- A list of all the medicines prescribed for the patient on discharge from hospital (and not just those dispensed at the time of discharge)
- Dose, frequency, formulation and route of all the medicines listed
- Medicines stopped and started, with reasons
- Length of courses where appropriate (e.g. antibiotics)
- Details of variable dosage regimens (e.g. oral corticosteroids, warfarin, etc.)
- Known allergies, hypersensitivities and previous drug interactions
- Any additional patient information provided such as corticosteroid record cards, anticoagulant books, etc.

This information should be clear, unambiguous and legible and should be available to the GP (or other primary care prescriber) as soon as possible. Ideally, this should be within two working days of the patient's discharge.

- **Suggested minimum dataset required in secondary care:**

It is suggested that the minimum dataset of information available on admission to hospital should include:

- Complete patient details i.e. full name, date of birth, weight if under 16 years, NHS/unit number, GP, date of admission
- The presenting condition plus co-morbidities
- A list of all the medicines currently prescribed for the patient, including those bought over-the-counter (where this is known)
- Dose, frequency, formulation and route of all the medicines listed
- An indication of any medicines that are not intended to be continued
- Known allergies and previous drug interactions

This information should be clear and legible and should be available to the hospital when the patient is admitted for planned admissions, and within 24 hours of admission for unplanned admissions. In addition to the suggestions made here, local agreements or policies may require further information to be provided.

1.8.2 Worldwide MR initiatives

In the USA, MR came to the forefront of health care in 2005; when it was designated by the Joint Commission as a patient safety goal. In 2005, the Joint Commission announced the National Patient Safety Goal number eight which was to "accurately and completely reconcile medicines across the continuum of care". Accredited organizations were required to develop and test processes for MR implementation.[71] In 2009, in recognition of the challenges that an organisation might face to ensure MR processes are in place, the Joint Commission removed MR from the accreditation decision criteria.[96] Instead, the National Patient Safety Goal number eight was reviewed and in June 2011; MR was retained as a safety goal but in tandem with other medication management requirements. The revised goal sets an expectation for maintaining accurate medication information while leaving organisations to define their MR process and adopt the workflow to encourage better performance in their own institution.[97]

The World Health Organisation launched the “High 5s project” in 2006 to address major concerns about patient safety.[98] The High 5s name derives from the project’s original intent to significantly reduce the frequency of five challenging patient safety problems. Accuracy of medicines information upon care transition was recognised as one of High 5s challenges. The World Health Organisation issued in 2009 a standard operating procedure to guide implementation of MR.[99] This was followed by a campaign lunched by the Institute of Healthcare Improvement to save 5 Million lives, the campaign named MR as a strategy to prevent adverse drug events. A starting toolkit was published in 2008 to enhance wide implementation of MR strategies.[100]

Many tools are currently available for optimisation of MR; in March 2012 the American Society of Health System Pharmacists published guidance *Improving Care Transitions: Optimizing Medication Reconciliation* in which pharmacists were recommended to take a leadership in the development of MR policies and procedures.[8] A similar initiative was published in 2012 by the Agency for Healthcare Research and Quality titled as *Medications at Transitions and Clinical Handoffs toolkit for Medication Reconciliation*.[101]

In 2004, MR was adopted by the Canadian council on health services accreditation as a patient safety goal.[102] In 2010 a report was published *Seamless Care: Pharmacists intervene to prevent adverse drug events and optimize drug therapy* reinforcing pharmacist role in preventing adverse drug events and optimising drug therapy while performing discharge MR.[103]

Initiatives adapting MR were lunched in Australia too, one of the leading countries in the WHO High 5s project. Admission MR is regarded as a part of standard clinical pharmacy

practice that is recommended for every inpatient. The Society of Hospital Pharmacists of Australia outlined MR as a professional practice standard.[104] Additionally, MR is one of the eight clinical practice improvement areas of the Safety and Quality Investment for Reform Program, and one of the five standards of the West Australian Process of Pharmaceutical Review policy. These are programmes created in Western Australia to empower the Department of Health's clinical governance and patient safety management systems to ensure delivery of safe, high quality, evidence-based health care to patients. [105]

Similarly, in the Netherlands, a Patient Safety Programme was launched in Dutch hospitals in 2007, which included a bundle intervention concerning MR at hospital admission and discharge. Since 2011, MR at hospital admission and discharge has been made compulsory by the Dutch government for every planned admission and upon discharge.[106]

1.9 Interventions to improve information transfer at the health interface

Interventions to improve information transfer have focused on promoting pharmacy led MR, multidisciplinary MR packages and incorporating a computer system in the production and transfer of information. Additionally, studies have evaluated the use of standardised forms for obtaining and transferring information, discharge planning and post discharge follow up.

1.9.1 Pharmacy led MR

Pharmacy led MR interventions have frequently been supplemented with other clinical activities such as discharge counselling,[78, 107-109] patient education,[110-112] medication review,[107, 110, 113-115] adherence aids,[60] participation with ward rounds[14, 116] and telephone follow up.[111, 112, 117, 118] Additionally, MR was evaluated across various settings such as emergency department,[76, 110, 119] surgical pre-admission clinic,[120, 121] outpatient[122] and ambulatory care.[123, 124] Pharmacy led MR was implemented at different point of care including admission MR [14, 68, 75] or discharge MR alone.[60, 125, 126] In fewer number of studies full MR process was implemented; i.e. at both admission and discharge.[118, 120, 127] MR was mostly led by a pharmacist with clinical training; however, less frequently MR was implemented by pharmacy technicians [107, 128] or pharmacy students.[111, 117, 129]

A number of studies in the UK have evaluated the pharmacist role in medication history taking and shown improvement in the accuracy of medication histories, inpatient charts, discharge prescriptions and allergy information. Those studies were, however, of small size, uncontrolled observational and of before and after design.[14, 76, 80, 116, 130, 131] Thus conclusions, most likely have been biased in favour of the pharmacist intervention.

Studies outside the UK are relatively larger in size; however they have varied widely in the MR intervention, setting, number of providers, comparator and outcomes measured. A USA study in 2012 consisted of 102 patients who received pharmacy led MR compared to 116 patients who received MR by the doctor. The MR pharmacist enhanced the completeness of medication histories and reduced adverse drug events attributed to admission errors.[132] This agrees with a previous USA study, in which MR was led by a pharmacist or pharmacy student who obtained medication histories.[133] These two studies adopted non-random selection of patients admitted to general medical units. However, the findings are consistent with a Canadian study across surgical pre-admission assessment which adopted a randomised controlled design. This latter study of 227 patients randomised into the intervention group and 237 in the control group compared pharmacy led MR with nurse-conducted medication histories plus surgeon-generated discharge summaries. In the intervention group, 20.3% had at least one postoperative error related to home medications, compared with 40.2% of control group ($p<0.001$).

Additionally, 29.9% of patients in the control group had at least one postoperative medication discrepancy with the potential to cause possible or probable harm compared with 12.9% in the intervention group ($p<0.001$).[121] The study therefore suggests that pharmacy led MR results in a significant reduction in errors and discrepancies, however, this difference may not be entirely attributed to the health professional delivering the MR. The intervention and control groups differed not only in terms of the professional delivering the service but also in the process; the intervention adopted the seamless uniprofessional MR process whilst the control group had a more disjointed approach of partial delivery by a nurse and doctor which may have introduced greater scope for communication issues and thus errors and discrepancies.

Inconsistent with the findings above, another randomised study conducted by Kripalani et al. in 2012 included 860 patients in both groups and reported that the effect of MR on preventable adverse drug events and clinically significant medication errors was less evident. Patients were hospitalised with acute coronary syndrome and acute decompensated heart failure, potentially those were at a greater risk of adverse drug events and required more complex care.[111] Therefore, the poor clarity about the true effects of pharmacy led MR on adverse drug events and clinically significant errors might reflect the heterogeneity between these study methods, intervention, provider and setting. This limits the ability to draw firm conclusions on this regard.

The influence of pharmacy led MR on health resource use such as length of hospital stay, readmission and emergency department visits is also uncertain. Optimising therapy and medicine use by ensuring an accurate and complete medicine list at admission and throughout hospital stay might shorten patient stay. However, the findings from Mortimer et al. [110] were not in agreement with such an assertion. In an emergency department, 199 patients were alternately allocated to either the intervention which was receipt of pharmacy led MR or the control which was MR from a doctor at admission and MR from a ward pharmacist at discharge. The intervention patients stayed longer in hospital compared to control patients ($p< 0.01$). The lack of randomisation and thus the risk of selection bias might underline the imbalances reported between the two groups; the MR pharmacist managed significantly more complex patients compared to the doctors and thus they might have stayed longer because of the nature of their presentation.[110] Similarly, in Sweden in 2012, a large before and after study, Hellstrom et al., including 1,216 patients in the intervention group and 2,758 control patients showed no significant effect on emergency department visits, rehospitalisation or mortality rates over 6 months.[134] In contrast, Scullin et al. and Gillespie et al., two randomised controlled studies, showed significantly fewer readmissions and emergency department visits for

patients receiving pharmacy led MR compared to standard care.[115, 135] Additionally, Scullin et al. showed a significant reduction in length of hospital stay.

Scullin et al. 2007 is a study in Northern Ireland including 371 patients in the intervention group and 391 in the control group. The intervention significantly lowered readmission rates over 12 months by 10%. It also delayed the time at which readmissions occurred; intervention patients took 20 days longer on average to be readmitted compared to control patients ($p = 0.036$). A more recent Swedish study conducted by Gillespie et al evaluated readmissions and emergency department visits combined for 199 patients in the intervention group and 201 patients randomised to the control group. Intervention patients showed a significant reduction in readmissions and emergency department visits compared to control patients. Hellstrom et al.[134] evaluated the effect of the addition of admission MR in wards which had already implemented discharge MR process as a part of the usual care; an important difference between these three studies is that, thus the effect of the intervention might have partially masked by the benefit of usual care MR. Whereas, Scullin et al.[115] and Gillespie et al.[135] evaluated the effect of full MR process at both admission and discharge compared to absence of MR at the control group. Additionally, in the latter two studies, patients were counselled on discharge, and in the study by Gillespie et al. they were also followed up by a telephone call five to seven days post discharge to ensure all medicines were being taken as intended. Discharge counselling and follow up by a phone call are non-MR care activities and may have enhanced post discharge care continuity and thus reduced risk of readmissions and emergency department visits on their own. Thus, conclusions on the true effect of MR on health resource use are not definitive and the extent to which MR contributed to the observed findings cannot be established without further work.

MR can aid in optimising prescribing such as stopping unnecessary medicines, switching formulation and managing patient own drugs, thus it would be plausible to assume that this might contribute to considerable savings. However, this can be established only through studies adopting a robust economic evaluation design. Unfortunately, studies that have attempted to estimate costs and savings related to pharmacy led MR, have generally considered only costs of medicine use without any estimates of other costs or savings such as health resource use and cost of harm associated with errors.[14, 68] Little evidence was available for the effects of pharmacy led MR on quality of life and thus further research is necessary.

In UK, the NICE/NPSA guidance in 2007 recommended pharmacist involvement in MR at admission based on findings from one randomised controlled trial, two before and after and five observational studies presented in a systematic review conducted by the

university of Sheffield which described the effect and cost-effectiveness of interventions aimed at preventing errors upon admission.[136] Pharmacy led MR appeared to be beneficial in reducing medication discrepancies, however none of the included studies assessed the effect of MR on adverse drug events and health resource use. Thus, the NICE/NPSA conclusion on pharmacy led MR may have been biased by the limited number of studies and methodological limitations of the included studies.

Two recent systematic reviews attempted to collate the available evidence on hospital based MR; Mueller et al.[137] and Kwan et al.[138] Both reviews highlighted that the quality of the evidence available for MR interventions is poor but indicated that the most rigorous research support the pharmacist related interventions.[137, 138] This indicates that the quality of the available evidence for pharmacy led MR has advanced little over time.

Recommendations supporting pharmacy led MR are informed by a number of existing randomised controlled studies,[111, 115, 135] however majority of the recommendations are derived from less rigorous designs. Those randomised controlled studies varied widely in interventions and outcomes measured. Additionally, Limited number of studies evaluated pharmacy led MR within UK settings. Up to the time of this thesis synthesis, all the randomised controlled studies, those assumed to inform the most robust evidence, are based outside the UK. And therefore, these recommendations are of limited generalisability due to differences between the UK NHS and other health care systems. This highlights insufficiency of the evidence and the need of UK relevant evidence.

1.9.2 Multidisciplinary package to implement MR

Studies described multidisciplinary MR packages including a pharmacy led MR implemented in a multidisciplinary core of various healthcare professionals such as doctors, nurses, GPs or community pharmacists. The workflow within these packages was supported by meetings and discussion between the team members, periodic reviews to ensure standardised implementation plus regular audits. The multidisciplinary MR packages described in the literature are highly heterogeneous and responsibilities are widely varying between professions based on the study setting, staffing capacity and workflow.

Two USA studies highlighted a favourable effect of multidisciplinary MR packages. The first study was an observational uncontrolled study of 102 patients. The study included nurses, pharmacists, and physicians as well as family medicine residents reconciling medicines at admission and discharge. The mean number of medication discrepancies at both admission and discharge was reduced significantly, $p < 0.05$.[139] The second study was of before and after design. In addition to doctors, nurses and pharmacist, the study

included occupational therapists, nutritionist, pharmacist and social workers developing collaboratively a care plan upon admission. GPs were also notified by patient admission and informed promptly upon discharge. In addition, discharge planning meeting was held with the nurse, doctor and patient to optimise care transition. No pharmacist input was at discharge. For 185 patients in the intervention group compared to 237 control patients, emergency visits were three times less likely to occur at 3 days of discharge, odds ratio [95% CI] =0.25 [0.10–0.62] ($p<0.05$). This effect was sustained at 30 days with emergency visits and readmissions, odds ratio [95% CI] =0.61 [0.36–1.03] ($p=0.06$).[140]

Both studies showed a significant reduction in discrepancies, readmissions and emergency visits, however their small size and non-randomised design, leaves plenty for further work. Subsequent studies need to assess acceptability of multidisciplinary MR packages by health professionals and application across institutions and trusts of different staff and resources.

Additionally, given the limited number of studies and the heterogeneity of MR packages, it is unclear how MR tasks can be divided optimally between professionals and what would be the most effective approach by which MR can be optimised.

1.9.3 IT based information transfer initiatives

Implementing computerised IT is considered a solution to ensure effective and timely communication at health interfaces; it is well accepted that employing an electronic pro-forma has expedited and enhanced legibility of discharge summaries.[60, 62] However, the risk of user selection and human errors is increasingly seizing attention.[43, 61] In addition to IT based production and transfer of information, the use of IT applications to integrate MR with medicine entry orders and medicine management software might hold potential for further enhancing patient care.

A web-based application that enabled GPs to visualise information regarding their patients' emergency department visits was implemented in Canada 2007 for 2,022 emergency department visits. GPs found information more useful, they could manage patient better and initiated actions more often following the receipt of information. However, though those could highlight the benefit on ensuring accuracy and continuity of care, these were not reflected as a reduction in GPs visits post discharge.[141] Similarly the use of a more sophisticated computerised MR tool integrating medicines list from several electronic sources and enabled other clinicians to review medicines reported to decrease unintentional discrepancies which were considered of potential harm with adjusted relative risk [95%CI]= 0.72; [0.52-0.99]. Nevertheless, the benefits on readmissions and emergency department visits were not apparent.

Worth noting, the later study was conducted in two hospitals with significant benefit on medication discrepancies seen at hospital 1 but not at hospital 2. No significant effect was shown in healthcare resources use in both hospitals. Variation in intervention success could reflect the extent of the MR tool integration into the existing computer system in the study hospitals. The system in hospital 1 was reported being set in an easier manner to input information and match patient medicine lists compared to the system of hospital 2. [142]

In 2007, the UK Patient safety advisory committee regarded that the evidence is insufficient to make recommendations on the use of IT based applications.[93] Since then, there is a range of new and developing technologies that appear to have benefits on reducing medicine errors and improving accuracy and usefulness of communication.[141, 142] However, it is not well established whether these improved healthcare resources use.[141, 142] Additionally, IT application features and the advances with the technology would widely vary between settings; this places a question on the applicability of these applications for wide scale implementation. It would be also uncertain whether similar outcomes would be yielded across different institutions and trusts.

1.9.4 The use of a standardised reconciliation document

The use of a standardised MR form to ensure optimum MR implementation could contribute to better communication of information. Research evaluating their effect is limited; however, those reported have shown a significant reduction in both discharge summary omissions and medication errors with the potential to decrease health resource utilisation. However, it did not report whether health resource use in the intervention group was significantly lower than control. A standardised discharge medication report was employed to document medicines changed and rationales. The report was sent to GPs and handed to patients at discharge. Eleven out of 248 (4.4%) patients in the standardised report group compared with 16 out of 179 (8.9%) patients needed medical care because of medication errors $p = 0.049$.[143]

The use of standardised MR forms might appear of low complexity and place limited demands on new or additional costly resources such as pharmacist or computer technology. It is important however, to obtain consensus between professionals on the use and the responsibility for the form completion. Otherwise, benefits might not be possible to achieve. In Canada, data related to a total of 3,275 medicines before implementation of a MR standardised form were compared to 3,240 medicines after form implementation. No particular profession was responsible for the completion of medication history forms whilst a doctor were assigned responsibility for form completion at discharge. Quality of medication information was comparable between groups (p=

0.86) on admission whist on discharge, there was a significant improvement in the quality of information P < 0.001.[144] Assigning the responsibility of form completion to a nominated profession might have enhanced the completion and utilisation of discharge forms, consequently this might have improved the quality of discharge information. Nonetheless, there was no overall improvement in the quality of information transfer.

Developing and incorporating a standardised MR form within the routine workflow is not free of challenges. Underutilisation of the form and unfamiliarity of the staff with the form may be problematic.[144] Employing a standardised form might be perceived by the care team as time consuming and thus contribute to increased complexity in care transition.[144] Therefore, more studies are needed to determine the effect of standardised MR forms on health resource use and the time needed to collect information and complete the form. It might be, however, of note that over time, experience with the form would build up and thus form completion might improve and become faster.[145]

1.9.5 Discharge planning and post discharge follow up

MR can be embedded within discharge planning which involves the development of an individualised discharge plan for the patient prior to leaving hospital and arranging follow up programmes with the GP or home nurse.[146, 147] A discharge program in USA in 2009, involving a nurse and a clinical pharmacist showed a positive impact on readmissions and emergency department visits. The nurse acted as a discharge advocate, arranging a post discharge follow up appointment, confirming MR and sending an individualised instruction booklet to GPs. The clinical pharmacist followed up patients via phone call or visit to reinforce discharge plans and review post discharge medicines. Within 30 days of discharge, intervention patients (n= 370) had significantly lower rates of readmission and emergency department visits compared to usual care (n= 368) with an odds ratio [95% CI] of 0.70 [0.515 to 0.937] (p= 0.009).[112] The true effect of MR on these findings is hard to establish as discharge planning might by itself optimise patient post discharge care and ensure continuity of care. This might have augmented MR benefits on readmissions and emergency department visits. However, a recent Cochrane review concluded that discharge planning has limited impact on readmission rates, hospital length of stay or health outcomes.[146] Therefore, further research is demanded to enable firm conclusions.

1.9.6 Education and training health care staff involved with care transition

Possible causes for deficiencies in care transition communication might be related to insufficient MR related training or education of health professionals. Thus, a possible intervention might aim to enhance care team awareness of the significance of accurate and complete information transfer on patient outcomes and continuity of care.

One study conducted an educational campaign targeting junior doctors. The campaign included teaching, posters and placing reminders in the hospital notes. For 580 patients, the discrepancy rate per patient discharge summary significantly reduced from 2.6 in the first two weeks of the study, i.e. pre-educational intervention, to 1.0 by the end of the study at 18 weeks. This decline in discrepancy rate also remained significant when only clinically important discrepancies were included. The proportion of admissions with one or more clinically important discrepancies also significantly decreased during the study from 46% to 24% ($p = 0.023$).[148] This study of note, however, more work is needed.

1.10 Barriers for implementation of medicines reconciliation

While MR appeared generally accepted at a conceptual level, wide implementation has not yet been achieved.[73, 149] Initiatives for MR optimisation have existed over the past 15 to 20 years in the UK and worldwide, so the lack of progress in MR practice is of concern. The institute of healthcare improvement stated in 2011, that frequently there is no standardised process to ensure a comprehensive patient‘s medicine list is available to all providers and compared with the most recent list of medicines as the patient moves through different levels of care.[73] There is also no clear agreement about the professional responsible for MR across settings and there is no wide national guide on who, where and when to implement MR.[149, 150]

Accurate sources of information may be difficult to identify at the time of care transition unless one has taken the time to explore and test different methods to collect information.[8, 73] Since the most rigorous evidence is supporting an increased involvement of the pharmacist in care transitions tasks, the extra time commitment to perform MR should be precisely estimated.[14, 76, 140] However, due to the variation between studies in the design, patients, complexity of interventions and MR process, a reliable estimate of the pharmacist time commitment is difficult to ascertain. The time needed has ranged from 10 minutes to 45 minutes.[17, 67, 80, 112, 133, 151, 152] Additionally, with interventions consisting of multi-components, the time and thus costs related to other health professionals, developing policies, forms, IT application and training should be also considered. The cost of pharmacist and other professional time is probably the main cost drive to consider before accepting wide application of MR.

Health professionals might resist IT based MR application, this might be heavily influenced by inadequate computer literacy and difficulties in layout. Additionally, the use of IT application might introduce user and selection errors.[64] Therefore, the needs for training, IT support, education of health professionals are key requirements for successful IT based MR implementation. Noteworthy, variances in the resources available to support

IT interventions and the feasibility of integrating MR with the existing computerised system might lead to different outcomes and acceptability between settings.[142]

Healthcare professionals may resist also changes in the existing practice; this is partially due to time or workload concern and insufficient training or education.[129, 144, 150] Additionally, continuous evaluation, auditing and feedback of MR process are time consuming.[140, 153, 154]

Finally, effective MR implementation might also be hindered by the lack of obligatory legislations which formalise wide MR implementation and the lack of collaboration between secondary care and primary care at national and organisational level.[150]

1.11 A place for evidence

The literature search presented earlier suggests that MR might improve care transition and patient outcomes plus health resource use. Yet, evidence is needed to draw these conclusions with confidence. This thesis aimed to design an MR intervention and develop a strategy for its evaluation. To fulfil this aim, three projects were conducted; an audit of discharge summaries to identify current deficits in information transfer to primary care, a systematic review to identify the most effective features of MR interventions and appropriate outcome measures for evaluation, plus design and interim analysis of a pilot randomised controlled study informed by the audit and systematic review. The work on these projects aimed to answer the questions presented in BOX 1.4. In answering these questions progress has been made in describing the optimum use of MR at the heath interface.

BOX 1.4 Areas for key research questions

1.12.1 What is the extent of practice adherence to the UK guidance on information transfer at the healthcare interface?

The quality of admission and discharge discrepancies has been extensively investigated; however, there is no large scale report on the quality of information received in primary care following patient discharge. Additionally, there has been no evaluation of the extent to which discharge summaries adhere to the minimum dataset recommend by the NPC. Thus, there is no indication of this recommendation impact on the quality of practice.

1.12.2 What are the factors contributing to better practice upon care transition and which are the ones implicated into poor performance?

Whilst poor practice is often highlighted, there is little information about the predictors of good practice. Additionally with sparse NHS resources, the identification of patient related risk factors which contribute to discrepancies would be useful for prioritising patients at high risk. Therefore, further investigation is warranted.

1.12.3 What is the best practice to implement MR?

It is difficult to describe the best approach to implement MR. Studies widely varied with respect to MR interventions, patients and outcomes measured. More studies are needed on the adoption and implementation of effective MR. A well-defined pharmacy led MR intervention must be developed to identify the best practice for MR. More studies of randomised design are needed to address the feasibility and effectiveness of MR in UK context.

1.12.4 What are the resources necessary to implement pharmacy led MR?

The cost of implementing pharmacy led MR is uncertain. Implementing pharmacy led MR might be constrained due to lack of resources. Accepting of pharmacy led MR service across trusts requires a precise estimation of the resources and the cost associated with MR implementation.

1.12.5 Is pharmacy led MR cost-effective?

Cost avoidance resulting from MR might be a challenging figure to capture. Potential cost saving might result from mitigating patient harm, improving prescribing and reducing health resource use. An evaluation of the cost-effectiveness of pharmacy led MR intervention compared with the current practice at care transition is needed to enable an answer whether health commissioners should accept pharmacy led MR services across NHS health interfaces. This however cannot be assumed without full economic evaluation.

1.12 Thesis purpose

1.12.1 Conducting a Trust-wide evaluation of information received in primary care

An in-depth investigation review of the factors that influence the quality of discharge information communicated to primary care is lacking. It was recognised that a view on the current practice and the quality of discharge summary information should be obtained. A Trust-wide evaluation would enable to highlight areas of improvement and inform the need for future interventions.

It was almost three years since the NPC guidance was issued, therefore, it was an appropriate time to audit current practice across Norfolk to improve understanding of discharge communication across the Trust. An evaluation of the potential harm associated with post discharge discrepancies by using a scientifically rigorous approach was also regarded appropriate.

Clinical governance is a system through which NHS organisations are accountable to safeguard high standards of care by creating an environment in which excellence in clinical care can flourish.[155] Clinical audit was integrated into clinical governance systems by the Department of Health in 1997.[156] The NHS took this further and proposed in 2008 a mandatory participation of all health staff in clinical audits.[157] Audits are the heart of clinical governance and aimed to be introduced within the NHS normal practice.[158]

All clinical audits conducted within NHS organisations follow the principles of *Best Practice in Clinical Audit* issued by NICE in 2008.[158] NICE defines audit as a quality improvement process that seeks to improve patient care and outcomes through a systematic review of care against explicit criteria.[158] Clinical audit is seen as a continuous cycle of a systematic process for establishing best practice, measuring care against criteria, taking action to improve care and monitoring practice to sustain improvement. Figure 1.1 illustrates the audit cycle and BOX 1.5 summarises the stages of a clinical audit.

Figure 1.1 The clinical Audit cycle[158]

NICE encourages NHS organisations to undertake baseline data collection to determine whether practice is in accordance with guidance.[159] A Trust-wide audit would be the first part of the clinical audit cycle and where practice deviating from the guidance is identified, changes would be recommended. Therefore, a Trust-wide audit was carried out; discharge summaries received in primary care practices across Norfolk were audited against the NPC minimum dataset of information transferred on discharge.

BOX 1.5 Clinical audit steps (NICE, 2008)[158]

Stage 1 - Preparation

- Choose a topic:
  - Preferably one which is a high priority for the organisation.
  - This may involve areas in which there is a high volume of work, high risks or high costs of care, or an area identified as a priority by patients.
- Identify available resources such as:
  - Organisations may have a local audit lead or office.
  - There may be existing guidelines defining desired standards for the topic chosen.

Stage 2 - Select criteria

- Define the criteria
  - This should be in the form of a statement, e.g. All patients with hypertension who smoke should be offered smoking cessation advice.
- Define the standard which is usually a target as a percentage
  - This may be a minimum standard or an optimal one, depending on the clinical scenario.

Stage 3 - Measuring level of performance

- Collect the data:
  - May be from computerised records, manual collection, or both.
  - May be retrospective or prospective.
- Analyse the data collected:
  - Compare actual performance with the set standard.
  - Discuss how well the standards were met.
  - If the standards were not met, note the reasons for this (if known)

Stage 4 - Making improvements

- Present the results and discuss them with the relevant teams in your organisation.
- The results should be used to develop an action plan, specifying what needs to be done, how it will be done, who is going to do it and by when.

Stage 5 - Maintaining improvements

- This follows up the previous stages of the audit, to determine whether the actions taken have been effective, or whether further improvements are needed.
- It involves repeating the audit (i.e. targets, results, discussion); hence the terms 'audit cycle' or 'audit spiral'.

1.12.2 Developing and evaluating an innovative pharmacy led MR intervention

MR contains several interacting components and a range of possible outcomes, variability in population and implementation between settings; thus it is believed to be an example of complex health intervention.[160] The Medical Research Council published a framework to help researchers and research funders to recognise and adopt appropriate methods for the development, evaluation and implementation of complex interventions.[160] BOX 1.6 summarises the main elements of the Medical Research Council's guidance.

BOX 1.6 The Medical Research Council process for the development, evaluation and implementation of complex interventions

The Medical Research Councils' process includes developing, piloting, evaluating, reporting and implementing

- **Developing**

o Identifying the evidence base

Identifying the relevant, existing evidence base, ideally by carrying out a systematic review

o Identifying/developing appropriate theory

Identify what changes are expected, and how change is to be achieved. For example interviews with 'stakeholders', i.e. those targeted by the intervention, or involved in its development or delivery. This should be done whether to develop an intervention or to evaluate an intervention that has already been developed and/or implemented. There may be lots of competing or partly overlapping theories and finding the most appropriate ones will require expertise in the relevant disciplines.

o Modelling process and outcomes

Obtain information about the design of both the intervention and the evaluation. One useful approach to modelling is to undertake a pre-trial economic evaluation. This may identify weaknesses and lead to refinements, or it may show that a full-scale evaluation is unwarranted, for example because the effects are so small that a trial would have to be infeasible large

- **Piloting and feasibility**

Ensure intervention can be delivered as intended, it is also important to develop an estimation of the effect sizes, variability and rates of recruitment and retention in a large scale evaluation.

BOX 1.6 The Medical Research Council process for the development, evaluation and implementation of complex interventions (continued)

- **Evaluating**

o Assessing effectiveness

Randomisation should be considered as it is the most robust method of preventing the selection bias. A crucial aspect of the design of an evaluation is the choice of outcome measures; which outcomes are most important, and which are secondary, and how to deal with multiple outcomes in the analysis. Sources of variation in outcomes are important to be considered as well as subgroup analyses.

o Understanding processes

Evaluation is often highly valuable in providing insight into why an intervention fails unexpectedly or has unanticipated consequences or why a successful intervention works and how it can be optimised. Process evaluation nested within a trial can also be used to assess fidelity and quality of implementation, clarify causal mechanisms and identify contextual factors associated with variation in outcomes. Process evaluations should be conducted to the same high methodological standards and reported just as thoroughly as evaluation of outcomes. However, they are not a substitute for an outcome evaluation, and interpreting the results is crucially dependent on knowledge of outcomes.

o Assessing cost-effectiveness

An economic evaluation should be included if at all possible, as this will make the results far more useful for decision-makers. Ideally, economic considerations should be taken fully into account in the design of the evaluation, to ensure that the cost of the study is justified by the potential benefit of the evidence it will generate, appropriate outcomes are measured, and the study has enough power to detect economically important differences. The main purpose of an economic evaluation is estimation rather than hypothesis testing, so it may still be worth including one even if the study cannot provide clear cost or effect differences. However, it is of most importance to handle uncertainty appropriately.

- **Reporting and implementing**

o Getting evidence into practice

Findings are made available using methods that are accessible and convincing to decision-makers in order to allow them to be translated into routine practice or policy. Information needs to be provided in accessible formats and disseminated actively.

BOX 1.6 The Medical Research Council process for the development, evaluation and implementation of complex interventions (continued)

o Getting evidence into practice (continued)

Approaches for effective implementation are:

- To involve stakeholders in the choice of question and design of the research
- To provide evidence in an integrated and graded way as reviews not individual studies and with variable length summaries to allow for rapid scanning
- To take account of context, and identify the elements relevant to decision-making, such as benefits, harms and costs
- To make specific recommendations as possible
- To use a multifaceted approach involving a mixture of interactive rather than didactic educational meetings, audit, feedback, reminders, and local consensus processes

Successful implementation depends on changing behaviour and often of a wide range of people. This requires understanding of the behaviours that need to change, factors maintaining current behaviour, barriers and facilitators to change. Further research may be needed to assist the process of implementation.

o Surveillance, monitoring and long term outcomes

Effects are likely to be smaller and more variable once the intervention becomes implemented more widely, and unanticipated consequences may begin to emerge. Long-term follow-up may be needed to determine whether short-term changes persist. It is worth thinking about how to measure rare or long-term impacts, for example through routine data sources and record linkage, or by re-contacting study participants.

1.12.2.1 Identifying the evidence base for pharmacy led MR studies

The quality of discharge information communication largely depends on the quality of information obtained on admission. At least half of discrepancies at discharge originate from discrepancies in medication histories and 72% of all potentially harmful discrepancies in admission or discharge orders were due to errors related to compiling pre-admission medicines list.[17, 28] Therefore, improving the continuity and quality of information received in primary care can be enhanced by optimum implementation of MR during hospital stay.

The Institute of Healthcare Improvement states in 2008 that the term MR has been occasionally not fully implemented; in some contexts, MR is widely accepted as a medication history taking task and in others it includes only discharge reconciliation.[161] Two years later, the Institute of Healthcare Improvement reported that MR is continuing to be a challenge for many hospitals and care settings. However, there were some examples of effective implementation.[73] The Institute of Healthcare Improvement also, highlighted the lack of clear ownership of the process and the need for a standardised approach to implement MR. In some cases, the collection of medication history is completed by a nurse, or by a pharmacist or a doctor in other cases. There is still no widely agreed defined process to communicate therapy changes and treatment plans between healthcare providers.[73]

Considering the pharmacist's knowledge of medicine use, increasingly many hospitals allocate pharmacists to quality assure the clinical information collected on admission and/or discharge. Pharmacist involvement and the time spent in MR differ between hospitals depending on the available resources and staff.[8] A UK study reported that pharmacy led clinical advice, medication history taking and discharge check are only provided in 40% of emergency departments.[15] In East of England pharmacy led MR is provided for only 50-60% of patients.[26, 162] Variations in the extents of pharmacy led MR also exist in the USA, Australia and Ireland.[163-165]

The impact of pharmacy led MR is not fully understood and the associated cost of expanding MR services to all admissions is uncertain. Therefore, without robust evidence on the effects and associated costs it is not possible to expand pharmacy led MR across all NHS healthcare interfaces.[166, 167]

Primary studies of various design, settings and measurements have been published in recent years evaluating hospital based pharmacy led MR. Therefore, a systematic search to summarise the published evidence which would progress to provide a rigorous summary of the existing evidence is of value.

The two recent systematic reviews of hospital based MR conducted by Mueller et al.[137] and Kwan et al.[137] identified that the most successful interventions relied on pharmacists and outlined that MR appears to be a potentially promising intervention to improve information transition.[138] Those systematic reviews, however, only described the clinical effect related to MR interventions and thus a collative review focusing on acquiring the evidence for the cost is warranted.

Therefore, an exhaustive systematic review to summarise all the relevant research evaluating the full MR process led by a pharmacist, pharmacy technician or pharmacy student was undertaken.

1.12.2.2 Development and evaluation of a novel pharmacy MR intervention

Both reviews on hospital based MR supported pharmacy led interventions.[137, 138] However, they showed varying conclusions with respect to the effect of MR on medication discrepancies and the use of health resources. Mueller et al. found a consistent reduction in medication discrepancies, meanwhile the reduction in resource use was less evident.[137] Kwan et al. found no effect of MR on reducing discrepancies which were considered clinically significant; however, a significant reduction in emergency department visits and readmissions was identified at 30 days post discharge.[138] Kwan et al. presumed the observed difference resulted from methodological differences between the two reviews; mainly in the selection criteria. Reviewing the bibliography of both reviews, both identified a different set of relevant studies. Kwan et al. identified studies that assessed the clinical significance of unintentional discrepancies, required a clear distinction between intentional and unintentional discrepancies and performed the assessments of clinical significance by at least one clinician independent from the study process. Mueller et al. included studies with MR being the primary focus of the intervention with no criteria of selection based on the outcomes measured. Nevertheless, both reviews derived conclusions from interventions that included non-MR aspects, those are of potential to improve admission and discharge process and enhance post discharge care coordination. As such, the degree to which MR contributed to the reported findings is unclear and the answer to the question regarding the true effect of MR remains unclear and warrants further investigation.

The systematic review in 2007 of interventions aimed to prevent medication errors at admission,[136] reported that NHS cost avoidance from pharmacy led MR was £106 per MR review ranging between £63 and £148.[44] Those costs, however, were only related to preventing medication errors. An economic model was informed by the aforementioned review; the cost-effectiveness of pharmacy led MR strategies on reducing adverse drug events was estimated with £10,000 per quality-adjusted life-year (QALY). The authors

also estimated the cost of implementing pharmacy led MR at £1,897 per 1000 prescription orders. However, there was uncertainty surrounding the model assumptions in estimating and identifying the proportion of errors leading to preventable adverse drug events.[168] Additionally, other costs associated with use of health resources and medicine use were not estimated. Those unmeasured costs are essential to obtain a precise estimate of pharmacy led MR cost-effectiveness. Therefore, further evidence to determine the cost-effectiveness of pharmacy led MR interventions is needed.

The use of theory and evidence from systematic reviews and undertaking feasibility and pilot studies is essential in the development and evaluation of interventions, those are highly recommended prior large scale evaluation.[160] MR is a complex intervention, as described earlier, and so a randomised controlled study would be the most robust method to evaluate and assess the effects and costs.[160] A pilot study would play an important role in providing information for the planning and justification of a large scale randomised controlled study evaluating a pharmacy led MR intervention. A pilot study is a version of the main study that is run in miniature scale to test whether the components of the intervention can all work together.[169] The Medical Research Council's guide recommends a feasibility and piloting stage to test acceptability, estimate the likely rates of recruitment and retention of subjects, and the calculate appropriate sample sizes. It also emphasises the role of the pilot in anticipating problems with acceptability, compliance, delivery of the intervention, recruitment and a very small effect size.[160]

Although, piloting is vital preparatory work, it is often skipped and poorly reported.[170, 171] Piloting data is also misinterpreted by some investigators; a pilot study is mainly descriptive and should be interpreted cautiously when making assumptions or using hypothesis testing.[169, 171]

Within this thesis, a pilot study was developed to provide an insight into the potential value of expanding the pharmacist MR service and to determine whether a larger scale trial would be feasible. If the patient recruitment rate was poor, the effect size negligible, or the impact from the service was minimal; further trials would be regarded as unnecessary.

1.13 Cost-effectiveness

In order for a new intervention to achieve cost-effectiveness, it should generate more health gain to the NHS patients than the existing alternative as a result of the additional cost imposed on the system. NICE, in assessing cost-effectiveness, is concerned with making decisions which are consistent with maximising patient health gains subject to the NHS budget constraint.[172]

Cost-effectiveness is a type of economic evaluation defined as a comparative analysis of alternative courses of action in terms of both their costs and consequences.[173] BOX 1.7 describes the four types of economic evaluation [173]

BOX 1.7 Types of economic evaluation (Drummond, 2005)[173]

- **Cost-minimisation analysis**

Cost-minimisation analysis describes the evaluation where the consequences of two or more interventions are broadly equivalent. In this type of analysis only costs are analysed, and the least costly alternative is chosen, provided that outcomes are known to be equal among alternatives.

E.g. For a number of medicines to treat hypertension; If the dose required to cause a 10 mmHg reduction in systolic blood pressure was known for several different medicines, the acquisition costs of the medicines could be calculated and the cheapest one identified.

- **Cost-effectiveness analysis**

A cost-effectiveness analysis is used when the costs and outcomes of different services/treatments are compared using an outcome that is bespoke to the intervention

E.g. Two medicines to treat hypertension (A and B); drug A causes a 10 mmHg drop in blood pressure and costs £120 per year, while drug B causes a 15 mmHg drop in blood pressure but costs £180 per year.

- **Cost-utility analysis**

It shares many similarities to cost-effectiveness analysis with particular attention on quality of the health gained or forgone. It is usually used to compare medicines or services for which success is measured using different outcomes using a generic outcome, usually expressed as QALY, which can be used to assess the effectiveness of interventions for different conditions

E.g. Knowing that £500 can prevent a fall while £200 can reduce pain by 50%

- **Cost-benefit analysis**

Within cost-benefit analysis the main outcome is valuated in monetary terms, as the patients' perceived value of a service or medicine measured as their willingness to pay for it.

Cost-utility analysis is frequently criticised for its narrow focus on health outcomes. Improvement in patient satisfaction, access to services or improve outcomes in other sectors of the economy, these can be measured by Cost-benefit analysis

The core components of a cost-effectiveness analysis include an estimation of the costs and the consequences associated with the intervention and its comparator(s). A comparator could be another intervention or the existing practice.[173] NICE recommends the "reference case" analysis for the purpose of the *Technology Appraisals Programme*. The reference case is a set of methodological requirements that NICE considers to be the most appropriate for the Technology Appraisal's Committee's purpose and consistent with the NHS objective of maximising health gain from limited resources.[172]

1.13.1 Costs

A cost is defined as the amount of resources consumed multiplied by its unit value.[172] Unit costs are defined as the value of each unit of resource such as medicine cost per dose or staff cost per hour. [172]

For the reference case, costs should be related to the use of NHS and personal and social services (PSS) resources. These resources should be valued using the prices relevant to the NHS and Department of Health.[174, 175] NICE required resource use and cost data to be identified systematically and all costing assumptions to be clearly defined.

The steps of an economic evaluation of any type are to identify, measure, value and compare the cost and consequences of the alternatives being considered.[173] Costing as a method is common to all types, but the range of costs is determined by the viewpoint of the analysis.[173] There are three stages for cost estimation: identification, measurement and valuation. BOX 1.8 describes the stages of cost estimation.

BOX 1.8 Stages of cost estimation (Drummond, 2005)[173]

- **Identification**

Identify the resources that might be consumed by the intervention. This is determined by the perspective of the study (1.13.3). Costs could be:

o Fixed costs(also called capital costs)

Costs which do not vary with the quantity of output and frequently needed to setup the intervention, e.g. rent, equipment, wages and salary

o Variable costs (also called operational costs)

Costs which vary with the level of output and required to deliver the intervention, e.g. time

o Knock on or consequence costs

Cost that are likely to be influenced by the intervention, this consists of patient's health status and value of resources saved.

BOX 1.8 Stages of cost estimation (continued) [173]

- **Measurement**

This stage include measuring/recoding the level of resources use. This could be performed by: patient questionnaire, diaries or the review of medical records.[176]

- **Valuation**

Assign a monetary value to the resources used by multiplying the quantities by the relevant prices. There are two main costing strategies[177]:

o Micro-costing

To identify, count, and price out every single health care service item consumed by each patient.

o Gross-costing

To identify, count, and price out health care encounters or other health care units that represent some aggregate of a bundle of service items (e.g. the average cost per hospital day or average cost per hospital admission

1.13.2 Effectiveness

For the reference case, cost-effectiveness, specifically cost–utility analysis, is the preferred form of economic evaluation. Health effects should be expressed in terms of QALY. QALY is an index of survival that is adjusted to account for the patient's quality of life during this time. QALYs incorporate changes in both quantity (longevity/mortality) and quality (morbidity, psychological, functional, social, and other factors) of life.[172]

The effectiveness of an intervention is assessed by comparing the incremental cost per QALY gained against the cost-effectiveness threshold which acts as a proxy for the cost consumed. NICE recommend the measurement of changes in health related quality of life to be reported directly from patients and the utility of change in the quality of life to be based on public preferences. Given the need for consistency across appraisals, one measurement method, the EQ-5D, is preferred for the measurement of health related quality of life in adults.[172]

The EQ-5D is a standardised and validated generic instrument. The EQ-5D comprises five dimensions of health: mobility, ability to self-care, ability to undertake usual activities, pain and discomfort, anxiety and depression. For each of these dimensions it has three levels of severity (no problems, some problems and severe problems). The system has been designed so that people can describe their own health related quality of life using a standardised descriptive system. A set of preference values elicited from a large UK population study is available for the EQ-5D health state descriptions. The York A1 tariff is usually used to assign scores to each EQ-5D health state description; the York A1 tariff is the most influential valuation work to date on the EQ-5D which has been undertaken by the Measurement and Valuation of Health group at York, UK through a large-scale survey in 1997. Their work elicited values for 243 health states defined by the EQ-5D using 2,997 interviews of members of the general population.[178] This set of values obtained by York A1 tariff can be applied to health related quality of life measurements to generate health-related utility value on a scale of 0 (death) to 1 (perfect health).

The conventional approach to calculate QALY is area under the curve.[173] This can be seen in Figure 1.2. The quality adjustment for each health status is multiplied by the time in the state and then summed to calculate total QALYs.

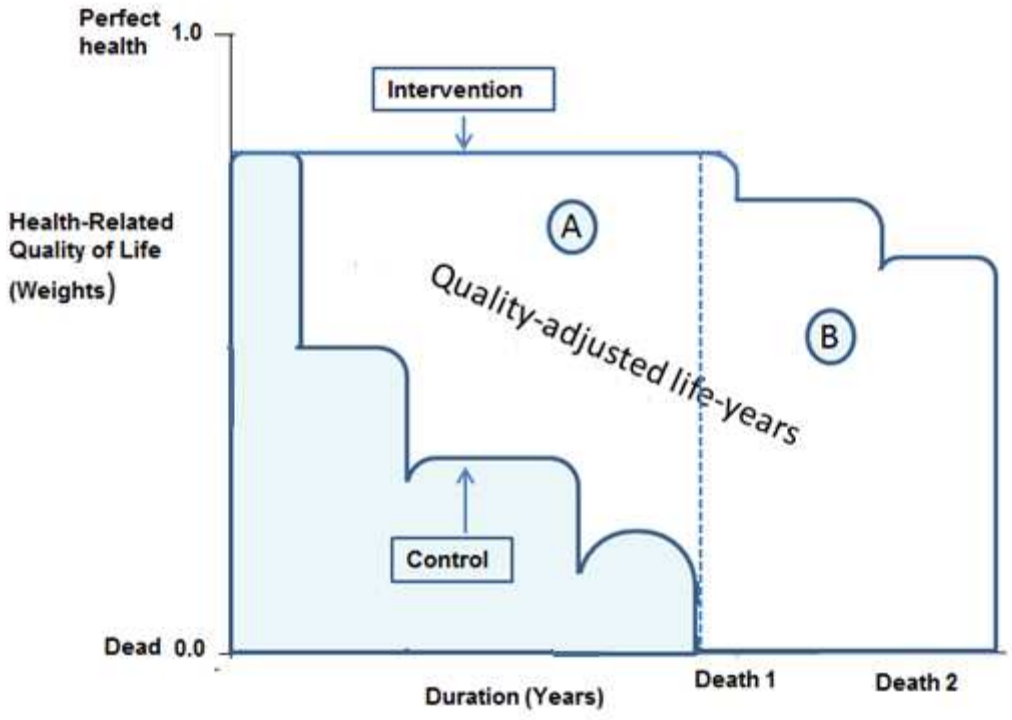


Figure 1.2 Quality-adjusted life-years gained from an intervention. (Drummond, 2005)[173]

In Figure 1.2, without the health intervention an individual's health related quality of life would deteriorate and he/she would die at the time of Death 1. With the intervention, however, the individual would deteriorate more slowly, live longer and die at the time of Death 2. The area between the two curves is the number of QALY gained by the intervention. Area A, in the amount of QALY gained due to quality improvement, meanwhile the area B is the amount of QALY gained due to quantity improvement, i.e. the amount of life extension.[173]

1.13.3 Perspective

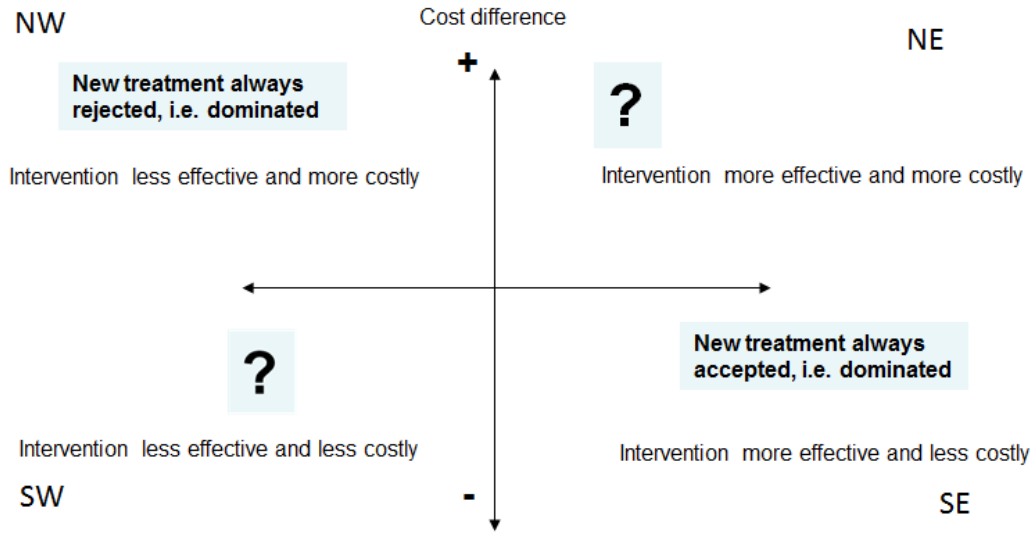
An economic evaluation can be carried out from different perspectives such as that of the society, health care payer, hospital, or patient. The perspective describes and determines the categories of costs and outcomes to be identified, measured, and valued. For example, an "NHS perspective" would imply that only costs to the NHS are to be included whereas the term "societal perspective" implies that all categories of cost should be included irrespective of whose responsibility it is to pay for the costs.[173]

NICE's perspective for the reference case is based on the costs to the NHS and PSS use. Only the costs that fall within the remit of these two organisations should be included. In addition, NICE regarded it as appropriate to consider the cost of the time spent by family members, friends or a partner providing informal care to the patient, otherwise it would have been provided by the NHS or PSS workers. A range of valuation methods exist to cost this type of care and therefore the method chosen should be clearly described.[175] .

1.13.4 Making decision using economic evaluation

The Technology Appraisal Committee is an independent advisory team which makes recommendations to NICE regarding the clinical and cost-effectiveness of treatments for use within the NHS.

When considering the cost-effectiveness of an intervention, dominance of the intervention or the control should be evaluated. Graphically this can be illustrated by the cost-effectiveness plane[179] presented in Figure 1.3. A new intervention is said to dominate control being less costly and more effective if it is located in the southeast quadrant. Vice Versa, a control dominates an intervention if it is located in the northwest quadrant, i.e. the new intervention is less effective and more costly.[180]

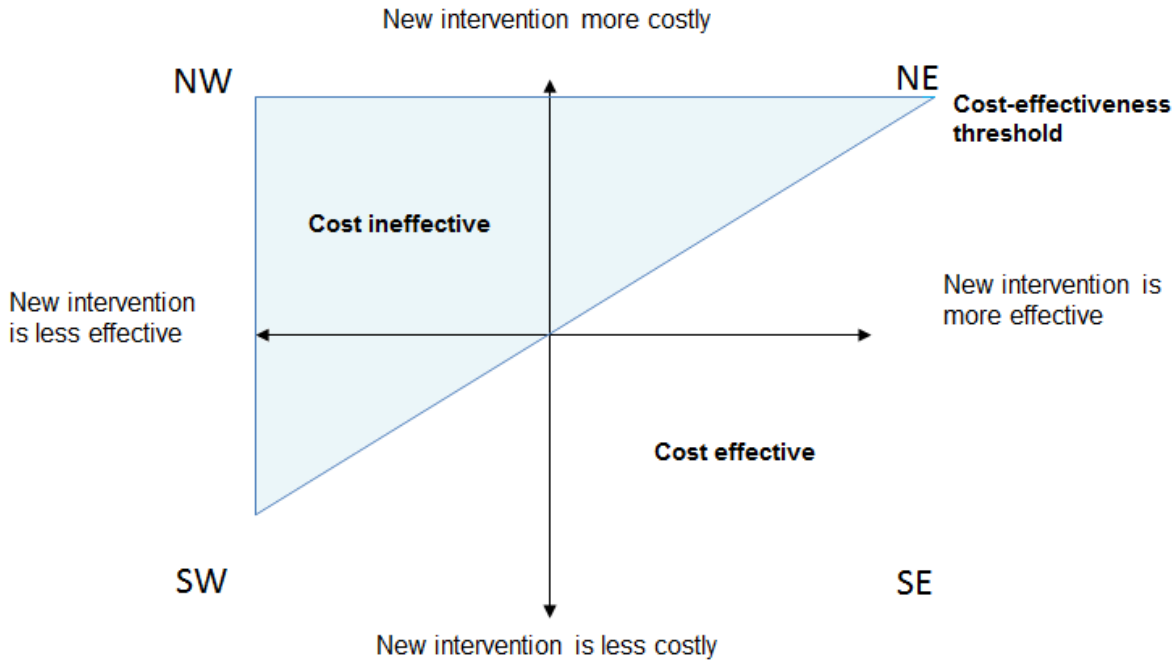


NW: northwest. NE: northeast. SW: southwest. SE: southeast

Figure 1.3 Cost-effectiveness plane

In the case of dominance, it is clearly appropriate to implement the least costly and most effective (or dominant) option and no recourse to calculate the cost-effectiveness ratio would be required. However, far more common is for a new intervention to be more effective and more costly. A decision should be made in such circumstances whether the additional health benefit is worth the additional cost.[180]

An Incremental Cost-effectiveness Ratio (ICER) is calculated as the difference in costs between alternatives divided by the difference in outcomes measured.[173] If the ICER of the new intervention is less than the acceptable cost-effectiveness threshold (i.e. the value a decision maker is willing to pay for a unit of health gained) then the treatment should be adopted. The graphical illustration of the decision for cost-effectiveness can be seen in Figure 1.4.



NW: northwest. NE: northeast. SW: southwest. SE: southeast

Figure 1.4 Decision for cost-effectiveness compared to the cost- effectiveness threshold

In the NICE reference case, an additional QALY receives the same weight regardless of any other characteristics of the people receiving the health benefit. NICE considers a value less than £20,000 and no more than £30,000 per QALY gained as acceptable for intervention adoption, i.e. the NHS cost-effectiveness threshold.[172]

NICE emphasises the importance of quantifying the uncertainty associated with the intervention cost-effectiveness decision. One method that is used to assess the uncertainty is to consider the likelihood that the intervention would be cost-effective if the threshold cost was changed. The probability that an intervention is cost-effective at different thresholds can be plotted to produce the cost-effectiveness acceptability curve (CEAC).[173]

In addition, the robustness of results should be tested by conducting a sensitivity analysis to account for uncertainty of the key estimates and the assumptions made during identification, measurement, and valuation of costs and outcomes.[172]

Herein, to gain insight into the cost-effectiveness value of a pharmacy led MR intervention in hospital, an economic evaluation was warranted.

Chapter 2

Methods

This thesis titled as “Optimising medicine reconciliation at the healthcare interface” consists of three projects; an audit, a systematic review, and an interim analysis of a pilot randomised controlled study. This chapter describes the methods for each project.

2.1 Audit of current practice on discharge information transferred to primary care

A Primary Care Trust-wide audit was conducted in order to describe the quality of information received in primary care upon patient discharge. This was to highlight areas of improvement in discharge information communication and inform the need for future interventions.

2.2 Systematic review of the effects and costs of pharmacy led medicine reconciliation (MR) interventions

A systematic review summarising relevant research on the effects and the associated costs with the implementation of pharmacy led MR interventions was conducted. This helped to identify the most effective approach to implement MR and informed the development of a pharmacy led MR intervention.

2.3 Development and evaluation of a novel pharmacy led medicine reconciliation study

A pilot randomised controlled study, the MedRec study, was designed and implemented to estimate the effects and cost-effectiveness of a pharmacy led MR intervention within inpatient setting. The MedRec pilot study aims to inform the optimum design of a pharmacy led MR intervention and to determine whether a larger scale trial is warranted and feasible.

2.1 Quality of discharge information upon hospital discharge: an audit at primary care

The literature review in chapter one highlighted that the quality of admission and discharge discrepancies has been extensively investigated; however, there is no large scale report on the quality of information received in primary care following patient discharge. Additionally, there has been no evaluation of the extent to which discharge summaries adhere to the minimum dataset recommend by the National Prescribing Centre (NPC). Thus, there is no indication of the impact of this recommendation on the quality of practice. Additionally, the transfer of clinical information at the health interface is a multi-factorial process. The relationships between factors and the quality of communication at the health interfaces are unclear and subject to confounding effects. Robust investigation of these factors in a UK context through a large scale evaluation was needed to enhance understanding of the predictors of communication deficit.

A Trust-wide audit would be the first part of the clinical audit cycle to identify where practice is deviating from the guidance. At the time of this thesis, it was almost three years since the NPC guidance was issued, therefore, it was an appropriate time to audit current practice across Norfolk to improve understanding of discharge communication across the Trust. An evaluation of the potential harm associated with post discharge discrepancies by using a scientifically rigorous approach was also warranted as the evidence summarised in chapter one demonstrates that frequently discrepancies were evaluated using non-validated tools. Additionally, there were insufficient details on the extent of agreement between raters.

Therefore, a Trust-wide audit was carried out; discharge summaries received in primary care practices across Norfolk were audited against the NPC minimum dataset of information that should be transferred on discharge. An investigation of predictors of adherence and medication discrepancies was carried out and consequently changes were proposed to optimise information transfer at the health interface.

Within NHS Norfolk, all discharge summaries were audited against NPC minimum dataset from January 2011 to April 2011. This audit was a joint collaboration between the University of East of Anglia (UEA) medicine management research team/ School of pharmacy and the NHS Norfolk primary care trust prescribing team.

As an audit, no ethical approval was sought. However, appropriate trust authorization to conduct the audit was obtained. Aim and Objectives of the audit are described in BOX 2.1.1

BOX 2.1.1 Aim and objectives of the discharge information audit

- **Aim**

The aim of this audit was to describe the quality of clinical information transferred upon patient discharge in one UK primary care trust.

- **Objectives**

The audit was designed to:

- Describe adherence of discharge summary content to the NPC minimum dataset of information transferred upon hospital discharge
- Evaluate the extent and the nature of discrepancies upon hospital discharge
- Estimate the clinical significance of discharge information discrepancies
- Identify the factors which increase the likelihood of discharge information and medication discrepancies

2.1.1 Audit site

Within the UK, there are three main types of hospital; teaching, district and community. Teaching hospitals combines assistance to patients with teaching to medical or pharmacy students and nurses, often they are affiliated to a university. Teaching hospitals frequently offer a wide and highly specialised range of specialities. District hospitals typically are the major health care facility in a local community or a region and don't have an affiliation to educational institution. These often of smaller number of beds and less specialised services. Whereas community hospital are often for intermediate or long term care, i.e. care for patients who are can be cared for out of acute care trust or primary care but yet independent to be cared at home. Those hospitals frequently care for elderly patients and required long recovery or rehabilitation. Health professionals in community hospitals are experienced with general care provisions.

In urban areas teaching hospitals predominate, whereas for more rural areas district and community hospitals predominately provide secondary care services. Norfolk is mainly rural with one large city and 21 market towns. The health of the Norfolk population is generally better than the England average; deprivation is lower and life expectancy is higher. However, Norfolk is served by one large teaching hospital, two district hospitals and 20 community hospitals. A Trust-wide audit thus offers a unique representation of the

quality of discharge summaries generated from these three different types of secondary care organisation.

2.1.2 Audit tool

An audit tool was developed incorporating the NPC minimum dataset which is summarised in Table 2.1.1, for which 100% adherence was expected.

The NPC minimum dataset of information recommended in primary care following discharge from hospital

1. Complete and accurate patient details, i.e. full name, date of birth, weight if under 16 year, NHS/unit number, consultant, ward, date of admission, date of discharge.
2. The diagnosis of the presenting condition plus co-morbidities
3. Procedures carried out
4. A list of all medicine prescribed for the patient on discharge from hospital (and not just those dispensed at the time of discharge)
5. Dose, frequency, formulation and route of all the medicine listed
6. Medicine stopped and started, with reasons
7. Length of courses where appropriate (e.g. antibiotics)
8. Details of variable dosage regimens (e.g. oral corticosteroids, warfarin, etc.)
9. Known allergies, hypersensitivities and previous drug interactions
10. Any additional patient information provided such as corticosteroid record cards, anticoagulant books.
11. This information should be clear, unambiguous and legible and should be available to the GP as soon as possible. Ideally, this should be within 2 working days of the patient's discharge

NHS: national health services. NPC: National Prescribing Centre. GP: General-Practitioner

Table 2.1.1 The NPC minimum dataset of information recommended in primary care following discharge from hospital

All the NPC minimum dataset elements listed above were included in the audit standards except "procedures carried out" and additional information related to corticosteroid record cards or anticoagulant books. It was not possible to identify whether procedures were carried or not when there was no information recorded in the discharge summary on this regard. The audit was conducted retrospectively, it was not possible to identify whether a patient was provided with the relevant record card or logbook.

The audit tool was formulated into a Microsoft Excel spreadsheet (Appendix 2). The auditors selected either "yes" or "no" by checking the option box when the information was present and /or accurate as appropriate. Free text boxes were included to allow auditors recording further information or comments when appropriate.

In addition to the NPC minimum dataset, the audit tool recorded the following information:

- Patient information related to age, gender, hospital, co-morbidities, ward speciality, length of hospital stay, admission type (planned vs. unplanned) and type of discharge summary (handwritten vs. electronic)
- Number of working days between discharge date and the receipt of the discharge summary by primary care
- Clinical information related to laboratory results, post admission complications
- Contact and role of the person responsible for discharge summary completion

From each hospital represented in the audit, a copy of the discharge summary template was obtained. For some hospitals more than one template was used; the template representing the majority of the discharge summaries from that hospital was selected.

2.1.3 Data collection

The audit period was conducted between January 2011 and April 2011. All 91 primary care practices across NHS Norfolk primary care trust were invited to participate in the data collection. Each practice was requested to sequentially collect a defined number of discharge summaries; this was based on a 5% proportion of the practice list size. A total sample of 3,761 discharge summaries was anticipated. The practice itself identified a member of staff to conduct the audit. The audit was part of the primary care trust quality and outcomes framework incentive scheme for 2010/2011.

2.1.4 Pilot

A sample of 200 discharge summaries sequentially selected of patients discharged to nine primary care practices in Norfolk during August 2010; those were audited using the initial version of the audit tool.

The pilot enabled the refinement of the tool and development of the audit process. The following amendments were informed by the audit:

- Inclusion of check boxes to simplify data entry
- Altered ordering of data entry to ensure ease & flow while completing the audit tool
- Simplification of the basic audit tool from three to one Microsoft Excel spreadsheet
- Inclusion of a field to collect data on allergy status
- Addition of free commentary text fields

2.1.5 Inclusion and exclusion criteria

A discharge summary was eligible if the patient was hospitalised for at least 24 hours on an inpatient ward. Discharge summaries of patients who were deceased before discharge, deceased prior to data collection or transferred to another NHS trust were excluded.

2.1.6 Audit communication

The audit was communicated to primary care practices via the lead prescribers' meeting held in September 2010 which included GPs, primary care administrative staff and pharmacists from almost all primary care practices across Norfolk. A brief overview of the audit aims, process and the audit tool was presented in a 20 minutes PowerPoint presentation which followed by discussion and comments. In addition, practices were informed about the audit by one to one communication, phone calls and emails.

2.1.7 Audit distribution and recall

Practices were emailed the audit guidance (Appendix 3) which included detailed guide for the completion of the audit tool and contact details for enquires. Each practice was sent the specified number, based on 5% of practice size, of audit tools using a secure NHS email. Some practices requested paper copies in preference to electronic; these were sent to them which were then returned by post to UEA team.

2.1.8 Confidentiality

No patient identifiable details were collected or attached with the audit tools. Discharge summaries were given unique audit identifiers; a list of patients' NHS numbers and their audit identifiers was generated and held in the practices. This list was maintained in the practice until the audit period ended.

A sample of handwritten discharge summaries was photocopied to assess variation in legibility assessment; these copies were anonymised.

2.1.9 Outcomes measurement

2.1.9.1 Adherence to NPC minimum dataset

The extent of discharge summary adherence to the NPC minimum dataset was estimated by scoring each discharge summary against a set of criteria described in Table 2.1.2. Discharge summaries for patients with no medication history or had no medicine changed, initiated or discontinued were scored only against the applicable criteria and therefore the extent of adherence to the NPC minimum dataset was estimated as a

percentage. BOX 2.1.2 describes the method for estimating the extent of adherence to the NPC minimum dataset.

BOX 2.1.2 Method for estimating discharge summary adherence to the NPC minimum dataset

Discharge summary adherence to NPC minimum dataset is estimated as:

Extent of adherence to NPC minimum dataset = [1-((S – T)/T)] ×100%

- Discharge summary adherence score (S)= Sum of the point(s) assigned to each applicable criterion
- T= score representing complete adherence to all applicable criteria

Discharge summaries were scored 1 point when a criterion was successfully fulfilled (i.e. the information was provided and/or accurate) and 2 points when it failed to fulfil the criterion. A total score for each discharge summary was calculated by adding all points assigned for each criterion (S). T is the score representing complete adherence to all criteria applicable to a given discharge summary. E.g. if a discharge summary had at least one medicine and there was at least one therapy change, including initiation, discontinuation or dose, formulation or route alternation, all 14 criteria would have been relevant and therefore 'T' = 14.

NPC minimum dataset criteria were organised into three categories: patient, admission and discharge information, medication information and therapy change information (Table 2.1.2). Discharge summaries were also scored with respect to each of the three categories and the extent of adherence to each category was estimated using similar method to which shown in BOX 2.1.2.

Categories	Criteria
Patient, admission & discharge details	1. Correct patient name 2. Correct date of birth 3. Consultant name 4. Ward 5. Date of admission 6. Date of discharge 7. Presenting diagnosis 8. Complete past medical history (PMH) and co-morbidities 9. Complete drug history 10. Known allergic or hypersensitivities, 11. Discharge summary is legible 12. Received within 2 days post discharge (weekends and public holidays were excluded).
Medication related information	13. Full list of all medicines a. All doses b. All frequencies c. All routes of administration d. All formulations e. Therapy duration when a medication was initiated by hospital
Therapy changes related information	14. List of all medication altered a. All medicines initiated with reason(s) b. All medicines discontinued with reason(s) c. All medicines changed with reason(s)

Table 2.1.2 Audit scoring criteria

2.1.9.2 Discharge discrepancies identification

A sample of discharge summaries was reviewed to identify discharge discrepancies. Practices were self-selected to take apart in the process of discharge discrepancies identification. From each practice a consecutive sample of discharge summaries were selected based on again 5% of the practice list size.

Primary care records were reviewed to identify discharge discrepancies using a reconciliation sheet (Appendix 4); the sheet incorporated information on patient pre-admission and discharge medicines. These were matched to identify discrepancies.

Information related to therapy durations, titration and monitoring plans were recorded for a set of medicines; those included: clopidogrel, anticoagulants, antibiotics, corticosteroids, analgesic and proton pump inhibitors. These medicines were identified following discussions with primary and secondary care pharmacists and with reference to national guidelines.[181, 182] It was agreed that these medicines would contribute to an increased risk of patient harm when associated with inaccuracies or omissions.

Types of discharge discrepancies are described in BOX 2.1.3. The identification of discharge discrepancies was undertaken by five researchers from the UEA; the thesis author (EH) and four final year pharmacy students. Prior the audit, the UEA auditors were trained on the tool completion, the use of the practices' computer system and process of discrepancies identification. Discussion led the development of standard operating procedures for discrepancies identification and classification. Weekly feedback meetings and discussions were held, this also aimed to minimise variation between auditors.

BOX 2.1.3 Type of discharge discrepancies

Discharge discrepancies included medication and reconciliation discrepancies.

- **Medication discrepancies**

Medication discrepancies were defined as any undocumented differences between discharge summaries and patients' most updated pre-admission medicines as recorded in the GP notes. Medication discrepancy classification was adapted from various studies [31, 34, 121, 127] and categorised as:

  - Omission of pre admission medication
  - Undocumented changes (dose, frequency, formulation or route)
  - Undocumented medication substitutions (generic substitution was not considered a discrepancy)
  - Failure to report reasons or indications for medication initiations
  - Failure to report reasons or indications for medication discontinuations

- **Reconciliation discrepancies**

A reconciliation discrepancy was considered when there was no recorded evidence of an explicit discharge summary recommendation being implemented in the GP held patient notes.

GP held patient records were reviewed and the extent to which hospital recommendations were implemented was recorded.

Auditors discussed, clarified and resolved each discrepancy with GPs or the practice based pharmacist. Medicines were categorised as described in the British National Formulary 59.

2.1.9.3 Clinical significance of discharge discrepancies

Medication and reconciliation discrepancies were stratified according to the following criteria:

- Discrepancy category
- Being explicitly recommended by the discharge summary
- Prescription only medication or over the counter medication
- Recommendation implemented by the GP

Resources were available to enable assessment of a sample of discrepancies; this was discussed with Norfolk prescribing team, it was estimated that 20 discrepancies would place reasonable burden on each assessor. Thus, a random sample of 20 discrepancies was evaluated by a clinical expert panel. The panel included one of each of the following professions: GP, consultant, primary care and hospital pharmacists. The Dean and Barber visual analogue scale (VAS) [183] was used to assess severity of discharge discrepancies. The method proposed by Dean and Barber does not require the knowledge of patient outcomes, where 0 represents a discrepancy with no potential effect and 10 for a discrepancy that may result in death. Dean and barber reported that a generalisable score for the severity of a medication error can be produced from at least four judges of experienced UK pharmacy, medical staff and nursing staff. The mean score from all assessors was estimated; mean score of each discrepancy was categorised as minor (<3), moderate (3-7) or severe (>7).

The time needed by GPs to confirm necessary actions was also estimated using a scale of 0, 15 min and > 30 min. The time scores assigned for discrepancies were categorised further into three categories; 1 (<15 min), 2 (15-30 min) and 3 (>30 min) and the median (IQ) was reported.

2.1.10 Validity and reliability

2.1.10.1 Face validity of the audit process and tool

Face validity of the audit tool was assessed prior the audit Trust-wide distribution by presenting the audit tool to two senior research pharmacists (DW and DB), a GP and two practice based pharmacists. Refinements were subsequently made to the language and the layout of the audit tool.

After the audit completion, two GPs, two primary care pharmacists and pharmacy technicians who were involved in the audit conduct from different practices were invited for one to one discussion. This was to gain insight on the quality of audit data and variations in the audit tool completion.

Auditors were self-selected; practices were contacted requesting two of each profession above who were directly involved with the audit completion. Discussions were structured and led by a set of open questions related to:

- Clarity of audit aims
- Ease of audit tool completion and handling.
- Nature and ambiguity with of the audit questions
- Time needed for audit completion
- Ambiguity with legibility rating

2.1.10.2 Quality assurance of the audit data

Practices were requested to retain hard copies of the audited discharge summaries. Practices were stratified by list size and five practices were randomly selected from each stratum. Twenty discharge summaries were randomly selected from each practice and re-audited. This would yield a total of 100 discharge summaries.

Agreement across the audit questions was evaluated using kappa statistics. Kappa scores ranging from 0.01-0.40 were considered of slight to fair agreement, 0.41- 0.60 of moderate agreement, 0.061-0.80 good and > 0.81 of substantial agreement.[35]

2.1.10.3 Legibility rating agreement

Legibility of handwritten discharge summaries was assessed using a four point scale:

- 'Legible'; all words clear '
- 'Some words illegible'; but report can be understood by a clinician
- 'Most words are illegible'; meaning of the whole unclear
- 'Illegible'; most or all words impossible to identify

This rating scale was informed by reviewing studies evaluated the legibility of doctors' handwriting in medical records and demonstrated considerable agreement between assessors. Additionally, the scale was believed reasonably objective and with minimum or limited ambiguity.[184, 185]

To ensure uniform legibility rating, the UEA auditors were trained until reasonable agreement was achieved. The UEA auditors scored a random sample of 20 handwritten discharge summaries collected during the pilot and discussed disagreements until consensus. Subsequently, the process was standardised to ensure minimum variation between UEA auditors.

After the audit completion, a random sample of 20 handwritten discharge summaries was selected from 14 practices and a GP independently re-rated them. This was to assess agreement in legibility assessment between auditors among various practices.

Being an ordinal rating scale, i.e. the differences between categories carry a meaningful message, therefore, the Inter-rater agreement for legibility was assessed using weighted kappa statistics. Weighted kappa statistics had similar interpretations to unweighted kappa scores. Cells were weighted according to the magnitude of disagreement; the method used to weight cells is the absolute error weight. All cells in the diagonal were given a weight of 1, those which deviated by one category were weighted with 2/3 and those deviating by two categories were weighted with 1/3. Total disagreement was weighted with 0.[186]

2.1.11 Statistical analysis

Data were processed using the Statistical Package for Social Science (SPSS version 18). Descriptive statistics were reported as a mean 95% [CI] and median (IQ) as appropriate.

In order to investigate the contributors and identify predictors of the quality of discharge information, regression analysis was deemed appropriate. Regression analysis and generalised linear model analysis (GLM) were utilised to estimate the relationships among variables and to model the effect of those variables on the outcomes, i.e. adherence to the NPC minimum dataset and medication discrepancies. As such, significant predictors of good practice and factors associated with substandard practice were identified at a significance level of $P < 0.05$.

Regression via enter method was used to explore the influence of patient demographics, admission type (planned vs. unplanned), discharge summary template, discharge summary type (handwritten or electronic), hospital, ward speciality and profession type. These factors were selected as they were widely reported in the literature (chapter one) as potentially influencing the quality of discharge information.

The influence of variables and the potential confounding effect of contributing factors needed to be examined thus regression models were adjusted; both adjusted and unadjusted models were reported.

Stepwise backward elimination was used to reach the most parsimonious GLM models; those models highlighted significant predictors and assessed the change in the outcome with a unit change in the predictor. GLM analysis was also used to determine the effect of ward speciality on discharge summary adherence to the NPC minimum dataset. Community and specialist care hospitals such as mental health hospitals were excluded from this analysis as they do not have the breadth of different ward specialities demonstrated by general hospitals. Similar analysis using regression and GLM was used across the three categories of the NPC minimum dataset.

All regression models were checked for assumptions of linearity, multicollinearity and Homoscedasticity (Appendix 5). Correlation matrixes were checked to identify any substantial association between predictors. Additionally, age, hospital stay and no. of medicines were checked for linearity, those were fitted in the regression models as categorical variables. There was consistent decreasing monotonic trend through levels. The Best fitting models were presented and discussed in this thesis.

It was decided that a linear relationship between the number of medication discrepancies per discharge summary and any predictors of medication discrepancies would not exist. Therefore discharge summaries were dichotomised into those with at least one discrepancy or no discrepancy at all. Logistic regression using enter method was used to identify the contributing factors to medication discrepancies. Assumption of logistic regression was checked, those are presented in Appendix 5.

2.2 Pharmacy led medicine reconciliation in hospital care: A systematic review

Following the discharge information audit, a systematic search was conducted to collate the available evidence on the effects and costs associated with pharmacy led medicine reconciliation (MR) interventions in hospital setting.

Aims and objectives of pharmacy led MR systematic review are described in BOX 2.2.1.

BOX 2.2.1 Aims and objectives of pharmacy led MR systematic review

- **Aims**

The systematic review aimed to:

  - Evaluate the published literature on the effects and costs associated with pharmacy led MR interventions in inpatient setting
  - Identify the optimal methods for delivering a pharmacy led MR service in inpatient setting.

- **Objectives**

The objectives were to:

  - Describe pharmacy led MR service with respect to:
    - The person or team providing MR
    - The setting where MR is delivered
    - The time to implement MR
  - Describe the targeted patient population
  - Describe outcomes measured such
  - Determine the resources needed to implement pharmacy led MR
  - Determine the costs and consequences associated with pharmacy led MR interventions and the process used for measurement and valuation of these costs and consequences
  - Describe the quality and design of studies evaluating the effects and costs of pharmacy led MR interventions

2.2.1 Literature search strategy

Studies were identified through comprehensive electronic and manual search that aimed to identify all the reports of published and unpublished studies. The search were carried out on 23rd March 2012 and completed by 3rd May 2012.

A comprehensive range of databases was searched:

- EMBASE & MEDLINE Ovid; search date in 23.03.2012
- CINAHL; search date in 19.04.2012
- Cochrane library which included Cochrane Database of Systematic Review, Database of Abstracts of Reviews of Effects and the NHS Economic Evaluation Database; search date in 26.04.2012
- The Centre of Reviews and Dissemination; search date in 28.04.2012
- PHARMLINE provided by the National electronic Library for Medicines; search date in 2/05/2012

Scoping search was conducted prior to finalising the search to identify all relevant search terms. Search strategy combining terms for medicine, reconciliation, hospital and pharmacist were used in combination with truncations (*), wild cards ($), adjacent search options (e.g. adj2), hyphens and other relevant boolean operators where allowed by the databases. The search strategies applied into the various databases are summarised in Appendix 6 (A-E).

Bibliographies of the included studies were also reviewed to identify additional references. Citation searching using SCOPUS database was performed. Additionally, authors and key institutions involved with research on MR evaluation and implementation were contacted by email to obtain any relevant work. This included the UK National Patient Safety Agency and NPC, Institute of healthcare improvement and Joint commission in USA. One month was allowed for authors and institutions to response.

2.2.2 Software to manage references

References were managed using Endnote X4 software

2.2.3 Inclusion criteria

2.2.3.1 Populations and sites

Studies evaluating adults and children receiving pharmacy led MR within inpatient settings. All type of admissions and ward specialities were considered.

2.2.3.2 Intervention type

Any study evaluating all of the following tasks of MR implemented by a pharmacist or pharmacy technician or pharmacy student was included:

- Collecting medicine history and other relevant information about patient medicines or any information that might affect the treatment choice such as allergies and hypersensitivities.
- Comparing collected information with inpatient medicine chart to ensure that patient medicines are complete and accurate
- Comparing inpatient information with discharge document to ensure all changes are documented and communicated clearly and accurately
- Pharmacist intervening to resolve and clarify any identified discrepancies with the medical team
- Documenting changes made to patient's medicines and communicate them clearly to the next care provider

2.2.3.3 Study design

All study designs were considered including randomised clinical trials (RCTs), non-randomised comparative studies, observational studies and before and after studies. Systematic reviews reference lists were checked to ensure that all relevant articles had been identified.

2.2.3.4 Language

No language restrictions were applied.

2.2.4 Exclusion criteria

Studies evaluating a pharmacy led MR via qualitative approach were excluded.

2.2.5 Screening and selection

The relevance of each study to the research question was assessed in three stages as described by figure 2.2.1. Screening was performed using a screening tool developed for the purpose of the review (Appendix 7).

Independent screening of titles and abstracts for relevance was performed by the thesis author (EH) and verified by a second senior researcher (AB). Discrepancies were discussed to obtain consensus. Any remaining disagreement was resolved by a third reviewer (DB). Authors were contacted when it was necessary for clarification or to obtain further information relating to the included studies.

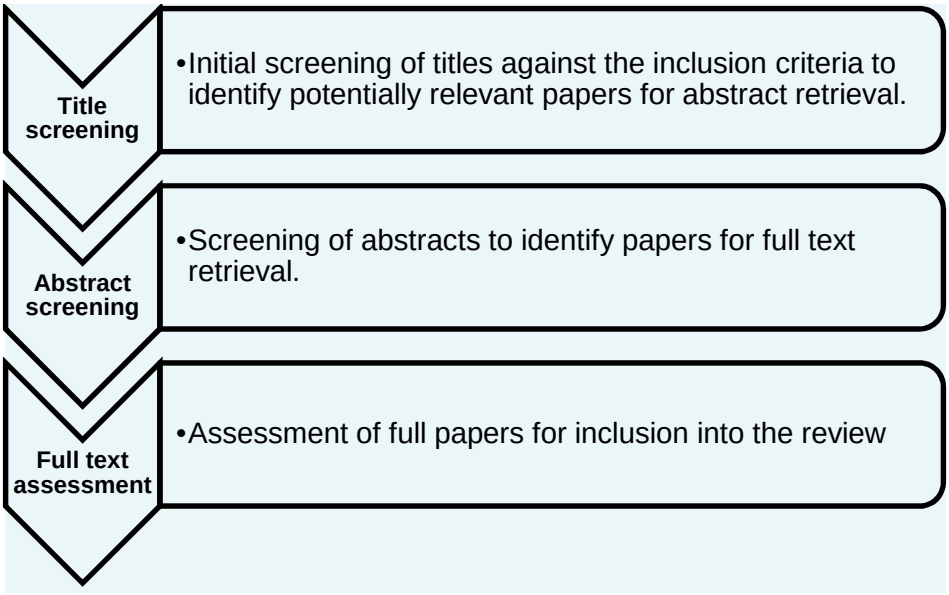


Figure 2.2.1 Pharmacy led MR systematic review screening stages

2.2.6 Data extraction

The thesis author (EH) extracted the relevant data from the included articles using a data extraction tool which was in a Microsoft Excel spreadsheet format (Appendix 8). The extraction tool incorporated the following details:

- Details related to study design, authors, country of correspondence, year of publication and setting
- Details related to study population, number of participant, speciality, recruitment, demographics and baseline comparability if applicable
- Details related to study intervention including feature of the intervention, the team providing MR, timing to provide the intervention, comparators and follow up.
- Details related to study outcomes including process and patient outcome data

The data extraction tool was piloted and face validated. Two relevant articles were presented to researchers with systemic review experience from different disciplines; those were invited to extract data using the tool. Interactive feedback was obtained through group and one to one discussions.

2.2.7 Outcome measurements

Information relating to the following measures was recorded:

- **Process oriented outcomes:**
  - Medication discrepancy rate
  - Pharmacy intervention to intercept discrepancies
  - Clinical significance of medication discrepancy
  - Resources necessary to implement MR such as time and training

- **Patient oriented outcomes**
  - Health resource use
  - Health related quality of life
  - Mortality rate

- **Associated costs**

Data related to cost measurment and valuation including fixed, variable and knocked on consequence costs was extracted. Cost outcome data were related to:

- Health care resource use such as length of hospital stay, readmission, emergency department visits
- Operating costs related to cost consumed in the MR intervention delivery, e.g. time commitment
- Fixed costs related to setting up the intervention, e.g. training or education sessions
- Cost savings or avoidance contributed by MR interventions

2.2.8 Quality assessment

Studies were not excluded based on quality. The thesis author (EH) assessed the quality of the included studies using a tool adapted from several sources including Cochrane guidance [23], the Critical Appraisal Skills Programme [50] and the Review Body for Interventional Procedures.[187] The tool adapted the Cochrane collaboration's table for assessing risk of bias; few modifications were introduced to enable the evaluation of non-RCT studies as well as RCTs and economic evaluations.

The handbook of Cochrane recommended assessing the risk of bias for non-randomised studies using six domains; those also recommended for RCTs. The Cochrane domains are: selection, performance, attrition, detection and reporting bias. The Cochrane tool was developed without having non-randomised studies in mind; thus it is stated that the six domains are not necessarily all appropriate for non-randomised study designs.[23] However, the general structure of the tool was believed useful and thus adopted by the pharmacy led MR systematic review.

The risk of bias assessment tool was piloted and face validated. Two relevant articles were presented to researchers with systemic review experience from different disciplines; those were invited to extract data using the tool. Feedback was obtained through group and one to one discussions.

Domains were assessed by providing a description of what happened in the study and providing a judgement on the adequacy of the study with regard to the domain. The judgement is formulated by answering a pre-specified question, such that an answer of 'Yes' indicates low risk of bias, an answer of 'No' indicates high risk of bias, and an answer of 'Unclear' indicates unclear or unknown risk of bias.

The tool employed in this systematic review incorporated nine domains in total (Appendix 9); additional domains related to clarity of study question and design, baseline comparability between groups, standardised intervention delivery and outcome measurement plus sample size calculation were assessed. Three additional domains assessing the validity of economic evaluation studies were also included; those related to well-defined perspective, appropriate cost identification, measurement and valuation and assessment of variability associated with the cost and cost-effectiveness estimate.

Detection bias related to blinding of outcomes measurement was considered of importance in assessing the measurement of medication discrepancies and their clinical significance. However, blinding of outcome assessors was considered less pertinent when less subjective outcomes were under question such as rate of readmissions and emergency department visits. In these, risk of bias was assessed whether studies obtained outcome data by using a standardised reporting system such as hospital data or self-report data.

2.2.9 Reporting

Reporting of the systematic review was based on the PRISMA statement 2009 which details the Preferred Reporting Items for Systematic Reviews and Meta-analysis.[188]

A protocol was developed and registered on the international database of prospectively registered systematic reviews (PROSPERO) in May 2012. The review registration number is CRD42012002386.

2.3 Medicine reconciliation at the health interface: The MedRec Study

The Medical research council's guide recommends "Identifying the relevant, existing evidence base, ideally by carrying out a systematic review", it also emphasises the use of piloting and feasibility before large scale evaluation (BOX 1.6). The systematic search to identify the relevant, existing evidence base on the effects and costs associated with pharmacy led MR was followed by a pilot randomised study of the cost-effectiveness of a pharmacy led MR service. MR is a complex intervention, as described earlier, and so a randomised controlled study would be, as recommended by the Medical research council's guide, the most robust method to evaluate and assess the effects and costs of a complex health intervention.[160] Randomisation is the most robust method of preventing selection bias and matching groups with respect to known and unknown confounding factors. A pilot study would play an important role in providing information for the planning of a large scale randomised controlled study if warranted including provision of data to inform the sample size calculation for a definitive study.

The pharmacy led MR systematic review informed the design and outcomes measures of the pilot RCT presented in this section. Having not received MR by a pharmacist within 24 hours of admission, patients were randomised to either receiving MR from the study pharmacist or receiving standard care. Standard care may or may not include receipt of MR as this was dependent on work load and staff availability and thus not available to all patients.

The pharmacy led MR study, the MedRec study, aim and objectives are descried in BOX 2.3.1

BOX 2.3.1 The MedRec pilot study aim and objectives

- **Aim**

The aim of the pilot study was to determine the optimum design of a larger scale RCT and evaluate a novel pharmacy led MR service within inpatient settings.

- **Objectives**

The study objectives were to:

- Estimate the possible effect size of an extended pharmacy led MR service
- Determine recruitment and follow up rates
- Describe the appropriate approach to recruitment
- Identify patients who might receive the most benefit from pharmacy led MR
- Identify resources necessary to implement pharmacy led MR
- Assess the MedRec intervention cost-effectiveness

2.3.1 Study development

2.3.1.1 Study management committee

The study management committee consisted of a collaborative research team from UEA and Cambridge University Hospital Foundation Trust. UEA team included the author thesis (EH), David Wright (DW), Ian Nunney (IN) and James Desborough (JD) from the school of Pharmacy and Richard Holland (RH) and Garry Barton (GB) from the Medical School. Cambridge University Hospital Foundation Trust team included Brit Cadman (BC) who is the study principal investigator (PI), Amanda Bale (AB) who is the senior researcher, Kellie Hempstead (KH) an assistant researcher, Helen Howe a chief pharmacist and two patient representatives. The study management committee met every three to four months to oversee the study progress.

2.3.1.2 Patient and public involvement

The medical research council recommends identifying and developing appropriate theory, this can be done by interviewing with 'stakeholders', i.e. those targeted by the intervention, or involved in its development or delivery. Prior the study commencement, the study protocol was presented to health professionals including doctors, nurses, pharmacists and patients. Feedback was received regarding the study design and process via a series of meetings. Each meeting started with a brief overview of the study and was structured around a list of pre-determined questions related to the study design, recruitment process and outcome measurements. Opinions on the study information leaflet and lay summary were also obtained.

2.3.1.3 Ethical review and approval

This study was funded by the Research for Patient and Benefit programme and was approved by the Essex ethics committee REC#12/EE/0143. The study registry number at ISRCTN.org, a non-profitable organisation that serves as a platform for registry of clinical trials, is ISRCTN23949491.

2.3.2 Study setting

The study was conducted at Cambridge University Hospital Foundation Trust which is a large university-affiliated teaching hospital. It took place in five adult medical wards in the medicine division comprising a range of medical specialities including gastroenterology, renal and endocrinology and two medicines for older people wards. The study wards were selected pragmatically (out of a total of 16 medical wards) following discussion with the lead pharmacist for medicine at the study site and the clinical services manager who was also principal investigator.

The selection criteria were the number of admissions, type of pharmacy service allocated to the ward and likelihood of ward closure during the study period. In terms of number of admissions, wards with the highest turnover were preferentially selected to increase the likelihood of recruiting the target number of patients. In terms of type of pharmacy service, those wards receiving specialist pharmacy services provided by senior pharmacists such as critical care, transplant, paediatrics, oncology and haematology were excluded. This was because the costs of delivering these services was significantly higher than the majority of wards due to the higher salary of the pharmacist and increased time spent per patient. Thus the selected wards had pharmacy service cover typical to routine care in the Trust and other similar trusts in the region.[26] In addition, wards which were anticipated to close during the study period were excluded.

The profile of the pharmacy service in the study wards was maintained at the same routine level during the study period. At the times of staff shortage due to vacancies and annual leave, the level of the service was reduced to a basic clinical safety service. This was applied across all wards in the Trust.

The specialities covered by the study wards were general medicine, renal, gastroenterology, endocrine and medicine for older people.

The study intervention was implemented seven days a week during working hours with the support of three MR pharmacists who followed a rota to ensure the extended service cover over week days as well as weekends.

2.3.3 Study communication

Pharmacy staff who were not involved in the study as well as medical and nursing staff in the study wards were informed about the study and the MR pharmacist role through educational meetings and one to one communication.

2.3.4 Patient recruitment and consent

Study recruitment started on 5th of July 2012 and extended until 6th April 2013. It was envisaged that 5-8 patients a week would be recruited and therefore nine months anticipated to complete patient recruitment.[189]

The study researchers were trained to consent patients and obtain consultee decision for patients under the Mental Capacity Act 2005.[190]

A nurse on the ward assessed the mental capacity of patients. When a patient was considered mentally competent to consent for a study the nurse asked whether the patient was comfortable to be approached by the study researcher. If agreeable, patients were approached by the study researcher and a written informed consent was obtained.

Patients were invited to take part in the study within 24 hours of their admission. This time window was considered from the time the patient is admitted to the ward excluding the time spent in the emergency department prior to transfer to inpatient wards.

Each participant was provided with a copy of the study information leaflet (Appendix 10) which included full details on the purpose of the study and the study process. The study information leaflet was analysed for ease of reading using the Flesch Reading Ease score [191] and demonstrated a score of 59 which described as 'fairly difficult to read'. This score is accounted for a 15 years old school reading level. There was a group of three syllable words frequently used in the study information leaflet such as pharmacist, participant, information, hospital, medicines, and questionnaire, these three syllable words were considered unchangeable as this might affect the quality and the clarity of the information leaflet. A score of 78 was found when these words were taken out. This accounted for 'fairly easy to read' with a level of 12 years old reading. However, the feedback on the study information leaflet from the patient stakeholder meeting and the patient representative members expressed satisfactory ease of reading.

As the intervention is non-invasive and aimed to be provided within 24 hours of admission, it was not possible to allow patients two days to consider the study participation. However, patients were given at least 2 hours to read the study information leaflet. They were welcomed to ask questions and offered any support they needed before consenting to the study (Appendix 11). Following patient consent, a letter was sent to the patient GP to inform him/her about the patient's participation.

2.3.4.1 Inclusion & Exclusion criteria

- **Inclusion criteria**

Patients who met all the following criteria were eligible for the study:

- Adult (≥18 years of age)
- Admitted within the previous 24 hours.
- Admitted with at least one regular or over the counter medicine to one of the study wards
- Have not received MR services from any member of the clinical team as part of the control care up to the point of recruitment

- **Exclusion criteria**

Patients were excluded if they met any of the following:

- Admitted via elective admission, this was to ensure that patients had not received MR during pre-admission clinic
- A study participant who was readmitted during the course of the study

2.3.4.2 Recruitment of patients under the Mental Capacity Act 2005

To ensure a representative sample, the study included patients who were admitted in a state of reduced consciousness which may be or not related to their illness and thus they lacked the mental capacity to consent. The MedRec intervention study is a low risk intervention, no or little disadvantage or burden to those patients was believed.

When the patient was considered mentally incompetent to consent, a patient consultee under the Mental Health Act 2005, section 32 was identified. When it was not possible to identify a consultee from the participant relatives or friends, an independent mental capacity advocate was to be nominated according to the local policy in CUHFT. The independent mental capacity advocate was independent from the research team and the study. A member of the nursing team asked whether a patient relative or friend is willing to advice the study researcher with regard the patient wishes about the study. If agreeable, the study researcher asked the consultee to offer an advice as whether he/she believed that the patient's wishes would be to take part in the study if they have not been mentally incapacitated. In such cases, the consultee was given a consultee information leaflet and allowed the time to consider the study participation (Appendix 12). In addition to full details on the study purpose and process, the consultee information leaflet included information with regard to the consultee role and responsibilities as specified under the Mental Capacity Act 2005. When a decision was made to take a part in the study, the consultee signed a consultee declaration form (Appendix 13).

Following the consultee consent, a letter was sent to the patient's GP to inform him/her about the study participation.

To safeguard patient confidentiality, the consultees were not asked about the patient's regular medicines. This information was obtained from elsewhere such GPs, previous admissions or repeat prescriptions.

When a patient lacked the mental capacity initially upon recruitment and his/her mental capacity was recovered during a later courses of the study, an informed decision was then sought from the patient him/herself.

2.3.5 Randomisation

Patients were randomised either into the intervention or control group using an automated randomisation system. The allocation to either intervention or control group was obtained using a centralised randomisation function built into the study database. Randomisation was stratified by wards; patients were randomised in a ratio of 1:1; intervention: control. The randomisation details were emailed to BC and AB. The intervention was a standardised service provided to patients across the study wards by a team of MR pharmacists who had a rota to ensure weekend cover of the service. There were three MR pharmacists delivering the intervention across five wards, thus it was impractical to randomise at a ward level. Additionally, a wash over effect of the intervention, i.e. the practice of the ward staff influencing or improving due to witnessing the intervention was unlikely because the nursing and medical team provided no MR as a part of the routine care. Additionally, the study pharmacists were informed not to discuss the study MR process with the ward pharmacy staff. Therefore, limited benefit was anticipated for cluster randomisation by ward, furthermore cluster randomisation would imply consenting patients after allocation to the study groups; this potentially might bias the study selection. Cluster randomisation also requires relatively large sample sizes to observe an effect; with a pilot design aiming to assess feasibility of the study process such an approach was considered inappropriate use of extra resources.

2.3.6 Blinding

The nature of the MedRec intervention precluded blinding of the study team; i.e. study researchers, PI, ward doctors and MR pharmacists as well as patients. However, ward nursing and medical team providing standard care to patients were blinded to the study allocation.

2.3.7 Study groups

The MedRec recruitment chart is summarised in Figure 2.3.1.

2.3.7.1 Intervention group

The study researcher informed the MR pharmacist to visit the patient when the allocation was for the intervention group; the MR pharmacist visited the patient within 24 hours of admission to implement a standardised MR and record the duration of MR tasks using a form developed for the purpose of the study (Appendix 14).

- **The MedRec intervention**

The MedRec intervention included a comprehensive reconciliation of patient medication list performed by a pharmacist within 24 hours of patient admission to identify discrepancies and resolve unintentional errors. The MR pharmacist also documented all medicines changed and communicated complete and comprehensive information clearly to the next health provider upon discharge. BOX 2.3.2 describes the MedRec intervention.

BOX 2.3.2 The MedRec intervention

The MR pharmacist:

- Verified medication histories and collated a comprehensive accurate list of all medicines the patient is taking using different sources of patient information.
- Compared the collated list with the patient active inpatient medicines list written by the medical team upon admission.
- Identified discrepancies between the above two lists were reviewed and discussed with the medical team to determine whether they were intentional or unintentional.
- Ensured that unintentional discrepancies resolved and all intentional changes documented clearly in the medical notes and discharge summary.

In addition to information obtained from the patient interview, the MR pharmacist used at least two source of information. Those included, but not limited to, patient own drugs, home medication list obtained from the GP, previous discharge summary or copy of repeat prescription.

Prior the study commencement, each MR pharmacist provided MR to at least 30 patients. The study PI observed each MR pharmacist undertaking at least three MR; this was to ensure a standardised and uniform delivery of the MedRec intervention between MR pharmacists.

2.3.7.2 Control group

Control group consisted of standard care provided to the patient by Cambridge University Hospital Foundation Trust staff who were independent from the study. Standard care included MR occasionally depending on resources and staff availability.

- **Control MR**

MR in the control group was defined as MR provided by a pharmacy staff who is independent from the study as a part of the usual care. In Cambridge University Hospital Foundation Trust at the time of the study, primarily MR was provided by pharmacy technicians and was provided typically after more than 24 hours of patient admission. In addition, there was rarely a significant opportunity for direct patient/carer interaction and limited contact with primary care for the purpose of obtaining or clarifying patient information. Nevertheless, there was also limited or no follow up of discrepancies and communication with the next health provider.

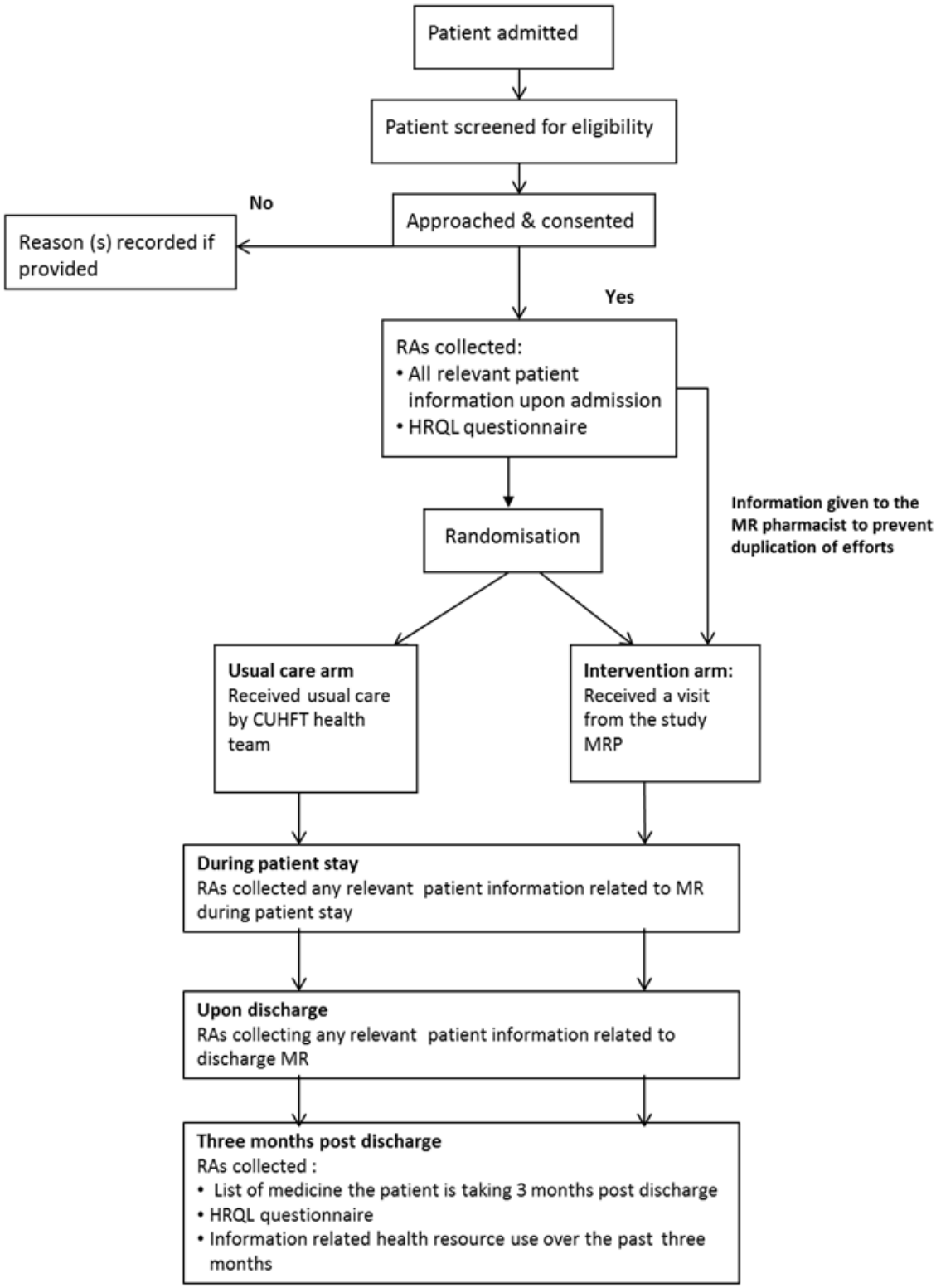
The study did not interfere with the clinical services provided for control patients. Pharmacy staff who were independent from the study were asked to record if and when a patient received control MR. Data were recorded using a form developed for this purpose. The form was advertised to the ward staff and placed in the ward pharmacy folder (Appendix 15).

2.3.8 Data management and collection

A study database was developed by the UEA clinical trials research unit which collated all information relating to patient admission, discharge and follow up. Identifiable patient data including name or contact details such as address, phone number, NHS number and information relating patient to the study number were kept in a separate, password protected database held by the study senior researcher and PI at the study site Hospital Foundation Trust.

The UEA research team accessed no patient identifiable information. The study database was kept on password protected drives, stored and processed on computers for research purposes only and it was accessed from a series of web-based data entry forms. Each user was assigned a username and password allowing different levels of data viewing

based on the role within the study and the blindness toward patient allocation. All web traffic was encrypted. Table 2.3.1 describes the MedRec study data collection process.



RAs: research assistants. **MR:** Medicine reconciliation HRQL: Health related quality of life. CUHFT: Cambridge university hospital foundation trust.

Figure 2.3.1 The MedRec study recruitment flow

Time point	Data collection
The study researcher at the following time points of the study:	
Pre-randomisation	Maintained a daily list of: • All newly admitted patients • Number of patients approached and recruited • Reason(s) for study decline or withdrawal if stated by the patient
Admission **(pre- intervention)**	• Recorded all relevant patient information upon admission • Photocopied inpatient medication chart(s) written by the medical team upon admission • Contacted the patient's GP to obtain a faxed list of medicines • Photocopied all medicine labels of patient own drugs • Asked the patient to complete a health related quality of life questionnaire
Admission post intervention **(Intervention group only)**	Photocopied post intervention medication chart(s) and medical note(s)
During hospital stay	• Photocopied all changes/amendments to the medication chart(s) during hospital stay • Recorded all relevant information to the MR pharmacist interventions and discrepancies' follow up • Recorded medical team action(s) in response to the MR pharmacist interventions • Recorded information related to MR (if any) received in the control group
Discharge **(pre- intervention)**	Photocopied medication chart(s) and medical notes upon discharge
Discharge post intervention (Intervention group only)	• Photocopied medication chart(s) and medical notes following MR pharmacist intervention • Recorded all relevant information to the MR pharmacist interventions upon discharge
Three months post discharge	• Obtained a list of medicines the patient is taking three month post discharge • Sent the health related quality of life & health resource use questionnaire to patients 3 months post discharge • Recorded relevant information related to readmission episodes; ward admitted to, date, duration and reason(s)

PODs: Patient own drugs. MR: Medicine reconciliation

Table 2.3.1 The MedRec study data collection process

2.3.9 Outcomes measurement

The MedRec study investigated a broad scope of study design, patient and process oriented outcomes, costs and consequences:

- **Study feasibility outcomes**
  - Outcomes informing the design of a future larger scale trial:
    - Recruitment and follow up rates
    - Feasibility of the study process
    - Feasibility of data collection
    - Feasibility of data analysis
    - Acceptability of the intervention

- **Process oriented outcomes**
  - Rate and nature of medication discrepancies
  - Clinical significance of medication errors
  - MR pharmacist interventions

- **Patient oriented outcomes**
  - Length of hospital stay
  - Post discharge health resource use of NHS and personal social service (PSS) services
  - Health related quality of life
  - Mortality

- **Cost-effectiveness outcomes**
  - Consumed costs
    - Time commitment to implement MR
    - Costs of medication errors
  - Consequence costs
    - Length of hospital stay
    - Post discharge health care resource use of NHS and PSS services
    - Use of social care and informal care
  - Effectiveness
    - Change in utility score over three months, e.g. EQ-5D scores
    - Incremental quality-adjusted life year (QALY) gain/loss
    - Incremental cost effectiveness ratio (ICER)

2.3.10 Process oriented outcomes

In chapter one, it was shown that MR pharmacist involvement can be useful in detecting and rectifying medication errors as well as preventing error recurrence upon discharge. It was also demonstrated that 30% to 50% of errors have the potential to cause clinically significant consequences. Thus, medication errors are an appropriate outcome to measure.

2.3.10.1 Identification of medication discrepancies

Medication discrepancies were evaluated at three time points: admission, discharge and three months post discharge.

The patients' active medical chart at each time point was reviewed to identify discrepancies by comparing these charts with the most comprehensive updated list of medicines the patient should be taking. When discrepancies existed, the medical record was searched for an explanation.

- **Medication discrepancies upon admission**

Any differences between the most updated comprehensive list, constructed by the study researcher for control patients or by the MR pharmacists for the intervention patients, and the inpatient medicine chart written upon admission i.e. within the first 24 hours of admission.

- **Medication discrepancies upon discharge**

Any undocumented differences between the active inpatient medicine chart upon discharge and discharge summary.

- **Medication discrepancies three months post discharge**

Any differences between the discharge summary and the list of patient medicines three months post discharge held by the GP.

Discrepancies were identified by a retrospective review. Figure 2.3.2 illustrates medication discrepancies identification process in both study groups.

Unintentional medication error rate in both study groups at admission, discharge and at 3 months post discharge were recorded. Number of patients experiencing at least one medication discrepancy at each time point was determined too. Discrepancies which identified three months post discharge were screened by the study principal investigator and discussed with GPs to determine the most appropriate action.

Medication discrepancies identification was performed by EH. To assess the consistency of discrepancies identification, ten medicine charts were reviewed independently by the study principal investigator and agreement was assessed using kappa analysis.

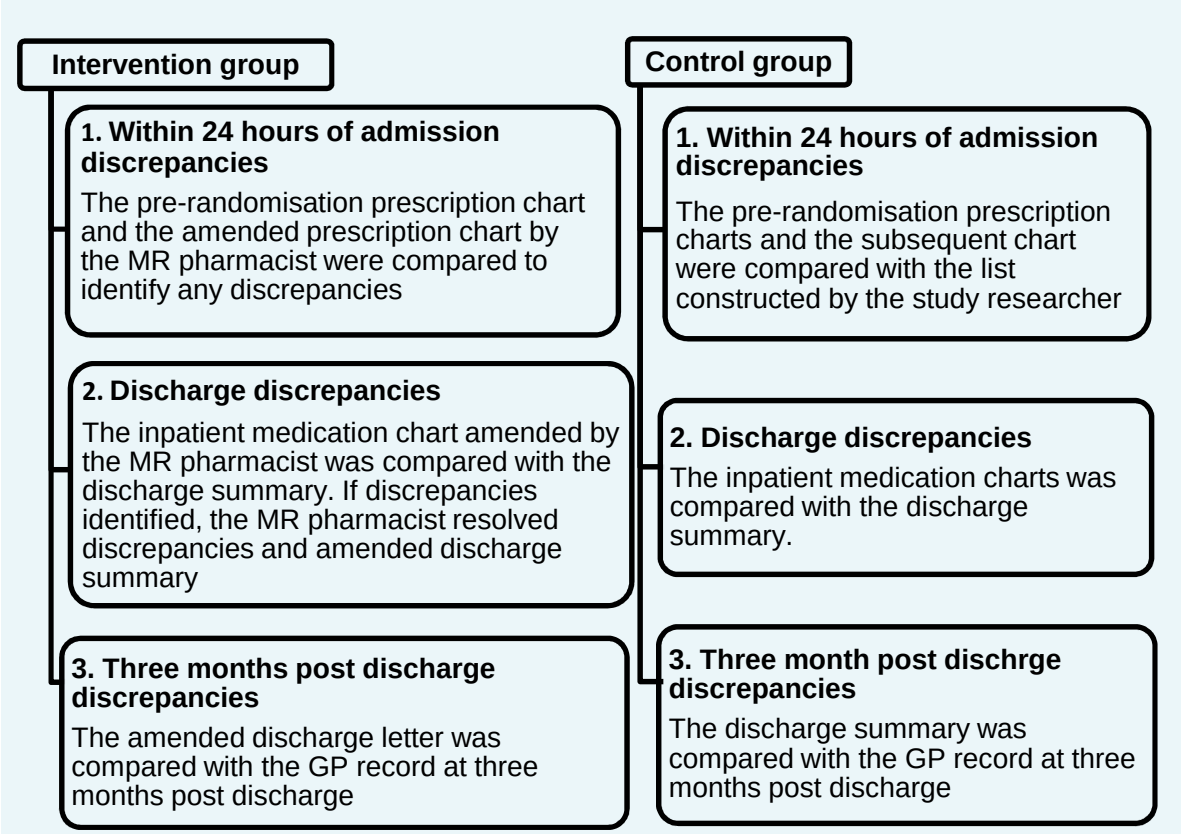


Figure 2.3.2 Medication discrepancy identification in both study groups.

2.3.10.2 Classification of medication discrepancies

Classification of medication discrepancies was adapted from Pippins et al;[28] each discrepancy was classified according to prescriber intention, location and type as described in figure 2.3.3.

Hence, medication discrepancy identification in the control care group was carried out 3 months post discharge; it was not possible to establish the intention with the medical team. Medical notes of control patients were reviewed for a documented evidence or clinical explanation for the rational of discrepancies. In some cases the discrepancy was obviously unintentional such as methotrexate prescribed once daily instead of once a week. In other instances, discrepancies were obviously intentional such as dalteparin given subcutaneously in a deep vein thrombosis prophylaxis dose while inpatient stay and discontinued upon patient discharge.

A set of assumptions were considered to establish the intention of prescriber, those were agreed after discussion with the study team. Assumptions are summarised in BOX 2.3.3.

BOX 2.3.3 Assumptions agreed to establish prescriber's intention

In order to establish the intention of prescribers and define a discrepancy whether intentional or unintentional in the control group, the following assumptions were agreed:

- The change of intravenous and subcutaneous medicine route of administration into oral forms upon discharge were considered intentional change, e.g. meropenem injection that was continued upon discharge to complete 5 days course with oral co-Amoxiclav® tablets

- Medicines prescribed as required in inpatient and omitted upon discharge was considered intentional discontinuation, e.g. senna 2 tablets ON as required

- Analgesics, laxatives, indigestion products, nausea and vomiting relief product and sleeping aids prescribed inpatient for regular use and discontinued upon discharge or for short term were considered intentional discontinuation/change in duration, e.g. metoclopramide or cyclizine prescribed for nausea

- Analgesics, laxatives, indigestion products, nausea and vomiting relief product and sleeping aids prescribed inpatient as required and continued for long term upon discharge were considered unintentional addition

- Medicines which were prescribed for regular use pre-admission or those been prescribed for regular use inpatient and discontinued upon discharge with patient prescribed other medicines from the same class were agreed to be intentional substitutions, e.g. patient prescribed senna tablets inpatient which omitted upon discharge but he/she was prescribed Movicol® sachets to take home

- Pre-admission medicines that is listed for patient regular use by at least two source of patient information and were omitted inpatient with no documented evidence to indicate those had been stopped or held while hospital stay were considered unintentional omissions, e.g. Seretide Accuhaler® listed for regular patient use in GP list and previous discharge summary but not transcribed in inpatient chart

- Generic and brand names of a medicine were considered interchangeable and thus this was not deemed as a discrepancy

Discrepancy classification was undertaken by EH supported by DW. In case of uncertainties or ambiguities, discrepancies classification was discussed and agreed with a clinical hospital pharmacist (BC).

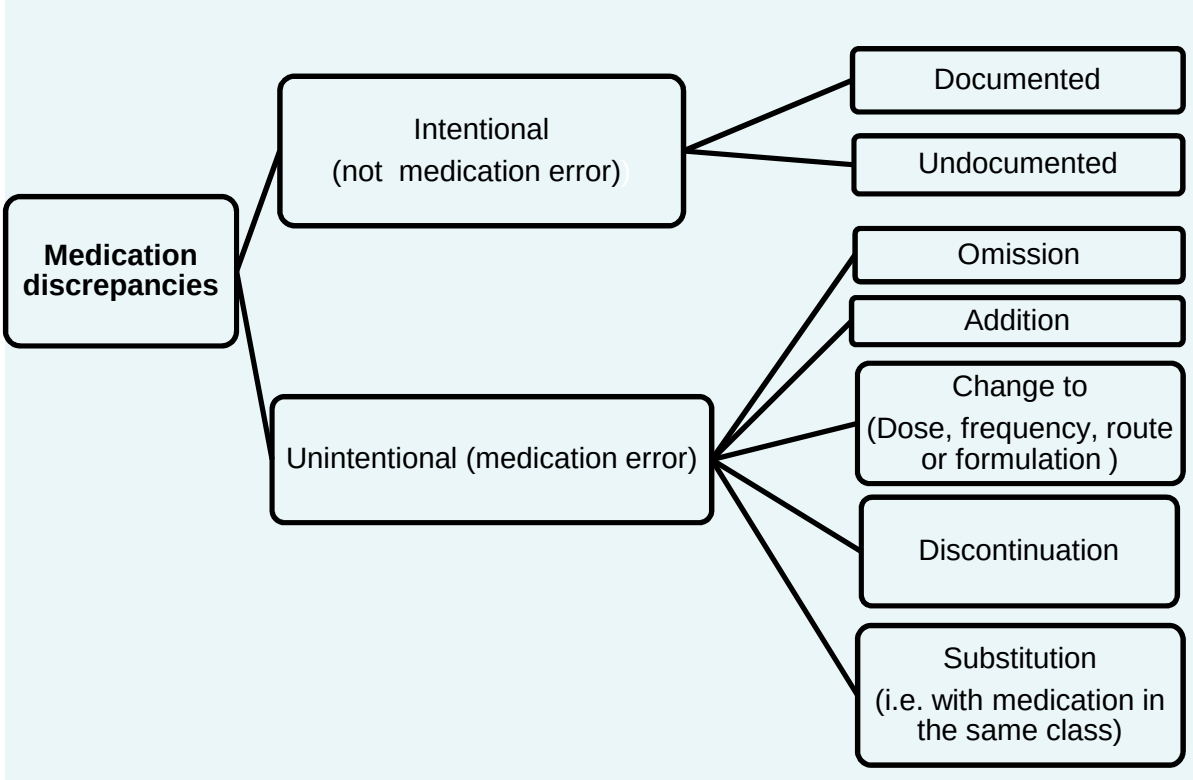


Figure 2.3.3 Medication discrepancy classification

2.3.10.3 Clinical significance of medication errors

Intentional medication discrepancies were not considered medication errors. In the intervention group, the MR pharmacist resolved intentional discrepancies and ensured comprehensive and accurate documentation in medical records and discharge summaries. Unintentional medication discrepancies were considered medication errors and therefore the severity and potential for patient harm were evaluated. Medication errors were stratified according to the type of discrepancy and the time point occurred (i.e. admission, discharge or 3 months post discharge). As a pilot study with an embedded feasibility component, a random selection of 20 discrepancies was clinically assessed for potential patient harm in order to estimate the feasibility of this process. The clinical significance of medication errors was assessed using the Dean and barber VAS.[183] The mean score for all assessor for each discrepancy was categorised as minor (<3), moderate (3-7) or severe (>7).[35]

2.3.11 Patient oriented outcomes

2.3.11.1 Length of hospital stay

The literature review in chapter one highlighted the lack of firm evidence for the effect of MR on hospital stay or other health resource use. For an intervention to be widely adopted, it is essential that it demonstrates cost-effectiveness. The beneficial effects of MR have been frequently cited, however, evidence of its impact on costs is less widely researched. Length of hospital stay was the primary outcome as MR might be expected to shorten length of hospital stay by optimising medicine prescribing upon admission and preventing adverse drug events. This would contribute to considerable cost savings for NHS trusts. Therefore, length of hospital stay was considered an appropriate patient oriented outcome to investigate.

Hospital stay period was estimated from the time a patient was admitted to the ward until discharge time from the hospital. When patients were transferred to other wards or inpatient services the period was included until discharge from the hospital.

2.3.11.2 Post discharge health resource use

MR could be expected to improve patient use of health resources. This might be influenced by the role of the MR pharmacist in optimising patient care during hospital stay and preventing unintentional drug adverse events. This would potentially improve post discharge care and reduce the burden of preventable unplanned readmissions. Additionally, this might improve patient quality of life and reduce health resource use.

- **Readmissions**

Readmission details were obtained from hospital records and via self-report by patients or consultees. Hospital records were reviewed to obtain details on readmissions episodes at three months post discharge. Self-report readmission details were obtained via postal questionnaire (Appendix 16) sent to patients three months post discharge.

- **Post discharge use of NHS and PSS services**

Details on patients' use of health resources were obtained via a postal questionnaire sent to patients three months post discharge (Appendix 16); details were obtained on:

  - Health resource use in community; i.e. NHS and PSS worker in community
  - Health resource use in hospital; i.e. NHS and PSS worker in hospital
  - Use of social and informal care

Non-responders were followed up once by post and then by phone. Consultees were asked to complete the questionnaire on behalf of the study participants.

2.3.11.3 Health related quality of life

Patients were asked to complete health related quality of life questionnaire (Appendix 16) at the time of recruitment and at three months post discharge. The questionnaire consists of two parts including the EQ-5D descriptive system and the EuroQol VAS.[192] The EuroQol VAS recorded the respondents self-rated health statues from 0 representing the worst imaginable health to 100 representing the best imaginable health. York A1 tariff was used to assign a value to each EQ-5D health state description.[178]

The hospital computer system was checked to ensure that the questionnaire was not be sent to participants who had died or readmitted (i.e. in hospital at the time of three month). The study was registered with the EuroQol group, an authorisation for the use of EQ-5D was obtained.

2.3.11.4 Mortality

At three months post discharge, primary care practices were contacted to identify patients who were deceased in both groups.

2.3.12 Cost-effectiveness

2.3.12.1 Cost estimation

NICE recommends costs from the perspective of the NHS and PSS.[172] It is also considered appropriate by NICE to include costs of informal care by family members, friends who live or do not live with the patient. Accordingly, the health resource use questionnaire attempted to capture details related to NHS and PSS worker visits, hospital services use, social care and informal carer. In addition to this, patients were also asked to report out of pockets expenses, those which were paid by patients as a result of their health over the three months period post discharge.

Using micro-costing valuation, a unit cost was specified for every resource consumed/ saved in healthcare service provision. The unit costs reported by personal social services research units and Department of Health reference costs, financial year 2011/2012, were assigned to each NHS and PSS use.[174, 175] The total costs were calculated for each cost unit by summing all single cost components that contributed to the MR intervention and patient use of health resouces. The mean incremental cost of the intervention was calculated by subtracting the estimated mean cost per patient of all NHS and PSS costs, time commitment and medication errors costs for control group from that for the intervention group.

The method to estimate the cost of informal carer time was based on Patal et al.[193] The opportunity cost defind as the value of the opportunities forgone by care givers as a result of time spent on care giving was used to estimate the cost of informal care. The UK minimum wage for the year 2011/2012 was £4.38 per hour; this was used as a proxy valuation of carer time.[194] Travel cost of informal carer who do not live with the patient was assigned the the avergage cost of return trip using public trasport in Great Britain in 2011/2012 in non-metropolitan reagions.[195]

In order to estimate the cost of MR received by control patients, it was assumed that on average control MR took 20 minutes and was provided by pharmacy technicians. The unit cost assigned to one hour employment of pharmacy technician taken from the National Career Service information and based on an average earning of £23,000 per year [196] was £11.64 per hour.

Medication errors costs were estimated based on published studies in USA and UK. The USA study reported that 4.8% 95%CI [3.7-6.1] of discrepancies upon patient transfer of hospital lead to adverse drug events.[197] From a prospective analysis of 18, 820 patients admitted to hospitals in UK and assessed for the prevelence of admissions due to an adverse drug event, it was estimated that patients admitted with an adverse drug event had a median stay (IQ) of 8 [4,18].[11].

Costs estimates were based on mean (SD); this was drawn based on the recommendations from Drummond et al and the NICE guidance for the *Method of Technology Apprasial programme.* Using the median will not allow policy makers to determine the total cost of treatment for a group of patients. For this, the mean is required because total cost for a group is the mean cost multiplied by number of patients in the group.[172, 173]

Costing was based on “Available- case analysis”; the mean for the available cases for each variable was estimated. Missing data were not imputed.

2.3.12.2 Effectiveness

In line with NICE recommendations for the reference case analysis, the York A1 tariff was used to estimate the utility weight scores.[178] QALY was used as the effectiveness measure and the health realted quality of life element was measured using EQ-5D scores.[198]

Area under the curve method without baseline adjustment was used to estimate the incremental QALY gain/loss.[173] However, baseline adjusment was warranted,[199] therefore the area under the curve method with baseline adjustment was also used to

estimate the mean change in QALY over three months post discharge for both groups, along with the mean incremental QALY gain/loss for the intervention.[200]

Providing the intervention dominance was not apparent as if the intervention was less costly and more effective than the control,[201] the incremental cost per QALY gain/lose, ICER associated with the intervention would be calculated. In line with NICE guidance, if an ICER to be calculated it would be compared with the NICE cost-effectiveness threshold of £20,000–30,000 per QALY.[172]

2.3.13 Statistical analysis (the MedRec interim analysis)

The present thesis reports the interim analysis of the MedRec study; comprising the data collected over the first three months, 5th July 2012 to 6th October 2012, for 60 patients equally distributed between the study groups. The MedRec study full protocol was developed by the thesis author (EH) with the support of the MedRec study research team. The MedRec study is due to be completed in August 2013. The interim analysis aimed to inform the full pilot analysis and provide insight in the initial findings**.**

All data were processed using the statistical package for social science (SPSS version 18, Chicago, USA software), descriptive data have been reported as mean ± SD or median (IQR) as appropriate.
Recruitment rate was estimated out of patient approached. The rate was also estimated out of eligible patient. The latter rate was estimated after deducting ineligible patients identified after conversing with the patient or the nurse, i.e. prescribed no medicine or seen by the ward pharmacist.

The study cover, the days the MR pharmacists and the study researchers were available, was calculated. Uncovered days were adjusted for holidays, weekends and annual leave.

The response rate of obtaining three month post discharge outcome data, i.e. the GP held medicine lists and health related quality of life questionnaires was estimated accounting for patients lost to follow up due to death. The response rates of primary care practices and patients were estimated for the first contact as well as the follow up contact(s).

The intervention effect size were estimated.[202] The time took for readmission to occur was estimated applying the Kaplan–Meier survival analysis log-rank test. Number to treat, the number of patients needed to receive MR intervention in order to prevent one readmission was also calculated.[203]

Hence, this is an interim anlysis of a pilot study, a sensitivity analysis to assess changes in the key assumptions was believed not warranted at this stage. Sensitivity analysis and the assessment of uncerantity associated with the decision regarding cost-effectiveness using cost-effectivness accepality curve (CEAC) was warranted for the full pilot analysis.[204]

Chapter 3

Results

Quality of discharge information upon hospital discharge: an audit in primary care

This chapter presents findings from the Trust-wide audit. The magnitudes of adherence to the total NPC minimum dataset and the categories related to admission, discharge and patient information, medication information and therapy change information were evaluated.

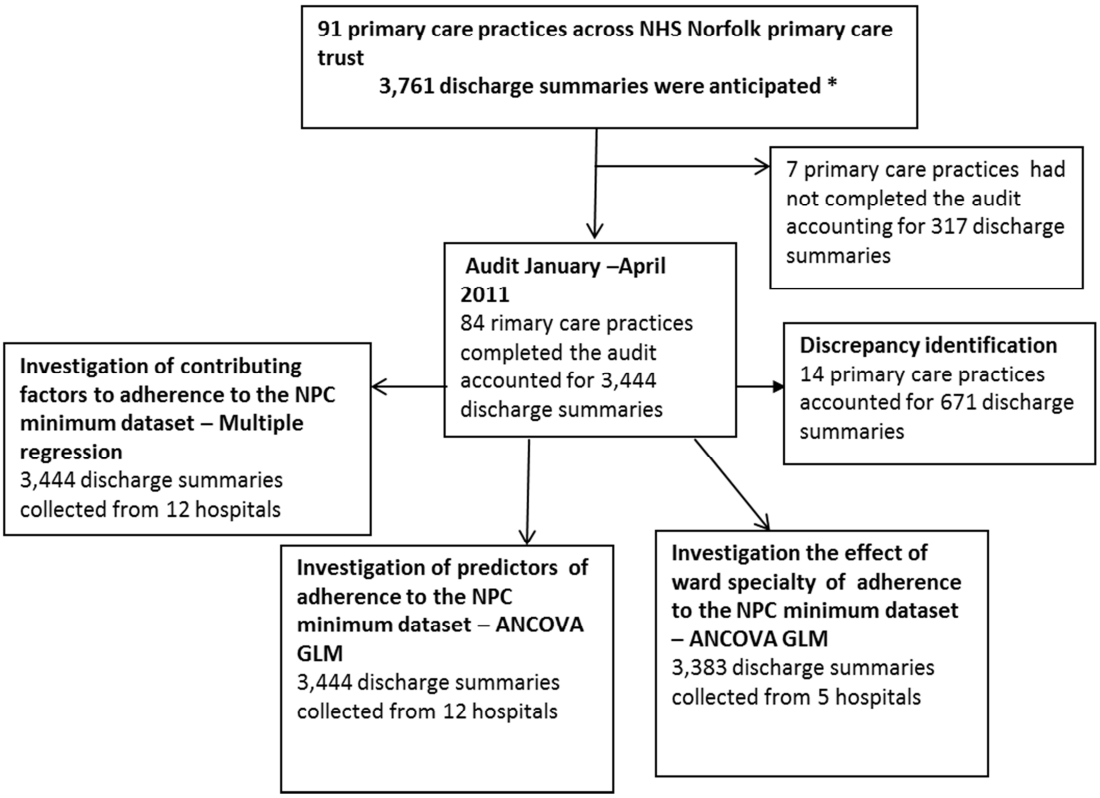
Additionally, contributing factors to the quality of discharge information were investigated; predictors of discharge summary adherence to the NPC minimum dataset and those associated with increased risk of discrepancy were also identified. The potential influence of these factors was investigated adjusting for possible confounding and covariate effects. Therefore, predictors of non-adherence to the NPC minimum dataset and the characteristics associated with an increased risk of discrepancy were described and recommendations to improve the current practice were developed. Figure 3.1 presents summary of audit data collected.

3.1 Audit sample

A total of 3,444 discharge summaries were audited from 84 primary care practices across NHS Norfolk representing 12 hospitals. Discharge summaries were primarily from two teaching hospitals (H1 and H4) which accounted for 2,421 (70.3%) and three district hospitals (H2, H3 and H5) accounting for 910 (26.4%). The remainder included private, mental health trusts, community hospitals and hospitals beyond the Norfolk/Suffolk/ Cambridgeshire region. The majority of discharge summaries represented unplanned admissions which accounted for 2,168 (63.0%) and for 365 (10.6 %) no information was available regarding admission type. The remainder were planned admissions. Discharge summaries were mainly electronic 2,570 (74.6%) and for patients discharged mostly in January; 1,666 (48.4%) and February; 950 (27.6%). There was a relatively even gender distribution; 1,753 (50.9%) were female. The median (IQ) age of patients was 66 (46, 80) years and the median duration of hospital stay was 4 (2, 8) days. Discharge summaries listed no medicines for 446 (13.5%) patients and the median (IQ) number of medicines prescribed per patient was 5 (2, 8).

Table 3.1 presents the audit sample characteristics. High proportion of the discharge summaries were from medicine for elderly wards 564 (16.4%), followed by urology 403 (11.7%) and general surgery 321 (9.3%) wards.

The role of the healthcare professional responsible for preparing the discharge summary was not indicated in 758 (22.0%) of the cases. When the profession type was provided, doctors accounted for 2,504 (72.7%). Of the discharge summaries prepared by doctors, foundation year doctors accounted for 853 (34.1%), whereas 1113 (41.4%) were prepared by doctors of unknown training. The second frequent profession type completing discharge summaries were specialised nurse practitioners with 146 (4.2%).



*Based on 5% of the practice size

Figure 3.1 Summary of the audit data

		Hospitals							
Characteristics	**Measure**	**H1 n=2,368**	**H2 n=715**	**H3 n=136**	**H4 n=57**	**H5 n=55**	**Community hospitals n=52**	**Tertiary hospital n=29**	**Mental trust n=21**
Patient demographics									
Age	Median (IQ)	66 (46,79)	67 (45,81)	60.5 (39.3,76.8)	59 (46,70)	73 (57,80)	76 (70.3,84.8)	65.5 (56.3-79.0)	70(44,47)
Female	N (%)	1,194 (50.4)	371 (51.9)	81 (59.6)	22 (38.6)	27 (49.1)	26 (50.0)	13 (44.8)	13 (61.9)
No. of medicines	Median (IQ)	6 (2,8)	5 (2,8)	6 (3,10)	6 (2,8)	5 (3,8)	6 (3,10)	6 (3.5,9.5)	4 9(2,5)
Hospital stay	Median (IQ)	4.5 (2,8)	4 (2,8)	3 (2,6)	3 (1.5,8)	4.5 (2,13)	13 (5,36)	6 (2,8)	8 (2,17)
Time of discharge summary arrival	Median (IQ)	2 (1,3)	2 (2,8)	1 (0,2)	2 (2,4)	2 (1,2.5)	2 (2,4)	2 (1,3)	2 (1,5)
Type of discharge summary									
Electronic discharge summaries	N (%)	2,211 (93.4)	110 (15.4)	126 (92.6)	29 (50.9)	25 (45.5)	30 (57.7)	21 (72.4)	14 (66.7)
Type of admission									
Unplanned admission	N (%)	1591 (67.2)	433 (60.6)	20 (14.7)	28 (49.1)	41 (74.5)	30(57.7)	9 (31.0)	13 (61.9)
Unspecified type of admission	N (%)	128 (5.4)	106 (14.8)	92 (67.6)	10 (17.5)	-	14 (26.9)	8 (27.6)	2 (9.5)
Ward specialities									
Medicine for Elderly	N (%)	454 (19.2)	73 (10.2)	21 (15.4)	3 (5.3)	1 (1.8)	7 (13.5)	3 (10.3)	2 (9.5)
Urology	N (%)	292 (12.3)	76 (10.6)	25 (18.4)	4 (7.0)	2 (3.6)	2 (3.8)	1 (3.4)	1 (4.8)
General surgery	N (%)	244 (10.3)	54 (7.6)	1 (0.7)	8 (14.0)	10 (18.2)	3 (5.8)	-	-
Thoracic	N (%)	210 (8.9)	27 (3.8)	5 (3.7)	1 (1.8)	-	-	-	-
Cardiology	N (%)	195 (8.2)	24 (3.4)	5 (3.7)	4 (7.0)	3 (5.5)	1 (1.9)	7 (24.1)	
Orthopaedic	N (%)	137 (5.8)	62 (8.7)	3 (2.2)	4 (7.0)	7 (12.7)	3 (5.8)	1 (3.4)	
Paediatrics	N (%)	131 (5.5)	63 (8.8)	6 (4.4)	2 (3.5)	-	1 (1.9)	-	
General medicine	N (%)	65 (2.7)	70 (9.8)	40 (29.4)	1 (1.8)	9 (16.4)	2 (3.8)	-	
Gynaecology	N (%)	105 (4.4)	21 (2.9)	13 (9.6)	4 (7.0)	2 (3.6)	-	2 (6.9)	
Oncology	N (%)	121 (5.1)	10 (1.4)	1 (0.7)	6 (10.5)	-	2 (3.8)		-
Gastroenterology	N (%)	90 (3.8)	26 (3.6)	2 (1.5)	2 (3.5)	4 (7.3)	-	2 (6.9)	
Ear, nose& throat	N (%)	56 (2.4)	5 (0.7)	6 (4.4)	-	-	1 (1.9)	-	
Neurology	N (%)	48 (2.0)	-	2 (1.5)	5 (8.8)	-	1 (1.9)	-	
Nephrology	N (%)	52 (2.2)	1 (0.1)	-	-	-	-	-	-
Endocrinology	N (%)	42 (1.8)	8 (1.1)	-	-	-	-	-	-
Others*	N (%)	68 (2.9)	51 (7.1)	1 (0.7)	10 (17.5)	15 (27.3)	7 (13.5)	4 (13.8)	8 (38.1)
Unspecified specialities	N (%)	58 (2.4)	144 (20.1)	5 (3.7)	3 (5.3)	2 (3.6)	22 (42.3)	9 (31.0)	10 (50.0)

*E.g. Dermatology, Rheumatology, Ophthalmology, Maternity care and Neonatal, rehabilitation

Table 3.1 Characteristics of the audit sample

Characteristics	Measure	Hospitals							
		H1 n=2,368	H2 n=715	H3 n=136	H4 n=57	H5 n=55	Community hospitals n=52	Tertiary hospital n=29	Mental trust n=21
Profession type									
Doctors[+]	N (%)	1,026 (43.3)	28 (3.9)	15 (11.0)	8 (14.0)	12 (21.8)	11 (21.2)	6 (20.7)	6 (28.6)
Foundation years	N (%)	363 (15.3)	435 (60.8)	4 (2.9)	18 (31.6)	12 (21.8)	10 (19.2)	5 (17.2)	6 (28.6)
Core medical training	N (%)	165 (7.0)	88 (12.3)	-	6 (10.5)	4 (7.3)	2 (3.8)	1 (3.4)	-
Speciality training	N (%)	71 (3.0)	25 (3.5)	1 (0.7)	6 (10.5)	3 (5.5)	2 (3.8)	9 (31.0)	2 (9.5)
Consultant	N (%)	95 (4.0)	25 (3.5)	2 (1.5)	2 (3.5)	2 (3.6)	2 (3.8)	1 (3.4)	1 (4 .8)
Registrar	N (%)	8 (0.3)	1 (0.1)	-	-	-	11 (21.2)	-	1 (4.8)
Pharmacists	N (%)	36 (1.5)	-	-	-	-	-	-	-
Specialist nurse practitioners	N (%)	135 (5.7)	5 (0.7)	-	2 (3.5)	-	1 (1.9)	3 (10.3)	-
Unspecified profession	N (%)	469 (19.8)	108 (15.1)	114 (83.8)	15 (26.3)	22 (40.0)	13 (25.0)	4 (13.8)	5 (23.8)

+unspecified training level

Continued
Table 3.1 Characteristics of the Audit sample

3.2 Adherence to the NPC minimum dataset

Mean [95% CI] discharge summary adherence to the total National prescribing centre (NPC) minimum dataset was 71.7% [70.21-73.2]. Table 3.2 illustrates the range of discharge summary adherence with different procedural characteristics.

	Discharge summary adherence			
	Total NPC Dataset	**Patient, admission & discharge information**	**Medication information**	**Therapy change information**
Type of admission				
Planned	71.3% [70.6-72.1]	77.2% [76.5-78.0]	63.9% [62.2-65.6]	46.3% [43.8-48.9].
Unplanned	71.8% [71.3-72.3]	77.5% [77.1-78.0]	62.9% [61.9-64.0]	49.0% [47.3-50.8]
Unspecified	72.6% [71.2-74.1]	76.4% [75.0-77.8]	70.8% [68.5-73.1]	55.4% [51.2-59.7]
Type of discharge summary				
Electronic	73.7% [73.3-74.1]	79.5% [79.1-79.9]	67.2% [66.3.-68.2]	50.9% [49.4-52.3]
Handwritten	67.0% [65.2-66.8]	71.0% [70.2-71.9]	54.8% [53.4-56.3]	40.2% [36.9-43.7].
Hospital				
H1	73.5% [73.1-74.0]	79.3% [79.0-79.7]	66.4% [65.4-67.4]	50.6% [49.0-52.1]
H2	65.0% [64.1-65.9]	69.8% [68.9-70.7]	54.3% [52.9-55.8]	41.8% [37.8-45.9]
H3	81.4% [79.7-83.2]	85.4% [83.9-87.0]	83.0% [80.0-86.0]	65.5% [60.0-71.0]
H4	73.5% [70.6-76.8]	79.7% [76.2-83.1]	69.1% [62.5-75.8]	46.9% [34.7-59.1]
H5	71.7% [68.3-75.1]	79.4% [76.7-82.1]	48.2% [40.2-56.2]	26.4% [14.6-38.2]
Community hospital	62.4% [58.1-66.9]	68.6% [64.3-72.9]	58.5% [49.5-67.5]	27.7% [15.8-39.6]
Tertiary hospital	68.3%[63.4-73.3]	73.8% [68.8-78.8]	58.9% [47.5-70.4]	31.0% [17.3-44.7]
Mental health trust	65.7% [60.6-70.8]	71.8% [66.1-77.5]	52.7% [63.4-41.9]	22.6% [8.7-36.7]
Ward speciality				
Medicine for Elderly	73.5% [72.6-74.4]	79.7% [78.8-80.6]	64.7% [62.8-66.7]	53.0% [49.7-56.2]
Urology	73.3% [72.2-74.4]	78.4% [77.1-79.1]	67.6% [65.3-69.9]	52.0% [48.3-56.2]
General surgery	71.1% [69.9-72.4]	78.1% [76.9-79.3]	58.8% [55.7-61.9]	42.3% [37.7-46.9]
Thoracic	73.3% [72.0-74.6]	78.7% [77.5-80.0]	67.2% [64.4-69.7]	51.5% [46.6-56.4]
Cardiology	73.0% [71.5-74.5]	78.9% [77.4-80.4]	65.2% [62.3-68.1]	50.7% [46.5-54.9]
Orthopaedic	68.6% [67.1-70.2]	75.0% [73.5-76.5]	63.5% [60.5-66.6]	34.9% [29.0-40.7]
Paediatrics	71.4% [69.7-73.1]	76.6% [74.9-78.2]	64.7% [61.0-68.3]	46.8% [40.8-52.8]
General medicine	72.0% [70.3-73.7]	75.8% [73.9-77.5]	64.8% [61.1-68.6]	58.3% [51.5-64.9]
Gynaecology	72.2% [70.1-74.3]	78.9% [77.1-80.6]	64.0% [59.4-68.5]	49.6% [42.0-56.9]
Oncology	73.9% [72.1-75.7]	77.8% [76.2-79.4]	68.2% [64.4-72.1]	58.9% [52.6-65.3]
Gastroenterology	69.6% [67.7-71.6]	75.7% [73.7-77.7]	60.2% [56.1-64.2]	48.1% [41.0-55.3]
Ear, nose& throat	75.6% [73.1-78.1]	79.7% [77.6-81.8]	57.7% [49.5-65.8]	30.2%[21.6-38.8]
Neurology	73.5% [70.6-76.3]	79.4% [76.7-82.0]	56.6% [48.1-65.0]	34.5% [26.6-42.4]
Nephrology	70.0% [66.9-73.1]	76.9% [73.8-80.0]	53.0% [43.7-62.2]	35.8% [26.2-45.5]
Endocrinology	74.4% [70.9-77.9]	82.0% [79.6-84.4]	47.9% [37.7-58.0]	32.7%[22.6-42.8]
Others*	71.4% [69.6-73.1]	76.9% [75.3-78.5]	49.5% [44.4-54.6]	21.3% [16.2-26.4]
Unspecified	64.4% [62.7-66.1]	68.8% [67.1-70.5]	60.2% [56.0-62.5]	49.0% [43.2-54.9]

*E.g. Dermatology, Rheumatology, Ophthalmology, Maternity care and Neonatal, rehabilitation. NPC: National prescribing centre

Table 3.2 Discharge summary adherence to the NPC minimum dataset

	Discharge summaries adherence			
	Total NPC Dataset	**Patient, admission & discharge information**	**Medication information**	**Therapy change information**
Profession type				
Doctors[+]	72.8% [72.2-73.5]	79.0% [78.4-79.6]	58.8% [57.0-60.6]	36.0% [33.94-38.1]
Foundation years	68.7% [67.9-69.5]	73.7% [72.9-74.5]	52.8% [51.0-53.2]	26.3% [23.9-28.7]
Core medical training	70.9% [69.6-72.2]	76.5% [75.1-77.8]	54.7% [51.2-58.1]	34.7% [30.1-39.4]
Speciality training	68.9% [66.7-71.2]	75.3% [73.0-77.5]	50.0% [44.5-55.5]	30.5% [23.7-37.2]
Consultant	71.9% [69.7-74.1]	77.3% [75.6-79.0]	52.1% [46.5-57.7]	31.4% [23.7-37.2]
Registrar	71.4% [65.6-77.2]	74.2% [68.5-79.9]	42.9% [26.7-59.1]	28.6% [12.0-45.2]
Pharmacists	74.6% [71.7-77.5]	80.1% [77.6-82.6]	69.1% [61.2-77.0]	51.5% [38.4-64.6]
Specialist nurse practitioners	74.5% [72.5-76.6]	79.8% [78.1-81.5]	65.6% [61.0-70.3]	53.0% [46.8-59.2]
Unspecified	73.6% [72.6-74.4]	79.1% [78.3-79.9]	67.5% [65.7-69.3]	50.5% [47.8-53.2]

+unspecified training level. NPC: National prescribing centre

Continued

Table 3.2 Discharge summary adherence to NPC minimum dataset

Adherence rates of discharge summaries arising from planned and unplanned admissions were similar. Electronic discharge summaries, however, were associated with a notably higher adherence rates compared to handwritten discharge summaries. Variation can be seen between hospitals, with H3 demonstrating the greatest adherence, whilst H2 and community hospitals demonstrating a substantially lower adherence rates than the other hospitals.

Wards exhibited a wide range of adherence rates with orthopaedic wards demonstrating the lowest adherence. Discharge summaries written by pharmacists and specialist nurse practitioners demonstrated better adherence rates compared to discharge summaries written by doctors. Discharge summaries prepared by foundation year doctors demonstrated the lowest adherence rate.

3.2.1 Adherence to the NPC minimum dataset relating to patient, admission and discharge information

Figure 3.2 illustrates adherence rates for patient, admission and discharge information. Mean [95% CI] discharge summary adherence was 77.3% [77.0-77.7] with co-morbidities, medication history and allergy status contributing to the most frequent omissions.

When reviewing a random selection of 100 discharge summaries, it was found that the omitted co-morbidities were frequently related to depression 62%, osteoporosis 53%, stroke 40%, history of acute MI 36%, skin conditions such as eczema and psoriasis 46%, plus asthma and chronic obstructive pulmonary disease 59%. Additionally, the most

omissions with medication histories were for analgesics 79%, laxatives 76%, antacids 64%, sleeping aids 48%, aspirin 63%, antihistamines 43% and vitamin supplements 44%.

A random selection of 100 discharge summaries for which the discharge teams recorded no information with respect to allergy status was reviewed. For 18% of patients there were no known allergies held in the GP records, whereas for the remainder one or more known allergens were recorded.

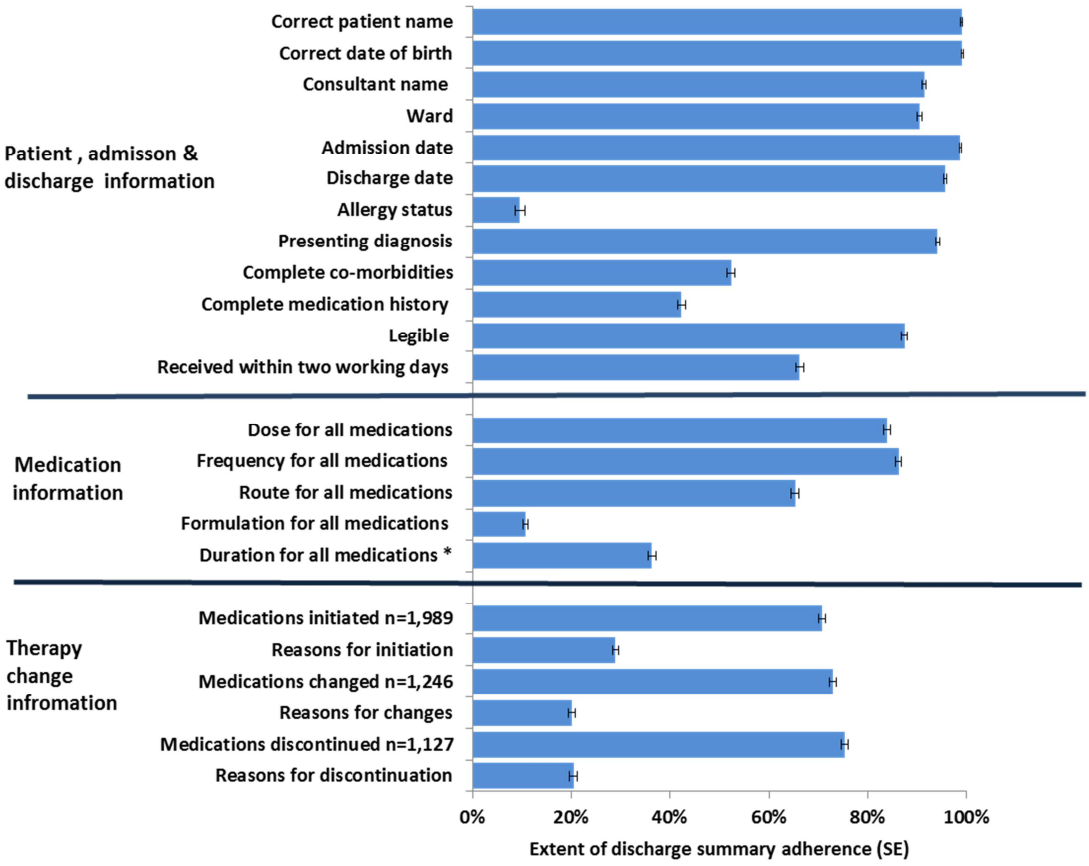


Figure 3.2 Magnitudes of discharge summaries adherence to NPC minimum dataset

A review of allergies documented in the GP records identified that frequently those were adverse drug reactions or intolerances; this was seen for 50 (61.0%) patients. adverse drug reactions are classified into Type A and B; Type A adverse drug reactions are due to an exaggerated response to the expected action of the drug, e.g. bradycardia with beta-blockers, whereas Type B adverse drug reactions are usually unpredicted reactions unrelated to the conventional pharmacology of the drug and occur only in susceptible individuals, e.g. Type B adverse drug reactions include anaphylaxis with penicillin.[205] Drug allergy is a type of adverse drug reaction to drugs encompasses a spectrum of immunologically-mediated hypersensitivity reactions with varying mechanisms and clinical presentations. Type B adverse drug reactions closely describe what is conventionally called a drug allergy. [206, 207] Reviewing the nature of allergy reaction described in primary care notes identified 17 (20.7%) patients being allergic to antibiotics, 8 (9.8%) patients

allergic to non-steroidal anti-inflammatory drugs or analgesics and 4 (4.9%) patients allergic to other medication groups such as immunosuppressant. Table 3.3 presents examples of allergies recorded in GP held records with their classification.

Medication/allergen	Nature of allergy as recorded in the GP held record	Classification**
Tamsulosin	Tamsulosin causes paraesthesia, swelling hot leg	Unpredictable ADR (type B)
Amlodipine	Certain moderate intolerance to Amlodipine oedema and lip swelling	Predictable ADR (type A)
Beta-blockers (Atenolol)	Airway obstruction	Predictable ADR (type A)
Dihydrocodeine	Nightmares	Predictable ADR (type A)
Clarithromycin	Nausea, Diarrhoea and abdominal pain	Predictable ADR (type A)
Hazelnut	S, swelling	Food allergy
Egg	local reaction face	Food allergy
Amoxicillin	Overspread body rash	Unpredictable ADR (type B)
Aspirin	Likely moderate allergy to causing intracranial haemorrhage	Predictable ADR (type A)
Metformin	Diarrhoea and abdominal pain	Predictable ADR (type A)
Bendroflumathiazide	likely moderate allergy to bendroflumathiazide causing impotence	Predictable ADR (type A)
Allopurinol	Widespread rash and limbs swelling	Unpredictable ADR (type B)
Simvastatin	Nausea and vomiting	Predictable ADR (type A)
Ciprofloxacin	Fever, rash	Unpredictable ADR (type B)
Trimethoprim/co-trimoxazole	Fatal allergy to Septrin	Unpredictable ADR (type B)

Classification based Edwards IR, Aronson JK. Adverse drug reactions: definitions, diagnosis, and management. The Lancet 2000;356** (9237):1255-59.[205]

Table 3.3 Examples of allergies recorded in primary care records

It can be seen that the majority of patients were mislabelled as having a known allergy; meanwhile this was a drug side effect or intolerance (type A). However, when a definite allergy existed it can be seen that, antibiotics were the most frequent allergens.

3.2.2 Adherence to the NPC minimum dataset relating to medication information

In general, discharge summaries demonstrated lower adherence to medication information compared to patient admission and discharge information. Mean [95% CI] discharge summary adherence to medication information was 64.0% [63.2-64.8]. Figure 3.1 illustrates adherence rates for medication information; particular deviations are manifested with formulation and duration information.

Exceptions to the deficits with formulation information were topical preparation, inhalers, eye drops and oral solutions which were often recorded in discharge summaries.

3.2.3 Adherence to the NPC minimum dataset relating to therapy change information

Discharge summaries reporting of therapy change information demonstrated the lowest adherence rates among the three categories of the NPC minimum dataset. Mean [95% CI] adherence was 48.9% [47.5-50.3] with particular omissions for the rationales of the medicines initiated, discontinued or changed. Figure 3.1 illustrates adherence rates for therapy change information.

3.3 Adherence to the NPC minimum dataset between admission and discharge summary types

Table 3.4 to 3.6 provide comparisons of discharge summaries adherence to the categories of the NPC minimum dataset with respect to admission and discharge summary types: planned admission, unplanned admission, electronic and handwritten. The lowest performance is indicated by bold type face.

No discernible differences were observed between planned and unplanned admissions across all categories of the NPC minimum dataset. However, unplanned admissions were more likely to report the rationales for therapy changes (Table 3.6).

Conversely, handwritten discharge summaries consistently demonstrated lower adherence rates across all categories of the NPC minimum dataset. With respect to handwritten discharge summary legibility, the majority of discharge summaries were electronic and thus legible. However, 374 (42.8%) 95%CI [39.5-46.1] of the handwritten discharge summaries were considered partially illegible and the clinical message regarded unaffected, 33 (8.8%) 95%CI [6.9-10.7] were considered mostly illegible with the meaning of the clinical message unclear and 13 (1.5%) 95%CI [0.69-2.3] were regarded completely illegible.

3.4 Adherence to the NPC minimum dataset between hospitals

Table 3.7 to 3.9 compare adherence rates across the three categories of the NPC minimum dataset between hospitals with the lowest performance indicated by bold type face. Persistent deviations were apparent with community hospitals discharge summaries, notable omissions were with the information related to consultant, ward name, presenting diagnosis and rationales of medicines initiated.

H2 showed particular deviations with medication histories, legibility, route of administration and details of medicines discontinued. Mental health trusts demonstrated notable deviations with allergy status, formulation and rationales of medicines changed. Table 3.10 presents the content of the discharge summary templates used by hospitals representing the majority of the audit sample. No two templates were identical and the extent of template adherence followed a similar pattern to discharge summary adherence rates to the NPC minimum dataset. The template adherence score was generated through recording the percentage of NPC criteria represented by the template fields. The template of H3 exhibited greatest adherence to the NPC minimum dataset whilst the template of H2 and community hospitals demonstrated the lowest adherence.

Expectedly, the variables of hospital and template were highly correlated; $r=0.93$ ($p=<0.001$), Spearman Rho.

	Admission type		Discharge summary type	
Patient, admission & discharge information	**Planned admission n=911 N (%)**	**Unplanned admission n=2,168 N (%)**	**Electronic n=2,570 N (%)**	**Handwritten n=874 N (%)**
Correct patient name	901 (98.9)	2,149 (99.1)	2,551 (99.3)	**858 (98.2)**
Correct date of birth	905 (99.3)	2,146 (99.0)	2,551 (99.3)	**860 (98.4)**
Consultant name	818 (89.8)	2,011 (92.8)	2,452 (95.4)	**697(79.7)**
Ward	822 (90.2)	1,987 (91.7)	2,440 (94.9)	**678 (77.6)**
Admission date	898 (98.6)	2,145 (98.9)	2,544 (99.0)	**855 (97.8)**
Discharge date	864 (94.8)	2,091 (96.4)	2,475 (96.3)	**822 (94.1)**
Allergy status	77 (8.5)	**157 (7.2)**	256 (10.0)	75 (8.6)
Presenting diagnosis	851 (93.4)	2,094 (94.6)	2,436 (94.8)	**804 (92.0)**
Complete past medical history	468 (51.4)	1,155 (53.3)	1,482 (57.7)	**318 (36.4)**
Complete drug history	393 (43.2)	933 (43.1)	1,102 (42.9)	**354 (40.5)**
legible	809 (88.8)	1,902 (87.7)	2,495 (97.1)	**514 (58.8)**
Received within 2 working days	599 (66.9)	**1,404 (65.4)**	1,675 (66.1)	578 (66.6)

Bold type face indicates lowest adherence to the criterion.

Table 3.4 Adherence to patient, admission and discharge information by admission and discharge summary types

	Admission type		Discharge summary type	
Medication information	**Planned admission n=771 N (%)**	**Unplanned admission n=1,908 N (%)**	**Electronic n=2,216 N (%)**	**Handwritten n=782 N (%)**
Dose for all medications	653 (84.7)	1,585 (83.1)	**1,837 (82.9)**	681 (87.1)
Frequency for all medications	**657 (85.2)**	1,634 (85.6)	1,890 (85.3)	693 (88.6)
Route for all medications	507 (65.8)	1,248 (65.4)	1,750 (79.0)	**209 (26.7)**
Formulation for all medications	79 (10.2)	150 (7.9)	262 (11.8)	**59 (7.5)**
Duration for all medications *	**174 (35.2)**	487 (37.6)	572 (35.8)	150 (38.6)

*All discharge summaries (n=1,989), planned (n= 495), unplanned (n= 1,295), electronic (n=1,598) and handwritten (n=391)
Bold type face indicates lowest adherence to the criterion

Table 3.5 Adherence to medication information by admission and discharge summary types

	Admission type		Discharge summary type	
Therapy change information	**Planned admission N (%)**	**Unplanned admission N (%)**	**Electronic N (%)**	**Handwritten N (%)**
	n=518	n=1,300	n=1,593	n=396
Medications initiated	348 (67.2)	910 (70.0)	1,180 (72.9)	**228 (57.6)**
Reasons for initiation	**116 (22.4)**	387 (29.8)	485 (30.0)	89 (22.7)
	n=319	n=786	n=1,045	n=201
Medications changed	238 (74.6)	570 (72.5)	791 (75.7)	**118 (58.7)**
Reasons for changes	**39 (12.2)**	183 (23.3)	214 (20.5)	37 (18.4)
	n=290	n=710	n=949	n=178
Medications discontinued	221 (76.2)	537 (75.6)	753 (79.3)	**96 (53.9)**
Reasons for discontinuation	**41 (14.1)**	170 (23.9)	198 (20.9)	32 (17.9)

Bold type face indicates lowest adherence to the criterion

Table 3.6 Adherence to therapy change information by admission and discharge summary types

NPC patient, admission & discharge information	Hospitals							
	H1	**H2**	**H3**	**H4**	**H5**	**Community**	**Tertiary hospital**	**Mental health trust**
	n=2,368	**n=715**	**n=136**	**n=57**	**n=55**	**n=52**	**n=29**	**n=21**
	N (%)	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**
Correct patient name	2,352 (99.3)	700 (97.9)	134 (98.5)	57 (100)	55 (100)	52 (100)	29 (100)	**19 (90.5**)
Correct date of birth	2,349 (99.2)	705 (98.6)	136 (100)	56 (98.2)	55 (100)	50 (96.2)	29 (100)	**20 (95.2)**
Consultant name	2,264 (95.6)	570 (79.7)	134 (98.5)	51 (89.5)	51 (92.7)	**29 (55.8)**	25 (86.2)	15 (71.4)
Ward	2,270 (95.9)	554 (77.5)	131 (96.3)	51 (89.5)	41 (74.5)	**26 (50.0)**	21 (72.4)	18 (85.7)
Admission date	2,342 (98.9)	700 (97.9)	136 (100)	57 (100)	55 (100)	**49 (94.2)**	29 (100)	21 (100)
Discharge date	2,290 (96.7)	667 (93.3)	135 (99.3)	52 (91.2)	52 (94.5)	48 (92.3)	26 (89.7)	**18 (85.7)**
Allergy status	160 (6.8)	50 (7.0)	70 (51.5)	22 (38.6)	4 (7.3)	13 (25.0)	7 (24.1)	**1 (4.8)**
Presenting diagnosis	2,235 (94.4)	660 (92.3)	20 (95.2)	55 (96.5)	54 (98.2)	**26 (50.0)**	54 (98.2)	20 (95.2)
Complete past medical history	1,373 (58.0)	**230 (32.2)**	85 (62.5)	33 (57.9)	33 (60.0)	18 (34.6)	13 (44.8)	12 (57.1)
Complete drug history	1,022 (43.2)	278 (38.9)	**50 (36.8)**	27 (47.4)	36 (65.5)	20 (39.2)	12 (41.4)	8 (38.1)
legible	2,295 (96.9)	**400 (55.9)**	123 (97.1)	46 (80.7)	46 (83.6)	43 (82.7)	23 (97.3)	17 (81.0)
Received within 2 working days	1,525 (65.3)	459 (65.0)	119 (87.5)	36 (64.3)	44 (80.0)	31 (59.6)	**17 (58.6)**	13 (61.9)

Bold type face indicates lowest adherence to the criterion.

Table 3.7 Adherence to patient, admission and discharge details between hospitals

Medication information	Hospitals							
	H1 **n=2,024** **N (%)**	**H2** **n=643** **N (%)**	**H3** **n=131** **N (%)**	**H4** **n=49** **N (%)**	**H5** **n=53** **N (%)**	**Community** **n=45** **N (%)**	**Tertiary hospital** **n=24** **N (%)**	**Mental health trust** **n=19** **N (%)**
Dose for all medications	1,673 (82.7)	563 (87.6)	123 (93.9)	42 (85.7)	**35 (66.0)**	37 (82.2)	22 (91.7)	18 (94.7)
Frequency for all medications	1,718 (84.9)	580 (90.2)	125 (95.4)	43 (87.8)	**34 (64.2)**	37 (82.2)	23 (95.8)	18 (94.7)
Route for all medications	1,598 (79.0)	**129 (20.1)**	114 (87.0)	33 (67.3)	32 (60.4)	28 (62.2)	13 (54.2)	11 (57.9)
Formulation for all medications	164 (8.1)	47 (7.3)	91 (69.5)	11 (22.4)	2 (3.8)	3 (6.7)	2 (8.3)	**0 (0)**
Duration for all medications *	536 (36.3)	116 (40.4)	19 (21.6)	14 (45.2)	12 (29.3)	15 (51.7)	**2 (12.5)**	4 (33.3)

*H1 (n=1,478), H2 (n= 287), H3 (n=88), H4 (n= 31), H5 (n=41), Mental health trusts (n=12), tertiary care hospital (n=16) and community hospitals (n=29)
Bold type face indicates lowest adherence to the criterion

Table 3.8 Adherence to medication information between hospitals

	Hospitals							
Therapy change information	**H1** **N (%)**	**H2** **N (%)**	**H3** **N (%)**	**H4** **N (%)**	**H5** **N (%)**	**Community** **N (%)**	**Tertiary hospitals** **N (%)**	**Mental health trust** **N (%)**
	n=1,514	n=286	n=78	n=32	n=42	n=28	n=18	n=11
Medications initiated	1,107 (73.1)	168 (58.7)	64 (82.1)	20 (62.5)	**15 (35.7)**	12 (42.9)	13 (72.2)	8 (72.7)
Reasons for initiation	437 (28.9)	66 (23.1)	46 (59.0)	9 (28.1)	8 (19.0)	**2 (7.1)**	5 (27.8)	1 (9.1)
	n=967	n=145	n=75	n=20	n=8	n=15	n=8	n=9
Medications changed	720 (74.5)	77 (53.1)	71 (91.0)	15 (75.0)	7 (87.5)	9 (60.0)	**3 (37.5)**	5 (55.6)
Reasons for changes	198 (20.5)	27 (18.6)	21 (28.0)	3 (15.0)	**0 (0)**	2 (13.3)	**0 (0)**	**0 (0)**
	n=881	n=121	n=64	n=19	n=7	n=16	n=9	n=8
Medications discontinued	689 (78.2)	**57 (47.1)**	62 (96.9)	16 (84.1)	5 (71.4)	8 (50.0)	5 (55.6)	5 (62.5)
Reasons for discontinuation	186 (21.1)	23 (19.0)	13 (20.3)	4 (21.1)	**0 (0)**	2 (12.5)	1 (11.1)	1 (12.5)

Bold type face indicates lowest adherence to the criterion

Table 3.9 Adherence to therapy change information between hospitals

	Electronic template			Handwritten template				
Information	**H1**	**H3**	**H4**	**H2**	**H5**	**Community hospital template**	**Tertiary hospital template**	**Mental trust**
Patient details								
Name	✓	✓	✓	✓	✓	✓	✓	✓
Date of birth	✓	✓	✓	✓	✓	✓	✓	✓
NHS number	✓	✓	✓	✓	✓	✓	✓	✓
Past medical history	✓	✓	✓	✓	✓	✓	×	×
Allergy and hypersensitivities	×	✓	✓	×	×	×	✓	×
Admission date	✓	✓	✓	✓	✓	✓	✓	✓
Discharge date	✓	✓	✓	✓	✓	✓	✓	✓
Presenting diagnosis	✓	✓	✓	✓	✓	✓	✓	✓
Procedures and investigation	✓	✓	✓	✓	✓	×	×	×
Discharge medicine details								
Name	✓	✓	✓	✓	✓	✓	✓	✓
Dose	✓	✓	✓	✓	✓	✓	✓	✓
Frequency	✓	✓	✓	✓	✓	✓	✓	✓
Route	✓	✓	✓	×	✓	✓	✓	×
Formulation	×	✓	×	×	×	×	×	×
Duration	✓	×	×	✓	✓	✓	✓	×
Therapy change								
Medication started	✓	×	×	×	×	×	×	×
Reason for medication started	×	×	×	×	×	×	×	×
Medication stopped	✓	✓	×	×	×	×	×	×
Reason for medication stopped	×	×	×	×	×	×	×	×
Medication changes	×	✓	×	×	×	×	×	×
Reason for medication changed	×	×	×	×	×	×	×	×
Ward details								
Consultant name	✓	✓	✓	✓	✓	✓	✓	✓
Ward name	✓	✓	✓	✓	✓	✓	✓	✓
% Template adherence to NPC minimum dataset	**73.9%**	**78.3%**	**65.2%**	**60.9%**	**65.2%**	**60.9%**	**58.3%%**	**45.8%**

NPC: National prescribing centre. NHS: National Health Services

Table 3.10 Templates of the primary medium of discharge summary

3.5 Adherence to NPC minimum dataset between wards

Table 3.11 to 3.14 compare wards adherence across the three categories of the NPC minimum dataset with the lowest performance indicated by bold type face.

Wards exhibited considerable variations in the extents of adherence to all categories of the NPC minimum dataset. No wards demonstrated better adherence across all categories.

3.6 Adherence to NPC minimum dataset between profession types

Tables 3.14 to 3.16 illustrate adherence to the categories of the NPC minimum dataset between profession types with the lowest performance indicated by bold type face.

It can be seen, that no healthcare professional performed better adherence rates across all categories. However, discharge summaries prepared by foundation doctors demonstrated the lowest performance with deviations predominantly in co-morbidities and medication histories, route of administration and duration.

Noticeably, discharge summaries prepared by consultants frequently lacked details on rationales of therapy changes (Table 3.16)

		Patient, admission and discharge information											
Wards		**Correct patient name**	**Correct DOB**	**Consultant name**	**Ward**	**Admission date**	**Discharge date**	**Allergy status**	**Presenting diagnosis**	**Complete co-morbidities**	**Medication history**	**Legible**	**Within two working days**
Medicine for Elderly	N	558	557	525	528	558	554	53	534	326	276	522	429
	(%)	(98.9)	(98.8)	(93.1)	(93.6)	(98.9)	(98.2)	(9.4)	(94.8)	(57.8)	(98.9)	(92.6)	(76.5)
Urology	N	399	401	389	378	402	390	37	**374**	203	167	361	278
	(%)	(99.0)	(99.5)	(96.5)	(93.8)	(99.8)	(96.8)	(9.2)	**(92.8)**	(50.4)	(41.4)	(89.6)	(69.8)
General surgery	N	319	318	289	300	318	311	27	298	172	144	286	230
	(%)	(99.4)	(99.4)	(90.0)	(93.5)	(99.1)	(96.9)	(8.4)	(92.8)	(53.6)	(44.9)	(89.1)	(72.3)
Thoracic	N	243	240	233	233	241	235	19	232	135	99	223	155
	(%)	(100)	(98.8)	(95.9)	(95.9)	(99.2)	(96.7)	(7.8)	(95.5)	(55.6)	(40.7)	(91.8)	(62.8)
Cardiology	N	235	234	217	219	235	224	23	224	144	98	219	**117**
	(%)	(100)	(99.6)	(92.3)	(93.2)	(100)	(95.3)	(9.8)	(95.3)	(61.3)	(41.7)	(93.2)	**(50.6)**
Orthopaedic	N	219	222	201	201	219	199	25	208	98	87	187	114
	(%)	(98.2)	(99.6)	(90.1)	(90.1)	(98.2)	(89.2)	(11.2)	(93.3)	(43.9)	(39.0)	(83.9)	(54.0)
Paediatrics	N	201	**199**	**179**	185	201	194	**9**	190	120	95	165	130
	(%)	(99.0)	**(98.0)**	**(88.2)**	(91.1)	(99.0)	(95.6)	**(4.4)**	(93.6)	(59.1)	(46.8)	(81.8)	(64.0)
General medicine	N	183	188	174	162	188	**177**	25	180	**79**	73	**148**	138
	(%)	(96.8)	(99.5)	(92.1)	(85.7)	(99.5)	**(93.7)**	(13.2)	(95.2)	**(41.8)**	(38.6)	**(78.3)**	(73.8)
Gynaecology	N	148	147	135	142	**140**	146	22	143	77	**53**	137	110
	(%)	(99.3)	(98.7)	(90.6)	(95.3)	**(94.0)**	(98.0)	(14.8)	(96.0)	(51.7)	**(35.8)**	(83.5)	(73.8)
Oncology	N	141	139	131	134	137	137	14	135	73	51	131	71
	(%)	(100)	(98.6)	(92.9)	(95.0)	(97.2)	(97.2)	(9.9)	(95.7)	(51.8)	(36.2)	(92.9)	(51.1)
Gastroenterology	N	131	132	126	**118**	129	124	10	121	60	56	113	82
	(%)	(99.2)	(100)	(95.5)	**(89.4)**	(97.7)	(93.9)	(7.6)	(91.7)	(45.5)	(42.4)	(85.6)	(62.1)

DOB: date of Birth

Table 3.11 Adherence to patient, admission and discharge information between wards

		Patient, admission and discharge information											
Wards		**Correct patient name**	**Correct DOB**	**Consultant name**	**Ward**	**Admission date**	**Discharge date**	**Allergy status**	**Presenting diagnosis**	**Complete co-morbidities**	**Medication history**	**legible**	**Within two working days**
Ear, nose& throat	**N (%)**	**66 (95.7)**	69 (100)	65 (94.3)	67 (97.1)	69 (100)	68 (98.6)	8 (11.6)	68 (98.6)	35 (50.7)	31 (44.9)	67 (97.1)	56 (81.2)
Neurology	**N (%)**	55 (96.5)	56 (98.2)	53 (93.0)	54 (94.7)	57 (100)	55 (96.5)	4 (7.0)	54 (94.7)	38 (66.7)	30 (52.6)	55 (96.5)	31 (54.4)
Nephrology	**N (%)**	52 (98.1)	53 (100)	48 (90.6)	50 (94.3)	51 (96.2)	53 (100)	1 (1.9)	50 (94.3)	32 (60.4)	19 (35.8)	48 (90.6)	39 (73.6)
Endocrinology	**N (%)**	50 (100)	**49 (98.0)**	49 (98.0)	50 (100)	50 (100)	50 (100)	4 (8.0)	49 (98.0)	29 (58.0)	25 (52.1)	49 (98.0)	31 (62.0)
Others*	**N (%)**	163 (99.4)	161 (98.2)	**142 (86.6)**	147 (89.6)	164 (100)	158 (96.3)	20 (12.2)	157 (95.7)	88 (53.7)	**57 (35.0)**	137 (83.5)	96 (59.3)
Unspecified	**N (%)**	246 (99.2)	246 (99.2)	193 (77.8)	150 (60.5)	240 (96.8)	**222 (89.5)**	30 (12.1)	**223 (89.9)**	**91 (36.7)**	95 (38.3)	**160 (64.5)**	152 (62.8)

*E.g. Dermatology, Rheumatology, Ophthalmology, Maternity care and Neonatal, rehabilitation. DOB: date of Birth

Continued

Table 3.11 Adherence to NPC minimum dataset related patient, admission & discharge information between wards

		Medication information				
Wards	**n**	**Dose for all medications N (%)**	**Frequency for all medications N (%)**	**Route for all medications N (%)**	**Formulation for all medications N (%)**	**Duration for all medications † N (%)**
Medicine for Elderly	524	448 (85.5)	451 (86.1)	383 (73.1)	48 (9.2)	114 (33.0)
Urology	343	305 (88.9)	314 (91.6)	261 (76.1)	46 (13.4)	79 (36.4)
General surgery	286	220 (76.9)	231 (80.8)	**149 (52.1)**	16 (5.6)	70 (33.5)
Thoracic	213	165 (77.5)	171 (80.3)	144 (67.6)	15 (7.0)	68 (44.2)
Cardiology	195	174 (89.2)	174 (89.2)	138 (70.8)	18 (9.2)	46 (31.7)
Orthopaedic	191	164(85.9)	165 (86.4)	111 (58.1)	17 (8.9)	43 (35.2)
Paediatrics	157	139 (88.5)	137 (87.3)	87 (55.4)	28 (17.8)	45 (40.5)
General medicine	168	145 (86.3)	146 (86.9)	**86 (51.2)**	48 (28.6)	34(37.4)
Gynaecology	131	111 (84.7)	111 (84.7)	82 (62.6)	17 (13.0)	30 (38.5)
Oncology	120	97 (80.1)	102 (85.0)	90 (75.0)	19 (15.8)	**25 (29.8)**
Gastroenterology	120	97 (80.1)	102 (85.0)	69 (57.5)	4 (3.3)	27 (34.2)
Ear, nose& throat	56	47 (83.9)	50 (89.3)	49 (87.5)	10 (17.9)	15 (42.9)
Neurology	47	38 (80.9)	41 (87.2)	39 (83.0)	12 (4.3)	12 (33.3)
Nephrology	**45**	**29 (64.4)**	**30 (66.7)**	31 (68.9)	**1 (2.2)**	13 (37.1)
Endocrinology	44	52 (72.7)	34 (77.3)	33 (75.0)	4 (9.1)	13 (41.9)
Others*	135	106 (78.5)	113 (83.7)	72 (53.3)	15 (11.1)	33 (43.4)
Unspecified	223	201 (90.1)	211 (94.6)	91 (40.8)	13 (5.8)	55 (41.7)

*E.g. Dermatology, Rheumatology, Ophthalmology, Maternity care and Neonatal, rehabilitation

†Medicine for Elderly (n=354), urology (n=217), general surgery (n=209), thoracic (n=154), cardiology (n=154), orthopaedic (n=122), paediatric (n=111), general medicine (n=91), gynaecology (n=78), oncology (n=84), gastroenterology (n=79), Ear, nose& throat (n=35), neurology (n=36), nephrology (n=35), endocrinology (n=32), others (n=76), speciality not indicated (n=132)

Table 3.12 Adherence to medication information between wards

	Therapy change information					
Wards	**Medications initiated N (%)**	**Reasons for initiation N (%)**	**Medications changed N (%)**	**Reasons for changes N (%)**	**Medications discontinued N (%)**	**Reasons for discontinue N (%)**
Medicine for Elderly	n=346 244 (70.5)	116 (33.5)	n=229 169 (73.8)	64 (28.0)	n=214 170 (79.4)	54 (25.2)
Urology	n=229 182 (79.5)	72 (31.4)	n=160 127 (79.4)	32 (20.0)	n=153 118 (77.1)	23 (15.0)
General surgery	n=213 124 (58.2)	54 (25.4)	n=109 75 (68.8)	20 (18.3)	n=93 70 (75.3)	17 (18.3)
Thoracic	n=161 126 (78.3)	50 (31.1)	n=94 65 (69.1)	15 (16.0)	n=79 59 (74.7)	13 (16.5)
Cardiology	n=148 116 (78.4)	33 (22.3)	n=112 91 (81.3)	13 (11.6)	n=100 83 (83.0)	14 (14.0)
Orthopaedic	n=117 **35 (29.9)**	**16 (13.6)**	n=67 43 (64.2)	11 (16.5)	n=57 40 (70.2)	10 (17.5)
Paediatrics	n=116 80 (69.0)	26 (22.4)	n=60 43 (71.7)	9 (15.0)	n=56 38 (67.6)	9 (16.1)
General medicine	n=85 62 (72.9)	35 (41.2)	n=63 51 (80.9)	18 (28.6)	n=53 46 (86.8)	22 (41.5)
Gynaecology	n=85 61 (71.8)	25 (29.4)	n=45 31 (68.9)	10 (22.2)	n=38 22 (57.9)	6 (15.8)
Oncology	n=91 72 (79.1)	36 (39.6)	n=59 49 (83.1)	18 (30.5)	n=52 45 (86.5)	16 (30.8)
Gastroenterology	n=77 52 (67.5)	23 (29.9)	n=35 21 (60.0)	**3 (8.6)**	n=40 29 (72.5)	10 (25.0)
Ear, nose& throat	n=37 27 (73.0)	12 (32.4)	n=22 18 (81.8)	5 (22.7)	n=18 13 (72.2)	2 (11.1)
Neurology	n=36 23 (63.9)	**4 (11.1)**	n=25 23 (92.0)	5 (20.0)	n=21 19 (90.5)	**2 (9.5)**

Table 3.13 Adherence to therapy change information between wards

Wards	Therapy change information					
	Medications initiated N (%)	**Reasons for initiation** N (%)	**Medications changed** N (%)	**Reasons for changes** N (%)	**Medications discontinued** N (%)	**Reasons for discontinue** N (%)
Nephrology	n=32 23 (71.9)	9 (28.1)	n=22 16 (72.7)	2 (9.1)	n=19 16 (84.2)	4 (21.1)
Endocrinology	n=32 21 (65.6)	7 (21.9)	n=19 8 (42.1)	2 (10.5)	n=20 11 (55.0)	7 (35.0)
Others*	n=82 45 (54.9)	18 (21.9)	n=42 26 (61.9)	7 (17.1)	n=41 25 (61.0)	6 (14.6)
Unspecified	n=128 93 (72.7)	34 (26.6)	n=83 53 (63.9)	17 (20.5)	n=73 45 (61.6)	15 (20.5)

*E.g. Dermatology, Rheumatology, Ophthalmology, Maternity care and Neonatal, rehabilitation

Continued

Table 3.13 Adherence to therapy change information between wards

		Profession type								
NPC patient, admission & discharge information		**Not indicated n=758**	**Doctor [a] n=1113**	**Foundation years n=853**	**Core medical training [b] n=266**	**Specialty training [c] n=120**	**Registrars n=21**	**Consultant n=131**	**Pharmacist n=36**	**Specialist nurse practitioner n=146**
Correct patient name	N (%)	751 (99.2)	1105 (99.3)	**839 (98.4)**	262 (98.5)	120 (100)	21 (100)	129 (98.5)	36 (100)	145 (99.3)
Correct date of birth	N (%)	750 (98.9)	1103 (99.1)	846 (99.2)	**262 (98.5)**	118 (99.2)	21 (100)	130 (99.2)	36 (100)	145 (99.3)
Consultant name	N (%)	690 (91.0)	1048 (94.2)	746 (87.5)	247 (92.9)	103 (85.8)	**12 (57.1)**	124 (94.7)	36 (100)	143 (97.9)
Ward	N (%)	690 (91.0)	1047 (94.1)	733 (85.9)	236 (88.7)	102 (85.0)	**16 (76.2)**	119 (90.8)	36 (100)	139 (95.2)
Admission date	N (%)	753 (99.3)	1103 (99.1)	834 (97.8)	263 (98.9)	120 (100)	**20 (95.2)**	131 (100)	36 (100)	139 (95.2)
Discharge date	N (%)	731 (96.4)	1072 (96.3)	**801 (93.9)**	258 (97.0)	113 (94.2)	20 (95.2)	125 (95.4)	35 (97.2)	142 (97.3)
Allergy status	N (%)	112 (14.8)	102 (9.2)	57 (6.7)	21 (7.9)	12 (10.0)	**1 (4.8)**	12 (9.2)	-	14 (9.6)
Presenting diagnosis	N (%)	705 (93.1)	1061 (95.3)	798 (93.6)	250 (94.0)	112 (93.3)	21 (100)	123 (93.9)	35 (97.2)	**135 (92.5)**
Complete co-morbidities	N (%)	423 (55.8)	650 (58.4)	**351 (41.1)**	121 (45.0)	61 (50.8)	(42.9)	74 (56.5)	21 (58.3)	90 (61.6)
Complete medication history	N (%)	332 (43.8)	445 (40.1)	**299 (35.1)**	126 (47.5)	44 (36.7)	3 (61.9)	49 (37.4)	18 (50.0)	64 (43.8)
legible	N (%)	674 (88.9)	1074 (96.5)	**632 (74.1)**	214 (80.5)	102 (85.0)	9 (90.5)	116 (88.5)	36 (100)	142 (97.3)
Received within 2 working days	N (%)	511 (69.5)	701 (63.6)	564 (66.4)	171 (64.3)	82 (68.9)	13 (65.0)	93 (71.5)	**15 (41.7)**	109 (74.7)

[a] Unspecified training level, [b]: Core medical training 1&2, speciality doctor 1&2, [c:] speciality doctor 3 & Fellow. # Bold type face indicates lowest adherence to the criterion

Table 3.14 Adherence to patient, admission & discharge details between profession types

Medication information	Measure	Profession type Not indicated n= 635	Doctor [a] n= 971	Foundation years n= 766	Core medical training [b] n= 236	Specialty training [c] n= 105	Registrars n= 16	Consultant n= 114	Pharmacist n= 33	Specialist nurse practitioners n= 122
Dose for all medications	N	551	812	651	188	82	14	**90**	30	100
	(%)	(86.8)	(83.6)	(85.0)	(79.7)	(78.1)	(87.5)	**(78.9)**	(90.9)	(82.0)
Frequency for all medications	N	561	833	667	197	**83**	13	94	30	105
	(%)	(88.3)	(79.0)	(87.1)	(83.4)	**(79.0)**	(81.3)	(82.5)	(90.0)	(86.1)
Route for all medications	N	450	761	**347**	130	59	10	75	30	98
	(%)	(70.9)	(78.4)	**(45.3)**	(55.1)	(56.2)	(62.5)	(65.8)	(90.9)	(80.3)
Formulation for all medications	N	132	93	48	16	**5**	-	8	3	16
	(%)	(20.8)	(9.6)	(6.3)	(6.8)	**(4.8)**		(7.0)	(9.1)	(13.1)
Duration for all medications *	N	142	246	110	62	31	5	31	9	51
	(%)	(32.4)	(35.0)	(25.9)	(38.5)	(41.9)	(50.0)	(41.9)	(39.1)	(39.3)

[a] Unspecified training level, [b]: Core medical training 1&2, speciality doctor 1&2, [c:] speciality doctor 3 & Fellow. # Bold type face indicates lowest adherence to the criterion
*Not indicated (n=438), doctor (n= 703), foundation year (n=424), core medical training (n= 161), specialty training (n=74), consultant (n=72), Specialist nurse practitioners (n=84), pharmacist (n=23) and registrar (n=10)

Table 3.15 Adherence to medication information between profession types

	Profession type								
Therapy change information	**Not indicated**	**Doctor [a]**	**Foundation years**	**Core medical training [b]**	**Specialty training [c]**	**Registrars**	**Consultant**	**Pharmacist**	**Specialist nurse practitioners**
	n=439	n=711	n=424	n=160	n=77	n=11	n=78	n=25	n=90
Medications initiated	308 (70.2)	517 (72.7)	281 (66.3)	114 (71.3)	**40 (51.9)**	8 (72.7)	56 (71.8)	18 (72.0)	66 (73.3)
Reasons for initiation	142 (32.3)	190 (26.7)	115 (27.1)	49 (30.6)	22 (28.6)	3 (27.3)	**13 (16.0)**	6 (23.1)	31 (34.4)
	n=340	n=466	n=203	n=77	n=35	n=7	n=55	n=10	n=53
Medications changed	280 (82.4)	319 (68.5)	133 (65.5)	57 (74.0)	23 (65.7)	**5 (71.4)**	40 (72.7)	10 (100)	42 (79.2)
Reasons for changes	64 (18.8)	88 (18.9)	48 (23.6)	22 (28.6)	7 (20.0)	1 (14.3)	**10 (18.2)**	1 (10.0)	10 (18.7)
	n=304	n=417	n=187	n=64	n=28	n=6	n=51	n=12	n=58
Medications discontinued	248 (81.6)	308 (731.9)	**122 (65.2)**	52 (81.3)	19 (67.9)	6 (100)	38 (74.5)	12 (100)	44 (75.9)
Reasons for discontinuation	49 (16.1)	82 (19.7)	46 (24.6)	23 (35.9)	5 (17.6)	2 (33.3)	**6 (10.7)**	5 (41.7)	11 (19.0)

[a] Unspecified training level [b]: Core medical training 1&2, speciality doctor 1&2, [c:] speciality doctor 3 & Fellow # Bold type face indicates lowest adherence to the criterion

Table 3.16 Adherence to therapy change information between profession types

3.7 Investigating contributing factors to discharge summary adherence to the total NPC minimum dataset

Tables 3.17-3.20 illustrate the adjusted models exploring the contributing factors to discharge summary adherence to the total and three categories of the NPC minimum dataset. Factors influencing discharge summary adherence to the total NPC minimum dataset is presented in Table 3.17. Contributors to good adherence included discharge summaries from H3, written by registrars or specialist nurse practitioners and unplanned admissions. It can be presumed from Table 3.17 that a discharge summary from H3 improves adherence to the total NPC minimum dataset by 7.61%. Additionally, a discharge summary prepared by a registrar or specialist nurse practitioner improves adherence to the total NPC minimum dataset by 7.6% and 2.51% respectively.

Contributors to lower adherence were discharge summaries from community, mental health trusts and H2 hospitals plus nephrology and orthopaedic wards. It can be seen that, discharge summaries from community, mental health trusts and H2 hospitals trended to demonstrate lower adherence rates by 10.5%, 6.19% and 5.49% respectively. Similarly, discharge summaries from nephrology and orthopaedic wards exhibited lower rated by 4% and 2% respectively.

Additionally, handwritten discharge summaries were more likely to exhibit lower rates approximately by 3% and with increased number of medicines the likelihood of good adherence potentially decreases.

3.7.1 Contributing factors to patient, admission and discharge information

Factors influencing discharge summary adherence to patient, admission and discharge information are presented in Table 3.18. The strongest contributing factor to better adherence was H3 accounting for an increase in adherence rate of 6.8%. Endocrinology and medicine for elderly wards as well as discharge summaries written by specialist nurse practitioners were also contributors to good adherence accounting for an increase in adherence rate by 5.2%, 3.1% and 2.2% respectively.

Conversely, community hospitals, mental health trusts and H2 as well as handwritten discharge summaries were contributors to poor adherence. Those trended to reduce adherence rate by 8.3%, 4.8%, 5.5% and 3.1% respectively. Increased number of medicines was associated with lower adherence rates too.

3.7.2 Contributing factors to medication infromation

It can be seen in Table 3.19 that, H3 and H4 are the strongest contributors to good adherence, contributing to better adherence by 11.4% and 7.6% respectively. This is followed by discharge summaries prepared by speciality training doctors accounting to an increase of 4.9%. Meanwhile, H5, community hospitals as well as H2 were contributors to poor adherence. Those attributed to lower adherence rates by 11.6%, 7.3% and 5.5% respectively.

Despite being a contributor to good adherence for patient, admission and discharge information, endocrinology wards were identified as a contributor to poor adherence with respect to medication information by 13.5%. In addition, general surgery wards, handwritten plus discharge summaries of older patients were contributing to poor adherence. Discharge summaries which were from general surgery wards exhibited lower adherence rate by 6.5%, whereas handwritten contributed to lower adherence rate by 8%.

3.7.3 Contributing to factors therapy changes infromation

There were no clear factors contributing to better adherence to therapy change information. There were, however, some very strong contributors to poor adherence with orthopaedic wards being the strongest contributor accounting to 21.7% reduction in adherence rate.

	Univariate analysis			Multivariate analysis		
Variable	**B**	**95%CI**	**p**	**B**	**95%CI**	**p**
Patient demographics						
Age	**-0.02**	**[-0.03-0.0]**	**<0.001**	-0.02	[-0.04- 0.02]	0.17
No. of medications	**-0.21**	**[-0.30-0.12]**	**<0.001**	**-0.25**	**[-0.34- -.15]**	**<0.001**
Hospital stay	-0.04	[-0.07-0.0]	0.03	-0.02	[-0.05-0.02]	0.33
Type of discharge summary						
Handwritten discharge summaries	**-7.71**	**[-8.58- -6.84]**	**<0.001**	**-2.96**	**[-4.28- -1.64]**	**<0.001**
Type of admission [a]						
Admitted via unplanned admission	0.05	[-7.64-0.87]	0.89	**1.03**	**[0.11-1.94]**	**0.03**
Unspecified type of admission	1.0	[-0.28-2.27]	0.13	**2.37**	**[0.79-3.92]**	**0.003**
Hospitals [b]						
Discharges from H2	**-8.48**	**[-9.40- -7.55]**	**<0.001**	**-5.49**	**[-6.99- -4.0]**	**<0.001**
Discharges from H3	**10.06**	**[8.06-12.06]**	**<0.001**	**7.61**	**[5.09-10.14]**	**<0.001**
Discharges from H4	2.02	[-1.07-5.12]	0.20	1.29	[-1.80-4.38]	0.41
Discharges from H5	-0.05	[-3.20-3.10]	0.97	0.02	[-3.04-3.08]	0.99
Discharges from tertiary hospital	-3.46	[-7.78-0.85]	0.12	-2.82	[-6.96-1.33]	0.18
Discharges from mental health trusts	**-6.09**	**[-11.15- -1.02]**	**0.02**	**-6.19**	**[-11.13-1.26]**	**0.01**
Discharges from community hospitals	**-9.39**	**[-12.61- -6.17]**	**<0.001**	**-10.50**	**[-14.12- -6.89]**	**<0.001**
Ward specialities [c]						
Discharges from Medicine for elderly wards	**2.08**	**[1.01-3.14]**	**<0.001**	1.46	[-0.59-3.51]	0.16
Discharged from Orthopaedic wards	**-3.31**	**[-4.91- -1.71]**	**<0.001**	**-2.11**	**[-4.48-0.26]**	**0.008**
Discharged from General surgery wards	-0.66	[-2.02-0.69]	0.34	-1.04	[-3.16-1.07]	0.33
Discharged from Urology wards	**1.76**	**[0.54-2.99]**	**0.01**	0.38	[-1.7-2.47]	0.72
Discharged from Gastroenterology wards	**-2.19**	**[-4.25-0.14]**	**0.04**	-2.45	[-5.03-0.12]	0.06
Discharged from Cardiology wards	1.31	[-0.26-2.88]	0.10	0.01	[-2.27-2.28]	0.99
Discharged from Thoracic wards	**1.70**	**[0.15-3.24]**	**0.03**	0.82	[-1.44-3.08]	0.48
Discharged from Paediatric wards	-0.36	[-2.04-1.32]	0.67	-1.32	[-3.89-1.25]	0.32
Discharged from Oncology wards	**2.24**	**[0.25-4.24]**	**0.04**	0.71	[-1.86-3.28]	0.59
Discharged from Nephrology wards	-1.76	[-4.96-1.45]	0.28	**-4.10**	**[-7.62-0.59]**	**0.02**
Discharged from Ear, nose& throat wards	**3.95**	**[1.13-6.76]**	**0.01**	1.44	[-1.75-4.63]	0.38
Discharged from Endocrinology wards	2.67	[-0.64-5.96]	0.11	1.78	[-1.74-5.31]	0.32
Discharged from Gynaecology wards	0.52	[-1.42-2.46]	0.60	-0.36	[-2.89-2.18]	0.78
Discharged from Neurology wards	1.75	[-1.34-4.84]	0.27	-0.63	[-4.04-2.78]	0.72
Discharged from other ward Specialties	-0.39	[-2.24-1.47]	0.68	0.57	[-1.88-3.02]	0.65
Unspecified speciality	**-7.90**	**[-9.41- -6.40]**	**<0.001**	**-4.22**	**[-6.52- -1.92]**	**<0.001**

B: The estimate of change in the outcome with one unit change of the predictor

Table 3.17 Factors contributing to discharge summary adherence to the total NPC minimum dataset

	Univariate analysis			Multivariate analysis		
Variable	**B**	**95%CI**	**P**	**B**	**95%CI**	**p**
Role of person responsible for discharge [d]						
Core medical training doctors	**-0.90**	**[-2.38-0.58]**	**0.23**	0.37	[-1.20-1.93]	0.64
Speciality training doctors	**-2.93**	**[-5.08- -0.78]**	**0.008**	-1.88	[-4.06-0.20]	0.09
Registrars	-0.36	[-0.36-4.70]	0.89	**7.60**	**[2.06-13.15]**	**0.01**
Consultants	0.20	[-1.86-2.27]	0.84	-0.05	[-2.14-2.04]	0.96
Doctors of unknown training level	**1.64**	**[0.80-2.48]**	**<0.001**	-0.42	[-1.56-0.72]	0.47
Pharmacists	2.88	[-1.0-6.76]	<0.15	1.53	[-2.24-5.29]	0.43
Specialist nurse practitioners	**2.9**	[0.96-4.87]	**0.01**	**2.51**	**[041-4.62]**	**0.02**
Unspecified profession	**2.33**	**[1.38-3.28]**	**<0.001**	0.26	[-1.02-1.55]	0.69

Constant B= 78.4, Std error=1.5, P <0.001. R square =0.16, adjusted R square= 0.15, Std error of the estimate=10.76. [a] Compared against planned admission, [b] Compared to H1, [c] Compared to general medicine wards, [d] Compared to foundation year doctors. B: The estimate of change in the outcome with one unit change of the predictor

Bold type face indicates statistically significant model predictors (i.e. p<0.05)

Continued

Table 3.17 Factors contributing to discharge summary adherence to the total NPC minimum dataset

Of note, the unadjusted model in Table 3.17 identified age, some type of ward specialities and professions as contributors to the quality of discharge information. However, those were not significant contributors when the model was adjusted. This most likely due to the confounding effect exerted by number of medicines and type of discharge summary.

	Univariate analysis			Multivariate analysis		
Variable	**B**	**95%CI**	**P**	**B**	**95%CI**	**p**
Patient demographics						
Age	-0.01	[-0.02-0.01]	0.59	-0.01	[-0.03-0.01]	0.47
No. of medications	**0.15**	**[0.06-0.24]**	**0.01**	**0.11**	**[0.02-0.20]**	**0.01**
Hospital stay	-0.02	[-0.06-0.01]	0.14	-0.01	[-0.04-0.02]	0.41
Type of discharge summary						
Handwritten discharge summaries	**-8.46**	**[-9.29- -7.64]**	**<0.001**	**-3.1**	**[-4.34- -1.85]**	**<0.001**
Type of admission [a]						
Admitted via unplanned admission	0.51	[-0.28-1.29]	0.21	0.55	[-0.31-1.41]	0.21
Unspecified type of admission	-1.02	[-2.26-0.21]	0.11	0.30	[-1.18-1.77]	0.70
Hospitals [b]						
Discharges from H2	**-9.49**	**[10.37- -8.6]**	**<0.001**	**-5.52**	**[-6.93- -4.11]**	**<0.001**
Discharges from H3	**8.42**	**[6.49-10.35]**	**0.001**	**6.77**	**[-4.39-9.15]**	**<0.001**
Discharges from H4	2.39	[-0.59-5.36]	0.12	1.60	[-1.32-4.51]	0.30
Discharges from H5	2.09	[-0.93-5.13]	0.17	2.27	[-0.62-5.16]	0.12
Discharges from mental health trusts	**-5.54**	**[-10.41- -0.67]**	**0.03**	-4.74	[-9.4- -0.08]	0.05
Discharges from tertiary hospitals	-3.51	[-7.66-0.64]	0.10	-3.10	[-7.01-0.82]	0.12
Discharges from community hospitals	**-8.87**	**[-11.97- -5.78]**	**<0.001**	**-8.29**	**[-11.69- -4.88]**	**<0.001**
Ward specialities [c]						
Discharges from Medicine for elderly wards	**0.78**	**[1.78-3.80]**	**<0.001**	**3.13**	**[1.19-5.06]**	**0.002**
Discharged from Orthopaedic wards	**-2.49**	**[-4.03- -0.95]**	**0.002**	0.22	[-2.02-2.45]	0.85
Discharged from General surgery wards	0.84	[-0.47-2.14]	0.21	1.89	[-.11-3.89]	0.07
Discharged from Urology wards	0.87	[-0.31-2.06]	0.15	1.33	[-0.64-3.29]	0.19
Discharged from Gastroenterology wards	-1.70	[-3.68-0.28]	0.09	-0.36	[-2.79-2.07]	0.77
Discharged from Cardiology wards	**1.69**	**[0.18-3.19]**	**0.03**	2.06	[-0.083-4.21]	0.06
Discharged from Thoracic wards	**1.52**	**[0.03-2.99]**	**0.05**	1.88	[-0.25-4.02]	0.08
Discharged from Paediatric wards	-0.78	[-2.39-0.84]	0.35	1.10	[-1.32-3.53]	0.37
Discharged from Oncology wards	0.47	[-1.45-2.38]	0.63	0.47	[-1.95-2.89]	0.71
Discharged from Nephrology wards	-0.45	[-3.5-2.6]	0.78	-1.34	[-4.66-1.97]	0.43
Discharged from Ear, nose& throat wards	2.43	[-0.28-5.14	0.08	1.94	[-1.07-4.95]	0.21
Discharged from Endocrinology wards	**4.74**	**[1.57-7.91]**	**0.003**	**5.17**	**[1.84-8.50]**	**0.002**
Discharged from Gynaecology wards	1.60	[-0.27-3.46]	0.09	2.19	[-0.21-4.58]	0.07
Discharged from Neurology wards	2.09	[-0.88-5.06]	0.17	1.23	[-1.99-4.44]	0.46
Discharged from other ward Specialties	-0.42	[-2.2-1.36]	0.65	**2.51**	**[0.20-4.82]**	**0.03**
Unspecified speciality	**-9.17**	**[-10.6- -7.74]**	**<0.001**	**-3.79**	**[-5.95- -1.62]**	**0.001**

B: The estimate of change in the outcome with one unit change of the predictor

Table 3.18 Factors contributing to discharge summary adherence to patient, admission and discharge information

	Univariate analysis			Multivariate analysis		
Variable	**B**	**95%CI**	**P**	**B**	**95%CI**	**p**
Role of person responsible for discharge [d]						
Core medical training doctors	-0.93	[-2.35-0.49]	0.20	0.56	[0.92-2.03]	0.46
Speciality training doctors	**-2.13**	**[-4.20- -0.06]**	**0.04**	-0.94	[-2.99-1.11]	0.37
Registrars	-3.14	[-8.02-1.73	0.21	4.26	[-0.98-9.49]	0.11
Consultants	-0.04	[-2.03-1.94]	0.96	0.03	[-1.95-1.99]	0.98
Doctors of unknown training level	**2.45**	**[1.64-3.26]**	**<0.001**	0.39	[0.69-1.46]	0.48
Pharmacists	2.79	[-0.94-6.52]	0.14	1.08	[-2.47-4.63]	0.55
Specialist Nurse Practitioners	**2.57**	**[0.69-4.45]**	**0.05**	**2.24**	**[0.25-4.22]**	**0.03**
Unspecified profession	**2.28**	**[1.36-3.19]**	**<0.001**	0.40	[-0.82-1.61]	0.52

Constant B= 80.19, Std error=1.4, P <0.001. R square =0.179, adjusted R square= 0.169, Std error of the estimate=10.16. [a] Compared against planned admission, [b] Compared to H1, [c] Compared to general medicine wards, [d] Compared to foundation year doctors. # Bold type face indicates statistically significant model predictors (i.e. p<0.05). B: the estimate of change in the outcome with one unit change of the predictor

Continued

Table 3.18 Factors contributing to discharge summary adherence to Patient, admission and discharge information

Similarly in Table 3.18, the unadjusted analysis identified some type of ward specialities and professions as contributors to the quality of discharge information; however this effect was not significant when the model was adjusted to number of medicines and type of discharge summary and admission.

	Univariate analysis			Multivariate analysis		
Variable	**B**	**95%CI**	**P**	**B**	**95%CI**	**p**
Patient demographics						
Age	**0.05**	**[-0.11-0.94]**	**0.01**	**-0.07**	**[-0.12-0.24]**	**0.003**
No. of medications	**2.56**	**[2.34-2.70]**	**<0.001**	-0.05	[-0.26-0.17]	0.66
Hospital stay	0.06	[-0.03-0.14]	0.21	0.04	[-0.03-0.10]	0.32
Type of discharge summary						
Handwritten discharge summaries	**-9.13**	**[-11.44- -6.81]**	**<0.001**	**-8.03**	**[-10.87- -5.19]**	**<0.001**
Type of admission [a]						
Admitted via unplanned admission	**51.99**	**[51.23-52.75]**	**<0.001**	-0.36	[-2.34-1.63]	0.72
Unspecified type of admission	**53.26**	**[51.0-55.51]**	**<0.001**	**6.79**	**[3.34-10.25]**	**<0.001**
Hospitals [b]						
Discharges from H2	**42.03**	**[40.42-43.64]**	**<0.001**	**-5.45**	**[-8.67- -2.23]**	**0.001**
Discharges from H3	**72.27**	**[68.54-75.99]**	**<0.001**	**11.40**	**[6.06-16.73]**	**<0.001**
Discharges from H4	**51.45**	**[45.56-57.33]**	**<0.001**	**7.58**	**[0.88-14.28]**	**0.03**
Discharges from H5	**38.45**	**[32.45-44.46]**	**<0.001**	**-11.59**	**[-17.95- -5.23]**	**<0.001**
Discharges from mental health trusts	**50.89**	**[41.16-60.61]**	**<0.001**	2.46	[-7.93-12.85]	0.64
Discharges from tertiary hospitals	**44.66**	**[36.39-52.94]**	**<0.001**	-0.62	[-9.78-8.52]	0.89
Discharges from community hospitals	**42.64**	**[36.47-48.82]**	**<0.001**	**-7.30**	**[-9.78-8.52]**	**<0.07**
Ward specialities [c]						
Discharges from Medicine for elderly wards	**53.35**	**[-51.57-55.13]**	**<0.001**	-0.67	[-5.09-3.75]	0.77
Discharged from Orthopaedic wards	**46.78**	**[43.84-49.73]**	**<0.001**	-1.92	[-7.03-3.18]	0.46
Discharged from General surgery wards	**44.94**	**[42.51-47.39]**	**<0.001**	**-6.52**	**[-11.10- -1.94]**	**0.005**
Discharged from Urology wards	**50.27**	**[48.12-52.42]**	**<0.001**	0.90	[-3.62-5.43]	0.70
Discharged from Gastroenterology wards	**46.87**	**[43.02-50.72]**	**<0.001**	-5.44	[-10.96-0.75]	0.05
Discharged from Cardiology wards	**46.48**	**[43.61-49.35]**	**<0.001**	0.71	[-5.67-4.25]	0.78
Discharged from Thoracic wards	**51.34**	**[48.52-54.14]**	**<0.001**	1.15	[-3.75-6.05]	0.65
Discharged from Paediatric wards	**42.20**	**[39.19-45.39]**	**<0.001**	2.81	[-8.53-2.90]	0.34
Discharged from Oncology wards	**50.28**	**[46.56-53.99]**	**<0.001**	-0.52	[-6.15-5.11]	0.86
Discharged from Nephrology wards	**44.98**	**[38.86-51.09]**	**<0.001**	-5.63	[-13.29-2.03]	0.15
Discharged from Ear, nose& throat wards	**49.72**	**[44.38-55.07]**	**<0.001**	0.77	[-6.35-7.88]	0.83
Discharged from Endocrinology wards	**39.86**	**[33.56-46.16]**	**<0.001**	**-13.54**	**[-21.15- -5.92]**	**0.001**
Discharged from Gynaecology wards	**48.46**	**[44.84-52.07]**	**<0.001**	-2.14	[-7.60-3.33]	0.44
Discharged from Neurology wards	**48.61**	**[42.72-54.49]**	**<0.001**	-1.35	[8.86-6.17]	0.73
Discharged from other ward Specialties	**41.74**	**[38.28-45.19]**	**<0.001**	-2.91	[-8.33-2.51]	0.29
Unspecified speciality	**46.57**	**[43.78-49.36]**	**<0.001**	1.62	[-3.34-6.58]	0.52

B: the estimate of change in the outcome with one unit change of the predictor

Table 3.19 Factors contributing to discharge summary adherence to medication information

	Univariate analysis			Multivariate analysis		
Variable	**B**	**95%CI**	**P**	**B**	**95%CI**	**p**
Role of person responsible for discharge [d]						
Core medical training doctors	**47.13**	**[44.44-49.82]**	**<0.001**	1.42	[-1.96-4.81]	0.41
Speciality training doctors	**42.16**	**[38.11-46.21]**	**<0.001**	**4.91**	**[-9.63-0.18]**	**0.04**
Registrars	**34.83**	**[25.09-44.57]**	**<0.001**	-9.68	[-22.75-3.39]	0.15
Consultants	**44.28**	**[40.40-48.15]**	**<0.001**	3.38	[-7.92-1.15]	0.14
Doctors of unknown training level	**53.19**	**[52.0-54.38]**	**<0.001**	**3.04**	**[0.59-5.49]**	**0.02**
Pharmacists	**55.36**	**[47.94-62.77]**	**<0.001**	6.58	[-1.47-14.64]	0.11
Specialist Nurse Practitioners	**47.06**	**[43.40-50.72]**	**<0.001**	3.07	[-1.58-7.73]	0.20
Unspecified profession	**50.04**	**[48.53-51.57]**	**<0.001**	1.69	[-1.07-4.44]	0.23

Constant B= 79.23, Std error=3.28, P <0.001. R square =0.118, adjusted R square= 0.106, Std error of the estimate=21.95. [a] Compared against planned admission, [b] Compared to H1, [c] Compared to general medicine wards, [d] Compared to foundation year doctors. # Bold type face indicates statistically significant model predictors (i.e. p<0.05). B: the estimate of change in the outcome with one unit change of the predictor

Continued
Table 3.19 Factors contributing to discharge summary adherence to medication information

Similarly in Table 3.19, the unadjusted analysis identified some type of hospitals, ward specialities and professions as contributors to the quality of discharge information; however this effect was not significant when the model was adjusted to number of medicines and type of discharge summary and admission.

	Univariate analysis			Multivariate analysis		
Variable	**B**	**95%CI**	**P**	**B**	**95%CI**	**p**
Patient demographics						
Age	0.04	[-0.01-0.09]	0.146	-0.02	[-0.07-0.10]	0.65
No. of medications	**0.56**	**[0.28-0.84]**	**<0.001**	-0.31	[0.66-0.05]	0.09
Hospital stay	-0.07	[-0.17-0.04]	0.23	-0.14	[0.27- -0.01]	0.05
Type of discharge summary						
Handwritten discharge summaries	**-17.9**	**[-20.61- -15.20]**	**<0.001**	**-8.73**	**[-13.05- -3.49]**	**0.001**
Type of admission [a]						
Admitted via unplanned admission	**31.30**	**[30.61-31.99]**	**<0.001**	2.87	[-0.56-6.49]	0.10
Unspecified type of admission	**29.81**	**[27.98-31.64]**	**<0.001**	**10.54**	**[4.10-10.98]**	**0.001**
Hospitals [b]						
Discharges from H2	**14.94**	**[13.61-16.27**	**<0.001**	-3.80	[-9.96-2.36]	0.23
Discharges from H3	**41.62**	**[38.62-44.61]**	**<0.001**	8.29	[-1.71-18.29]	0.10
Discharges from H4	**26.52**	**[21.84-31.20]**	**<0.001**	-1.67	[-13.89- -10.54]	0.79
Discharges from H5	**15.36**	**[10.59-20.1]**	**<0.001**	**-17.0**	**[-27.95- -5.96]**	**<0.003**
Discharges from mental health hospitals	**17.81**	**[10.09-25.53]**	**<0.001**	-5.40	[-24.91-14.09]	0.59
Discharges from tertiary hospital	**26.24**	**19.68-32.8]**	**<0.001**	-4.39	[-20.28-11.49]	0.59
Discharges from community hospitals	**11.71**	**[6.79-16.62]**	**<0.001**	**-20.41**	**[-34.42- -6.40]**	**0.004**
Ward specialities [c]						
Discharges from Medicine for elderly wards	**34.02**	**[32.57-35.46]**	**<0.001**	-3.42	[-12.04-5.19]	0.44
Discharged from Orthopaedic wards	**17.39**	**[15.02-19.75]**	**<0.001**	**-21.65**	**[-31.56-11.73]**	**<0.001**
Discharged from General surgery wards	**27.29**	**[25.34-29.25]**	**<0.001**	**-13.07**	**[-21.84- -4.29]**	**0.004**
Discharged from Urology wards	**30.56**	**[28.82-32.29]**	**<0.001**	-5.34	[-14.15-3.47]	0.24
Discharged from Gastroenterology wards	**28.16**	**[25.09-31.28]**	**<0.001**	-7.83	[-18.31-2.65]	0.14
Discharged from Cardiology wards	**34.35**	**[32.07-36.62]**	**<0.001**	-5.82	[-15.06-3.42]	0.22
Discharged from Thoracic wards	**33.24**	**[30.99-35.48]**	**<0.001**	-6.80	[-16.07-2.17]	0.15
Discharged from Paediatric wards	**25.81**	**[23.34-28.28]**	**<0.001**	**-11.53**	**[-22.11- -0.94]**	**0.03**
Discharged from Oncology wards	**37.18**	**[34.23-40.23]**	**<0.001**	1.47	[-8.84-11.77]	0.78
Discharged from Nephrology wards	**26.24**	**[26.24-35.94]**	**<0.001**	**-14.12**	**[-27.38- -0.85]**	**0.04**
Discharged from Ear, nose& throat wards	**25.44**	**[21.19-29.69]**	**<0.001**	-8.75	[-21.87-4.37]	0.19
Discharged from Endocrinology wards	**27.9**	**[22.9-32.89]**	**<0.001**	**-17.55**	**[-30.86- -4.24]**	**0.01**
Discharged from Gynaecology wards	**26.21**	**[23.32-29.10]**	**<0.001**	-8.55	[-19.09-1.99]	0.11
Discharged from Neurology wards	**29.75**	**[25.07-34.43]**	**<0.001**	**-16.48**	**[-29.28-3.67]**	**0.01**
Discharged from other ward Specialties	**16.58**	**[13.82-19.34]**	**<0.001**	**-14.64**	**[-25.29- -3.99]**	**0.007**
Unspecified speciality	**24.08**	**[-21.85-26.08]**	**<0.001**	0.60	[-10.45-9.25]	0.90

B: the estimate of change in the outcome with one unit change of the predictor

Table 3.20 Factors contributing to discharge summary adherence to therapy change information

	Univariate analysis			Multivariate analysis		
Variable	**B**	**95%CI**	**P**	**B**	**95%CI**	**p**
Role of person responsible for discharge [d]						
Core medical training doctors	**30.23**	**[28.08-32.37]**	**<0.001**	2.37	[-3.73-8.48]	0.45
Speciality training doctors	**25.79**	**[22.57-29.01]**	**<0.001**	6.51	[-14.68-1.66]	0.12
Registrars	**23.76**	**[16.04-31.48]**	**<0.001**	0.65	[-19.94-21.23]	0.95
Consultants	**26.75**	**[23.67-29.83]**	**<0.001**	5.49	[-13.65-2.68]	0.19
Doctors of unknown training level	**32.74**	**[31.73-33.74]**	**<0.001**	2.43	[-6.76-1.89]	0.27
Pharmacists	**35.27**	**[29.39-41.16]**	**<0.001**	2.18	[-15.45-11.08]	0.75
Specialist Nurse Practitioners	**32.76**	**[29.86-35.67]**	**<0.001**	0.65	[-7.16-8.46]	0.87
Unspecified profession	**31.81**	**[30.57-33.06]**	**<0.001**	-1.67	[-6.63-3.29]	0.51

Constant B= 70.46, Std error=6.01, P <0.001. R square =0.068, adjusted R square= 0.051, Std error of the estimate=33.6. [a] Compared against planned admission, [b] Compared to H1, [c] Compared to general medicine wards, [d] Compared to foundation year doctors

Bold type face indicates statistically significant model predictors (i.e. p<0.05). B: the estimate of change in the outcome with one unit change of the predictor

Continued

Table 3.20 Factors contributing to discharge summary adherence to therapy change information

In Table 3.20, the unadjusted analysis identified some type of hospitals, ward specialities and professions as contributors to the quality of discharge information; however this effect was not significant when the model was adjusted to number of medicines and type of discharge summary and admission.

3.8 Predictors of adherence to the NPC minimum requirements

The regression models presented earlier, Table 3.17-3.20, have outlined an association between discharge summary adherence to the NPC minimum dataset and factors such as number of medicines, type of discharge summary, hospital and ward speciality plus profession type.

Such influences should be examined while accounting for potential covariates and confounding effects between factors. Therefore, further insights to identify the predictors of non-adherence plus the characteristics associated with increased adherence to the NPC minimum dataset was investigated using ANCOVA-GLM analysis. The audit data was modified prior to implementing ANCOVA-GLM. These modifications are described in BOX 3.1 summarises.

BOX 3.1 Modifications to the audit dataset prior ANCOVA-GLM analysis

- Association between hospitals and the quality of discharge template (section 4.1.4) believed to represent a potential confounding effect. Both factors are highly correlated and as such one factor should be retained in the model. Discharge summary template was included in the ANCOVA-GLM analysis

- In order to employ the ANCOVA-GLM analysis, it was believed that the wide 95% CIs associated with subgroups with very small number of data points would not allow comparative conclusions to be drawn and therefore subgroups were combined:
    - Subgroups of hospitals with less than 50 data points was merged into "others" category
    - Subgroups of ward speciality of less than 100 was merged into "others" category
    - Doctors of different training levels were combined

Table 3.21 examines the significant predictors of discharge summary adherence to the total NPC minimum dataset.

Factors related to discharge summary template, number of medicines, ward speciality and discharge summary type exhibited significant influences on discharge summary adherence to the total NPC minimum dataset, all p <0.05. It can be seen from Table 3.21 that discharge summary template accounted for the largest proportion of variation within the adherence to the total NPC minimum dataset, sum of squares $_{df=6}$=7512.50.

Variables	Type III Sum of Squares	Df	Mean Square	F	p
Corrected Model	84120.76a	198	424.90	3.60	<0.001
Intercept	31966.70	1	31966.70	272.40	<0.001
Age	125.30	1	125.30	1.10	0.30
No. of medicines	**3015.70**	**1**	**3015.70**	**25.70**	**<0.001**
Hospital stay	46.80	1	46.80	0.40	0.53
Type of discharge summary	**519.70**	**1**	**519.70**	**4.40**	**0.04**
Type of admission	265.20	2	132.60	1.10	0.32
Discharge summary template	**7512.50**	**6**	**7512.50**	**64.0**	**<0.001**
Ward speciality	**2859.10**	**12**	**238.30**	**2.0**	**0.02**
Profession type	299.40	3	99.80	0.9	0.47
Error	339973.70	2897	117.40		
Total	1600000.0	3096			
Corrected Total	424094.4	3095			

df: degree of freedom

Table 3.21 Predictors of discharge summary adherence to the total NPC minimum dataset

Stepwise backward elimination resulted in the model presented in Table 3.22. The effect of discharge summary template on discharge summary adherence to the total NPC minimum dataset adjusted for number of medicines and discharge summary type identified template of community hospitals and H2 as significant predictors of lower adherence rates; whereas, H3 template attributed to better adherence.

Variables	B	Std. Error	t	p	95% CI Lower limit	95% CI Upper Limit
Constant	78.60	0.75	104.77	<0.001	77.13	80.07
No. of medicines	-0.24	0.04	-5.53	<0.001	-0.33	-0.16
Type of discharge summary						
Handwritten	-3.51	0.63	-5.58	<0.001	-4.749	-2.28
Electronic	0					
Discharge summary template						
Template of H1	0					
Template of H2	**-5.83**	**0.68**	**-8.59**	**<0.001**	**-7.17**	**-4.50**
Template of H3	**8.14**	**0.70**	**8.40**	**<0.001**	**6.24**	**10.05**
Template of H4	1.66	1.50	1.11	0.27	-1.28	4.59
Template of H5	-0.13	1.53	-0.09	0.93	-3.13	2.87
Template of community hospitals	**-9.47**	**1.56**	**-6.09**	**<0.001**	**-12.53**	**-6.42**
Template of other hospitals	**-6.61**	**1.45**	**-4.60**	**<0.001**	**-9.43**	**-3.80**

*Final step of stepwise backward elimination
R^2 = 0.14, adjusted R^2= 0.137

Table 3.22 Effect of discharge summary templates on adherence to the total NPC minimum dataset adjusting for number of medicines and discharge summary type*

Significant predictors of discharge summary adherence across the three categories of the NPC minimum dataset are identified in Tables 3.23-3.28.

3.8.1 Predictors of adherence to patient, admission and discharge information

Table 3.23 examines predictors of discharge summary adherence to patient, admission and discharge information.

Similarly, discharge summary template accounted for the largest amount of variation in patient, admission and discharge information, sum of squares $_{df=6}$ =7832.90. Stepwise backward elimination resulted in the table presented in Table 3.24. The effect of discharge summary template on discharge summary adherence to patient, admission and discharge information adjusting for the influence of discharge summary type and number of medicines outlined template of community hospitals as the strongest predictor of poor adherence.

Variables	Type III Sum of Squares	df	Mean Square	F	p
Corrected Model	69674.39	93	749.19	7.12	<.001
Intercept	401996.10	1	401996.10	3821.15	<0.001
No. of medicines	**547.81**	**1**	**547.81**	**5.21**	**0.02**
Age	1.80	1	1.80	0.02	0.90
Hospital stay	35.30	1	35.30	0.34	0.56
Type of discharge summary	**497.27**	**1**	**497.27**	**4.73**	**0.03**
Type of admission	40.56	2	20.28	0.19	0.83
Discharge summary template	**7832.90**	**6**	**1305.48**	**12.41**	**<0.001**
Profession type	146.050	3	48.68	0.46	0.71
Error	315819.45	3002	105.20		
Total	18890000	3096			
Corrected Total	385493.83	3095			

df: degree of freedom

Table 3.23 Predictors of discharge summary adherence to patient, admission and discharge information

Variables	B	Std. Error	t	p	95% CI Lower limit	95% CI Upper limit
Intercept	79.05	0.32	249.04	<0.001	78.43	79.67
No. of medicines	0.11	0.04	2.71	0.01	0.03	0.20
Type of discharge summary						
Handwritten	-4.77	.86	-5.55	<0.001	-6.46	-3.09
Electronic	0	.	.	.	.	.
Discharge summary template						
Template of H1	0					
Template of H2	**-8.54**	**1.02**	**-8.39**	**<0.001**	**-10.54**	**-6.54**
Template of H3	**6.33**	**0.96**	**6.63**	**<0.001**	**4.46**	**8.21**
Template of H4	3.92	1.95	2.01	0.04	0.10	7.74
Template of H5	-0.58	2.10	-0.28	0.78	-4.70	3.53
Template of community hospitals	**-9.49**	**1.92**	**-4.95**	**<0.001**	**-13.24**	**-5.73**
Template of other hospitals	-4.293	1.683	-2.550	.011	-7.594	-0.99

*Final step of stepwise backward elimination
R^2=0.18, adjusted R^2=0.16

Table 3.24 Effect of discharge summary template on adherence rate to patient, admission and discharge information adjusting for number of medicine and discharge summary type*

3.8.2 Predictors of adherence to medication information

Table 3.25 examines predictors of discharge summary adherence to medication information. Likewise, discharge summary templates accounted for the largest amount of variation in medication information, sum of squares$_{df=6}$ =10412.39.

Variables	Type III Sum of Squares	df	Mean Square	F	p
Corrected Model	193120.94	92	2099.14	4.33	<0.001
Intercept	282267.09	1	282267.09	582.17	<0.001
No. of medicines	351.87	1	351.86	0.73	0.39
Age	**3195.47**	**1**	**3195.47**	**6.59**	**0.01**
Hospital stay	208.91	1	208.91	0.43	0.51
Type of discharge summary	**3143.89**	**1**	**3143.89**	**6.48**	**0.01**
Type of admission	**3800.18**	**2**	**1900.09**	**3.92**	**0.02**
Discharge summary template	**10412.39**	**6**	**1735.40**	**3.58**	**0.002**
Profession type	997.0	3	332.33	0.69	0.56
Error	1404044.28	2957	474.82		
Total	13870000	2997			
Corrected Total	1589687.27	2996			

df: degree of freedom

Table 3.25 Predictors of discharge summary adherence to medication information

The effect of the discharge summary template adjusting for age, discharge summary type and admission type (Table 3.26) identified handwritten discharge summary the strongest predictor of poor adherence. H3 template is the only significant predictor of good adherence to medication information.

It can also be seen that when the effects of the template and the type of discharge summary were adjusted in the model, no significant influence was exhibited by admission type.

Variables	B	Std. Error	t	p	95% CI Lower limit	95% CI Upper limit
Intercept	70.13	1.43	49.11	<0.001	67.33	72.93
Age	**-0.04**	**0.02**	**-2.14**	**0.03**	**-0.069**	**-0.003**
Type of discharge summary						
Handwritten	**-13.47**	**3.62**	**-3.72**	**<0.001**	**-20.58**	**-6.37**
Electronic	0					
Type of admission						
Unspecified type of admission	2.74	2.75	0.99	0.32	-2.65	8.12
Unplanned admission	-2.03	1.17	-1.77	0.08	-4.28	0.28
Unplanned	0	.	.	.	.	.
Discharge summary template						
Template of H1	0					
Template of H2	-2.49	3.97	-0.63	0.53	-10.278	5.31
Template of H3	**16.04**	**4.56**	**3.52**	**<0.001**	**7.11**	**24.98**
Template of H4	6.78	7.33	0.93	0.36	-7.60	21.15
Template of H5	-16.75	8.95	-1.87	0.06	-34.30	.807
Template of community hospitals	-21.33	10.94	-1.95	0.05	-42.79	.130
Template of other hospitals	-1.36	6.64	-0.21	0.84	-14.38	11.67

*Final step of stepwise backward elimination
R^2=0.13, adjusted R^2=0.11

Table 3.26 Effect of discharge summary template on adherence rate to medication information adjusting for age, discharge summary and admission type*

3.8.3 Predictors of adherence to therapy change information

Table 3.27 examines the significant predictors of discharge summary adherence to therapy change information. Discharge summary template was the main predictor of discharge summary adherence to therapy change information. The impact of the discharge summary template on therapy change information is summarised in Table 3.28. All templates were significant predictors of poor adherence to therapy change information with the exception to the template of H3.

Variables	Type III Sum of Squares	df	Mean Square	F	p
Corrected Model	171155.39	87	1967.30	1.70	<0.001
Intercept	96924.28	1	96924.28	83.62	<0.001
No. of medicines	1803.79	1	1803.79	1.56	0.21
Age	2920.09	1	2920.09	2.52	0.11
Hospital stay	2846.69	1	2846.69	2.47	0.12
Type of discharge summary	853.98	1	853.98	0.74	0.39
Type of admission	2614.88	2	1307.44	1.13	0.32
Discharge summary template	**15194.84**	**6**	**2532.47**	**2.19**	**0.04**
Profession type	842.51	3	280.84	0.24	0.87
Error	2326218.65	2007	1159.05		
Total	7451319.44	2095			
Corrected Total	2497374.04	2094			

df: degree of freedom

Table 3.27 Predictors of discharge summary adherence to therapy change information

Variables	B	Std. Error	t	p	95% CI Lower limit	95% CI Upper limit
Intercept	50.55	0.80	63.544	<0.001	48.99	52.11
Discharge summary template						
Template of H1	0					
Template of H2	**-8.71**	**2.0**	**-4.353**	**<0.001**	**-12.63**	**-4.79**
Template of H3	**14.90**	**3.50**	**4.265**	**<0.001**	**8.05**	**21.75**
Template of H4	-3.62	5.47	-0.662	0.51	-14.34	7.10
Template of H5	**-24.16**	**5.21**	**-4.642**	**<0.001**	**-34.37**	**-13.96**
Template of community hospitals	**-22.86**	**6.04**	**-3.785**	**<0.001**	**-34.71**	**-11.02**
Template of other hospitals	**-13.68**	**5.33**	**-2.565**	**0.01**	**-24.13**	**-3.22**

*Final step of stepwise backward elimination
R^2=0.11, adjusted R^2=0.09

Table 3.28 Impact of discharge summary template on therapy change information*

3.9 Effect of ward specialty on discharge summary adherence to the total NPC minimum dataset

Wards speciality exhibited potential significant effect (Table 3.21) on discharge summary adherence to the total NPC minimum dataset.

Community and specialist care hospitals are lacking the breadth of specialities which are demonstrated by general hospitals and thus it was believed that the influence of ward speciality should be investigated across the main general hospitals in the audit. Therefore, a total of 3,383 discharge summaries presenting the five general hospitals in the audit were analysed to establish the influence of ward speciality on discharge summary adherence to the NPC minimum dataset.

Table 3.29 examines the influence of ward specialty on discharge summary adherence to the total NPC minimum dataset.

The effect of ward speciality adjusting for discharge summary type and number of medicines (Table 3.30) identified orthopaedic ward as a strong predictor of poor adherence the adherence to the total NPC minimum dataset.

Table 3.31 and 3.32 demonstrate the influence of ward speciality on discharge summary adherence to patient, admission and discharge information. Adjusting for the number of medicines and type of discharge summary identified orthopaedic wards again as a strong predictor of poor adherence.

Table 3.33 and 3.34 demonstrate the influence of ward speciality on discharge summary adherence to medication information. Adjusting for age and discharge summary type higlighted general surgery and gastroentrology wards as significant predictors of poor adherence.

Table 3.35 and 3.36 demonstrate the influence of ward speciality on discharge summary adherence to therapy change information. The effect of ward speciality adjusting for hospital stay identified orthopaedic ward to be a strong predictor of poor adherence to therapy change information.

Variables	Type III Sum of Squares	df	Mean Square	F	p
Corrected Model	74005.01	195	379.53	3.19	<0.001
Intercept	395430.14	1	395430.14	3318.70	<0.001
Age	424.82	1	424.82	3.57	0.06
No. of medicines	**2514.04**	**1**	**2514.04**	**21.10**	**<0.001**
Hospital stay	94.82	1	94.82	0.80	0.37
Type of discharge summary	**1536.36**	**1**	**1536.36**	**12.89**	**<0.001**
Type of admission	267.73	2	133.86	1.12	0.34
Ward speciality	**3217.61**	**12**	**268.13**	**2.25**	**0.01**
Profession type	277.39	3	92.46	0.78	0.51
Error	338868.38	2844	119.15		
Total	1.609E7	3040			
Corrected Total	412873.39	3039			

df: degree of freedom

Table 3.29 Influence of ward specialty on discharge summary adherence to the total NPC minimum dataset

Variables	B	Std. Error	t	p	95% CI Lower limit	95% CI Upper limit
Intercept	77.46	1.11	69.80	<0.001	75.28	79.64
No. of medicines	-0.25	.05	-5.42	<0.001	-.34	-0.16
Type of Discharge summary						
Handwritten discharge summary	-9.51	1.64	-5.79	<0.001	-12.73	-6.29
Electronic discharge summary	0	.	.	.	.	.
Ward specialities						
Discharges from Medicine for elderly wards	-0.99	1.19	-0.83	0.41	-3.33	1.34
Discharged from Orthopaedic wards	**-5.52**	**1.42**	**-3.90**	**<0.001**	**-8.30**	**-2.75**
Discharged from General surgery wards	**-3.57**	**1.29**	**-2.77**	**0.01**	**-6.10**	**-1.04**
Discharged from Urology wards	-1.59	1.24	-1.28	0.20	-4.03	0.84
Discharged from Gastroenterology wards	**-4.21**	**1.57**	**-2.68**	**0.01**	**-7.29**	**-1.13**
Discharged from Cardiology wards	-2.37	1.35	-1.75	0.08	-5.01	0.28
Discharged from Thoracic wards	-1.72	1.33	-1.29	0.20	-4.39	0.89
Discharged from Paediatric wards	-2.38	1.45	-1.65	0.10	-5.22	0.45
Discharged from Oncology wards	-1.51	1.47	-1.03	0.30	-4.39	1.36
Discharged from Gynaecology wards	**-3.37**	**1.48**	**-2.28**	**-0.02**	**-6.27**	**-0.47**
Discharged from other ward Specialties	-2.45	1.23	-1.95	0.05	-4.90	0.01
Unspecified speciality	**-6.54**	**1.56**	**-4.20**	**<0.001**	**-9.59**	**-3.49**
Discharged from General medicine	0					

*Final step of stepwise backward elimination
R^2 = 0.18, adjusted R^2= 0.12

Table 3.30 Effect of ward speciality on discharge summary adherence to the total NPC minimum dataset adjusting for number of medicines and discharge summary type*

Variables	Type III Sum of Squares	df	Mean Square	F	p
Corrected Model	76528.29	195	392.45	3.73	<0.001
Intercept	422230.15	1	422230.15	4012.44	<0.001
Age	78.69	1	78.69	0.75	0.39
No. of medicines	**597.29**	**1**	**597.29**	**5.68**	**0.02**
Hospital stay	107.45	1	107.45	1.02	0.31
Type of discharge summary	**912.24**	**1**	**912.24**	**8.67**	**0.003**
Type of admission	48.54	2	24.27	0.23	0.79
Ward speciality	**3365.84**	**12**	**280.49**	**2.67**	**0.001**
Profession types	154.60	3	51.53	0.49	0.69
Error	299275.28	2844	105.23		
Total	1.859E7	3040			
Corrected Total	375803.57	3039			

df: degree of freedom

Table 3.31 Influence of ward specialty on discharge summary adherence to patient, admission and discharge information

Variables	B	Std. Error	t	p	95% CI Lower limit	95% CI Upper limit
Intercept	79.319	1.05	75.59	<0.001	77.26	81.38
No. of medicines	0.12	0.04	2.68	0.007	0.03	0.20
Type of Discharge summary						
Handwritten discharge summary	**-9.82**	**1.56**	**-6.32**	**<0.001**	**-12.87**	**-6.78**
Electronic discharge summary	0	.	.	.	.	.
Ward specialities						
Discharges from Medicine for elderly wards	1.32	1.17	1.18	0.24	-0.88	3.53
Discharged from Orthopaedic wards	**-3.69**	**1.34**	**-2.75**	**0.006**	**-6.31**	**-1.06**
Discharged from General surgery wards	-0.06	1.21	-0.05	0.96	-2.45	2.34
Discharged from Urology wards	-0.09	1.18	-0.08	0.94	-2.40	2.21
Discharged from Gastroenterology wards	-1.79	1.49	-1.20	0.23	-4.70	1.13
Discharged from Cardiology wards	-0.43	1.28	-0.34	0.74	-2.94	2.07
Discharged from Thoracic wards	-0.10	1.26	-0.08	0.94	-2.57	2.37
Discharged from Paediatric wards	-0.54	1.37	-0.40	.69	-3.22	2.14
Discharged from Oncology wards	-1.74	1.39	-1.25	.21	-4.45	0.98
Discharged from Gynaecology wards	-0.29	1.40	-0.21	.84	-3.03	2.46
Discharged from other ward Specialties	-0.32	1.19	-0.27	.79	-2.64	2.00
Unspecified speciality	**-5.77**	**1.47**	**-3.92**	**<0.001**	**-8.65**	**-2.88**
Discharged from General medicine	0					

*Final step of stepwise backward elimination
R^2= 0.20, adjusted R^2 = 0.15

Table 3.32 Effect of ward speciality on discharge summary adherence to patient, admission and discharge adjusting for number of medicines and discharge summary type*

Variables	Type III Sum of Squares	df	Mean Square	F	p
Corrected Model	219639.94	189	1162.12	2.40	<0.001
Intercept	302009.63	1	302009.63	622.36	<0.001
No. of medicines	54.54	1	54.54	0.11	0.74
Age	**6203.71**	**1**	**6203.71**	**12.78**	**<0.001**
Hospital stay	409.31	1	409.31	0.84	0.36
Type of discharge summary	**4810.32**	**1**	**4810.32**	**9.91**	**0.002**
Type of admission	662.55	2	331.27	0.68	0.51
Ward speciality	**14946.87**	**12**	**1245.57**	**2.57**	**0.002**
Profession type	311.82	3	103.94	0.21	0.89
Error	1193757.13	2460	485.27		
Total	1.224E7	2650			
Corrected Total	1413397.07	2649			

df: degree of freedom

Table 3.33 Influence of ward specialty on discharge summary adherence to medication information

Variables	B	Std. Error	t	p	95% CI Lower limit	95% CI Upper limit
Intercept	77.81	2.69	28.97	<0.001	72.54	83.08
Age	-0.08	0.02	-3.39	0.001	-0.126	-0.034
Type of Discharge summary						
Handwritten discharge summary	**-17.09**	**3.46**	**-4.93**	**<0.001**	**-23.87**	**-10.29**
Electronic discharge summary	0					
Ward specialities						
Discharges from Medicine for elderly wards	-4.78	2.62	-1.82	0.07	-9.91	.36
Discharged from Orthopaedic wards	-1.58	3.08	-0.51	0.61	-7.62	4.47
Discharged from General surgery wards	**-9.80**	**2.76**	**-3.56**	**<0.001**	**-15.21**	**-4.40**
Discharged from Urology wards	-3.70	2.68	-1.38	0.17	-8.95	1.55
Discharged from Gastroenterology wards	**-9.60**	**3.37**	**-2.85**	**0.004**	**-16.21**	**-2.99**
Discharged from Cardiology wards	-5.11	2.94	-1.74	0.08	-10.87	0.65
Discharged from Thoracic wards	-4.52	2.85	-1.59	0.11	-10.11	1.07
Discharged from Paediatric wards	-6.04	3.40	-1.78	0.08	-12.71	0.62
Discharged from Oncology wards	-4.08	3.17	-1.29	0.20	-10.29	2.13
Discharged from Gynaecology wards	-7.62	3.21	-2.37	0.02	-13.91	-1.33
Discharged from other ward Specialties	**-8.51**	**2.73**	**-3.12**	**0.002**	**-13.86**	**-3.16**
Unspecified speciality	-5.53	3.59	-1.54	0.12	-12.57	1.51
Discharged from General medicine	0					

*Final step of stepwise backward elimination
R^2= 0.08, adjusted R^2= 0.07

Table 3.34 Effect of ward speciality on discharge summary adherence to medication information adjusting for age and type of discharge summary *

Variables	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	291643.46	181	1611.29	1.40	0.001
Intercept	132816.93	1	132816.93	115.59	<0.001
Age	1.56	1	1.56	0.001	0.97
No. of medicines	1781.17	1	1781.17	1.55	0.21
Hospital stay	**6277.79**	**1**	**6277.77**	**5.47**	**0.02**
Type of discharge summary	1269.10	1	1269.10	1.10	0.29
Type of admission	1376.67	2	688.33	0.60	0.55
Ward speciality	**20075.32**	**12**	**1672.94**	**1.47**	**0.03**
Profession type	237.58	3	79.19	0.07	0.98
Error	2155673.11	1876	1149.08		
Total	7360000.00	2058			
Corrected Total	2447316.57	2057			

df: degree of freedom

Table 3.35 Influence of ward specialty on discharge summary adherence to therapy change

Variable	B	Std. Error	t	p	95% CI Lower limit	95% CI Upper limit
Intercept	58.89	3.83	15.40	<0.001	51.39	66.39
Hospital stay	-0.18	0.07	-2.62	0.009	-0.31	-0.05
Ward specialities						
Discharges from Medicine for elderly wards	-3.74	4.22	-0.89	0.38	-12.00	4.53
Discharged from Orthopaedic wards	**-24.08**	**5.07**	**-4.72**	**<0.001**	**-34.07**	**-14.08**
Discharged from General surgery wards	**-14.57**	**4.43**	**-3.29**	**0.001**	**-23.25**	**-5.89**
Discharged from Urology wards	-5.27	4.40	-1.12	0.23	-13.90	3.36
Discharged from Gastroenterology wards	**-10.98**	**5.42**	**-2.03**	**0.04**	**-21.61**	**-0.39**
Discharged from Cardiology wards	-7.82	4.66	-1.68	0.10	-16.96	1.33
Discharged from unspecified ward Speciality	-6.34	5.01	-1.27	.21	-16.15	3.48
Discharged from Thoracic wards	-6.60	4.63	-1.42	0.16	-15.69	2.49
Discharged from Paediatric wards	**-12.20**	**4.91**	**-2.49**	**0.01**	**-21.82**	**-2.57**
Discharged from Oncology wards	0.80	5.18	0.16	0.88	-9.36	10.96
Discharged from Gynaecology wards	-8.02	5.37	-1.50	0.14	-18.55	2.51
Discharged from other ward Specialties	**-16.0**	**4.43**	**-3.61**	**<0.001**	**-24.69**	**-7.31**
Discharged from General medicine	0					

*Final step of stepwise backward elimination
R^2= 0.12 , adjusted R^2= 0.03

Table 3.36 Effect of ward speciality on discharge summary adherence to therapy change information adjusting for length of hospital stay*

3.10 Discharge discrepancies

3.10.1 Medication discrepancies

GP held records relating to patient medicines were reviewed for 671 discharge summaries to identify medication discrepancies. Hospitals listed 3,803 medications and when reviewing the GP held records it appeared that these patients were prescribed a total of 4,594 medications. Thus, hospitals had omitted 791 medications.

A total of 1,843 medication discrepancies were identified; 559 (83.3%) of discharge summaries 95%CI (80.48-86.12) had at least one medication discrepancy. The median (IQ) number of medication discrepancies was 2 (1, 4) per discharge summary. Table 3.37 presents the distribution of medication discrepancies between admission and discharge summary type, hospitals and wards.

It can be seen that planned admissions demonstrated a higher rate of medication discrepancies with addition discrepancies predominating. Higher frequencies of omission discrepancies, however, can be seen with unplanned admissions.

Electronic discharge summaries were associated with a higher proportion of discharge summaries bearing at least one medication discrepancy with omission discrepancies predominating. Mental hospital trust demonstrated the highest rates of omission and addition discrepancies.

Ear, nose & throat and orthopaedic wards demonstrated the highest rate of medication discrepancy with addition discrepancies predominating.

Consultant discharge summaries demonstrated the highest rate of medication discrepancies which were predominantly addition discrepancies.

		Type of discrepancy					
	N	**At least one medication discrepancy**	**At least one omission: regular medications were omitted**	**At least one addition: unstated new medications were added upon discharge**	**At least one unstated changes (dose, frequency or formulation)**	**At least one unstated reasons of therapy discontinuation**	**At least one unstated medication substitutions**
Admission type							
Planned	180	158 (87.8%)	67 (37.2%)	109 (60.6%)	16 (8.9%)	3 (1.7%)	7 (3.9%)
Unplanned	491	401 (81.7%)	202 (41.1%)	201(40.9%)	48 (9.8%)	22 (4.5%)	20 (4.1%)
Discharge summary type							
Electronic	545	464 (85.0%)	232 (42.6%)	317 (58.2%)	58 (10.6%)	23 (4.2%)	22 (4.0%)
Handwritten	126	95 (76.0%)	37 (29.4%)	84 (66.7%)	6 (4.8%)	2 (1.6%)	5 (4.0%)
Hospitals							
H1	525	422 (84.2%)	226 (43.1%)	299 (57.1%)	56 (10.7%)	22 (4.2%)	21 (4.0%)
H2	66	51.0 (77.3%)	12 (18.2%)	48 (72.7%)	1 (1.5%)	-	3 (4.5%)
H4	9	9 (100%)	3 (33.3%)	6 (66.7%)	1 (11.1%)	-	1 (11.1%)
H5	48	36 (75.0%)	20 (40.8%)	33 (67.3%)	4 (8.2%)	-3 (6.1)	1 (2.0%)
Community hospitals	13	6 (48.0%)	2 (15.4%)	7 (53.85)	-	-	1 (7.7%)
Mental hospital trust	10	10 (100%)	6 (60.0%)	8 (80.0%)	2 (20.0%)	-	-
Wards							
General surgery	121	91 (81.3%)	40 (33.1%)	72 (59.5%)	13 (10.8%)	7 (6.3%)	5 (4.5%)
Medicine for Elderly	125	103 (77.4%)	60 (48.0%)	81 (64.8%)	13 (10.4%)	5 (4.0%)	4 (3.2%)
Thoracic	57	50 (84.7%)	18 (31.6%)	32 (56.1%)	7 (12.3%)	2 (3.7%)	4 (7.0%)
Paediatrics	54	36 (83.7%)	22 (40.7%)	33 (61.1%)	4 (7.4%)	-	-
Orthopaedic	36	38 (97.4%)	16 (44.4%)	23 (63.9%)	-	2 (5.6%)	-
Urology	41	34 (85.0%)	19 (46.3%)	21 (51.2%)	5 (12.2%)	2 (4.9%)	1 (2.4%)
Cardiology	27	26 (81.3%)	12 (44.4%)	18 (66.7%0	3 (11.1%))	-	1 (3.7%)
Gastroenterology	27	24 (88.9%)	7 (25.9%)	18 (66.7%)	3 (11.1%	-	2 (7.4%)
General medicine	24	18 (75.0%)	8 (33.3%)	9 (30.5%)	1 (4.2%)	2 (8.3%)	3 (12.5%)
Gynaecology	24	17 (81.0%)	6 (25.0%)	13 (54.2%)	1 (4.2%)	-	-
Endocrinology	21	16 (72.7%)	8 (38.1%)	14 (66.7%)	2 (9.5%)	1 (4.8%)	-
Oncology	19	19 (95.0%)	9 (47.4%)	7 (36.8%)	1 (5.3%)	-	-
Nephrology	18	17 (94.4%)	10 (55.6%)	11 (61.1%)	4 (22.2%)	1 (5.6%)	2 (11.1%)
Neurology	16	15 (93.8%)	9 (56.3%)	8 (50.0%)	1 (6.3%)	-	1 (6.3%)
Ear, nose & throat	14	13 (100%)	7 (50.0%)	9 (64.3%)	4 (28.6%)	-	-
Others*	47	33 (80.5%)	18 (40.1%)	32 (68.1%)	2 (4.3%)	2 (4.2%)	4 (8.5%)

*E.g. Dermatology, Rheumatology, Ophthalmology, Maternity care and Neonatal

Table 3.37 Distribution of medication discrepancies between admission type, discharge summary type, hospitals, wards and profession types

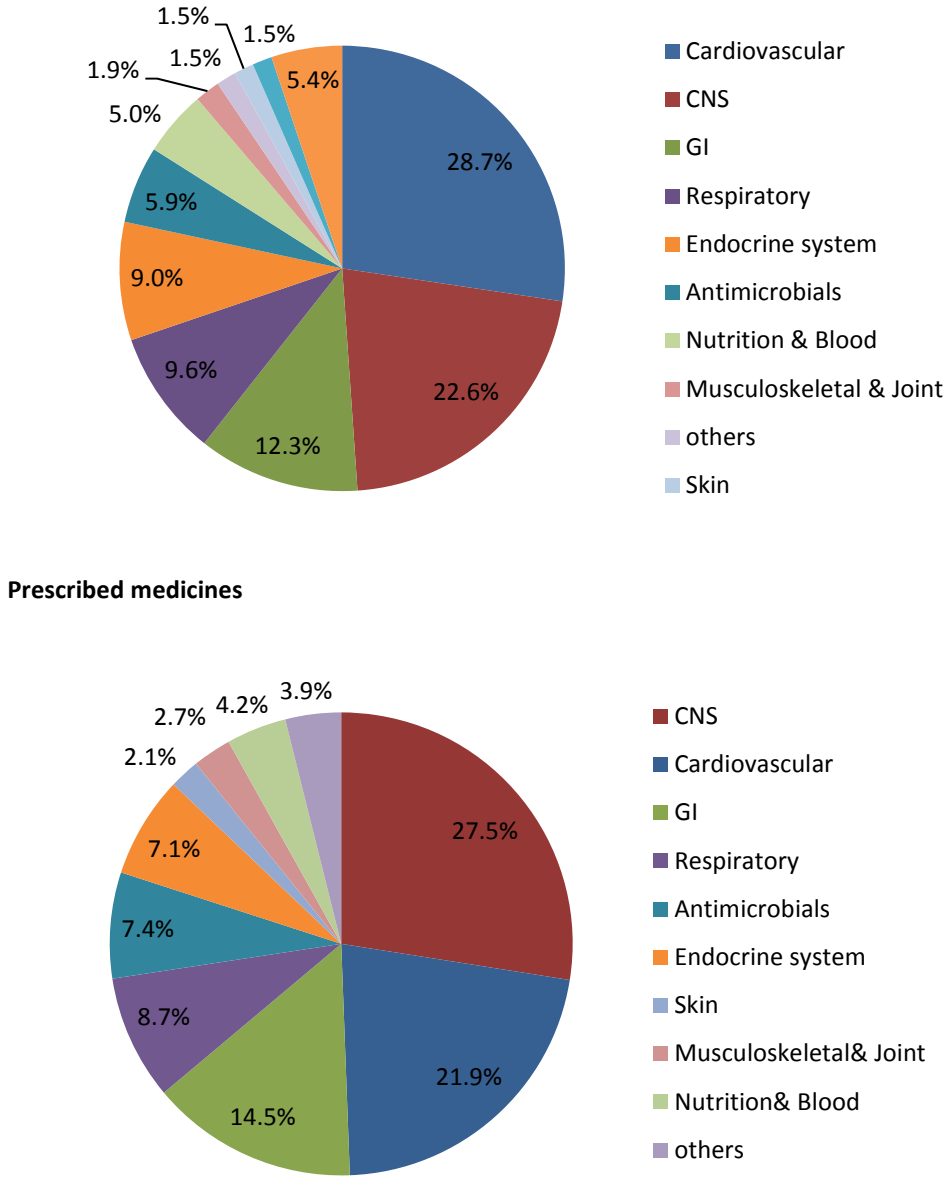
		Type of discrepancy					
	N	**At least one medication discrepancy**	**At least one omission: regular medications were omitted**	**At least one addition: unstated new medications were added upon discharge**	**At least one unstated changes (dose, frequency or formulation)**	**At least one unstated reasons of therapy discontinuation**	**At least one unstated medication substitutions**
Profession type							
Doctors[+]	151	124 (82.7%)	58 (38.4%)	94 (62.3%)	11 (7.3%)	4 (2.6%)	5 (3.3%)
Foundation years	301	252 (60.6%)	130 (43.2%)	175 (58.1%)	34 (11.3%)	-	13 (4.3%)
Senior house officers	45	33 (73.3%)	13 (28.9%)	26 (57.8%)	1 (2.2%)	2 (4.4%)	2 (4.4%)
Registrars	3	2 (66.7%)	2 (66.7%)	-	-	-	1 (33.3%)
Consultants	29	25 (86.2%)	9 (31.0%)	22 (75.9%)	7 (24.1%)	-	-
Pharmacists	10	6 (60.0%)	6 (60.0%)	6 (60.0%)	2 (20.0%)	-	1 (10.0%)
Specialist nurse practitioners	21	11 (52.4%)	11 (52.4%)	11 (52.4%)	3 (14.3%)	-	-
Unspecified	111	87 (78.4%)	41 (36.9%)	68 (61.3%)	8 (7.2%)	7 (6.3%)	6 (5.4%)

[+]Unspecified training level

Continued

Table 3.37 Distribution of medication discrepancies between admission type, discharge summary type, hospitals, wards and profession types

Figure 3.3 presents frequencies of prescribed medicines and medicines implicated to discrepancies.



CNS: central nervous system. GI: Gastroenterology. Classification based on British National Formulary 59

Figure 3.3 Comparison of prescribed medicines and medicines implicated to discrepancies

It can be seen that, central nervous system medicines were most frequently associated with medication discrepancies followed by cardiovascular, gastrointestinal and respiratory medications. However, it can be seen that these also are the most frequently prescribed medication classes. Table 3.38 summarises the nature of medication discrepancies and the classes of medicines contributing to discrepancies.

	Type of discrepancy				
Medication subclass*	**Regular medicine omitted n=791**	**Unstated new medicine Added n=902**	**Unstated changes (dose, frequency or formulation) n=82**	**Unstated reasons of therapy discontinuation n=38**	**Unstated medication substitutions n=30**
Analgesics and Nonsteroidal anti-inflammatory drugs	85 (10.7%)	297(32.9%)	7 (8.5%)	1 (2.6%)	1 (3.3%)
Bronchodilators	58 (7.2%)	24 (2.7%)	3 (3.7%)	-	2 (6.7%)
Antianginal (nitrate, CCB) preparation	53 (6.7%)	16 (1.8%)	3 (3.7%)	3 (7.9%)	1 (3.3%)
PPIs and H2-receptor antagonists	44 (5.6%)	46 (5.1%)	4 (4.9%)	-	5 (16.7%)
Laxative	41 (5.2%)	82 (9.1%)	3 (3.7%)	1 (2.6%)	3 (10.0%)
Lipid-regulating medications	36 (4.5%)	14 (1.6%)	2 (2.4%)	-	1 (3.3%)
Anaemias, vitamins, minerals and bone metabolism	45 (5.7%)	41 (4.6%)	3 (3.7%)	2 (5.3%)	4 (13.3%)
Hypnotics, anxiolytics, psychosis and Parkinson	48 (6.1%)	26 (2.9%)	3 (3.7%)	1 (2.6%)	1 (3.3%)
Hypertension and heart failure (BB, ACEI,ARB, diuretics)	54 (6.8%)	29 (3.2%)	14 (17.1%)	18 (47.4%)	5 (16.7%)
Antiplatelet	31 (3.9%)	46 (5.2%)	-	1 (2.6%)	-
Antidepressant	30 (3.8%)	9 (1.0%)	2 (2.4%)	1 (2.6%)	-
Corticosteroids inhaled	29 (3.7%)	12 (1.3%)	3 (3.7%)	-	3 (10.0%)
Corticosteroids oral	7 (0.88%)	41 (4.5%)	6 (7.3%)	2 5.3%)	-
Skin preparation	27 (3.4%)	12 (1.3%)	-	1 (2.6%)	-
Anti-diabetic medication	26 (3.3%)	12 (13.3%)	6 (7.3%)	1 (2.6%)	-
Ophthalmic preparation	17 (2.1%)	5 (0.6%)		-	-
Antiepileptic preparation	14 (1.9%)	14 (1.6%)	11 (13.4%)	1 (2.6%)	-
Nausea & vertigo	10 (1.3%)	14 (1.6%)	-	1 (2.6%)	2(6.7%)
Antimicrobial (antibacterial, antifungal, etc.)	16 (2.0%)	118 (13.1%)	1 (1.2%)	-	1 (3.3%)
Anticoagulant	8 (1.0%)	30 (3.3%)	4 (4.9%)	1 (2.6%)	-
Hormones and contraception	16 (2.0%)	2 (0.2%)	-	-	-
Antihistamines	15 (1.9%)	5 (0.6%)	-	1 (2.6%)	-
Others †	81 (10.2%)	8 (0.9%)	7 (8.5%)	2 (5.3%)	1 (3.3%)

* Classification based on British National Formulary 59. CCB: Calcium channel blockers. PPIs: Proton pump inhibitors. BB: Beta blockers. ACEI: angiotensin-converting-enzyme inhibitor. ARB: Angiotensin receptor blockers. † Others: nasal preparation, antispasmodic, obstetrics and urinary tract disorders.

Table 3.38 Medication classes implicated to medication discrepancies

It can be seen that analgesics were associated with a high proportion of both omissions and additions. Paracetamol accounted for 199 (10.8%) of medication discrepancies followed by opioid analgesics which were involved in 111 (6.0%) of which codeine phosphate accounted for almost 50% of these discrepancies. Cardiovascular discrepancies were largely attributable to aspirin which accounted for 155 (38.5%) of cardiovascular discrepancies; these often were due to aspirin being prescribed at antiplatelet dosing without any specification on therapy indications or follow up plans.

The extents to which discharge summaries recorded the duration and the titration plans of the medicines associated with increased risk of harm are illustrated in Figure 3.4.

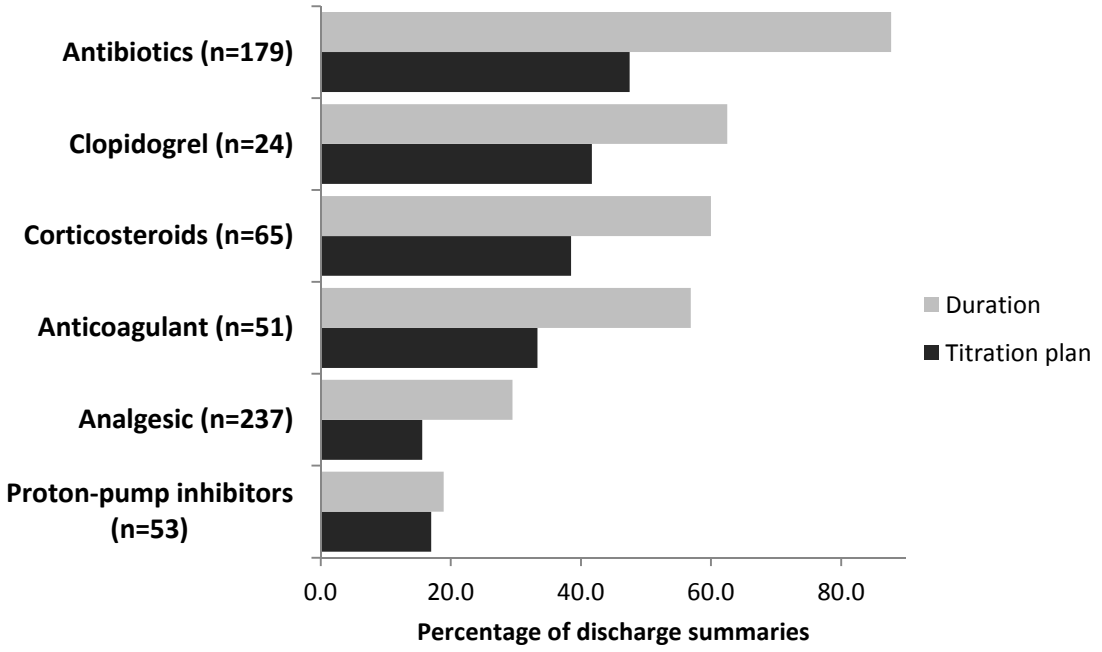


Figure 3.4 Duration and titration plan for antibiotics, clopidogrel, corticosteroids, anticoagulant, analgesic and proton pump inhibitors

Satisfactory communication of antibiotics durations can be seen, however performance with the other medicines is poorer. Additionally, titration plans were often not recorded.

3.10.2 Factors contributing to medication discrepancies

The logistic regression model which is summarized in Table 3.39 highlighted that patients who were prescribed more medicines had higher odds of having a medication discrepancy; with every increase in a prescribed medicine, the potential for a medication discrepancy increased by 15%, odds ratio [95%CI] =1.15 [1.10-1.24]. Figure 3.5 illustrates medication discrepancy rate with number of medicines.

As the number of medications increases from 1 through to 5, the likelihood of patients experiencing at least discrepancy also increases. Beyond 5 medicines, there is still a gradual but less pronounced increase in medication discrepancy risk.

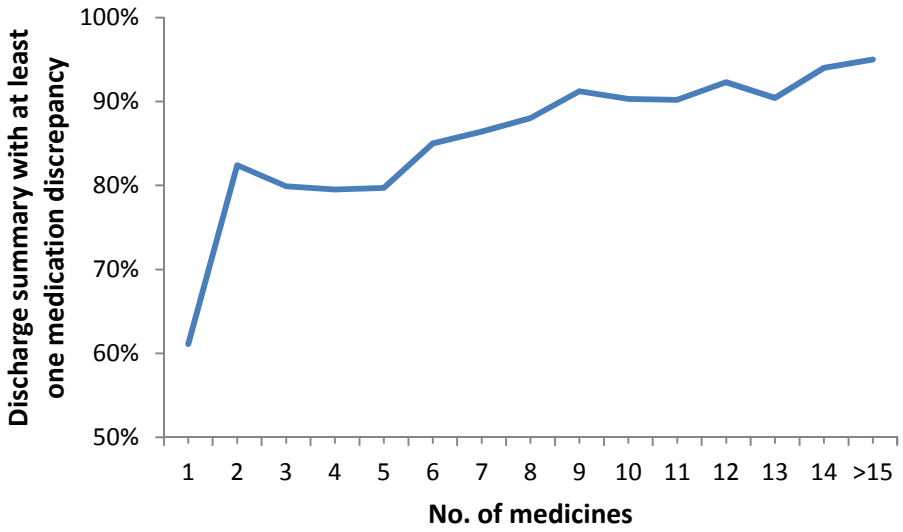


Figure 3.5 Distribution of medication discrepancies and number of prescribed medicines

Additionally, patients who were discharged from orthopaedic wards were almost 11 times at higher risk of having a discharge summary with a medication discrepancy, odds ratio [95%CI] =10.93 [1.11-107.71].

Of note, the unadjusted analysis identified handwritten discharge summary as a predictor of increased risk to medication discrepancy, however this effect was not significant when the model was adjusted to number of medicines. Similarly, this can be seen for the effect of unplanned admission discharge summary. This highlights the confounding effect between variables and the potential benefit of adjusting the model to enable better understanding of the true effects of variables on the quality of discharge information.

		Univariate analysis			Multivariate analysis		
Variable	**N**	**OR**	**[95%CI]**	**p**	**OR**	**[95%CI]**	**p**
Patient demographics	671						
Age		1.0	[0.98-1.01]	0.49	1.0	0.98-1.01	0.58
No. of medications		**1.10**	**[1.04-1.17]**	**0.001**	**1.15**	**1.10-1.24**	**<0.001**
Hospital stay		1.0	[0.98-1.01]	0.81	1.0	0.98-1.03	0.69
Type of discharge summary							
Handwritten discharge summaries	129	**1.79**	**[1.11-2.87]**	**0.02**	0.38	0.10-1.46	0.16
Type of admission [a]							
Unplanned admission	491	**1.61**	**[0.98-2.66]**	**0.06**	0.80	0.43-1.48	0.48
Hospitals [b]							
H2	66	0.97	[0.21-4.45]	0.96	1.43	0.32-6.38	0.64
H4	9	0.62	[0.12-3.1]	0.56	3.27E8	0.00	0.99
H5	48	2.9E8	0.00	0.99	1.41	0.34-5.86	0.64
Community hospitals	13	2.9E8	0.00	0.99	2.97	0.23-37.73	0.40
Mental health or private trust	10	0.55	[0.11-2.82]	0.47	3.93E8	0.00	0.99
Ward specialities [c]							
Medicine for elderly	133	0.83	[0.35-1.99]	0.68	0.80	0.23-2.77	0.73
Orthopaedic	**38**	**9.21**	**[1.09-77.56]**	**0.04**	**10.93**	**1.11-107.71**	**0.04**
General surgery	122	0.73	[0.22-2.43]	0.61	1.47	0.45-4.88	0.53
Urology	40	1.05	[0.43-2.58]	0.91	1.55	0.36-6.62	0.56
Gastroenterology	27	1.37	[0.43-4.39]	0.59	2.62	0.51-13.60	0.25
Cardiology	31	1.94	[0.47-8.08]	0.36	1.01	0.25-4.17	0.98
Thoracic	59	1.05	[0.32-3.41]	0.94	1.14	0.30-4.38	0.85
Paediatric	43	1.35	[0.47-3.85]	0.57	2.15	0.47-9.94	0.33
Oncology	20	1.25	[0.41-3.82]	0.69	4.17	0.41-42.09	0.23
Nephrology	18	4.61	[0.53-39.71]	0.17	4.28	0.42-43.75	0.22
Ear, nose & throat	12	4.12	[0.48-35.70]	0.20	0.00	-	0.99
Endocrinology	22	3.9E8	0.00	0.99	0.52	0.12-2.33	0.40
Gynaecology	21	0.65	[0.19-2.18]	0.48	1.38	0.29-6.55	0.69
Neurology	16	1.03	[0.27-3.92]	0.96	2.92	0.28-30.06	0.37
Other specialities	41	3.64	[0.42-31.74]	0.24	1.15	0.31-4.29	0.84
Profession type [d]							0.83
Core medical training	73	2.10	[0.18-23.99]	0.54	1.91	0.81-4.50	0.14
Senior house officers	45	2.27	[0.19-26.33]	0.51	0.96	0.36-2.55	0.94
Consultants	28	3.56	[0.29-43.31]	0.32	1.33	0.40-4.43	0.64
Registrar	3	2.31	[0.19-28.72]	0.51	0.16	0.004-5.68	0.31
Doctors of unknown training	226	3.13	[0.23-43.02]	0.39	1.21	0.65-2.25	0.54
Pharmacists	10	2.13	[0.15-29.66]	0.57	0.75	0.14-4.1	0.74
Specialist Nurse Practitioners	21	2.76	[0.24-31.23]	0.41	0.94	0.27-3.31	0.93
Unspecified profession	111	2.0	[0.11-34.82]	0.63	0.95	0.45-199	0.89

OR: odds ratio. [a] Compared against planned admission, [b] Compared to H1, [c] Compared to general medicine wards, [d] Compared to foundation year doctors # Bold type face indicates statistically significant model predictors (i.e. p<0.05)

Table 3.39 Summary of logistic regression model of factors predicting medication discrepancies

The model summarised in Table 3.39 demonstrated good fit to predict medication discrepancies (p=0.73, Hosmer & Lemeshow test) and it accounts for 15% (Nagelkerke R square= 0.15) of the variances in the predicted potentials for medication discrepancies. The model assumptions are checked and presented in Appendix 5.

3.10.3 Reconciliation discrepancies

The discharge team provided 241 explicit recommendations for therapy monitoring, initiation, changes such as dose, frequency or formulation changes and discontinuation of which there was documented evidence that it had been followed in primary care for 194 (80.5%) occasions. Reconciliation discrepancies occurred with 175 patients (26.1%) and were carried on after patients being discharged up to eight weeks. Table 3.40 presents examples of reconciliation discrepancies.

With respect to therapy monitoring, there were 23 (9.5%) recommendations, of which 9 (39.1%) were not followed. There were 190 (78.8%) therapy initiations recommended of which 110 (57.9%) involved prescription only medicines. There was no evidence of these medicines being initiated in 19 (17.3%) cases. The initiations of over the counter medicine medicines were not followed for 11 (13%).

Changes to dose, frequency or formulation were not followed for two (out of 6) recommendations for over the counter medicines and three (out of 11) for prescription only medicines. On two occasions, recommendations to discontinue over the counter medicines were made and on neither occasion this was implemented. Requests to discontinue prescription only medicines therapy were implemented on three out of nine occasions.

Following discussion with GPs and primary care pharmacists based on practices, it appeared that recommendations predominantly were not implemented due to informed decision. This was for 26 (53.1%) cases. Meanwhile, for 18 (36.7%) cases, this was because the recommendations were not brought to the GP attention due to being handled by other member of the healthcare team such as the nurse or the pharmacist or due to system or person errors. For 4 (8.2%) recommendations the GP followed the patient preference and for one (2.0%) recommendation the GP recalled a conversation with the hospital staff agreeing to take an alternate action.

3.10.4 Clinical significance of discharge discrepancies

The mean [95% CI] score 4.3 [3.47-5.13] indicating risk of moderate patient harm.

Thirteen (65%) of the discrepancies were considered of moderate harm (i.e. average score 3-7). Six discrepancies (30.0%) were scored < 3 and thus considered of minor risk whilst only one discrepancy was considered of severe harm (i.e. average score > 7). Table 3.40 presents examples of discharge discrepancies with their estimated severity.

Discharge summary discrepancy	TTO information	Discharge summary information	Discrepancy description	Severity
Addition of new medication (medication discrepancy)	Simvastatin 40 mg ON (unknown form)	PC: Right lacunar infarction No comments or further information provided regarding simvastatin	Simvastatin was not continued by the GP post discharge. The GP no changes to therapy and patient is not taking any other lipid lowering agent.	Moderate
Change of dose (reconciliation discrepancy)	Prednisolone (unknown form) 30 mg BD PO	PC: Pulmonary fibrosis and lower respiratory tract infection Prednisolone was requested to be tapered.	Prednisolone dose was not tapered. Prednisolone 30 mg BD is prescribed on repeat screen since discharge. Patient is prescribed omeprazole pre-admission but no bone prophylaxis.	Severe
Addition of new medication (reconciliation discrepancy)	Atenolol (unknown form) 50 mg OD PO Warfarin (unknown form) as per INR PO	PC: Atrial fibrillation The GP was requested to continue atenolol and warfarin	Warfarin and atenolol was not prescribed by the GP post discharge. The GP made no changes to therapy and patient is not taking any other anticoagulants or beta blockers.	Severe
Therapy monitoring (reconciliation discrepancy)	Ferrous sulphate 2 tablets BID PO	PC: Atrial fibrillation The GP was requested to check anaemia.	The GP did not check anaemia. Last results for anaemia in primary care held record November 2010. Patient is regularly prescribed ferrous sulphate tablets since 2003.	Minor
Change of dose discrepancy (reconciliation discrepancy)	Aspirin (unknown form) 150 mg OD PO	PC: Femoral neck fractures following bed fall The GP was requested to continue aspirin 150 mg.	The GP did not increase aspirin dose to 150 mg. The GP made no changes to therapy and patient is remained on pre-admission aspirin 75 mg OD PO.	Minor

ON: evening time. PO: per oral route. INR: International Normalised Ratio. BD: twice a day. OD: once daily. PC: primary compliant. TTO: to take home medicine. GP: general practitioner

Table 3.40 Examples of discharge discrepancies and their estimated risk

Discharge summary discrepancy	TTO information	Discharge summary information	Discrepancy description	Severity
Therapy discontinuation (reconciliation discrepancy) Addition of new medication (medication discrepancy)	Bisoprolol 10 mg OD PO Verapamil 80 mg TD PO	PC: Paroxysmal Atrial Fibrillation (PAF). Bisoprolol was requested to be stopped due to wheezing. No comments or further information regarding verapamil	Bisoprolol was not stopped by the GP. The GP made no changes to therapy and patient prescribed both bisoprolol and verapamil on repeat screen.	Moderate
Unstated medication substitution (medication discrepancy)	Amlodipine (unknown form) 5mg OD PO	PC: Extrcapsular left fracture neck femur No rationale for the drug substitution provided.	The GP did not change lercanidipine to amlodipine. The GP made no changes to therapy and patient remained on pre-admission lercanidipine 10 mg BD	Minor
Addition of new medication (medication discrepancy)	Codeine phosphate 60 QDS PO (unknown form) Paracetamol (unknown form) 1g QDS (PRN) PO	PC: Ovarian cancer No comments or further information regarding codeine phosphate or paracetamol.	The GP did not add codeine phosphate and/or paracetamol. The GP made no changes to therapy and patient is not taking any other analgesics.	Moderate
Therapy monitoring (reconciliation discrepancy	None relevant to the discrepancy		The GP did not monitor calcium levels though patient was discharged since two weeks. Serum calcium was 3.1 mmol at discharge.	Moderate

PO: per oral route. BD: twice a day. OD: once daily. TD: three times a day. QDS: Four time a day. PRN: As required. PC: primary compliant. GP: general practitioner

Continued
Table 3.40 Examples of discharge discrepancies and their estimated risk

3.10.5 Estimated time needed by the GP to confirm necessary action

For 11 discrepancies the estimated time needed by the GP to confirm the action in response to the medication discrepancy was estimated. The median (IQ) estimated time was 1.5 (1, 2) indicating that the time taken to confirm the necessary action was typically less than 15 minutes. None of the discrepancies estimated to require > 30 min.

3.11 Additional discharge information

In addition to the NPC minimum dataset, discharge summaries recorded additional clinical information related to:

3.11.1 Laboratory results and procedures

Discharge summaries recorded information regarding procedures and laboratory tests for 2,396 (69.6%) and 1,471 (42.7%) patients respectively. These patients accounted for 3,920 procedures and 2,394 laboratory tests. Results were reported for 2,165 (62.9%) procedures and 2,127 (88.8%) laboratory tests. Hospital team comments on these procedures and tests were provided only for 1,807 (46.1%) and 1,044 (43.6%), respectively.

3.11.2 Adverse drug reactions during hospitalisation and post admission complications

Discharge summaries reported adverse drug reactions for 453 (13.2%) patients, such as hypotension, dehydration and cellulitis. Post discharge complications were reported for 663 (19.3%) patients, those were mainly infections 410 (61.8%), deep vein thrombosis 223 (33.6%) and bleeding 30 (4.5%).

3.11.3 Contact details if needed by primary care

Contact details for primary care enquiries such as name, role and contact number of person responsible for discharge were recorded for 2,712 (78.7%), 2,686 (78.0%) and 2,201 (63.9%) discharge summaries respectively. Nevertheless, ward contact number was only provided in 453 (13.2%) discharge summaries.

3.12 Variations in the audit data

Ninety five discharge summaries were selected and re-audited. Kappa scores [95 % CI] related to the audit questions are presented in Table 3.41. Mean [95 % CI] of kappa scores was 0.83 [0.81-0.85] and ranged between good to substantial agreement.

The greatest variations were with therapy changes including medicines changed, initiated and discontinued followed by legibility scoring. Variations were also apparent with the number for days to receive discharge summary by primary care and contact details of the person responsible for discharge. User entry errors and uncompleted questions (i.e. blank fields) frequently contributed to these variations. The latter was the predominating reason for the variation with therapy change questions. A prime contributor to the variation in legibility scoring was related to auditors' judgment of whether a discharge summary was considered partially illegible and whether the meaning of the clinical message was obscured or not. Variation related to legibility scoring is further described in a later section (3.13).

Variation in the number of working days needed to receive the discharge summary was due to differences in auditors' interpretation (Table 3.41). Additionally, discharge summaries frequently lacked a nominated person to contact regarding patient hospitalisation and therefore auditors varied in inputting this information.

To obtain further insights on the extents and the rationales of variations within the audit data and obtain guidance on the analysis, one to one discussions with six auditors were arranged.

Auditors included two of each profession: GP, primary care pharmacist and primary care pharmacy technicians. Discussions with the two pharmacists and one pharmacy technician occurred through face to face conversations, whereas discussions with the GPs and one pharmacy technician were over phone. Discussions lasted on average 20 minutes. The key comments from the discussions are summarised in Appendix 17. Table 3.41 provides examples on the auditors' quotes.

Information	Kappa [95% CI]†	Rationale of variations
Age	1 *	
Hospital	1	
Type of discharge summary	1	
Admission date	1	
Correct patient name	1	
Correct date of birth	1	
Presenting diagnosis	1	
Past co-morbidities	0.97 [0.59-1]	Variations in co-morbidities for which patient prescribed medicines vs. co-morbidities with no medications prescribed. E.g. ovarian cyst, stroke, etc.
Gender	0.93 [0.86-1]	Inputting errors and incompletion of the field
Ward specialty	0.93 [0.87-0.98]	Auditors deciphered ward speciality from ward name. E.g. Pentney ward for cardiac care. Quote "*I used to work in this hospital and when I was able to work out the speciality I reported it" PT1*
ADR during hospitalization	0.88 [0.70-1]**	Auditors not completing the related field plus variations in sections of the discharge summary ADRs were recorded.
Type of admission	0.86 [0.78-0.94]	Auditors deciphered type of admission from the clinical history recorded in the discharge summary. Quote "*when the type of admission was not specified but yet can be known from the clinical information I selected unspecified type of admission with comment as free text in the adjacent commentary box"* PT1
Allergy status	0.83 [0.61-1]	Variations in drug intolerances/adverse effects vs. actual drug allergy/hypersensitivities
Contact number to be used by the GP for enquires	0.81 [0.69-0.93]**	Variations in the contact number of the health care professional responsible for discharge or prepared TTOs list vs. the ward consultant.
Medication history	0.81 [0.69-0.93]	Variations in medicines prescribed for regular patient use vs. acute or as needed or repeat medicines that are never issued.
Name of professional responsible for discharge	0.79 [0.47-1]	Variations in the health professional believed to be responsible for discharge or prepared TTOs list vs. the ward consultant.
Consultant name	0.79 [0.52-1]	Auditors not completing the related field plus variations when more than one consultant is named within the discharge summary.

*Pearson correlation. PT: pharmacy technician. TTO: to take home medicines. ADR: adverse drug reaction

Table 3.41 Variation in the audit data

Information	Kappa [95%CI]†	Rational of variations
Was discharge summary received within 2 working days?	0.78 [0.65-0.91]	Auditors not completing the related field plus adding weekends and public holidays to the estimated time spent to receive discharge
Does the discharge summary clearly state all medication that has been started?	0.78 [0.60-0.96]	Auditors not completing the related field plus variations in the response when discharge team had not stated all medicines started. Quote "*If hospital stated 'no* change to regular medication*' I picked yes for being stated and left reason blank. I would have responded same if no actual changes was done and hospital stated nothing"PT2*
Does the discharge summary clearly state all medication that has been changed?	0.77 [0.48-1]	Auditors not completing the related field plus variations in the response when discharge team had not stated all medicines changed. Quote "*If hospital stated 'no change to regular medication' I answered no. I did the same response when no actual changes was done and hospital stated nothing"Ph1*
Ward contact number	0.76 [0.37-1]**	Variations in ward contact number vs. hospital contact number.
If any drug change, is (are) the reason(s) reported/ specified?	0.76 [0.45-1]	Auditors not completing the related field plus variations in the response when discharge team had not stated the reason (s) for all medicines changed.
Discharge date	0.74 [0.39-1]	Variations in the date in which the discharge summary was prepared vs. the date it was sent to the GP
Role of professional responsible for discharge	0.72 [0.52-0.92]	Variations in the role of the health professional believed to be responsible for discharge or prepared TTO list vs. the ward consultant.
Does the discharge summary clearly state all medication that has been stopped?	0.71 [0.34-1]	Auditors not completing the related field plus variations in the response when discharge team had not stated all medicines stopped.
Contact name to be used by the GP if information regarding hospitalisation required	0.70 [0.46-0.94]	Variations in the health professional believed to be responsible for discharge or prepared TTOs vs. the ward consultant.

PT: pharmacy technician. Ph: pharmacist. TTO: to take out medications. †:p<0.05 unless specified otherwise.** p≥0.05

Continued
Table 3.41 Variation in the audit data

Information	Kappa [95%CI]†	Rational of variations
If any drug stopped, is (are) the reason(s) reported/specified?	0.69 [0.32-1]	Auditors not completing the related field plus variations in the response when discharge team had not stated reason(s) for all medicines stopped.
legibility score	0.67 [0.43-0.91]	Variation in auditors' judgment whether illegibility obscured the meaning of the clinical report or not
If any drug started, is (are) the reason(s) reported/specified?	0.61 [0.37-0.85]	Auditors not completing the related field plus variations in the response when discharge team had not stated reason(s) for all medicines started.

†:p<0.05 unless specified otherwise indicating statistically significant agreement.** p≥0.05

Continued
Table 3.41 Variation within the audit data

The re-audit and the one to one discussions enabled better understanding of the audit data quality and the extent of variations associated with the audits' questions. The re-audit and one to one discussions informed the decisions presented in BOX 3.2. Those informed the analysis and interpretation of the audit.

BOX 3.2 Decisions informed by the quality assurance of the audit data

- **Questions related to therapy changes (i.e. medicines initiated, changed, discontinued)**

Uncompleted (blank) fields were analysed in lights of the auditors' comments (Appendix 17). Any uncertainty was clarified by contacting auditors.

- **Contact name and number for enquires**

Variations with respect the name and the contact details were neglected. It was believed that these variations won't be pertinent to practice providing the auditor considered there was an accessible name and contact details recorded by the discharge summary.

- **Number of days to receive discharge summary**

It was not possible to check whether auditors added weekends and public holiday or not to the number of days to receive discharge summary. However, discharge summary of patient discharged on weekends and public holiday were checked and compared to patient discharged form same hospital and ward to investigate anonymities. Any uncertainty was clarified by contacting the auditors.

3.13 Legibility rating agreement

Weighted Kappa scores [95% CI] was 0.86 [0.59-1] (p=0.001) indicating substantial significant agreement. Disagreement was found with 3 (15%) discharge summaries.

3.14 Summary of the main findings

In summary, findings from this Trust-wide audit highlighted three years after the implementation of the UK minimum dataset for discharge information transfer, the requirements are not consistently met. The deviations identified reflect those of previous studies: allergy status, co-morbidities, medication history, details of medicines prescribed and rational of therapy changes as common omissions.

Eight out of ten discharge summaries had at least one discrepancy. Majority of discharge discrepancies had the potential to cause moderate patient harm. Discrepancies were primarily omissions of a pre-admission medicine or additions of new medicines without indicating that it is newly initiated or providing a reason for the initiation. Medicines most frequently implicated to discrepancies were also the most frequently prescribed.

This audit identified that in some instances where information was explicitly provided by the discharge team, recommendations were not implemented by the primary care team resulting in reconciliation discrepancies which continued up to two months post discharge.

Considerable variations in the extent of hospital adherence to the NPC minimum dataset was demonstrated by the study hospitals with H3 demonstrating the greatest adherence. Notably, deviations between hospitals followed a similar pattern to the extent of discharge summary template adherence to the NPC minimum dataset. Templates with high adherence incorporated fields to collect information that was otherwise frequently omitted, e.g. allergy status and therapy change information. The explicit presence of these fields potentially prompted discharge teams to record this information in the discharge summary.

Electronic discharge summaries demonstrated better adherence to the NPC minimum dataset compared to handwritten discharge summaries. Diagrammatic representation indicated that discharge summary of a patient prescribed five medicines or more were associated with an increased risk to experience a medication discrepancy.

Discharge summary from orthopaedic ward was found a predictor of poor adherence to the NPC minimum dataset and contributed to an increased risk of discrepancy.

3.15 Audit dissemination

A comprehensive report presenting the audit findings has been prepared and disseminated across all primary care practices in NHS Norfolk primary care trust.

The audit findings were presented in UK and international conferences in form of posters and oral presentations:

- Hammad E A, Wright DJ, Bhattacharya D, Wood J. Communication of clinical information on health interface: An audit pilot. Conference abstract. International journal of pharmacy practice. 2011; supp 1:page 48

- Hammad E A, Wright DJ, Bhattacharya D, Wood J. Communication of clinical information upon hospital discharge: A regional audit. Conference abstract, International journal of pharmacy practice. 2012; supp 1:page 21

- Hammad E A, Wright DJ, Walton C, Wood J, Bhattacharya D. Medicine reconciliation: An evaluation of hospital discharge discrepancies in one UK primary care trust. Conference abstract. International Pharmaceutical Federation (FIP) congress, Amsterdam- Netherland 2012.

A full paper of the audit findings are currently under review by a peer reviewed journal.

3.16 Re-audit

To complete an audit cycle, changes to the practice should be implemented if warranted and re-audited to evaluate progress. This should be done with ample and reasonable time frame. A re-audit was not plausible within the time frame of this thesis. Recommendations for the purpose of the re-audit, however, are presented in BOX 3.3.

BOX 3.3 Recommendations for the re-audit

For the purposes of the re-audit, the audit tool requires simplification and amendments to facilitate the audit completion and minimise auditors' variations. These are outlined below:

1. Addition of an option for not applicable entries, e.g. no therapy changes, no allergy, no medicines prescribed

2. Addition of a field for NHS number compiling with the NPC minimum dataset requirements

3. Removal of sections related to procedures and laboratory tests, post admission complications. Those were felt laborious and time consuming. Additionally, auditors felt that the relevance of these details vary between patients and within different contexts. Additionally, without the knowledge on the accuracy of these procedures and tests, limited conclusions can be drawn on the quality and the significance of these details availability to patient post discharge care.

Chapter 4

Discussion

Quality of discharge information upon hospital discharge: an audit in primary care

4.1 Extent of adherence to the NPC minimum dataset

Findings from the Trust-wide audit, on the quality of discharge information transferred to primary care presented in chapter three, highlighted that three years post implementation of the NPC minimum dataset, requirements were persistently not met. Deviations identified reflected those of previous studies including allergy status, medication and co-morbidity history, details of medicines prescribed upon discharge and rationales of therapy changes.[29, 48, 65, 131, 145]

The majority of discharge summaries made no reference to drug allergies or hypersensitivities despite a record of one or more allergies existing in the primary care notes for almost half of those patients. However, in many cases, whilst labelled as allergies, these were drug intolerances or adverse reactions rather than allergies. When a definite allergy was present, it was frequently antibiotic or food related. If information is absent or inaccurate at the point of admission, then it is unlikely that it would be accurately communicated upon discharge.[16, 17, 30] Thus allergy and hypersensitivity information may not have been available or accurate during the inpatient stay which is consistent with other reports[24, 131] and of concern in terms of patient safety.

In addition, the audit outlined frequent omissions of pre-admission medicines and co-morbidity history. This is consistent with a previous UK audit across 12 primary care trusts in 2009,[19] and therefore the lack of progress with discharge information communication is of concern. Persistent deficits can be highlighted with information regarding medicine formulation and duration. However, the recipient of the discharge summary, who is the GP, usually has access to a more comprehensive and long term patient history, thus the clinical implication is likely to be limited to cases encountered with medicines newly initiated during the hospital stay. In agreement with findings from previous studies, the audit found frequent omissions in the details and rationales of therapy changes.[29, 48] This information has been reported by GPs as necessary in order to optimise and expedite continuity of care.[40] GPs might need to spend some time to resolve ambiguities in discharge summary and acquiring further contact with hospital team.[31]

The Trust-wide audit investigated the extent to which information additional to the NPC minimum dataset, such as laboratory tests and procedures, post admission complications and discharge team contact details were communicated. There was reasonably good practice in reporting the results of laboratory tests and procedures, however, hospital doctors recorded their comments on those tests or procedures for less than 50% of cases. More than 20% of discharge summaries lacked contact details of the person responsible for discharge. This might exacerbate the cost implications related to the time that might

be spent by GPs to resolve ambiguities in discharge summary and enquiring further details.

4.2 Discharge discrepancies

Eight out of ten discharge summaries had at least one medication discrepancy. This rate is comparable to discrepancy rates previously reported. The nature of these discrepancies was also similar to other reports, which were primarily omissions of pre-admission medicines or addition of a new medicine without providing a rationale for initiation.[29, 31, 32, 51, 163, 208, 209]

Medicines most frequently implicated in discrepancies concurred with previously published studies.[13, 29, 31-33, 35, 44] These medicines were also the most frequently prescribed medicines suggesting that discrepancies are arising from generic procedural issues. A possible reason for incomplete therapy change information could be the perception of the secondary care team that GPs will decipher these changes from the clinical history provided. It may also be that the medicine is considered of low risk, such as analgesics or laxatives and therefore detailed information was considered trivial.[59, 210]

Noteworthy, the audit identified that in some instances where information was explicitly provided by the discharge team, recommendations were not implemented in primary care resulting in reconciliation discrepancies. These discrepancies continued up to two months post discharge. Previous research has suggested that the lack of implementation might be largely due to informed decisions made by GPs.[211, 212] This was in line with the audit findings, albeit, for one third of reconciliation discrepancies the lack of implementation was due to human errors and deficits in the process of handling incoming communication from secondary care. The current practice for processing incoming communication to GPs differs widely. In some primary care practices, information is processed by administrative staff such as the practice receptionist whilst for others it is processed by clinical staff such as a nurse or pharmacist. Primary care practices also use different software to store and view incoming communication. There is also an active NHS intranet providing a direct connection to secondary care in some practices whilst for others this is unavailable.

Inadequate communication of discharge information might lead to unintended changes of patient medicines or unnecessary prescribing.[197, 209, 213, 214] These pose a risk of adverse drug events and costs implicated to patient safety and health care resources use.[48, 197] Approximately, 65% of the evaluated discrepancies had the potential to cause moderate patient harm. These results are in accordance with a similar study which adapted the same validated approach.[35]

Incomplete information regarding therapy changes and discharge medicines might also confuse primary care providers and compromise continuity of patient care.[49, 50]. GPs might need to spend time attempting to establish whether a change was intentional. This audit, estimated that the GP might have spent 15 minutes on average per discrepancy to confirm necessary action. In addition to being time consuming, without having a timely and comprehensive discharge notification GPs might feel unable to continue patient care and maintain clinical responsibility.[49, 215]

The audit also explored information on medicines frequently prescribed and considered of increased risk to cause patient harm including proton pump inhibitors, anticoagulants, clopidogrel, antibiotics and corticosteroids. There was limited communication of titration plans and duration for these medicines. Research has demonstrated that these medicines are often not titrated according to guidelines.[216, 217] The lack of guidance from secondary care may therefore be a contributing factor to such deviation in practice.

4.3 Predictors of non-adherence to the NPC minimum dataset and discharge discrepancies

The audit attempted to identify factors contributing to discharge summary adherence to the NPC minimum dataset and those associated with increased risk of discrepancy. The potential influence of these factors was investigated adjusting for possible confounding and covariate effects between variables. Therefore, predictors of non-adherence to the NPC minimum dataset and the characteristics associated with an increased risk of discrepancy were explored.

Considerable variations were seen between hospitals; H3 demonstrated the greatest adherence. Notably, deviations between hospitals followed a similar pattern to the extent of discharge summary template adherence to the NPC minimum dataset. This is supported by previous research outlining that the use of a standardised discharge summary form resulted in a more comprehensive and accurate communication of discharge information.[145, 218, 219]

Electronic discharge summaries demonstrated better adherence to the NPC minimum dataset compared to handwritten discharge summaries. Electronic production of discharge summaries widely reported to be useful in reducing hand transcription and allowing faster and uniform recording of discharge information.[61, 63, 64] However, whilst electronic discharge summaries remove the element of illegibility, they are subject to errors due to incorrect selection or user entry.[43, 64] In this audit, an electronic discharge summary contributed to a better adherence to the NPC minimum dataset, yet an electronic discharge summary predicted an increased risk of omissions.

The inverse relationship between the number of prescribed medicines and both adherence to the NPC minimum dataset plus increased risk of medication discrepancy is intuitive and consistent with previous reports.[16, 30, 32, 35, 52-54] Diagrammatic representation indicated that discharge summaries of patients prescribed five or more medicines were associated with an increased risk of medication discrepancy which is consistent with other reports.[33, 34, 44, 55]

A discharge summary from an orthopaedic ward is a predictor of poor adherence to the NPC minimum dataset and contributed to an increased risk of discrepancy; this was shown by other studies.[220, 221] Orthopaedic discharge summaries persistently recorded no rationales for therapy changes and provided incomplete information related to medication and co-morbidity histories. Short stay admissions for minor risk procedures and inattention to secondary conditions unrelated to the surgical procedure could explain these frequent deficits. This is consistent with findings from a recent report in 2012 highlighting that errors occurred on discharge were more likely attributed to medicines unrelated to the primary diagnosis.[222] Inattention to secondary conditions and consequently medicines which is unrelated to primary diagnosis might be of significant implications to patient care and safety; a national wide review in USA included over than 11 million discharged patient from 2003-2004 highlighted that among patients who were readmitted within 30 days after a surgical discharge, 70.5% were for unrelated condition.[223] Thus, it is important to devote equal attention to all patient medicines.

The audit did not find differences between profession types with respect to discharge summary adherence to the NPC minimum dataset or risk of discrepancy. Two large reports from UK [13, 66] which is consistent with findings from small studies in USA and Europe [28, 45] highlighted foundation year doctor a contributing factor to increased risk of error. The absence of apparent effect of profession type in our audit could reflect the limited number of data points among profession types and doctor training, this warranted merging subgroups. Additionally, high proportion of discharge summaries was of unspecified profession type or of doctors with no indication of the training level. Thus, no firm conclusion can be drawn on this regard warranting further work.

Similarly, no discernible differences were demonstrated between planned and unplanned admissions; length of hospital stay or patient age and gender were also not identified as significant contributors to the quality of discharge information.

4.4 Strength and limitations

This is the first large scale report investigating adherence to the NPC minimum dataset across one UK primary care trust. Whilst this is not generaliseable to the whole of the UK, the audit has presented data representing various hospitals and specialities. This study is also the first to evaluate the clinical significance of discharge discrepancies using a rigorous approach. To the best of our knowledge, this is also the first study which has attempted to describe reconciliation discrepancies. Therefore, recommendations were proposed on both side of the healthcare interface. Additionally, this is the first Trust-wide audit which thoroughly investigated the predictors of adherence to the NPC minimum dataset and risk of discharge discrepancy.

Of most important, unlike the existing wide scale UK audits,[26, 44] the presenting audit assessed the variation contributed by the use of various auditors. Assessment of variation between auditors was important to enable appropriate analysis and interpretation of findings. The quality assurance of the audit data was satisfactory, indicating good to substantial agreement. Thus the audit findings can be presented with confidence.

However, there are few limitations that warrant discussion. This study has reported the magnitudes of discharge summary adherence to the NPC minimum dataset but it is not possible to comment on the accuracy of the information provided by secondary care. Therefore, further work to capture the accuracy of discharge information is necessary. In addition, little can be known from the audit findings about the proportion of discharge discrepancies that actually led to adverse drug events. Discharge discrepancies were frequently found but these may carry less actual harm to patients.[34]

This study has identified clear predictors of good adherence and thus allowed recommendations to be developed. These are presented in BOX 4.1. However, the amount of variance explained by regression models was small and thus a substantial proportion remains unexplained warranting further work.

Noteworthy, the discharge summary template was identified as a significant predictor of the quality of discharge information. Such a finding might help to promote the implementation of a standardised pro-forma across all NHS trusts. This conclusion, however, might be limited by the variation in templates employed between wards within each hospital. The template representing the majority of discharge summaries generated from each hospital was selected for this audit. The lack of standardisation and use of multiple templates may indicate high variation in care standards and patient management. Therefore, it is impossible to test to which extent the effect of template is affected by the variation in the workflow and staff between hospitals and wards. Future investigation is of value.

BOX 4.1 Audit recommendations

- **To develop a comprehensive electronic pro-forma**
  This potentially might increase adherence to the NPC minimum dataset requirements. However, transcribing and user selection errors are still inherited and require great attentions and users training.

- **To prioritise patients prescribed five or more medicine**
  These patients may need greater care while completing their discharge summaries and therefore future interventions should be targeted at this high risk group.

- **To develop guidance for medicine reconciliation (MR) procedures within primary care**
  This may reduce the proportion of unintentional failures to implement secondary care recommendations and smooth the process of care continuity.

4.5 Implications for practice

Interventions to improve the transfer of information upon discharge are likely dependent on effective Medicine reconciliation (MR) at patient admission. Errors within information obtained on admission are frequently perpetuated on discharge.[17, 28] Therefore, improving the quality of information received in primary care might be enhanced by effective MR practice upon admission and during hospital stay.

Electronic production and transfer of discharge information may enhance the quality and completeness of discharge information; however, user errors and uncompleted fields remain pertinent issues. Hence, attention to update and complete input of information to the computer system, user training and IT support are important to minimise these errors.[63, 64] A standardised electronic pro-forma incorporating fields for information frequently omitted, such as allergy information, could improve the quality of information transfer upon discharge.[64]

Knowledge regarding which patients who might benefit from MR would help to prioritise the service where resources are most scarce. There could be a prompt to take greater care when completing the discharge summary of patients who have been prescribed five or more medicines.

Lack of reconciliation in primary care may be due to the lack of guidance,[19, 21, 224] a standard MR process might help to prevent inadvertent failures in implementing discharge recommendations in primary care.

4.6 Implications for future work

Further exploration of the factors contributing to variations in performance across wards and the reasons why such variations exist is warranted. This might help to enhance the understanding of underlying reasons for variations in practice and the contributions to good adherence by others. One possible way to achieve this would be through interviews with care providers involved in care transition tasks

In summary, this audit identified discrepancies with the information transferred upon discharge and highlighted non-reconciled recommendations by primary care team. The findings of this audit showed that the procedures in use for transferring information at the health interface are not optimum. MR is proposed as a solution for health care transition deficits. Optimum implementation of MR during hospital stay might offer the benefit of enhancing continuity and quality of information transfer at discharge and thus received in primary care. Efforts to identify the effects and the best practice to implement MR which might be translated into national recommendations are of value.

The next chapter reports findings from the systematic review aimed to summarise the available evidence on the effects and resources necessary to implement pharmacy led MR interventions in hospital

Chapter 5

Results

Pharmacy led medicine reconciliation in hospital care: A systematic review

The audit results in the previous chapter, identified that the current process for discharge information transfer in not optimal; discrepancies were identified at both sides of the health interface. The audit identified the prevalence and type of discrepancies occurring within standard care. The next stage in developing and evaluating an intervention tailored to address such discrepancies was exploring the existing evidence to identify the features of effective interventions, the most appropriate outcome measures, the resources necessary to deliver such an intervention and the most effective approach to implementation. Medicine reconciliation (MR) is proposed as a solution for health care transition deficits thus a comprehensive systematic literature search was of studies reporting full implementation of MR was undertaken.

Additionally, the audit highlighted areas for improvement and contributors to poor performance. This informed the need for future interventions aiming to enhance continuity and quality of information transfer at discharge and received in primary care. Optimum implementation of MR during hospital stay would offer the benefit of enhancing post discharge care and continuity of information transfer. Therefore, next step of this thesis work was to determine the effect of MR and resources necessary as well as to describe the best practice of MR in hospital.

5.1 Literature search

The literature search returned 4,065 citations of which 17 studies met the inclusion criteria. The study selection process and number of papers excluded at each stage of the review is illustrated in Figure 5.1. Moderate agreement; kappa [95%CI] =0.48 [0.45-0.51] p=<0.001 was achieved at the title screening stage. Ambiguity and inconsistency in the terminology used to describe MR accounted for 62% of disagreements. Of the screened abstracts, one third were retained for full text screening with good agreement, kappa [95%CI] =0.63 [0.45-0.51] p=<0.001. Disagreement was heavily influenced by a paucity of information in the abstracts and required full text review to confirm that all elements of the MR process were performed.

At the full text screening stage, agreement between the two independent reviewers was much higher, with a kappa value [95%CI] of 0.91 [0.80-1.0], indicating substantial agreement. The main reasons for exclusion of studies are summarised in Figure 5.1. It can be seen that studies were excluded most frequently due to lack of implementing all elements of the MR process.

5.2 Included studies

There were 10 controlled studies of which six were randomised controlled studies [109, 115, 118, 135, 225, 226], two non-randomised prospective observational [227, 228] and two before and after design.[113, 229] The remaining were prospective uncontrolled design.

Seven studies were based in USA [108, 109, 114, 118, 229] and Canada [230, 231]. Nine conducted in Europe of which four were in UK [115, 225, 228, 232], Netherlands [107], Spain [227], two in Sweden [113, 135] and France [233]. One study was based in Australia.[226]

All the included studies were in the English language except one French article.[233] Table 5.1 summarises the characteristics of the included studies with respect to study design, sample size, duration, measured outcomes, comparator plus the inclusion and exclusion criteria.

5.3 Pharmacy led MR

Pharmacy led MR was commonly compared with usual care which consisted of standard pharmacy care provided by a member of the ward staff. However, Hellstrom et al. evaluated the effect of a full pharmacy led MR intervention extending from admission until discharge compared with a discharge MR service which was received by all patients as part of the standard care.[113] In two studies, the standard care included nurse led MR. [118, 229] In one study a nurse verified patient medicines only if it was requested by the doctor.[231]

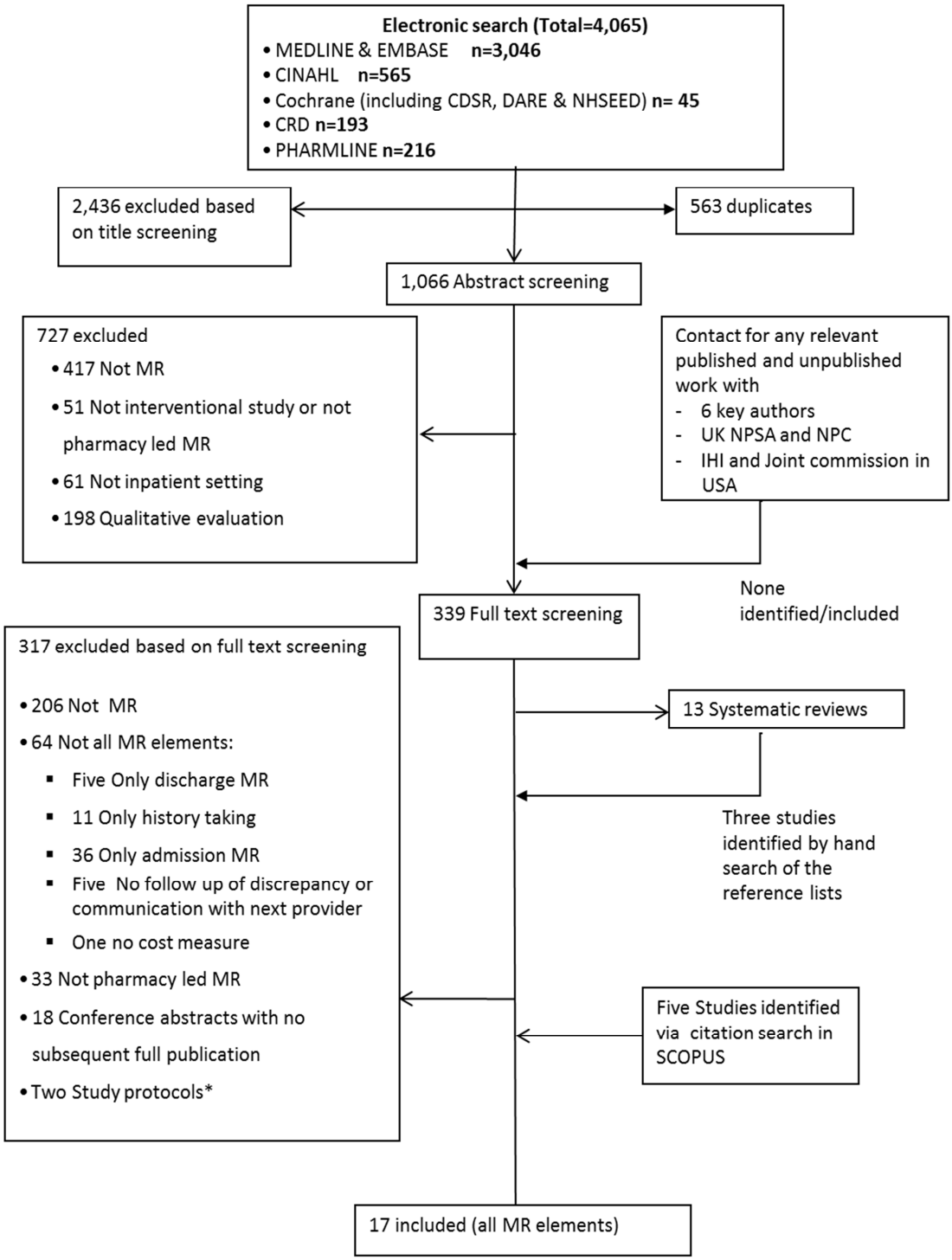
Table 5.2 describes aspects of pharmacy led interventions between studies. It can be seen that the MR process was frequently supplemented by other clinical pharmacy activities such as pharmacotherapy consultation,[107, 109, 114, 115, 135, 228, 230] patient education [107, 109, 114, 115, 118, 225-228, 231, 232] and discharge counselling. [107, 108, 135, 229, 230, 232, 233]

Table 5.3 summarises features of MR process between the included studies with respect to settings, time to implement MR, service cover and provider. The majority of the included studies took place mainly in general internal medicine wards and were led by a pharmacist of clinical or hospital residency experience. In two studies MR was implemented by pharmacy technicians of which MR was led by a team of pharmaceutical consultants who are pharmacy technicians completed an additional three year degree and obtained further pharmacotherapy and patient communication training.[107] The other study was performed by pairs of pharmacists and pharmacy technicians.[115] A pharmacist - nurse collaborative approach to implement MR was evaluated in one study.[229]

For the purpose of this chapter and the later discussion (chapter six), MR pharmacist refers to the MR provider, who could be a pharmacist, a pharmacy technician or a pharmaceutical consultant.

The time point since admission when MR was initiated was reported by six studies. MR was implemented shortly or within 24 hours of admission in three studies.[108, 113, 233] The remaining implemented MR after 24 hours up to 72 hours after admission.[118, 225, 231]

MR was implemented all weekdays during normal working hours in six studies. [113, 135, 229-231, 233] One study reported weekdays and weekends service [225] and few studies reported less extensive MR coverage for two to four days per week. [108, 109, 232]



*Authors were contacted; no published or unpublished relevant data were available
MR: Medicine reconciliation
CINAHL: Cumulative Index to Nursing and Allied Health Literature. CDSR: Cochrane Database of Systematic Review. DARE: Database of Abstracts of Reviews of Effects. NHSEED: NHS Economic Evaluation Database. CRD: The centre of Reviews and Dissemination.
NPSA: National Patient and Safety Agency. NPC: National prescribing centre. IHI: Institute of Healthcare Improvement

Figure 5.1 Studies selection and reason for exclusion

Authors, Year	Study design, sample size	Duration	Outcomes measured	Control	Inclusion criteria	Exclusion criteria
Karapinar-Carkit 2012[107]	Prospective uncontrolled, 262	Nine months	Medication costs/savings in relation to labour costs	-	*Age:* All adults *Number of medications*: ≥ one prescribed medicines *Condition:* Discharged from pulmonology department	*Transferred from/to other wards/hospital:* Not included *Hospital stay:* Discharged within 24 hours or after office hours *Unable to consent*: Physical/mental constraints, language restrictions, or terminal illness. *Included from previous admission:* Not included *Discharge destination*: Discharged to a nursing home
Perennes 2012[233]	Prospective uncontrolled, 61	Five months	Classification and significance of unintentional medication variances	-	*Age:* ≥ 65 years old or more.	*Transferred from/to other wards/hospital:* Not included *Hospital stay:* Discharged before the finalisation of MR *Unable to consent*: Unable to communicate and in isolation or institutionalised
Boso-Ribelles 2011[227]	Prospective uncontrolled [a], 675	Six months	Identification of drug related problems, number of emergency department visits and hospitalisation over three months	-	*No. of medications:* > four medicines listed in the first hospital prescription	None

[a] Number of emergency visits and hospitalisations which were experienced by the patients included in the programme compared against those experienced by patients excluded from the programme due to a lack of resources.. MR: Medicine reconciliation

Table 5.1 Summary of included studies

Authors, Year	Study design, sample size	Duration	Outcomes measured	Control	Inclusion criteria	exclusion criteria
Hellstrom 2011[113]	Before and after Pre-implementation n=101 Post-implementation n=109	Three months	Change in medication appropriateness index between admission and discharge, drug related readmissions and emergency department visits within three months post discharge	Standard care which included only MR upon discharge	*Age:* ≥ 65 years *No. of medications:* ≥ one medicines for regular use	A patient stayed in the study wards during one of the study inclusion dates [b]
Makowsky 2009[230]	Multi-centre, quasi controlled clinical trial Intervention n=220 Control n=231	12 months	Quality score of patient care, hospital readmissions within three and six months	Usual care included traditional reactive clinical pharmacy by either ward-based or dispensary-based staff pharmacists.	*Age:* >18 years *Condition:* Primary diagnosis of coronary artery disease, community acquired pneumonia , chronic obstructive pulmonary disease, heart failure, or type 2 diabetes mellitus [c] and not due palliative cancer	*Transferred from/to other wards/hospital:* Not included *Hospital stay:* Admitted for two days *Others:* Resided outside the capital Health catchment area.
Koehler 2009[118]	Randomised controlled pilot study Intervention n=20 Control n=21	Four months	Hospital readmissions and emergency department visits at 30 and 60 days following discharge	Usual care with floor nursing staff providing MR upon admission and discharge	*Age:* ≥70 years *No. of medications*: ≥ five medicines regularly *Condition:* ≥ three chronic co-morbid conditions, not admitted primarily for a surgical procedure or terminal diagnosis	*Hospital stay:* an average length of hospital stay between 5 and 6 days, patients who could not be enrolled within 72 hours following admission

[b] November 1, 2006 (before the intervention), and March 1, 2007, November 1, 2007 and April 1, 2008 (about 1 month after implementation of the intervention in wards. [c] These disease states were chosen because they are among the most common reasons for admission to the participating teams, are associated with frequent hospital readmissions, and have high-quality evidence to contribute to drug related problems. MR: Medicine reconciliation

Continued
Table 5.1 Summary of included studies

Authors, Year	Study design, sample size	Duration	Outcomes measured	Control	Inclusion criteria	Exclusion criteria
Koehler 2009 cont. [118]	-	-	-	-	*Others:* Requirement for assistance with one activity of daily living, pre-admission residence at home or assisted living with a reasonable expectation of disposition back to that domicile.	*Unable to consent:* Not conversant in English, no reliable phone contact, have no proxy caregiver who could speak English and be reached by phone. *Discharge destination:* Residence in a long-term care facility, skilled nursing facility or nursing home prior to hospitalisation with anticipated discharge back to that facility *Others:* Life expectancy six months
Rabi and Dahdal. 2007[108]	Prospective Uncontrolled, 150	One months	Pharmacist's intervention resolving unintentional discrepancies	-	All patients offered intervention	None
Bayley 2007[114]	Prospective Uncontrolled, 99	Nine months	Type and impact of pharmacist's intervention	-	Patient with primary care physician employed by the hospital system, in-patient stay of at least one day	*Hospital stay:* Overnight "observation" patients *Unable to consent*: With documented memory or mental health issues
Scullin 2007[115]	Randomised controlled study Intervention n=371 Control n=391	18 months	Length of hospital stay, readmission rate within 12-month, health care practitioner satisfactions	Usual care	*Age:* ≥ 65 years *No. of medications*: ≥ four regular medications, taking a high risk medicine(s) or antidepressant *Others*: A previous hospital admission within the last six months, prescribed intravenous antibiotics on the day of admission	Scheduled admissions, patients admitted from private nursing homes

Continued
Table 5.1 Summary of included studies

Authors, Year	Study design, sample size	Duration	Outcomes measured	Control	Inclusion criteria	exclusion criteria
Bolas 2003[225]	Randomised controlled study Intervention n=119 Control n=124	Two weeks [d]	Interventions made during the preparation of medication histories and their clinical significance, emergency department visits within three months	Usual care including standard clinical pharmacy service, with no discharge counselling.	*Age:* ≥ 55 years *No. of medications*: ≥ three medicines taken regularly	*Transferred from/to other wards/hospital:* Not included *Unable to consent*: Patient or carer unable to communicate with pharmacist, mental illness or alcohol related admission, home visit or study follow up was declined upon admission *Discharge destination*: Admitted or transferred to a nursing home
Stowasser 2002[226]	Randomised controlled study Intervention n=104 Control n=105	One month [e]	Mortality, readmission and emergency department visits, change in functional health status, health resource use	Usual care by a clinical pharmacist included review of medication history and current medication, medication supply, counselling on medications and preparing discharge medicines	Patients returning to community following discharge	*Transferred from/to other wards/hospital:* Not included *Hospital stay:* Discharged within 24 hours of admission *Unable to consent*: Unable or unwilling to consent, unable to provide follow up data *Included from previous admission:* Not included *Discharge destination*: Discharged to hostel or nursing home Others: Hospital outpatients admission

[d] Follow- up 10-14 days post discharge [e] Follow up 30 days.

Continued

Table 5.1 Summary of included studies

Authors, Year	Study design, sample size	Duration	Outcomes measured	Control	Inclusion criteria	Exclusion criteria
Hick 2001[228]	Prospective controlled 50 in each group	-	Number, classification and clinical significance of pharmaceutical interventions	Standard post-admission pharmacist ward visit only, which involved checking medication charts for errors and omissions, and making interventions when deemed necessary	*Age:* ≥ 29 years	None
Brookes 2000[232]	Prospective uncontrolled, 109	Five months	Medication related problems, GP and community pharmacist opinions on the service	-	*Age:* ≥ 60 years *No. of medications*: ≥ four drugs *Others:* Admitted via the medical admission unit	None
Kramer 2007[229]	Before and after study Pre-implementation n= 147 Post-implementation n=136	Six months	Feasibility and efficiency of nurse-pharmacist MR, effect on patient safety, and satisfaction of service users.	Pre-implementation phase included admission medication histories and discharge medication counselling followed standard care process which included a nurse led MR	*Age:* ≥ 18 years	*Transferred from/to other wards/hospital:* Not included *Hospital stay:* Admitted for 23 hour observation, *Unable to consent*: Admission due to intentional drug overdose *Others:* Medication history was obtained more than two hours after admission [f]

[f] The rationale for excluding patients when the nursing medication history was obtained over 2 hours after admission was to avoid confounding factors. MR: Medicine Reconciliation. GP: General practitioner

Continued
Table 5.1 Summary of included studies

Authors, Year	Study design and sample size	Duration	Outcomes measured	Control	Inclusion	Exclusion criteria
Gillespie 2009[135]	Randomised controlled study Intervention n=182 Control n=186	21 months [g]	Hospital visits (emergency department visits and readmission) within 12 months	Standard care without direct involvement of pharmacists at the ward level	*Age:* All patients	*Included from previous admission*: Not included *Others:* Scheduled admissions
Vira 2006[231]	Prospective controlled,60	one month	Discrepancies in patient medication upon admission and discharge, clinical significance of unintentional medication discrepancies	Pharmacy or nursing verification of the patients' medication use history if requested by a physician or if there were incomplete or unusual drug orders. At discharge, pharmacists provided medication education if specifically requested by a physician and for additional patients as time permitted	All new admissions in the previous 24 hours	Patient admitted to rehabilitation and chronic care wards
Spinewine 2007[109]	Randomised controlled study Intervention n= 96 Control n=90	19 months [h]	Appropriate of prescribing on admission, discharge and three month post discharge using Medication appropriateness index, mortality, readmission rate	Usual care with acute geriatric evaluation and management care	All admitted patients in the study period *Condition:* Not due to terminal illness	*Transferred from/to other wards/hospital:* Not included *Hospital stay:* Length of stay of 48 hours or less or pharmacist unable to perform an abstracted chart within 3 days of admission because of time constraint *Included from previous admission:* Not included *Others:* Life expectancy of less than three months, patient had been cared for by geriatrician

[h] Seven month recruitment and 12 months follow up. [g] nine month recruitment plus 12 month follow-up. MR: Medicine Reconciliation.

Continued
Table 5.1 Summary of included studies

Study	All MR elements	Pharmacotherapy consultation & medication review	Discharge counselling/planning	Patient and carer education	Written medication information handed to patient	Phone Follow up post discharge	Ward round and bedside care	Medicine helpline	Medication supply/patient own drugs management
Karapinar-Carkit 2012[107]	✓	✓	✓	×	×	×	×	×	×
Perennes 2012[233]	✓	×	✓	×	✓	×	×	×	×
Boso-Ribelles 2011[227]	✓	×	✓	×	×	✓	×	×	×
Hellstrom 2011[113]	✓	✓	×	×	×	×	×	×	×
Makowsky 2009[230]	✓	✓	✓	×	×	×	✓	×	×
Koehler 2009[118]	✓	✓	✓	✓	×	✓	×	×	×
Rabi and Dahdal. 2007[108]	✓	×	✓	×	×	×	✓	×	×
Bayley 2007[114]	✓	✓	✓	✓	×	✓	×	×	×
Scullin 2007[115]	✓	✓	×	✓	×	×	×	×	×
Bolas 2003[225]	✓	×	×	✓	×	×	×	✓	×

Table 5.2 Aspects of pharmacy led interventions by study

Study	All MR elements	Pharmacotherapy consultation & medication review	Discharge counselling/planning	Patient and carer education	Written medication information handed to patient	Phone Follow up post discharge	Ward round and bedside care	Medicine helpline	Medication supply/patient own drugs management
Stowasser 2002[226]	✓	✓	×	✓	×	×	×	×	✓
Hick 2001[228]	✓	✓	×	✓	×	×	×	×	×
Brookes 2000[232]	✓	✓	✓	×	✓	×	×	×	✓
Kramer 2007[229]	✓	×	✓	×	×	×	×	×	×
Gillespie 2009[135]	✓	✓	✓	✓	×	✓	×	×	×
Vira 2006[231]	✓	×	×	×	×	×	×	×	×
Spinewine 2007[109]	✓	✓	×	×	✓	×	×	×	×

Continued

Table 5.2 Aspects of pharmacy led interventions by study

Authors, Year	Settings	Time to implement MR	Pharmacy MR Service cover	Provider (s)
Karapinar-Carkit 2012[107]	Pulmonary medicine department	-	No details	A team of pharmaceutical consultants [a]
Perennes 2012[233]	General Internal medicine ward	25 (41%) within 24 hours of admission 31% between 24 - 48 hours of admission 28% >48 hours after admission	Weekdays	An intern hospital pharmacist [b]
Boso-Ribelles 2011[227]	Cardiology and cardiovascular surgery ward	-	-	A Pharmacist
Hellstrom 2011[113]	General internal medicine ward	Shortly after admission	Weekdays	A Clinical pharmacist
Makowsky 2009[230]	General internal medicine and family medicine wards	No details	Monday-Friday during normal working hours	Team based Pharmacist [c]
Koehler 2009[118]	General internal medicine ward	Within 72 hours of admission [d]	-	Team of 4 clinical pharmacists [e]
Rabi and Dahdal. 2007[108]	Cardiology ward	The same day or prior admission	2- 3 days per week	A college-based primary care pharmacist resident
Bayley 2007[114]	Acute care unit	-	-	A transitional of care pharmacist doctoral prepared [f]

[a] Pharmaceutical consultants: Pharmacy technicians who have completed an additional 3-year bachelor degree program, they are specifically trained in pharmacotherapy and communication with patients. [b] 9 years hospital residency programme. [c] Pharmacists who have a Bachelor of Science in Pharmacy degree, had completed a 1-year hospital pharmacy residency and had practiced as hospital-based clinical pharmacists prior to study participating; one team-based pharmacist had 8 years of practice experience in an intensive care unit, whereas the other had a total of 5 years of experience in intensive care and internal medicine settings. [d] Starting no later than 24 hours after enrolment and continuing up to 1 week following hospital discharge. [e] Upper-level pharmacy residents completing their inpatient clinical rotations. [f] Doctoral prepared with residency training in internal medicine. MR: Medicine reconciliation

Table 5.3 Features of the MR process by study

Authors, Year	Settings	Time to implement MR	Pharmacy MR Service cover	Provider (s)
Scullin 2007[115]	General internal medicine and surgical wards	-	-	Team consisted of five pairs of clinical pharmacists and pharmacy technicians.
Bolas 2003[225]	Medical admission unit	Within 48 hours of admission	Weekdays & weekends	A community liaison pharmacist
Stowasser 2002[226]	-	-	A clinical pharmacist	A clinical pharmacist
Hick 2001[228]	Pre-admission clinic visit	-	A pre-admission clinic pharmacist	A pre-admission clinic pharmacist
Brookes 2000[232]	Medical admission unit	-	2.5 days per week	A community liaison pharmacist
Kramer 2007[229]	-	-	Monday to Friday (7:00 am-3:30 pm)	Pharmacist and nurse collaboration
Gillespie 2009[135]	Acute General internal medicine ward	-	Weekdays (8:00 am to 4 pm)	Two clinical pharmacists
Vira 2006[231]	acute care unit	At least 24 hours after admission	Weekdays	A pharmacist
Spinewine 2007[109]	Acute geriatric evaluation and management	-	4 days per week	A clinical pharmacist

MR: Medicine reconciliation

Continued
Table 5.3 Features of the MR process

5.4 Targeted patient population

A wide spectrum of inclusion criteria can be seen in Table 5.1; studies frequently targeted patients who are newly admitted and prescribed one or more medicines. It can be seen that most of the studies approached patients within 24 hours of admission. However, Bolas et al. and Koehler et al., however, approached patients between 48 and 72 hours of admission to allow inclusion of weekend admissions and to ensure the effect of the MR intervention was not obscured by a short hospital stay. [118, 225]

Generally, studies included patients who were prescribed at least four medicines.[115, 118, 225, 227, 232] Medicines were differentiated into regular and as required; frequently studies targeted patients who were prescribed at least one regular medicines.[113, 115, 118, 225]

The main reason for patient exclusion was a short hospital stay of less than 24 or 48 hours [107, 229, 230, 233], inability to consent for reasons such as language, mental incapacity or illness [107, 114, 225, 229, 233] and patients transferred to other ward, care team or health facility such as a nursing care facility.[107, 225, 229, 230, 233]

Table 5.4 summarises the characteristics of the included patients relevant to age, gender, number of medicines and type of admission. All the included studies were conducted in adult population with age ranging between 65 years to of 93 years old. Exception to this was the study by Vira et al.[231] Vira et al. excluded patients from rehabilitation and chronic care wards which can might explain the younger population seen in the study compared to the rest of the included studies. Overall, an even gender distribution was seen in all the studies except for Perennes et al.[233] and Bayleys et al;[114] those had higher proportion of female participants.

Two studies recorded no details on the number of medicines prescribed to the patient.[108, 230] Six studies reported the total number of medicines prescribed [109, 114, 118, 135, 231, 233] and four studies differentiated the number of medicines into admission and discharge. [107, 225-227] Three studies differentiated medicines into regular and as required use. [113, 228, 229] A patient was prescribed more than six medicines on average. However, patients in the study of Vira et al.[231] and Hick et al.[228] were prescribed lower number of medicines; mean (SD) were 3.6 (3.5) and 4.36 (2.51) respectively. Patients in the study by Vira et al. were younger and were not under the care of the chronic care wards, this might have been attributed to these patients being prescribed fewer medicines. Patients in the study by Hick et al.[228] exhibited a wide age range; 30 to 90 years old and were admitted to a general surgery ward via planned admissions. Those patients might have had a less complex medicine regimen. Details of admission type were not recorded in the majority of studies; however, five studies recorded admission type in which they were mostly unplanned admissions.[107, 115, 135, 225, 231]

Authors, Year		Age		Gender (male)		No. of medications	Type of admission (planned)
	Measured patients	Mean (SD)	**Measured patients**	N (%)	**Measured patients**	Mean (SD)	N (%)
Karapinar-Carkit 2012[107]	All patients	65 (17)	All patients	131 (50%)	Admission	6.6 (3.8)	35 (13%)
					Discharge	9.1 (4.7)	
Perennes 2012[233]	All patients	78 (7.4) Range (65-95)	All patients	20 (31.2%)	All patients	7 (2.9) Range (1-15)	46 (75%)
Boso-Ribelles 2011[227]	Intervention	67.7 (14.5)	All patients	423 (62.6%)	Admission	7.8 (no details)	No details
	Control	69.7 (13.9)			Discharge	8.9 (no details)	
Hellstrom 2011[113]	Intervention	83.0 (7.0)	Intervention	49 (45%)		**Regular use medicines***	No details
					Intervention	8 (5-11)	
	Control	81.8 (7.4)	Control	50 (49.4%)			
					Control	7 (5-11)	
						As needed medicines*	
					Intervention	1 (1-3)	
					Control	1 (1-3)	
Makowsky 2009[230]	Intervention	74.9 (13.9)	Intervention	104 (47.1%)	-	No details	No details
	Control	73.2 (14.7)	Control	102 (44.2%)			

*median (IQR) [a] Two hundred and sixty-four patients were admitted to the cardiology department in the first trimester of 2007; 151 of them were included in the study (intervention) versus 113 patients who were excluded (control). SD: Standard deviation.

Table 5.4 Characteristics of included patients by study

Authors, Year		**Age**		**Gender** (male)		**No. of medications**	**Type of admission (planned)**
	Measured patients	Mean (SD)	**Measured patients**	N (%)	**Measured patients**	Mean (SD)	N (%)
Koehler 2009[118]	Intervention	77.2 (5.3)	Intervention	3 (15%)	Intervention	12.0 (5)	No details
	Control	79.8 (5.6)	Control	8 (38.0%)	Control	11 (3)	
Rabi and Dahdal. 2007[108]		No details		No details	-	-	No details
Bayley 2007[114]	All patients	78.9 (No details) Range (60-94)	All	35 (33%)		9.8 (No details)	No details
	Older than 85 N (%)	33 (31%)					
Scullin 2007[115]	Intervention	70.3 (13.8)	Intervention	167 (45.0%)	-	-	100% unplanned admission [b]
	Control	69.9 (4.8)	Control	192(49.0%)			
Bolas 2003[225]	Intervention	73 (No details) Range (1-27)	Intervention	32(40.0%)	**Admission** Intervention	6.3 (No details) Range (3-21)	100% unplanned admission [b]
	Control	75 (No details) Range (1-37)	Control	31 (39.0%)	Control	6.2 (No details) Range (3-14)	
					Discharge Intervention	6.79 (No details) Range (2-18)	
					Control	6.73 (No details) Range (2-16)	

[b] Unplanned admissions were excluded. SD: Standard deviation

Table 5.4 Characteristics of included patients by study

Authors, Year		Age		Gender (male)		No. of medications	Type of admission (planned)
	Measured patients	Mean (SD)	**Measured patients**	N (%)	**Measured patients**	Mean (SD)	N (%)
Stowasser 2002[226]					**Admission**		No details
	Intervention	67.4 (13.0)	Intervention	63(56.0%)	Intervention	7 (3.7)	
	Control	65.6 (14.0)	Control	69 (54.0%)	Control	7.2 (3.6)	
					Discharge:		
					Intervention	7.6 (3.5)	
					Control	7.6 (3.8)	
Hick 2001[228]	Intervention	67.4 (15.5) Range (30-91)	Intervention	21(42.0%)	**Admission regular medicines** Intervention	2.78 (2.31)	100% planned admission
	Control	63.0 (16.1) Range (30-88)	Control	26 (52.0%)	Control	2.52 (2.58)	
					Admission as needed medicines		
					Intervention	1.12 (1.08)	
					Control	0.50 (0.93)	
					Discharge all prescribed medicines Intervention	4.36 (2.51) 3.60 (3.0)	
					Control		
					Discharge regular medicines	3.28 (2.33)	
					Intervention	3.46 (2.44)	
					Control		
					Discharge as needed medicines Intervention	2.30 (1.39)	
					Control	3.12 (1.49)	

SD: Standard deviation

Continued

Table 5.4 Characteristics of included patients by study

Authors, Year		Age		Gender (male)		No. of medications	Type of admission (planned)
	Measured patients	Mean (SD)	**Measured patients**	N (%)	**Measured patients**	Mean (SD)	N (%)
Brookes 2000[232]	All patients	75 (no details) Range (60-92)	-	No details	All patients	8.0 (no details) Range (4-14)	No details
	Older than 60 n (%)	234 (56%)					
Kramer 2007[229]	Intervention	65.7 (17.6)	Intervention	74(51.0%)	**Total no. of medications**		No details
	Control	64.4 (16.0)	Control	69 (52.0%)	Intervention	8.3 (5.2)	
					Control	6.0 (4.0)	
					Regular medicines		
					Intervention	6.2 (4.3)	
					Control	4.9 (3.5)	
					As required medicines	2.0 (1.9)	
					Intervention	1.0 (1.6)	
					Control		
					Herbal supplements	0.1 (0.6)	
					Intervention	0.1 (0.34)	
					Control		

SD: Standard deviation

Continued

Table 5.4 Characteristics of included patients

Authors, Year		Age		Gender (male)		No. of medications	Type of admission (planned)
	Measured patients	Mean (SD)	**Measured patients**	N (%)	**Measured patients**	Mean (SD)	N (%)
Gillespie 2009[135]					**Regular medicine**		100% unplanned admission
	Intervention	86.4 (4.2)	Intervention	77(42.3%)	Intervention	8.7 (4.5)	
	Control	87.1 (4.1)	Control	75 (40.3%)	Control	7.3 (4.4)	
Vira 2006[231]					**Admission**		
	All patients	56.0 (24.0)	All patients	30 (50%)	All patients	3.6 (3.5)	13 (22%)
Spinewine 2007[109]					**Regular medicine**		No details
	Intervention	82.4 (6.9)	Intervention	27(28.1%)	Intervention	7.9 (3.5)	
	Control	81.9 (6.2)	Control	30 (33.3%)	Control	7.3 (3.3)	

SD: Standard deviation

Continued

Table 5.4 Characteristics of included patients

5.5 Effects of pharmacy led MR

5.5.1 Medication discrepancies and the MR pharmacist interventions

There were considerable variations in the discrepancy rates per patient among the included studies (Figure 5.2). This might reflect differences between studies with respect to the intervention and discrepancy measurement. Additionally, variances in discrepancy rate might be attributed to studies reporting only the rate of unintentional discrepancies without considering intentional discrepancies as errors.[108, 231, 233]

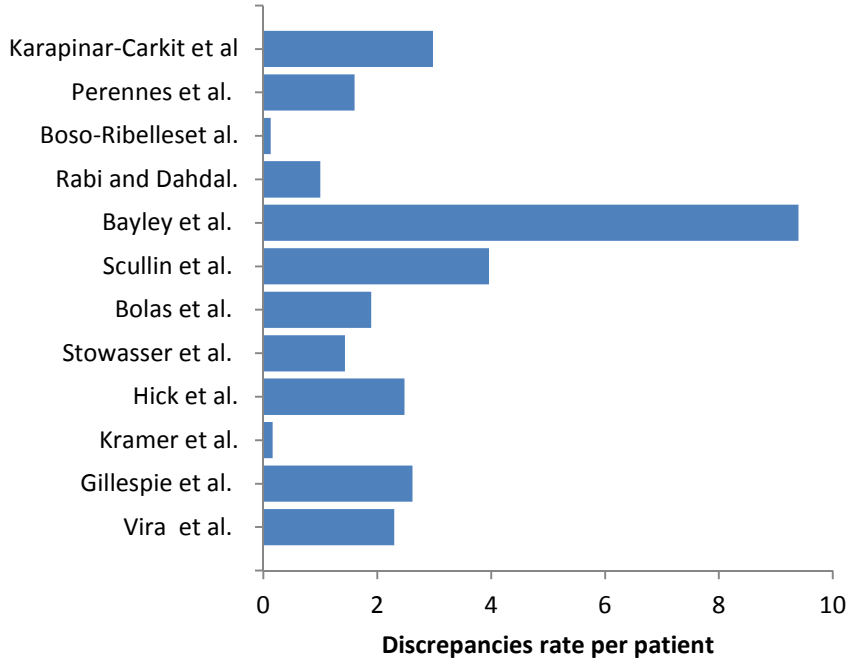


Figure 5.2 Discrepancies rate per patient by study

It can be seen in Table 5.2 that the MR pharmacist often provided non-MR care activities in addition to MR. Thus, studies collectively described discrepancies related to MR and non-MR interventions.[109, 114, 225-228] The highest rate was reported by Bayley et al.; [114] the MR pharmacist interventions were mainly related to medicine consultations. Of these only 20% were related to MR, those were related to allergy clarification.

The lowest rate of discrepancies was found by Kramer et al.[229] Ward staff were asked to complete the documentation of the MR process and to record interventions using computer system; Kramer et al reported that documentation was found incomplete and thus the reported rate is likely to underrepresent the actual rate of discrepancy.[229]

Table 5.5 summarises details of MR discrepancies by study. There were notable variations in the nature of the reported discrepancies. Some studies reported only omission or addition discrepancies, whereas others reported discrepancies such as change to frequency, dose, route of administration and allergy information.

It can be seen that medication omissions and allergy documentation were the most frequent type of discrepancies.[108, 114, 225, 229, 231, 233] Roughly, equal numbers of discrepancies were identified upon admission, during hospital stay and at discharge. [114, 231] However, the types of discrepancies varied over the course of the hospital stay. Admission discrepancies were mainly omissions of pre-admission medicines. Clarification of allergy information frequently occurred upon admission too; Kramer et al and Bayley et al.[114, 229] outlined significant improvement in allergy identification and documentation for intervention patients in comparison to control patients.[229] Discrepancies in medicine's details and additions were identified at a later point of inpatient stay or upon discharge. The pharmacist's role upon discharge was mainly focused on returning the patient to pre-admission medicines and reconciling the changes occurred during the hospital stay.[109, 114]

Studies have highlighted a benefit of MR on post discharge medication information; this was highlighted by Bolas et al.[225] and Stowasser et al.[226] Bolas et al.[225] examined patient medicines at 10-14 days post discharge and outlined significant improvement in the correlation between discharge prescription and home medicines. Thirty days post-discharge, Stowasser et al.[226] found fewer medicines changed in the intervention groups compared to the control group, 33% and 56% respectively. However, the proportion of patients experiencing medicine changes was similar between the study groups.

The potential impact of the MR intervention on patient own drugs, i.e. home medicine brought with patient upon admission, management and minimising medicines wastage was evaluated by Bolas et al.[225] Pharmacy led MR optimised the management of patient own drugs; this was evident by increasing the rate of patient own drugs reconciliation and more patients having their patient own drugs returned for use upon discharge.

5.5.2 Clinical significance of medication discrepancies and MR pharmacist interventions

Seven studies described the clinical significance of discrepancies identified during MR process; these studies used various classifications and rating systems.[114, 225, 227-229, 231, 233] In four studies, the clinical significance of a discrepancy was determined based on a clinical judgment by one or more clinical experts using own developed tools.[114, 225, 231, 233] Two studies adapted standardised tools from previous published work.[225, 228] One study used the Dean and Barber visual analogue scale approach.[228]

A doctor and a pharmacist evaluated the clinical impact of unintentional discrepancies in the study of Perennes et al. More than 50% of the unintentional discrepancies were considered clinically significant.[233] The pharmacist considered more discrepancies with

low to moderate clinical consequences compared to the doctor who assigned no clinical effects or consequences to the same discrepancy.

Boso- Ribelles et al. employed more generic classification based on a judgment by the study pharmacist. More than 80% of the identified drug related problems were considered potential and one out of ten drug related problems were considered actual.[227]

Bayleys et al. rated pharmacist interventions with respect to length of impact as short or long term. Additionally, Bayleys et al. assessed the clinical importance ranging from "simple cost saving" to "prevent of morality". One out of three interventions prevented serious morbidities.[114] All ratings were based on the study pharmacist's judgment; however, the ratings were reviewed by two independent pharmacists and the variances identified were discussed.

Similar to Perennes et al.,[233] Vira et al. evaluated the clinical importance of unintentional discrepancies. Clinical importance was considered when a discrepancy caused or had the potential to cause death, permanent or temporal disability, prolonged hospital stay, readmission, need for additional treatment and monitoring to protect the patient from harm. The MR pharmacist intercepted three out of four discrepancies considered clinically important before causing patient harm. This was based on one internist doctor judgment.[231]

A validated system was employed by Bolas et al; using Eadon [234] ratting system grading "0" as being detrimental to patient health through to "6" which is potentially lifesaving. Discrepancies assessment was performed independently by a consultant and a pharmacist. More than 90% of the interventions were graded as significant or very significant resulting in improvement within the standards of care and preventing major organ failure or adverse reactions. The pharmacist again rated interventions with greater significance compared to the consultant.[225]

The work of Hick et al. on the clinical significance was based on Dean and Baber approach;[183] using a visual analogue scale with four clinical expert judges. Four senior pharmacists rated the interventions on a visual analogue scale ranging from 0 to10 with anchors of life threatening and lifesaving effect. The study pharmacist interventions exhibited more potential positive impact to patients compared to the ward pharmacist's interventions. Dean and Barber approach is a validated estimate of medication error severity; Hick et al believed that the same can be applied to the clinical significance of the MR pharmacist interventions. There was no significant agreement between assessors, ($p<0.001$). Further to the use of visual analogue scale, Hick et al. graded interventions using a standardised scale adapted from a published study in the USA with a few

modifications to ensure simplicity of wording. The tool was devised to assess the clinical impact of pharmacist interventions.[235] Interventions were graded using “1” with adverse effect on patient to “6” with potentially lifesaving effects. The results of the modified Hatoum scale [235] were in agreement with Dean and Barbers’ tool. Again, the study pharmacist interventions exhibited significantly more potential impact to improve patient care compared to the ward pharmacist interventions.[228]

Kramer et al. reported their intent to employ the existing policy of errors reporting in the study hospital, but due the lack of documentation it was not possible to assess the clinical significance.[229]

Authors, Year	Nature of discrepancy	N (%)	Clinical significance	N (%)	Rater(s), agreement
Karapinar-Carkit 2012[107]	Correction of formulary changes	70 (9.0%)	-	-	-
	Omission of pre-admission medication	409 (52.3%)			
Perennes 2012[233]	**Unintentional** [a]		**Doctor judgment** [b]:	19 (50%)	A Doctor and a pharmacist, no details on agreement
	Omission of pre-admission medication	29 (76%)	Not susceptible to have clinical consequence		
	Wrong regimen	6 (16%)	Susceptible to low clinical consequence	17 (45%)	
	Wrong dosage and incorrect frequency of administration	3 (8%)	Susceptible to moderate clinical consequence	2 (5%)	
	Intentional		**Pharmacist judgment** [b]**:**		
	Undocumented	58 (97%)	Not susceptible to have clinical consequence	9 (24%)	
			Susceptible to low clinical consequence	15 (42%)	
			Susceptible to moderate clinical consequence	11 (29%)	
Boso-Ribelles 2011[227]	Occurred in the transfer of medical care	76 (87.2%)	Potential DRPs	73 (83.9%)	-
	Drug related problem identified during admission reconciliation	1 (1.2%)	Actual DRPs	10 (11.5%	
	Drug related problem identified during discharge reconciliation	82 (94.3%)			
Rabi and Dahdal. 2007[108]	Improper documentation of allergies	26 (46.4%)	-		-
	Medications omission of medication taken before admission	20 (35.7%)			
	Wrong dose	6 (10.7%)			
	Deletion or addition of medication	4 (7.1%)			

[a] Non-prescribed over the counter medications were not taken into account to identify these divergences. [b] Only unintentional discrepancies were evaluated for clinical consequence. MR: Medicine reconciliation

Table 5.5 Summary of MR discrepancies and MR pharmacist interventions

Authors, Year	Nature of discrepancies	N (%)	Clinical significance	N (%)	Rater(s), agreement
Bayley 2007[114]	**Admission interventions**		**Impact**		All ratting done by the study clinical pharmacist, the first 20 patients in the study were independently reviewed by the pharmacy manager and study author.
	Allergy Information updated/deleted	27 (13.8%)	Short-term impact	190 (20.5%)	
	Existing allergy reaction clarified	120 (61.2%)	Long-term impact	151 (16.3%)	
	New allergy identified	49 (25.0%)	Both short-term and long-term impact	583 (62.9%)	
	In hospital interventions				
	Allergy Information updated/deleted	1 (0.28%)	**Importance**		
	Existing allergy reaction clarified	4(1.1%)	Interventions prevented serious morbidity	273 (29.2%)	
	New allergy identified	4 (1.1%)			
	Intercepting an order of medicine the patient is allergic to	1 (0.28%)	Interventions prevented potential adverse drug event	626 (67.7%)	
	Discharge interventions		Interventions precluded cost (e.g. improper product selection)	27 (2.9%)	
	New allergy identified	1 (0.38%)			
	Follow up interventions**				
	New allergy identified	1 (0.38%)			
	Allergy Information updated/deleted	1 (0.37%)			
	Intervention decrease morbidity				
	Existing allergy reaction	22 (8%)			
	New allergy identified	4 (1%)			

**Follow up care plans with primary care. MR: Medicine reconciliation

Continued

Table 5.5 Summary of MR discrepancies and MR pharmacist interventions

Authors, Year	Nature of discrepancies	N (%)	Clinical significance	N (%)	Rater(s), agreement
Scullin 2007[115]	Discrepancies related to a medicine name	871 (62.7%)	-	-	-
	Discrepancies related to a medicine form	58 (4.2%)			
	Discrepancies related to a medicine strength	137 (9.9%)			
	Discrepancies related to a medicine dose	164 (11.8%)			
	Discrepancies related to a medicine frequency	159 (11.4%)			
Bolas 2003[225]	Drugs missing from patient prescription chart	110 (49%	**Consultant** [C]		Independently by a hospital pharmacist and medical consultant. No details on agreement
			An intervention that is detrimental to patient's well-being or patient care	None	
	Incorrect dose/frequency	46 (20%)	An intervention that is significant but does not lead to an improvement in patient care	20 (8.9%)	
	Clarification of strength or presentation	32 (14%)	An intervention that is significant and results in an improvement in the standard of care	171 (76.0%)	
	Drug choice query	10 (4.5%)	An intervention that is very significant and prevents major organ failure or adverse drug event	34 (15.1%)	
	Incorrect drug	11 (5%)	An intervention that is potentially lifesaving	None	
			Pharmacist [C]		
			An intervention that is detrimental to patient's well-being or patient care	9 (4.0%)	
			An intervention that is significant but does not lead to an improvement in patient care	7 (3.1%)	
			An intervention that is significant and results in an improvement in the standard of care	117 (52.0%)	

Continued

Table 5.5 Summary of MR discrepancies and MR pharmacist interventions

Authors, Year	Nature of discrepancies	N (%)	Clinical significance	Rater(s), agreement
Bolas 2003[225] (cont.)	An intervention that is very significant and prevents major organ failure or adverse drug event	87 (38.7%)		-
	An intervention that is potentially lifesaving	5 (2.2%)		
Hick 2001[228]	**Discrepancies identified by MR pharmacist** Interactions, previous adverse drug event, drug therapy in 'Nil By Mouth' periods, the need for long term medication, and information documented in medical records	42 (33.9%)	**Visual analogue scale** Mean (SD) VAS scores for intervention 1.6 (0.94) vs. for control 1.1(0.59), (p=0.003) MWU-test Natural log (ln) transformed VAS scores, (p=0.03) ISTT	Two methods were used: **Visual analogue scale;** Four senior pharmacists rated every intervention, agreed on the rated grades, no significant agreement ANOVA p <001
	Dosage discrepancies	24 (19.4%)		
	Drug choice/identity discrepancies	55 (44.3%)		
	Discrepancies identified by the ward pharmacist Interactions, previous adverse drug reactions, drug therapy in 'Nil By Mouth' periods, the need for long term medication, and information documented in medical records	13 (11.7)	**Modified Hatoum Scale;** The median (IQR) grades intervention 3 (3 to 4) and 3 (2 to 3) for control (MWU, p=0.005).	**Modified Hatoum Scale;** second panel (comprising four senior pharmacists, with equal experience to the first), In 85% of cases two out of three assessors
	Dosage discrepancies	47 (42.4%)		
	Drug choice/identity discrepancies	37 (33.3%)		
Brookes 2000[232]	**Admission** 66 patients (60.5%) were found to have a discrepancy in their medication history on admission as follows: incorrect or missing strength of medication, incorrect or missing dose of medication, drug omitted from medication history, drug recorded but no longer taken by the patient	-	-	-
	Discharge In 36 cases (33%) there were problems with the discharge Procedure [d]			

VAS: Visual analogue scale. MWU: Mann–Whitney U test. MR: Medicine reconciliation.SD: Standard deviation. IQR interquartile range. ANOVA: Analysis of variance

Continued

Table 5.5 Summary of MR discrepancies and MR pharmacist interventions

Authors, Year	Nature of discrepancies	N (%)	Clinical significance	Rater(s), agreement
Kramer 2007[229]	**Pre-implementation phase**[d]		**Pre-implementation** [e,f] two category B errors and one category C error. **Post-implementation** [e,f] Three category B errors and one category C error.	-
	Incomplete medicines	8 (33%)		
	Duplicate medicines	5 (20.8%)		
	Dosage changes	5 (20.8%)		
	Adverse drug events	1 (4.2%)		
	Allergies changed	5 (20.8%)		
	Post-implementation phase[d]			
	Incomplete medicines	4 (8.3%),		
	Duplicate medicines	3 (6.3%)		
	Dosage changes	15 (31.3%)		
	Adverse drug events	1 (2.1%)		
	Allergies identified	24 (50.0%)		
	Allergies changed or allergy incomplete	1 (4.7%)		
Gillespie 2009[135]	Transcription errors and faulty omission or addition of drugs were frequently detected by the pharmacists.	-	-	-

[d] In the pre-implementation phase, admission medication histories and discharge medication counselling followed standard care processes. A nurse obtained each patient's medication history and called the patient's physician for admission medication orders. The nurse then handwrote admission medication orders in the physicians' order section of the medical record. At discharge, the nurse handwrote each patient's medication list and provided discharge counselling. In post-implementation pharmacists and nurses collaborated to electronically complete admission and discharge medication reconciliation documentation. [e] Categories A through C classified by National Coalition Council Medication Error Reporting Program Taxonomy; category A = circumstances or events that have the capacity to cause error, category B = an error occurred but did not reach the patient, category C = an error occurred and reached the patient but did not cause harm. [f] Severity of potential errors prevented were categorized using the hospital's policy for categorizing medication errors. MR: Medicine reconciliation.

Continued

Table 5.5 Summary of MR discrepancies and MR interventions

Authors, Year	Nature of discrepancies	N (%)	Clinical significance	N (%)	Rater(s), agreement
Vira 2006[231]	**Total** [g]		▪ **Overall**		An internist
	Omitted medications	80 (59%)	Patients with at least one clinically important unintended variance 95% CI 11 (18%) [9 to 28]		
	Incorrect/omitted details (dose, route, frequency)	18 (13%)	Clinically important unintended variances 0.33 per patient		
	Medication unintentionally ordered	4 (3%)	▪ Intercepted	15 (75%)	
	Lack of discharge instruction regarding medicines changed in hospital	34 (25%)	▪ Not intercepted	5 (25%)	
			Variances leading to harm 0.07 per patient		
	Discrepancies at admission	50 (72%),	▪ **Admission**		
	Omitted medication/prescription	15 (22%)	Patients with at least one clinically important unintended variance 95% CI 9 (15%) [6 to 24]		
	Incorrect/omitted details (dose, route, frequency)		Clinically important unintended variances 0.17 per patient		
	Medicines unintentionally ordered	4 (6%)	▪ Intercepted	8 (80%)	
			▪ Not intercepted	2 (20%)	
	Discrepancies at discharge		Variances leading to harm 0.03 per patient		
	Omitted medication/prescription	30 (45%)	▪ **Discharge**		
	Incorrect/omitted details (dose, route, frequency)	3(4%).	Patients with at least one clinically important unintended variance 95% CI 5(9%) [2 to 16]		
			Clinically important unintended variances 0.17 per patient		
			▪ Intercepted	7 (70%)	
			▪ Not intercepted	3 (30%)	
			Variances leading to harm 0.03 per patient		

[g] Unintentional errors. MR: Medicine reconciliation.

Continued

Table 5.5 Summary of MR discrepancies and MR pharmacist interventions

Authors, Year	Nature of discrepancies,	N (%)	Clinical significance	N (%)	Rater(s), agreement
Spinewine 2007[109]	**On admission** At least one unnecessary drug was prescribed to 84.4% of control and intervention patients on admission. **On discharge** Unnecessary drug use in 77.8% of control patients and 37.5% of intervention patients.	-	-	-	-

MR: Medicine reconciliation.

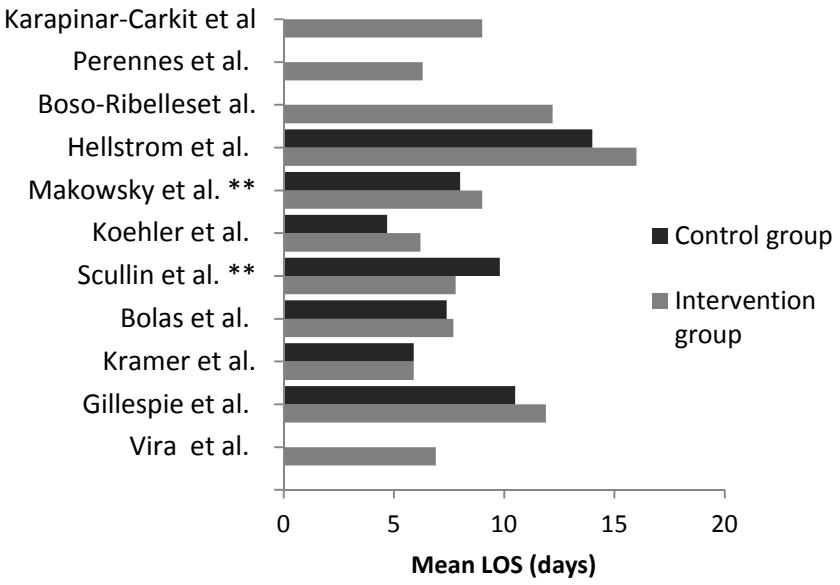
Continued

Table 5.5 Summary of MR related discrepancies and MR pharmacist interventions

5.5.3 Length of hospital stay

Length of hospital stay was reported as a descriptive demographic in eight studies. [107, 113, 135, 225, 227, 229, 231, 233] Duration of hospital stay was compared between the intervention and the control groups in seven studies, of which four of them included length of hospital stay as a measured outcome.[115, 118, 226, 230] Frequently intervention patients stayed for longer time compared to control patients; however this was often not statistically significant all p > 0.05.[113, 135, 225, 229] Mean of hospital stay by study can be seen in Figure 5.3.

Scullin et al. was the only study which demonstrated a significant reduction in length of hospital stay. The duration of hospital stay was reduced by 2 days on average; mean [95%CI] 9.8 [8.8-10.9] days for the intervention group and 7.8 days [7.1-8.6] for the control group (p=0.003). [115] In contrast, Makowsky et al. reported significant increase in length of hospital stay of intervention patients compared to control patients; adjusted median ratio [95% CI] was 1.16 [1.01, 1.34] (p=0.031).



*Median length of hospital stay

Figure 5.3 Average length of hospital stay by study

5.5.4 Readmissions and emergency department visits

Details of readmissions and emergency department visits can be seen in Table 5.6. Overall, studies reported fewer readmissions and emergency department visits for intervention patients compared to control patients; however, this was often not statistically significant. Readmissions and emergency department visits were evaluated at different time post discharge which ranged from 30 days up to 12 months. At 30 days post discharge, readmission rate in the intervention group was reduced in the study by Stowasser et al; this effect just failed to reach statistical significance.[226] Mean (SD) number of readmissions per patient was 0.12 (4) for the intervention group compared to the control group which was 0.46 (1.9) (p=0.055).[226] Of note, mean planned visits was significantly lower in the intervention group compared to the control group; 6.3 vs. 8.61 respectively $p < 0.05$.

Koehler et al. found significant reductions in readmission and emergency department visits. This effect appeared 30 days post discharge but was not continued beyond 60 days.[118] At three months, unplanned drug related readmissions were significantly reduced in the intervention group in the study by Hellstrom et al. The absolute risk reduction [95% CI] was 6.4% [1.2-14.1].[113] However, the proportions of patients experiencing at least one drug related admission were similar between groups. All cause of hospital readmissions combined with emergency department visits were significantly reduced three months post discharge in the study by Makowsky et al. Similar to Koehler et al. this significant effect was not carried on six months post discharge.[230] Conversely, at longer follow up of 12 months post discharge, Scullin et al. found a significant reduction in hospital readmissions. The average number of readmissions per patient for the intervention group compared to control patients was 0.8 and 1.0 respectively. Numbers of readmissions as well as the proportions of patients readmitted were significantly lower in the intervention group compared to the control group. Additionally, the average duration of readmissions was reduced by 3.4 days, (p=0.068) and patients took significantly longer time (262 days) to be readmitted to hospital compared to control patients (242 days), (p=0.036).[115]

Koehler et al. also highlighted that the time for readmissions and emergency department visits to occur was longer for intervention patients compared to control patients. Number of days for the first readmission or emergency department visit to occur was 36.2 and 15.7 days respectively, $p < 0.05$. Additionally, duration of readmissions was shorter for intervention patients with mean (SD) 3.7 (2.1) days compared to patients in control group 2.2 (2.1). Koehler et al. was a pilot study of small scale; 20 in each group, there was no sufficient power for statistical comparison between groups.[118]

Authors, Year		All hospital revisit (Readmission & emergency department visits)		Readmissions		emergency department visits	
	Measure	**Intervention** No. patients (%)	**Control** No. patients (%)	**Intervention** No. patients (%)	**Control** No. patients (%)	**Intervention** No. patients (%)	**Control** No. patients (%)
Boso-Ribelles. 2011[227]	Over the first 3 months [a]	-	-	61 (40.4%)	63 (55.8%)	82 (54.3%)	73 (64.6%)
Hellstrom 2011[113]	Three months post discharge **	6 (5.6%)	12 (12%)	2 (1.9%) [b]	3 (3%)	None	3 (3%)
Makowsky 2009[230]	Three month post discharge**	80 (36.2%)	105 (45.5%)	-	-	-	-
	Six months post discharge*	112 (50.7%)	130(56.3%)				
Koehler 2009[118]	0-30 days post discharge **	2 (10%)	8 (38%)	-	-	-	-
	31- 60 day post discharge*	1 (5%)	4 (20%)				
	0-60 days post discharge*	9 (42.9%)	6 (30%)				
Rabi and Dahdal. 2007[108]	Over 1 month study		-	2 (3.6%)	-	-	-
Scullin 2007[115]	12 month follow**[c]		-	141 (38.0%)	172 (44.0%)	-	-
Bolas 2003[225]	Three month post discharge		-			No details about frequency*	

[a] Comparing the number of emergency visits and hospitalisations over the first trimester of 2007 which were experienced by the patients included in the programme against those experienced by patients excluded from the programme due to a lack of resources. [b] Unplanned admissions. [c] Two patients (one intervention and one control) were excluded from the analysis due to insufficient medical record data. Numbers to treat, i.e. receiving the study service in order to prevent one readmission 11.7 patients. * NS ($p > 0.05$) ** sig ($p < 0.05$).

Table 5.6 Summary of readmissions and emergency department visits by study

Authors, Year	Measure	All hospital revisit (Readmission & emergency department visits)		Readmission		Emergency department visits	
		Intervention	Control	Intervention	Control	Intervention	Control
Stowasser 2002[226]	30 days post discharge Planned readmissions * No. patients (%)	-	-	12 (11%)	17 (13%)	-	-
	Unplanned admission* No. patients (%)	-	-	9 (8.0%)	12 (9.4%)		
	No. unplanned admission per patient, mean (SD)	-	-	0.08 (0.3)	0.13 (0.5)		
Brookes 2000[232]	During the period of the study (five months) No. patients (%)	-	-	7 (6.4%)	65 (8.8%)	-	-
Kramer 2007[229]	30 days post discharge* No. patients (%)	-	-	8 (5.7%)	17 (11.6%)	9 (6.1%)	12 (8.8%),
Gillespie 2009 [g] [135]	12 months post discharge* No. patients (%)			106 (58.2%)	110 (59.1%)		
	No. per patient, mean (SD)	1.46 (1.88)	1.69 (2.24)	0.049 (0.06)	0.24 (0.32)	0.27 (0.35)	0.5 (0.66)
Spinewine 2007[109]	12 months post discharge* No. patients (%)	-	-	250 (32.6%)	220 (33.7%)	60 (7.9%)	78 (12.0%)

*NS (P >0.05),** sig <0.05. [g] Comparison using quotient. SD: standard deviation

Continued

Table 5.6 Summary of readmissions and emergency department visits by study

5.5.5 Health resource use in community

Stowasser et al. evaluated health resource used in community 30 days post discharge using a post survey. Response rates for the intervention group were 93% and 85% for the control group. Total number of visits to health care professionals were fewer for patients in the intervention group compared to control group; mean (SD) were 7.54 (7.4) and 9.94 (10) respectively ($p<0.05$). Health services visits were differentiated into GP, medical specialist, community pharmacist and domiciliary nurse; the only significant reduction was for the visits of medical specialists; mean (SD) was 0.67 (1.1) for the intervention group and 0.94 (1.2) for the control group ($p<0.05$).

5.5.6 Health Related Quality of Life

One study [226] evaluated the impact of pharmacy led MR on health status measured by SF- 36.[236] SF- 36 is a short-form health survey contains 36 questions with eight measures: bodily pain, general health, physical functioning, role physical, mental health, role emotional, social functioning and vitality.

Thirty days post discharge, patients in the intervention group showed improvement with all health measures except for general health. However, the only statistically significant improvement was for bodily pain and physical functioning, $p <0.05$. Control patients showed improvement for bodily pain, physical functioning, mental health and vitality which was significant for bodily pain, physical functioning and vitality. Magnitudes of changes in the intervention group, however, were more profound compared to the control group, except for vitality.

5.5.7 Mortality

Impact of the MR intervention on mortality was reported by three studies.[109, 115, 135, 226] At 12 months, all three studies found similar death rates between the intervention and the control patients. Although, these conclusions are derived from randomised controlled studies, there were significant imbalances between groups. In two studies, compared to the control group, more patients in the intervention group required more complex care. Those who were prescribed more medicines were also intervention patients.[109, 135]

5.6 Cost associated with pharmacy led MR

Studies reported a range of costs associated with pharmacy led MR interventions (Table 5.7). However none of these studies estimated these costs via an economic evaluation design. Only one study performed a form of cost analysis from a health insurer's perspective.[107] Table 5.8 summarises costs associated with the MR interventions. Primarily, costs were related to the additional use of the MR pharmacist [107, 231] medicine

use [107, 225, 232], readmissions and emergency department visits [115, 135, 232] and other health care professional time.[228, 229]

The time spent to implement MR was valued in two studies; in the study by Karapinar-Carkit et al. the time was converted into labour costs of a pharmaceutical consultant which was estimated as €41.04/ patient (sensitivity analysis €25.56-€59.40). The study also valued the time in relation to a clinical pharmacist and a pharmacy technician labour cost which was €49.24/ patient and €32.83/ patient respectively (Table 5.8). Vira et al. valued the costs related to pharmacist time spent performing admission MR yielding a cost of $10.6/patient. This estimation was based on the overall time required to perform the admission reconciliation which was 1,090 minutes for all patients in the study (n=60).[231]

Medicine costs/savings were evaluated by Karapinar-Carkit et al.[107] Three mutually exclusive categories of errors were identified (Table 5.5) of which only the correction of hospital formulary and therapy optimisation errors were considered of real costs to patients prescriptions and consequently to health insurers. Errors related to discrepancies identified between pre-admission and inpatient medicines considered of no costs since the patient is taking them prior admission, and therefore these errors were not included. Medicine costs/savings were thus estimated as the difference between the labour costs and medicines costs related to the correction of hospital formulary and therapy optimisation errors. Discharge medicines intended for chronic use were prescribed for one month in the study department and thus medicines costs/savings were estimated at one month post discharge. Additionally, medicines costs/savings were estimated at six months period assuming that chronic medicines often continued up to 6 months. Medicines contributed to costs for patients but not to insurers were not included and thus the costs of the interventions contributed by over the counter and herbal products were not estimated. Those medicines are paid by patients in Netherland.[107] Karapinar-Carkit et al. demonstrated that the net saving in medicine costs contributed by the MR interventions was €21.77/patient at one month and €96.65/patient six months. Savings didn't outweigh the pharmacy labour cost after one month, whereas it overweighed the labour costs at six months post discharge with a net saving of €55.62 /patient (sensitivity analysis €37.25-€71.10).[107] The cost savings attributed to a clinical pharmacist and a pharmacy technician were estimated; at six months post discharge net savings were €47.41/patient (25.37-65.98) for the clinical pharmacist and €63.82/patient (sensitivity analysis €49.13-€76.21) for the pharmacy technician. Similarly, cost savings didn't outweigh the labour costs of the clinical pharmacist and the pharmacy technician at one month post discharge.[107]

Costs related to reconciliation and management of patient own drugs upon admission were evaluated by Brookes et al. and Bolas et al.[225, 232] The costs of patient own drugs returned from wards that were left behind 13 patients after discharge were on average £25.22. Consequently over three weeks and for 35 patients, the wastage related to inappropriate management of patient on drugs was estimated more than £15,000 annually.[232] Bolas et al. reviewed the medicines which were returned to the pharmacy over the study period, the estimated costs of patient own drugs that could have been returned and used was over £4,000 annually.

Savings related to readmissions and emergency department visits can be outlined from Table 5.8 in three studies. [115, 135, 232] Scullin et al. suggested substantial saving in costs contributed by reduction in hospital stay. Cost savings were estimated based on savings in beds occupancy which then were extrapolated assuming that 64.5% of patients were eligible for the pharmacist intervention. The potential annual saving was estimated to be over £3 million.

Cost savings related to prevention of readmissions were estimated by Brookes et al. Over four months, 18 readmissions were prevented which extrapolated to an annual base of 72 readmissions with an estimated average stay of 7.7 days. Consequently, total cost savings for the prevented readmissions was estimated to be £80,000 annually. Over one year, the study by Gillespie et al. estimated the direct costs related to both readmissions and emergency department visits balanced with the cost of MR intervention. Cost of intervention was based on the salary of one experienced pharmacist working half time and equivalent to nine months with 182 patients. The unit costs and valuation of readmissions and emergency department visits costs were not described.[135] Costs of readmissions and emergency department visits were lower in the intervention group compared to the control group which balanced the cost of the intervention and contributed to approximately $250 savings per patient.[135]

Saving in nurses' time was evaluated by Kramer et al. Approximately one hour of the nurse time, which would have been required to document allergies in the computer, was spared. The study also involved doctors and nurses completing different steps of MR process primarily in discharge reconciliation report. No details were reported for the estimation or valuation of this time. Conversely, Koehler et al. reported an increased time spent by the nurse care coordinator who worked collaboratively with the MR pharmacist. The nurse reported spending additional 20-25 minutes performing wide spectrum of clinical activities including counselling patients and families, documentation and faxing of the study forms. Karapinar-Carkit et al. reported no costs or savings related to the time of

other health professionals; all tasks were performed independently by the MR pharmacist.[107]

Savings in doctors' time was reported by one study.[228] The pharmacist increased time commitment to obtain medication histories, transcribe medication and provide patient counselling might have spared doctors' time to perform other activities. The mean time saved for the doctors was 14 minutes per patient which accounted for a total of 63 hours per month. Nevertheless, the time saved for the doctors' or the nurses' reported by Kramer et al. and Hick et al. was not amounted against to the extra time commitment spent by the MR pharmacist.[228, 229]

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Study	Overall cost of intervention	Medication errors/ADEs	patient on drugs use	Length of hospital stay	Readmission	emergency department visits	Pharmacist time	Other healthcare professional time	Primary care use	Patient expenses	Informal care
Karapinar-Carkit 2012[107]	×	✓	×	×	×	×	✓	×	×	×	×
Perennes 2012[233]	×	×	×	×	×	×	×	×	×	×	×
Boso-Ribelles 2011[227]	×	×	×	×	×	×	×	×	×	×	×
Hellstrom 2011[113]	×	×	×	×	×	×	×	×	×	×	×
Makowsky 2009[230]	×	×	×	×	×	×	×	×	×	×	×
Koehler 2009[118]	×	×	×	×	×	×	×	×	×	×	×
Rabi and Dahdal. 2007[108]	×	×	×	×	×	×	×	×	×	×	×
Bayley 2007[114]	×	×	×	×	×	×	×	×	×	×	×
Scullin 2007[115]	×	×	✓	×	✓	×	×	×	×	×	×
Bolas 2003[225]	×	✓	✓	×	×	×	×	×	×	×	×
Stowasser 2002[226]	×	×	×	×	×	×	×	×	×	×	×

ADE: Adverse Drug event. MR: Medicine reconciliation

Table 5.7 Scope of costs measured by study

Study	Overall cost of intervention	Medication errors/ADEs	Patient own drugs use	Length of hospital stay	Readmission	emergency department visits	Pharmacist time	Other healthcare professional time	Primary care use	Patient expenses	Informal care
Hick 2001[228]	×	×	×	×	×	×	×	×	×	×	×
Brookes 2000[232]	×	×	✓	×	✓	×	×	×	×	×	×
Kramer 2007[229]	×	×	×	×	×	×	×	×	×	×	×
Gillespie 2009[135]	✓	×	×	×	✓	✓	×	×	×	×	×
Vira 2006[231]	×	✓	×	×	×	×	✓	×	×	×	×
Spinewine 2007[109]	×	×	×	×	×	×	×	×	×	×	×

ADE: Adverse Drug event. MR: Medicine reconciliation

Continued
Table 5.7 Scope of costs measured by study

Authors, Year	Variable costs	Cost /patient	Knock on consequence costs	Cost /patient	knock on consequence savings	Cost /patient
Karapinar-Carkit 2012[107]	**Labour costs** [a,b]		**Medicines related cost 1 month** [d]		**Medication related saving 1 month** [d]	
	Admission and discharge medication reconciliation	€21.52[c]	Total medicine use cost	€1.51	Total medication saving	€23.27
	Transfer of medication information (including adjustments in final discharge prescriptions	€2.14[c]				
	Patient counselling (including discussion results with hospital physician)	€17.38[c]	**Medicines cost 6 months** [d]		**Medication related saving 6 months**	
			Total medication cost	€7.30	Total medication saving	€103.95
Scullin 2007[115]					**Length of hospital stay reduction** [e]	£424
					Opportunity cost saving £ 3.3 million per annum	
					Reduction of length of hospital stay for readmissions Opportunity cost saving of £2.8 million per annum	

[a] MR process was carried out by a team of pharmaceutical consultants. [b] Based on a mean yearly salary for a pharmaceutical consultant of €60.000, 44 working weeks, and a productivity of 50% (exchange rate: EUR 1 = USD 1.3443). [c] Based on a mean yearly salary for a pharmaceutical consultant of €50.000, 46 working weeks, and a productivity of 70%. [d] Errors relate to the prevention of medication discrepancies between the pre-admission and in-hospital prescribed medication was considered not to represent real costs for society, as the patient was using these drugs before hospitalization. Therefore, these interventions were not included in the cost calculation and only the difference between labour costs and hospital formulary induced changes and optimization of pharmacotherapy intervention costs associated with medication reconciliation was compared. [e] A medical bed in the Trust at the study time £212 per day. MR: Medicine reconciliation

Table 5.8 Summary of MR related costs

Authors, Year	Variable costs	Cost /patient	knock on consequence costs	Cost /patient	knock on consequence savings	Cost /patient
Bolas 2003[225]	-	-	**Patient own drugs** The cost of patient own drugs which could have been returned to patients and reused was estimated as £4582 per year based on a review of the drugs returned to pharmacy and the discharge prescription	-	-	-
Brookes 2000[232]	-	-	**Patient own drugs** The value of the patient own drugs left ranged from £5.60 - £66.20. In the case of 35 patients during a three week period £88.70 was wasted equivalent to £15.330 annually	£25.22	**Treatment of readmissions** Opportunity cost saving related to reduce rate of readmission £83,484 annually (i.e. the costs associated with the treatment of these re-admissions)	-
Gillespie 2009[135]	-	-	**Emergency department visits** Intervention control **Readmissions per patient** Intervention Control **Cost of intervention**	 $160 $260 $12,000 $12,300 $170	Cost savings balanced against the cost of the intervention was	$230
Vira 2006[231]	Cost of pharmacist time for admission reconciliation [g]	$10.6	Clinically important medication discrepancy detected at admission	$64		

[f] Rate of exchange7.15 Swedish Kronor=$1 US on October 25, 2008 and comparison using difference. [g] This estimate was based on an overall time requirement of 1090 minutes for admission reconciliation for all 60 patients and the cost of admission reconciliation was calculated by multiplying the number of hours spent by an hourly rate for clinical pharmacist time of $35 Canadian. MR: Medicine reconciliation.

Continued

Table 5.8 Summary of MR related costs

5.7 Resources needed to implement MR

5.7.1 Time commitment

An increased pharmacist time commitment was needed in order to implement MR interventions. The estimated times spent by the pharmacist to implement MR varied between studies and ranged between 10 to 15 minutes and up to two hours (Table 5.9). Variations between studies can be seen; some studies reported the total time spent by the MR pharmacist to implement the intervention whilst others described the time spent performing MR and non-MR elements. Approximately, 20-30 minutes were spent by the pharmacist to complete admission and discharge MR.[107, 108, 229, 233] Longer time was estimated by few studies; those accounted for the additional time spent in obtaining or transfer information to GPs or community pharmacists[114, 118, 233] or performing administrative tasks such as printing and computer system updating.[114, 229] Additionally, in some instances the medicine lists prepared by the MR pharmacist enquired validation or discussion with doctors or patients, this contributed to an additional time spent by the study pharmacist ensuring the completion of the MR process.[114, 118, 228, 229]

The methods employed to record the intervention time might have contributed to the observed variations too. The study by Karapinar- Carkit et al. recorded the time using a stopwatch for 59 (22.5%) patients. Bayley et al. recorded the time using two methods; a self-estimated time for each activity over one-week period and an observed time by a trained observer who shadowed the MR pharmacist for a day.[114] Kramer et al. estimated the time using two approaches: self-reported and observation by the study investigator. Average time to complete the admission medication history timed by the study investigator was five minutes less than the self-reported time by the study pharmacist. [229] No details were reported on the approaches followed for the time estimation in the remaining studies.[108, 118, 233]

5.7.2 Training and education

Education and training comprise potential resources necessary to set up the MR intervention. Table 5.10 summarises details of MR related training and education. Training and education of the study team as well as ward staff were reported by five studies with contents of the received training and education sessions being described by 3 studies.[115, 118, 230] MR education and training was achieved mainly through meetings [118, 229, 230], lectures or workshops [115] posters,[229] one to one communication [114, 229] and by written instructions attached to the patient note.[229]

The training was related to the targeted diseases[230] and covering various therapeutic topics as well as intent, documentation and delivery of the study intervention.[115, 118, 230] The MR pharmacist in the study by Bayley et al. spent two days rounding with the medical team to become formally integrated in the hospital medical team before commencing the study.[114] The study by Kramer et al., involved pharmacist, nurses as well as doctors training on the intervention process and documentation, computer medication order entry, medication history interview and phone survey skills.[229]

The time spent for the purpose of the MR training and education was approximately 2-3 hours divided over one or more sessions.[118]

Author, Year	Measure	Activities	Time per patient (minuets)
Karapinar-Carkit 2012[107]	Mean (SD)	Total time of intervention	62.7 (14.6)
		Admission and discharge MR	32.9 (6.6)
		Patient counselling	26.6 (9.8)
		Transfer of medication information (including adjustments in final discharge prescriptions	3.3 (2.8)
Perennes 2012[233]	Mean (range)	Total time	46 (no details)
		Patient interview or family member	16 (5-40)
		Obtain medication information from patient notes and GP letter	12 (5-15)
		Obtain faxed copy of the medication dispensed by the community pharmacies	21 (10-45)
Boso-Ribelles 2011[227]	-	Time from intervention identification to resolution ▪ < 10 min for 97.7% of interventions ▪ 10 min for 2 interventions ▪ None exceed 30 min with any case	-
		Phone call Patient contacted 7 days post discharge to resolve any quires, no details on duration	-
Koehler 2009[118]	Mean	Medication education, reconciliation, and optimization of drug therapy by MR pharmacist	20
		Patient or carer counselling by the study nurse	20-25
		Phone call Patient contacted 5- 7 days post discharge, no details on duration	-
Rabi and Dahdal. 2007[108]	Mean	Admission interview	15
		Discharge counselling including list of discharge medications prepared by study pharmacist and given to patient	10

MR: Medicine reconciliation

Table 5.9 Time commitment to implement MR

Author, Year	Measure	Activities	Time per patient (minuets)
Bayley 2007[114]	Mean (range)	**Admission**	
		Collect historical data, print/read, print/reconcile electronic health record, draft care plan, review/document pertinent labs,	45 (30–60)
		Medication history by patient interview, review paper chart data,	37.5 (30–45)
		Identify patients	37.5 (30-45)
		Inpatient	
		Daily Rounding, update new labs/culture information, assess current progress, ascertain discharge plan, follow up interventions	75 (60–90)
		Discharge	
		Type discharge medication list	22.5 (15–30)
		Counsel patient	30 (20–40)
		Prepare printouts	37.5 (30–45)
		Write follow up care plan, update medication list, update allergies, route final document to primary care physicians	75 (60–90)
		Enter data on recommendations made	12.5 (10–15)
		Phone call [a]	
		3-5 days post discharge to confirm patient understanding on medications and answer any questions,	(3–5)
Bolas 2003[225]	-	Follow up home visit or telephone	-
		10–14 days after discharge by either a call	
Hick 2001[228]	Mean	**Pharmacist**	
		Medication history taking.	Extra 5 minutes. Range (4 to 6)
		Over all additional time commitment	11.5
		Doctors	
		The mean time saved for the doctor	14 minutes

[a] The MR pharmacist could not provide accurate estimates of the total time spent on patient follow-up calls. While each call was brief (3–5 minutes), the calls were interspersed with other activities and often involved multiple calling attempts to reach the patient. MR: Medicine reconciliation

Continued

Table 5.9 Time commitment to implement MR

Author, Year	Measure	Activities	Time per patient
Kramer 2007[229]	Mean (SD)	**Nurses time** to input allergies in the computer system	
		Before MR intervention	69.1 (98)
		After MR intervention	141.1(238.8)
		Pharmacist time	
		Before MR intervention	112.9 (70)
		After MR intervention	64.1(38.7)
		Completed admission medication history	12.9 (9.34)
		Time to clarify medications	1.18 (5.84)
		Time to perform interventions	1.4 (2.25)
Gillespie 2009[135]	Mean	Total time	140
Vira 2006[231] [b]	Median (IQR)	Admission reconciliation	15 (10–21)

[b] Time required for discharge reconciliation was not record. MR: Medicine reconciliation. IQR: interquartile range

Continued
Table 5.9 Time commitment to implement MR

Author, Year	Training/education details
Makowsky 2009[230]	A series of education sessions led by local pharmacist experts (1 on each target disease state and 1 on documentation of clinical care activities), was conducted with the team-based pharmacists prior to commencing the study [a]
Koehler 2009[118]	Three training meetings (each 45 minutes in duration) regarding the intent and delivery of the study intervention and use of study forms.
Bayley 2007[114]	Prior to the onset of the study, the pharmacist rounded with each hospitalist for two successive days and became formally integrated into the hospitalist team.
Scullin 2007[115]	A programme of accelerated clinical training covering major therapeutic topics was implemented. This consisted of lectures and workshops provided by specialist staff (pharmacists, nurses and hospital physicians), and was complemented by study days provided by the Northern Ireland Centre for Postgraduate Pharmaceutical Education and Training.
Kramer 2007[229]	**Nurses education** Education sessions before study initiation. Nursing education was provided by investigators at staff meetings and individually. **Pharmacist education** All pharmacists attended a three-hour, hands-on computer education session. Before pharmacists were scheduled to work on the study unit, they completed an electronic medication order-entry competency evaluation covering admission through discharge using a test patient. **Doctors education** ▪ Posters were placed on the medical unit to educate physicians about the medication reconciliation process. ▪ Individual education was provided for physicians who frequently admitted patients to the unit. ▪ Orange sheets placed in the front of the medical record of patients enrolled with written instructions explaining how to view medications, what to complete on the reports, and whom to contact with questions. **Care coordinator education [b]** In-service education to explain the medication reconciliation documentation process. **Nursing home contact** Nursing homes and skilled-nursing facilities were contacted to explain the intent of the medication reconciliation discharge and patient medication discharge reports and to obtain feedback for improvement. **Pharmacist order entry** Special order types for home medication and discharge medication were developed in the clinical pharmacy care system. [c] **Telephone surveyor training** All researchers conducting telephone surveys completed a questionnaire measuring comprehension of a review of survey design methodology, telephone survey etiquette,and avoidance of bias in telephone surveys.

a Most responsible or primary diagnosis of Coronary Artery Disease, community acquired pneumonia, chronic obstructive pulmonary disease, heart failure or type 2 diabetes mellitus were included. [b] Care coordinators are either registered nurses or licensed social workers who direct case management activities. Care coordinators often assist with compilation of discharge or transfer medication lists. [c] The special order types prevented home medications from being visible to nurses in the electronic medication administration record but allowed pharmacists to view the medications throughout each patient's hospitalization.

Table 5.10 Details of MR training/education

5.8 Quality and design of studies evaluating pharmacy led MR

Outcomes of quality assessment are illustrated in Figures 5.4 and 5.5

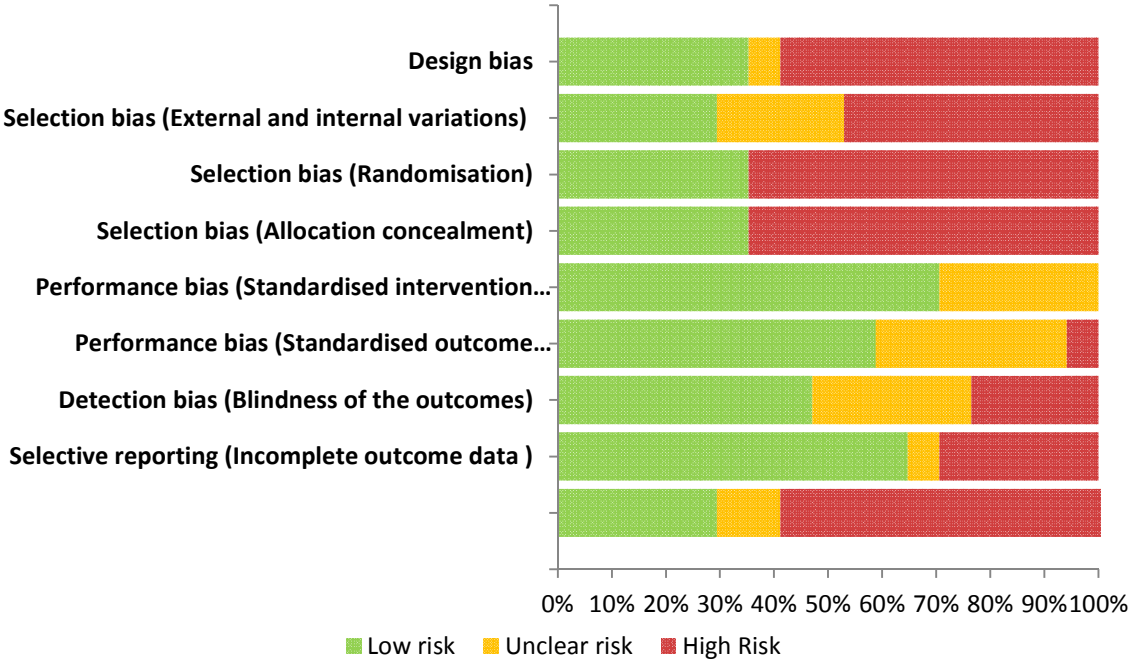


Figure 5.4 Outcomes of risk assessment by bias type

Overall, studies were susceptible to high risk of design and selection bias. Additionally, it can be seen that studies frequently failed to demonstrate adequate power and were presented with concerns on the appropriateness of the statistical analysis. Appendix 18 presents detailed description of bias assessment

5.8.1 Design bias

The included studies were mainly of non-randomised and/or uncontrolled design; they were therefore regarded with high risk of design bias.

5.8.2 Selection bias

Incomparability at baseline and ambiguity of patient selection approach were the main reason led to high risk of bias judgment. Koehler et al. and Gillespie et al. are RCTs; they were, however, susceptible to selection bias namely due to lacking sufficient evidence to assume the study groups were comparable at baseline.[118, 135] In those studies, intervention patients were prescribed more medicines compared to the control group and considered of greater illness acuity upon admission. Those regarded as factors of considerable confounding effect on MR.

No sufficient information describing the process by which patients were identified warranted a judgment of high selection bias risk in the study by Brookes et al. and Perennes et al.[232, 233]

5.8.3 Performance bias

For five studies, there were insufficient details to precluded risk of performance bias relevant to standardised delivery of the MR intervention which warranted "unclear" judgement.[107, 114, 227, 231, 232] A standardised MR delivery was achieved by using standardised set of open and closed questions during patient interview,[113, 233] and undertaking education sessions prior to the study commencement [229, 230] or attending training meetings.[118] Additionally, studies used standardised operating procedures and data collection forms for the delivery and documentation of the MR process.[109, 115, 135, 225, 228] For two studies, the information collected were double checked and verified by other health professionals, e.g. ward doctors, community pharmacists or GPs. [226, 233]

Majority of studies demonstrated no concerns of bias relating to standardised outcome measurement. Standardised outcome measurements was achieved by: blinding investigators who were responsible for study analysis,[135] using standard operating producers and data collection forms developed by multiple researchers,[109, 113, 230] and adapting a previously published standardised approach or employing an existing hospital policy. [114, 118, 229] This was also achieved by an independent review [115] and verification of outcome data from multiple sources [226, 233]

5.8.4 Detection bias

Only four studies adequately described blinding outcomes assessment, this was achieved by blind or independent assessors. [109, 113, 115, 135, 230] For the majority of studies, outcome measurements were performed by the MR pharmacist and therefore it was not possible to conceal group allocation. Non-blinding of outcome measurement relevant to readmissions and emergency department visits and mortality was considered not concerning, providing outcome data was obtained from a standardised and indisputable sources such as: hospital computer system,[118, 226] a national database or reporting systems.[118, 230]

5.8.5 Selective reporting (Incomplete outcome data)

Majority of studies considered not susceptible to selective reporting bias; all outcomes measured were reported with no concerns of missing outcomes data. However, Stowasser et al.[226] reported no details on emergency department visits, meanwhile Gillespie et al.[135] reported no sufficient details on drug related emergency department visits, omissions and transcribing errors.

Concerns were presented in the study by Rabi and Dahdal due to incomplete discharge data relating to 16 patients. Fifty six medication histories were conducted upon admissions; however, only 40 discharge counselling sessions were reported. Reasons for

the unreported sessions were not discussed and thus it was not possible to preclude risk of reporting bias.[108]

5.8.6 Adequacy of study power & analysis

Only five of the included studies introduced no concerns regarding the adequacy of the study power and the statistical analysis.[109, 113, 115, 135, 230] Most of the studies reported no sample size or study power estimation. Particular concerns were with those of relatively small sample size.[108, 118, 231, 233]

5.8.7 Validity of economic evaluations

There was no study of economic evaluation design, and thus it was not permissible to assess risk of bias using the domains pre-specified for the purpose of assessing the quality of economic evaluations (appendix 9). One exception was the study by Karapinar-Carkit et al which attempted cost analysis of pharmacy labour costs in relation to medicine use.[107]

Nevertheless, those studies reported costs, considered limited scope of costs and consequences. Additionally, the costs and the cost savings were not valued based on a well-established valuation process and it was not possible to identify whether the unit costs were appropriate or of realistic values.

The cost analysis by Karapinar-Carkit et al., employed a very limited perspective, a health insurer's view, and considered only the cost of pharmacy labour time in relation to medicines costs. Additionally, labour costs were estimated based on a selected sample of the study patients without enough information regarding patient selection or characteristics. Thus, the quality of the cost measurement is unknown.[107] However, Karapinar-Carkit et al. demonstrated a reliable valuation procedure, clearly identified the sources of all cost units, employed justifiable and realistic values, and reported full details of the study assumptions. Additionally, Karapinar-Carkit et al. also examined the uncertainty in the costs and cost savings by means of a sensitivity analysis for the factors varying medicines and labour costs.[107] Those were the main cost variables**.**

Figure 5.5 Outcomes of risk assessment by study

Figure 5.5 Outcomes of risk assessment by study (continued)

Overall, there is a scarcity of rigorously designed studies for the effects and the costs of pharmacy led MR with only two studies demonstrating low risk for all domains of bias. For the remainder, methodological limitations introduced potential risks of bias and therefore conclusions around the questions of the effects and associated costs with pharmacy led MR implementation can only be drawn with caution.

5.9 Summary of main findings

Medication discrepancies at the time of hospital admission, inpatient stay and discharge are common and significant. Pharmacist involvement in intercepting omission discrepancies and ensuring accurate allergy information was evident. However, heterogeneity and methodical limitations do not allow conclusive conclusions on the benefits on patient oriented outcomes and post discharge health resource use.

Only one study demonstrated significant reduction in length of hospital stay; the effect of pharmacy led MR on readmissions and emergency department visits was unclear. Significant benefits, however, were shown on readmission duration and the time took for readmissions to occur. There was limited evidence for the effect of MR on the quality of patient life, though a favourable effect was reported by one study. In addition, no effect was observed on mortality rate up to12 months post discharge.

Conclusions on the associated cost of MR intervention should be considered with hesitation. Findings reported on costs/savings associated with MR were derived by no means of robust health economic evaluation.

In summary, pharmacy led MR was a useful method for identifying and rectifying medication errors at times of transition. However, the effect on health care resource use is less clear. Only 17 studies evaluated full MR process; those showed considerable variations with MR interventions, measures and methods. Such variances impede combining the results to provide an overall indication for the effects and costs of pharmacy led MR. No meta-analysis of the identified evidence was warranted.

Chapter 6

Discussion

Pharmacy led medicine reconciliation in hospital care: a systematic review

6.1 Hospital based pharmacy led MR intervention

In the previous chapter, pharmacy led MR systematic review of the effects and costs associated with pharmacy led MR showed that the transfer of information and thus continuity of care could be improved by the MR pharmacist involvement. However, the effects on post discharge health resource use, mortality and quality of life are less certain. There was also limited evidence on the associated costs with pharmacy led MR implementation.

Relatively few studies described the implementation of a full MR process despite MR tasks being well defined.[72, 73] This may be because what counts as MR varies between organisations and workflows; in some encounters it includes only medication history whereas in other encounters it might constitute of more specialised care such as medication review and discharge planning.[73, 149] However, the clarity of MR as a process is improving, more recently published studies are increasingly reporting the full MR process.[107, 233] There are a number of reasons cited for why incorporation of the full MR process is still a challenge for many hospitals;[237] foremost were highlighted by the Institute of Healthcare Improvement in 2011. The Institute of Healthcare Improvement highlighted lack of a clear ownership of the process and absence of a standardised MR process.[79] Medication review is an example of a key part of the prescribing process which was clearly defined and standardised across NHS in 2008, which may be partly attributable to its wide application.[238] Similarly, it would be expected that developing well defined MR processes would help in optimising the delivery and application of MR.

Across literature varying terminology was used to describe MR, all of which needed to be considered in order to obtain the most comprehensive evidence synthesis. MR was commonly supplemented by other non-MR care activities; and there were considerable variations with MR interventions and measurements across the included studies. Several studies focused on process orientated outcomes such as the identification of medication discrepancies, MR pharmacist interventions, accuracy and completeness of medical notes, or inpatient charts. Other studies measured more patient orientated outcomes such as length of hospital stay, readmission rates and health related quality of life. However, no study assessed comprehensively both process and patient orientated outcomes.

Collating the evidence from the included studies; features of the best MR practice and foremost outcomes to measure are proposed in BOX 6.1 and 6.2.

BOX 6.1 Features of hospital based MR practice

- Successive steps that include obtaining, verifying and documenting an accurate list of medicines the patient is taking and comparing the list with inpatient and discharge list to identify and resolve discrepancies [110-112, 116-118, 121, 137, 237-245]
- Led by pharmacist with hospital residency experience or pharmacy technician with additional training in pharmacotherapy and communication skills [110-112, 116-118, 121, 137, 237-245]
- Implemented within 24 hours of admission [111, 116, 245]
- Structured/semi-structured patient and/or carer interview upon admission to verify medication history [116, 137, 237, 239, 242, 245]
- Implemented on weekdays during normal working hours [5, 7, 8, 11, 12, 17]
- Targeted at high risk patients who are prescribed at least one or more regular medicines [116, 118, 121, 237, 240]
- Discrepancies are confirmed using at least two sources of patient information [118, 137, 237, 241, 243, 245]
- All relevant patient information is collected of such as allergies, previous adverse drug events, over the counter medicines and herbal medicine use [111, 118, 243-245]
- Discrepancies are resolved by discussion with doctors and nurses upon admission and discharge [116, 118, 121, 244]
- MR process delivered and documented in standardised approaches [116, 137, 239]
- Discharge information is communication to patients, GPs and community pharmacists on the day of discharge or shortly afterwards [137, 240, 243, 245]

BOX 6.2 Foremost MR related outcomes measured

Process oriented

- Unintentional medication errors [107, 228, 231]
- Significance of medication errors [114, 225, 227-229, 231, 233]
- Pharmacist interventions [108, 114, 225, 228]
- Time commitment [107, 108, 114, 118, 135, 225, 227-229, 231, 233]

Patient oriented

- Length of hospital stay [115, 118, 226, 230]
- Readmission rate [109, 113, 115, 118, 226, 227, 230]
- Emergency department (ED) visits [113, 118, 135, 225-227]
- Health resource use in community [226]
- Health related quality of life [226]
- Mortality rate [109, 135, 226]

6.2 Effects of pharmacy led MR

The involvement of MR pharmacist at the points of care transition was useful for identifying and rectifying medication errors and improving the completeness of medication history and allergy information.[107, 108, 114, 115, 135, 225-229, 231, 233] MR was also reported to improve the association between discharge prescription and medicines the patient is taking post discharge; i.e. post discharge home medicine list was more closely matched with discharge list.[225, 226] The latter effect might have been influenced by the increased involvement of the MR pharmacist at discharge; the MR pharmacist was responsible for ensuring the accuracy of discharge prescriptions and promptly sent discharge information to GPs and/or community pharmacists on the day of discharge or shortly afterward. This may have improved the continuity of care and prevented inappropriate changes to therapy.[225, 226] Nevertheless, these assertions are not conclusive as none of the studies investigated the reasons or underlying factors leading to post discharge changes in medicines.

The clinical significance of identified discrepancies and MR related interventions were assessed by a number of studies;[114, 225, 227, 228, 231, 233] however, only two studies used a standardised validated approach.[225, 228] In addition, the definitions of clinical significance and classification of discrepancies varied widely. In addition, the definitions of clinical significance and classification of discrepancies varied widely. Two of the included studies differentiated discrepancies into intentional and unintentional, the latter were referred as error.[231, 233] Twenty percentage and 50% of unintentional discrepancies were found clinically significant by the latter two studies.[231, 233] This is in line with findings from a recent systematic review of 12 studies conducted by Kwan et al. which reported that 34% of unintentional discrepancies have the potential to result in clinically significant consequences.[138] Kwan et al., outlined that whilst unintentional errors are common, far less number affect patients and have clinical significance on patient health,[138] this was also highlighted by other reports.[31, 34, 44, 45] Due to variation in the range of identified discrepancies in this review and varying definitions as well as measurements of discrepancies; the effect of MR on reducing clinically significant discrepancies and whether those might contribute to actual patient harm is unclear.

The MR pharmacist played a role in reconciling patient own drugs brought to hospital upon admission and ensuring appropriate use during hospital stay and upon discharge.[225] Beside considerable cost savings, this may have a significant impact on patient safety; without clear information a patient or carer may duplicate therapy or continue with medicines intended to be discontinued.[10, 19]

Limited evidence was found for the effect of MR on health related quality of life; one study reported a favourable but non-significant effect using SF-36.[226] More studies are required to gain further insight on the effect of MR on health related quality of life. Additionally, EQ-5D, is the preferred method for the measurement of health related quality of life by the National Institute for Health and Care Excellence, the use of EQ-5D is recommended for the purpose of the Technology Appraisal Programme. Thus an evaluation of MR effect on health related quality of life using EQ-5D is needed.[172]

The true effect of MR on length of hospital stay and mortality cannot be assumed without more robust evaluation which accounts for confounding factors as well as the effect of non-MR clinical activities. Three studies found no effect of MR on mortality rates up to 12 months post discharge. However, the effect of MR on mortality might be difficult to establish based on these findings. Confounding factors might have affected patient survival rates such as complexity of medicine regimen and disease progression.[112, 137]

Only one study demonstrated significant reduction in length of hospital stay of patients who received pharmacy led MR.[118] MR interventions can be expected to shorten length of hospital stay by optimising medicines prescribing and preventing adverse drug events.[127, 251] Unexpectedly, length of hospital stay was slightly higher in the intervention group compared to control group in most of the included studies, however this effect was often not significant.[121, 136, 137, 237] A possible explanation might be, that the MR pharmacist interventions increased the time needed to stabilise patients after proposing changes or slightly delayed patient discharge in order to complete discharge documentation and counselling.[111, 137, 239, 240, 243] However, it is not possible to establish whether this effect might have been influenced by MR or non-MR aspects of the interventions, such as drug consultations, medicines review and patients or carers counselling upon discharge. In addition, length of hospital stay could be influenced by various factors that are hard to measure or evaluate such as disease progression, seriousness of illness, variance in type and number of medicines as well as the diagnosis upon admission.[252, 253]

Most studies reported lower rates of readmissions and emergency department visits among patients who received pharmacy led MR,[109, 113, 135, 226, 229] however, this was often not statistically significant. Nonetheless, significant benefit of MR was evident on duration of readmission and the time readmissions or emergency department visits occurred.[115, 118] However, the time longevity of these effects cannot be established from the existing studies; with readmission and emergency department visits being explored at varying time. The window within which the effect of MR on readmissions and emergency department visits can be most evident is not well known. Omissions and inaccuracies of

pre-admission medicines are errors commonly identified by MR. Errors related to long term home medicine may result in readmissions and emergency department visits in long term and thus a significant effect might not to be expected over a relatively short time period. At 12 months, Scullin et al. found a significant reduction in hospital readmissions, readmission duration and the time readmissions occurred.[115] Assuming that the effect of MR would be more evident at longer period of follow up is inconsistent with finding from Koehler et al. and Makowsky et al.[118, 230] Significant reduction was seen at 30 days and three months but was not evident at 60 days and six months respectively.[118, 230] Koehler et al. included pharmacy led MR implemented within a multidisciplinary care bundle. The effect shown at such short follow up time, 30 days, might have been augmented by the multidisciplinary care bundle. The systematic review by Kwan et al, pooled three RCTs and identified a significant reduction in readmissions and emergency department visits at 30 days post discharge too.[138] Similarly, these studies also included non-MR and MR tasks provided by other health professionals including IT based applications, a discharge nurse advocate, patient education and follow up phone call.[112, 142, 239] Thus, it is uncertain to what extent pharmacy led MR has contributed to this effect. In addition, without detailed investigation of the nature of each readmission and emergency visit, it is not possible to account for confounding factors which might contribute to readmissions or emergency department visits other than by MR. Recent changes in NHS polices promoted a “30 days discharge tariff”, i.e. making secondary care responsible for patient care up to 30 days post discharge, and the target to reduce emergency readmissions occurring with 28 days post discharge.[240, 241] This warrants the need to further exploring MR benefits on readmission and emergency department visit and to identify the window within which the effect of MR on readmissions and emergency department visits can be most evident.

The use of community health resources at 30 days post discharge was reduced among patients who had received MR in one study.[226] When visits were differentiated, there were significantly fewer visits to specialist doctors but not for other professionals such as GPs, community pharmacists or domiciliary nurses. In line with this, one study evaluated GP and specialist doctor visits at three months post discharge and found no significant change for either type of professional visits.[242] Further follow up to 6 months found also no significant difference in GP visits.[243] However, the first study of the latter two focused on admission MR whilst the other implemented pharmacy led MR upon discharge only. Thus, the evidence for full MR process effect on health resource use is lacking.

6.3 Costs associated with pharmacy led MR

Conclusions regarding costs associated with the MR intervention should be drawn with caution. Findings reported by the reviewed studies were not derived from health economic evaluations. One study, attempted a cost analysis of medicine costs in relation to the MR pharmacist labour cost.[107] However, Karapinar- Carkit et al. excluded the cost of pre-admission medicine omissions. Omissions of pre-admission medicines are the most common type of MR related errors.[108, 114, 225, 229, 231, 233] Indeed, the majority of the MR-pharmacist's time is spent on medication history verification.[114, 229, 233] Therefore, considerable costs were unmeasured by Karapinar- Carkit et al.[107]

An increased time commitment is needed by the pharmacist to implement MR. This might be the key driver of the costs associated with MR implementation.[107, 231] Time spent by the MR pharmacist varied widely among the included studies; variation within the MR interventions did not enable to draw a precise estimation of the average time required to implement MR. Therefore, a time estimate that can be adjusted across different settings and workflows was not drawn.

Nevertheless, the cost of pharmacist time could be balanced by the savings in medicine costs,[107, 225] reduction in hospital stay or readmissions and emergency department visits.[115, 135, 232] Costs may be also balanced by freeing the time of other healthcare professionals such as junior doctors and nurses.[228, 229] MR could also require extra time for documentation and administrative tasks as well as to contact GPs or community pharmacists.[118, 229] However, the review identified no study which valued the costs of increased MR pharmacist time balanced with cost savings in other health care professionals' time and health resource use. Therefore, conclusions on the overall costs/savings of pharmacy led MR are limited due to paucity of the available evidence.

The identified studies showed that MR interventions required no specialised or complex training. The MR pharmacist usually had no additional clinical training beside education concerning MR process and study documentation.[114, 135, 225, 228, 229, 231] Therefore, no additional or advanced skills are needed for pharmacists to perform MR. However, education on the study intent and process should be in place to ensure standardised delivery of the intervention.

Other costs related to MR implementation were not identified or measured by any of the included studies. Costs requiring consideration include the development of standardised forms and study procedures as well as the cost of implementing a new hospital policy plus the time of other health professionals in both primary and secondary cares. This is necessary in order to obtain an accurate estimate of the resources necessary for MR implementation.[136]

6.4 The quality of the evidence of pharmacy led MR

The majority of participants were adult, aged on average 60 years, and mainly from general internal medicine wards. Studies were based mostly in one ward and targeted patients with a wide set of characteristics such as: patients admitted in normal working hours;[107] prescribed one or more medicines of regular use or pre-specified high risk medicines.[113, 115, 118, 225, 229] Conversely, patients who were discharged to nursing homes or transferred to other wards or hospitals,[107, 225, 229, 230, 233] short hospital stay,[107, 229, 230, 233] weekends or out-of-hours admissions, planned admissions,[115, 135, 225] non-English speakers or mentally incapacitated patients were commonly excluded.[107, 114, 225, 229, 230, 233] Those excluded patients might be at increased risk of medication errors and presented with greater complexity of care. Additionally, there might be limited access to primary care services or community pharmacists and fewer staff on duty during weekends and out of hours admissions.[10, 65] These differences should be taken into consideration when translating this review's findings into different care areas, populations such as paediatric patients or different types of admission, or clinical settings such as outpatients or ambulatory care.

Applicability of the studies' findings also needs to be considered in light of the differences existing between worldwide health care systems, processes for sharing information and funding of patient care. The included studies were conducted in several countries including USA, Canada, Europe and Australia. Non-UK study findings may not be directly transferrable to the UK context. Three UK based studies [115, 225, 232] met the inclusion criteria and were all carried out in Northern Ireland. Differences in patient population and workflow between England and Northern Ireland NHS should be considered when interpreting these findings.

In addition, systematic differences in ways likely to affect outcomes of the included studies which have been introduced by design and selection bias impede firm conclusions on the MR effect. These were not ruled out in two third of the included studies. The lack of details on the use of adequate methods for randomisation and allocation concealment might has increased the risk of bias in favour of the intervention.[107, 108, 113, 114, 118, 135, 226-229, 231-233]

Additionally, although some efforts were made to 'blind' the study team, patients and doctors; this was usually precluded by the nature of the intervention. This also increased the risk of bias in favour of the intervention. Herein, blinding of outcome measurements was a pertinent issue to consider. Susceptibility to bias introduced by non-blinded assessors could not confidently be ruled out in almost 50% of studies.[107, 108, 114, 225, 227-229, 232, 233] However, this was less concerning where less subjective outcomes were reported such as number of hospital readmissions, emergency department visits and mortality rates. This was the case if outcome data were obtained from a reliable reporting system or source of information.[118, 226, 230] There were also concerns on the statistical power and thus the meaningfulness of the hypothesis testing which was a dominating concern with small scale studies.[108, 118, 231, 233]

A positive aspect was that the majority of the included studies demonstrated clearly defined interventions and standardised data collection methods as well as outcome measurements. Similarly, the majority of studies were considered free of selective reporting bias.

The lack of any economic evaluation study, ambiguity and heterogeneity in costs estimation preclude conclusive answer to the question on the resources necessary to implement pharmacy led MR. Thus, a broad economic evaluation of costs and effects of MR is warranted of value.

Due to limited quality and the heterogeneity of the presented evidence no meta-analysis presentation was warranted.

6.5 Strengths and limitations

This systematic review has some commonality with the published recent systematic reviews on hospital based MR.[137, 138, 244] There are differences in the scope; those reviews described only the effect of pharmacy led MR interventions taking place at any point of hospital care, whereas this review focused on the full MR process and aimed to investigate the effect as well as costs associated with the intervention. To the best of our knowledge and up to the time of this thesis synthesis, there is no other comprehensive review which has systematically considered both aspects.

There are number of elements strengthen the confidence with this review findings. The evidence of this review was based on a comprehensive search strategy that incorporated all key search terms and systematically searched these through all relevant databases. Additionally, no limitations were applied on study language, year of publication or design. Efforts to capture unpublished research were made by contacting authors and key institutions in the UK and USA. Bibliographies of the included studies and reviews on MR

were also hand searched to identify additional references. SCOPUS database citation was also searched and citation alerts were followed through the work on this review up to the time of this thesis synthesis.

A tool based on the Cochrane method for assessing risk of bias was adapted with few modifications to fit the purpose of this review. The tool was validated by senior researchers/ systematic reviewers through one to one communication and group discussion. The systematic review protocol was registered on an international database. The work progress on the systematic review was kept transparent and up to date.

The review is, however, subject to some limitations. Foremost, although applying no restrictions on the year of publication allowed an extensive review capturing all possible evidence on MR and accounting for variations in terminology over the years, it is important to note that the practice of MR is also changing over time. The Institute of Healthcare Improvement outlined in 2011 that MR is not yet optimised but has improved since it was first launched 2005.[73] For most of the included studies, MR was compared with usual care. Usual care related to MR practice was different among settings and it is not possible to compare evidence on the effect of pharmacy led MR versus usual care between older [225, 226, 228, 232] and newer studies.[108, 109, 113-115, 118, 135, 227, 229, 230]

Variation in MR terminology could explain five relevant articles found outside the prescribed search of which three met the study inclusion criteria.[109, 135, 231] Additionally, Medicine/ medication reconciliation was not always used to describe the intervention and arguably this means that the screening for relevant studies was subjective and open to individual interpretation. However, the elements of a full MR process were clearly defined in the selection criteria. Furthermore, two independent reviewers performed screening at all stages thereby minimising the risk of personal error.

The true effect of pharmacy led MR might become unclear in multicomponent/disciplinary interventions. MR was often supplemented by non-MR care and in two studies this was implemented within a multicomponent care bundle designed to improve patient outcomes.[113, 118] Thus, this review identifies that there are potential benefits of MR which could balance the associated costs. However, this review is not able to answer whether the benefits observed were directly contributed by pharmacy led MR interventions or whether MR should be delivered in a multidisciplinary care programme or in supplement with other non-MR activities in order to achieve clinical significance on patient outcomes and health costs. This warrants further research.

6.6 Implications for further research

Developing and evaluating a pharmacy led MR is complex and it is essential that all resource costs and effects are determined through a rigorously designed study. More robust primary research of randomised design is needed to address questions on the clinical effects and costs of pharmacy led MR. Designing studies of randomised design to assess costs and effects is complex; the intervention and outcomes to measure should be considered carefully (BOX 6.1 and 6.2).

The paucity of evidence in the UK and the methodological limitations of the evidence available elsewhere underscore the need for robust evidence on pharmacy led MR within NHS settings. Ideally, the evidence in need, as described in BOX 6.3, should be derived from a randomised design with blind outcome measurement comprising process and patient oriented outcomes (BOX 6.2). The intervention and measurement methods should be standardised and consistent. A detailed description of usual care, patient screening and selection process is also necessary. It is essential that the evidence would enable a precise estimate of MR cost-effectiveness.

BOX 6.3 Features of MR intervention to develop

- Derived from robust study design
- Clearly defined and evidence based process
- Well recognised owner of the process (pharmacist, nurse or doctor)
- Proven to improve process and patient oriented outcomes
- Cost-effective
- Transferrable across different settings and workflows

This review informed the development of an innovative a pharmacy led MR service presented in the next chapter.

Chapter 7

Results

Medicine reconciliation at the health interface: The MedRec Study

The journey to address the aim of designing a medicine reconciliation (MR) intervention and develop a strategy for its evaluation has reached the stage of testing. The literature review, audit and systematic review of chapters one to six have identified the areas of sub-optimal current practice, potential strategies for enhancing the transfer of information between healthcare interfaces and trial design aspects warranting consideration.

This chapter focuses on the feasibility of the study design that has been informed by these earlier stages. Additionally, it provides an early indication of the effects and costs/savings associated with the intervention.

7.1 Patient recruitments

The hospital system was checked daily to obtain a list of all patients admitted within the previous 24 hours via accident and emergency department. One hundred seventeen patients were not identified by the daily screen due to lack of hospital record update. Thus, the total number of patients admitted to the study wards over the first 3 months of the MedRec study was 665 patients of which 105 (15.8%) patients were approached. The main reasons for not approaching patients are summarised in Table 7.1.

Reasons	N (%) n=560
Not eligible for the study inclusion	80 (14.3%)
Unable to consent consultee within 24 hours of admission	103 (18.4%)
The study researchers and/or MR pharmacists unavailable performing administrative tasks	87 (15.5%)
MR pharmacists unavailable due to sick or annual leave, weekly off days and performing other clinical activities not related to the study	77 (13.8%)
Out of the the study researchers working hours	55 (9.8%)
Not possible to approach patients, e.g. meal time, medical round, away from bed, risk of infection	48 (8.6%)
RAs unavailable: sickness, annual leave, off days	40 (7.1%)
Unable to consent patient within 24 hours of admission	25 (4.5%)
Nurse unavailable to assess patient capacity or willingness to speak to the RAs	16 (2.9%)
Others*	29 (5.2%)

*Patient known to RAs, patient with No Fixed Abode, discharged or transferred. MR: medicine reconciliation

Table 7.1 Reasons for not approaching patients

7.1.1 Excluded patients

Reasons for patients' exclusion are summarised in Figure 7.1. Most frequently, patients were excluded because they have been seen by the ward pharmacy staff member who was frequently a pharmacy technician. The ward technician mainly checked patient own drugs and medicine supplies.

Patients were also excluded on advice from the nursing team; nurses advised the study team not to approach patients who were distressed, unable to cope or overwhelmed. Additionally, patients who were prescribed no medicines or anticipated to stay for less than 24 hours were also excluded as per the exclusion criteria.

7.1.2 Consultee identification

The main barrier for consenting patients was the inability to obtain an informed patient decision or consultee declaration within 24 hours of admission. This was more frequent for patients who were admitted with partial or complete lack of mental capacity due, but not limited, to dementia, confusion, blindness or alcoholism.

The consultee was intended to be a person or carer with close relationship to the patient, and therefore the study team attempted to approach potential consultees during the ward visiting time. Visiting time at the study site was between 15:00 to 20:00. To ensure

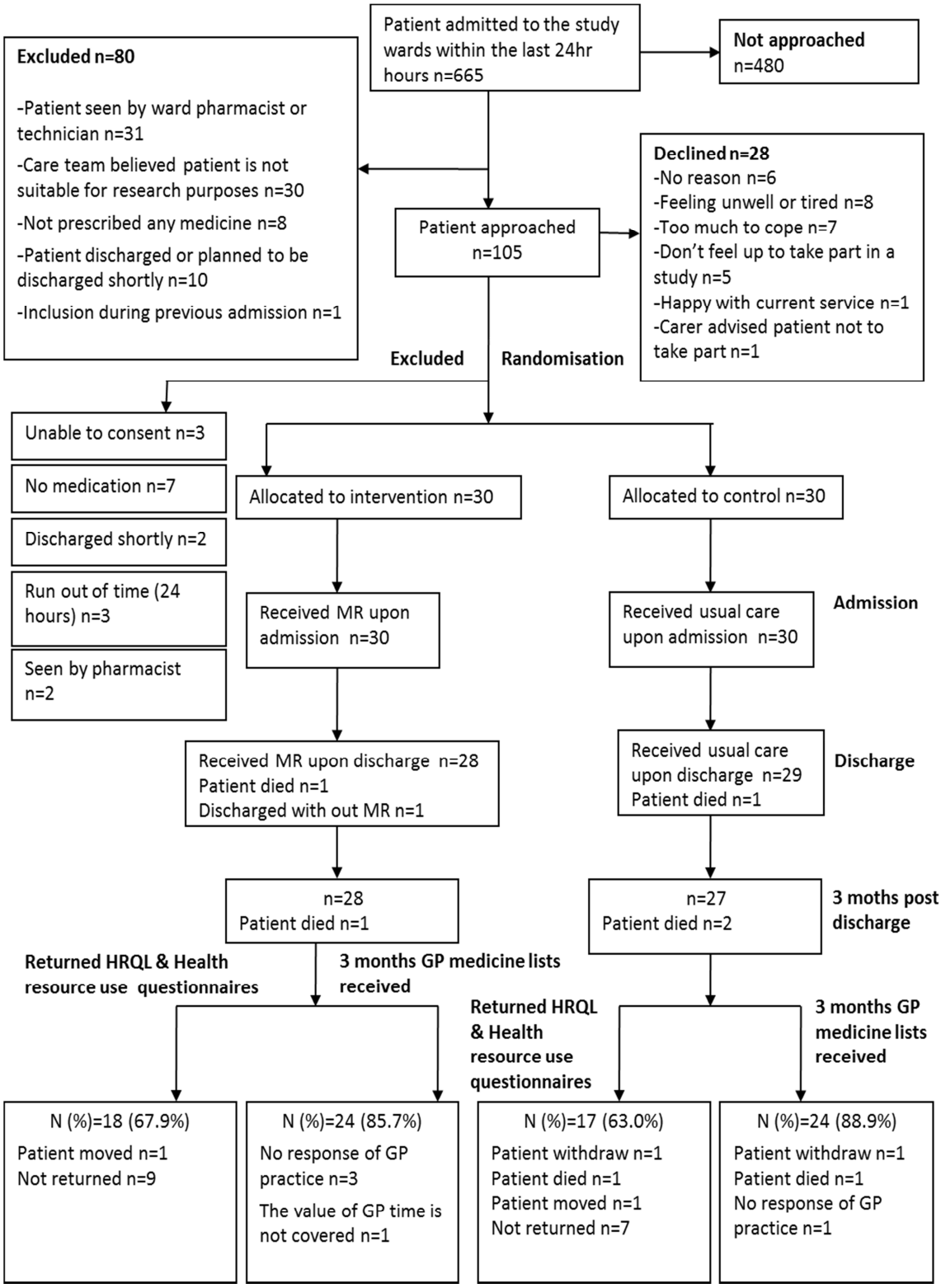
minimum burden and discomfort to the patient, the consultee was approached in the last 60 or 90 minutes of the visiting hours. In many instances, this occurred after the study researcher and MR pharmacists had departed and frequently by this time the 24 hours recruitment window had been passed. Over the first three months of the MedRec study (section 2.3), only one success of consultee (1.7%) enrolment was achieved.

7.1.3 Unavailability of the MR Pharmacists or the study researchers

Recruitment was not possible when the MR pharmacists and/or study researchers were not available. Mainly, this was because time was consumed in documenting MR process or performing administrative tasks such as filing, printing or faxing. It was also due to sickness, weekly days off or holidays.

The study MR pharmacists were existing hospital staff members and performed their research activities in addition to their usual care duties. At the study commencement, only two MR pharmacists were implementing MR. At later course of the study, additional three MR pharmacists were accredited to perform MR and subsequently they joined the research team, this maximised the study cover.

The senior study researcher (AB) covered 37.5 hours/week and the assistant researcher (KH) covered 22.5 hours/week. KH was an existing pharmacy technician and performed her research activities three days/ week. For one or two hours in the morning she provided ward based duties, after which she pursued patient recruitment. Over the three months period, MR pharmacists covered 90% (83 days) and the study researchers were available for 83.7% (77 days). Annual and sick leaves contributed to 57% of the uncovered days (n=26 days). The remaining uncovered days where due to weekly days off, bank holidays or database maintenance.



HRQL: Health related quality of live. GP: general practitioner. MR: Medicine reconciliation.

Figure 7.1 The MedRec study diagram

7.1.4 Patient declined study participation

Reasons for declining the study participation can be seen in Figure 7.1. Most frequently, patients declined to take part in the study because they were frail.

7.2 Recruitment rate

Patient recruitment can be seen in Figure 7.2. Overall, recruitment rate was close to the intended target; the number of patient recruited fell only 5 patients below the target. Rate for recruitment out of approached patients was 57.1%. Meanwhile, the recruitment rate out of eligible patients (n=88) is 68.2%. The later rate was estimated after deducting ineligible patients identified after conversing with the patient or the nurse, i.e. prescribed no medicine or seen by the ward pharmacist.

It can be seen that, at the first two weeks the study recruitment rate was achieving the target. A notable decrease occurred at the third week of the study commencement; this was due to unavailability of the study team for pre-booked annual leave and summer holidays.

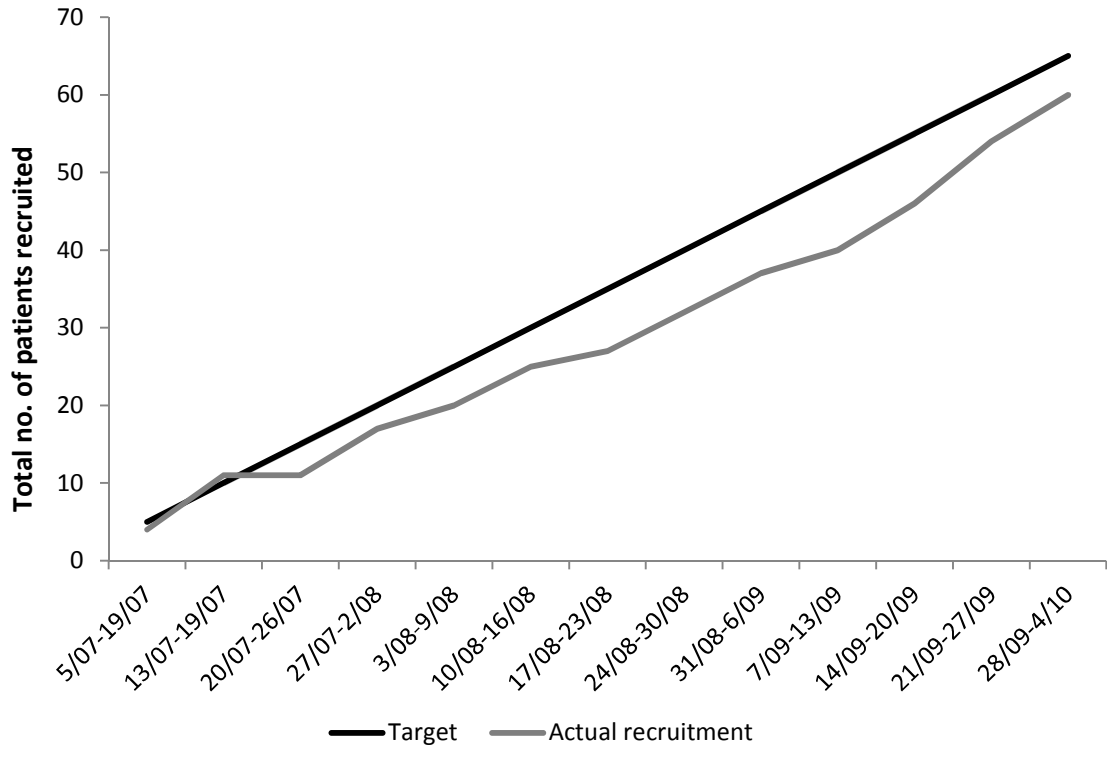


Figure 7.2 Recruitment rate compared to target rate

Five recruits were targeted per week; however the study team attempted to exceed the target to 8-10 patients per week. In practice, this was not achievable and constrained by difficulties related to patient identification and time constraints. Details of recruitment barriers can be seen in (Appendix 19).

7.3 Feasibility of implementing the MR Process

The MedRec process was implemented as intended (section 2.3.7.1). Due to limited study cover at the early stage of the study, discharge MR was implemented retrospectively after the patient discharge. However, the additional MR pharmacists cover enabled the team to follow up and identify patients planned for discharge on daily basis. Discharge medicines were reconciled at the time of patient discharge and GPs were sent discharge letters promptly on the day of discharge.

7.4 Feasibility of data collection

All the study data collection tools were ensured to be comprehensible and appropriate. Additionally, standard operating procedures were developed to guide data collection and input. There were, however, few challenges in data collection process which were not anticipated. These are presented in Appendix 19.

7.5 Feasibility of data management

The study database was tested to ensure user utility and ease of data input and extraction. System errors and break down were reported promptly once occurred. Deficits with the database were discussed with the IT supporting team.

The database layout is yet not optimised; the medicines section requires adjustment and the layout could be modified to facilitate comparing medicine lists at the different time points. Appendix 20 summarises amendments suggested for the MedRec database.

7.6 Acceptability of the intervention and study process

The question for the acceptability of the intervention can't be fully answered at this stage without comprehensible insight from patients and ward staff. However, it can be outlined that patient consent and the randomisation approach appeared to be feasible. Although, the time pressure for consenting consultees should be of note.

Patients agreed to be randomised and endorsed the concept of randomisation. The study information leaflet and the consent form found understandable and clear. Additionally, the study researchers identified the best way for providing a suitable explanation and eliciting informed decision for patients.

7.7 Follow up rate

7.7.1 Death

Five patients died in both groups during the study follow up period; i.e. three months post discharge. Two patients were in the intervention and three in the control groups. Two intervention patients did not receive full MR of which one patient discharged before receiving discharge MR and the other died during hospital stay (Figure 7.1).

7.7.2 Withdrawal

Minimum burden to patients was anticipated by the MR intervention; none of the study patients withdraw while in hospital stay or during three month post discharge. However, one patient withdrawn beyond the three month period; the patient lacked mental capacity at the latter time and the consultee advised the study team with patient withdrawal.

7.7.3 Medicines prescribed to patients in primary care three months post discharge

At three months post discharge, in total 48 (87.3%) medicine lists held by GPs were available for both groups (Figure 7.1). Lists were not available for the deceased patients, i.e. six patients of which five died during the study follow up and one beyond the three months window. Additionally for 4 (7.3%) patients, the primary care practices did not respond to the study team requests up to the point of this analysis. In one case, the primary care practice declined the RA request indicting that the GP time that would be spent processing the request was more than the value offered as a complementary fund by the study; i.e. £5. The three months list was not available too for the patient who had withdrawn beyond three months of discharge; the GP list was not received up to the point the patient was withdrawn and thus no further contact made to obtain the medicines list.

Twenty seven GP lists were received following the first request by fax (56.3%). For the remainder (n=21), the study team initiated a second contact to prompt primary care practices to send these. Median (IQ) days to receive GP list was 9 (2, 32) days and ranged between same day up to 95 days. Median (IQ) days upon the first contact was 4.5 (1, 11) days ranging from same day to 44 days. Upon the second contact the median (IQ) days was 5 (2, 9) ranging from same day to 42 days.

Christmas and New Year holidays slightly increased the days needed to receive the GP list, adjusted medians (IR) were 9 (2, 34) days for Christmas and New Year compared to 8 (1,29) days. Additionally, when adjusting for Christmas and New Year, it was noted that the study researchers were more likely to initiate a second request 14 (43.8%) compared to 7 (30.4%) during the holiday season.

7.7.4 Health related quality of life and Health resource use at 3 months

In both groups 35 (63.6%) patients returned health related quality of life and health resource use questionnaires. Three month health related quality of life and health resource use questionnaires were not available for the deceased patients (n=6) and the patient who was withdrawn and two patients who had moved (Figure 7.1). More details on those patients are described in Appendix 21.

Patients returned health related quality of life and health resource use with a median (IQ) of 18 (11, 42) days ranging from six to 85 days. Twenty three (65.7%) of returned questionnaires were received following the first contact (i.e. sending questionnaire by post) with a median (IQ) of 12 (10, 18) days ranging between six to 26 days. A reminding letter was sent after one month of the first contact, eight (66.7%) patients responded and returned the questionnaire with a median (IQ) of 10 (3, 19) days ranging between one to 29 days. The study researchers called non-responders after four weeks of sending the reminding letter. In total the study researchers called 18 patients. Consequently, four questionnaires were returned with a median (IQ) of seven (3, 10) days following the call and ranging between two to 10 days.

7.8 MR in the control group

Three MR control forms were not retained in the ward folder and 12 were returned uncompleted. The review of patients' medical notes showed:

- One patient received MR with no details on the time and the person who provided MR
- One patient received patient own drugs check by a pharmacy technician
- Eight patients received control MR

In total 24 (80%) patients in the control group received MR by the ward pharmacy team as per the study site policy. Table 7.2 summarise details of MR in the control group.

Control MR		n=23[a]
Time MR delivered	within 24 hours	9 (39%)
	Within 48 hours	6 (26.1%)
	Within 72 hours	2 (8.7%)
	More than 72 hours	6 (26.1%)
Duration [b]	10 minutes	12 (80%)
	< 30 minutes	3 (20%)
	>30 minutes	-
Provider [c]	Pharmacist	8 (38.1%)
	Pharmacy technician	12 (57.1%)
Source of information	Patient	3 (13.0%)
	Laminated list with patients	1 (4.3%)
	Patient own drugs	15 (65.2%)
	GP referral letter	1 (4.3%)
	GP list	2 (8.7%)
	Outpatient clinical letter	2 (8.7%)
	Repeat prescription	5 (21.8%)

[a] For one patient no details on timing or duration. [b] No details on time spent to provide MR for 8 patients.
[c] No details on MR provider for 3 patients. MR: Medicine reconciliation. GP: general practitioner.

Table 7.2 Details of MR in control group

It can be seen that control MR was often implemented after 48 hours and mainly by pharmacy technicians and took frequently 10 minutes. Only one source of information was used with patient own drugs being the primary source.

7.9 Patient characteristics

Table 7.3 summarise patient characteristics in both study groups. Both groups were similar with respect to all baseline characteristics. Additionally, both groups were similar with respect to the baseline health related quality of life measures (Table 7.4). However, intervention patients had higher baseline mean of EQ-5D score compared to control patients.

Characteristics	Measure	Intervention n=30 N%	Control n=30 N%
Demographics			
Female	N (%)	15 (50%)	19 (63.3%)
Age	Mean (SD)	63.0 (20.6)	56.2 (24.3)
No. medicine on admission	Median (IQ)	10 (6.8,14)	10 (7,15)
No. medicine on discharge	Median (IQ)	8 (4.8,11.3)	8 (6,15)
Reason for admission	N (%)		
Abdominal pain, nausea and vomiting		3 (10%)	8 (26.7%)
Chest pain and tightness		6 (20%)	3 (10%)
Collapse and fall		4 (13.3%)	4 (13.3%)
Confusion		3 (10%)	-
Exacerbation of asthma, SOB due to chest infection		3 (10%)	5 (16.7%)
Leg, shoulder or knee pain		1 (3.3%)	4 (13.3%)
Others*		10 (30%)	6 (20%)
Day of admission			
Weekdays	N (%)	22 (73.3%)	25 (83.3%)
Time of admission			
Working hours	N (%)	5 (16.7%)	8 (26.7%)

*Worsening or renal function, skin ulceration and cellulitis, ethanol abuse and seizure.SD: Standard deviation. IQ: Interquartile

Table 7.3 Baseline characteristics

Health related quality of life measures at baseline	Measure	Intervention N=30	Control N=30
Mobility	N (%)		
No problem		11 (36.7%)	4 (13.3%)
Some problem		14 (46.7%)	19 (63.3%)
Confide to bed		5 (16.7%)	7 (23.3%)
Self-care	N (%)		
No problem		20 (66.7%)	18 (60.0%)
Some problem		8 (26.7%)	10 (33.3%)
Unable of self-care		2 (6.7%)	2 (6.7%)
Usual activities	N (%)		
No problem		9 (30.0%)	6 (20.0%)
Some problem		12 (40.0%)	17 (56.7%)
Unable to perform any unusual activity		9 (30.0%)	7 (23.3%)
Pain & discomfort	N (%)		
No pain		8 (26.7%)	7 (23.3%)
Moderate		17 (56.7%)	15 (50.0%)
Extreme		5 (16.7%)	8 (26.7%)
Depression/anxiety	N (%)		
I am not anxious or depressed		12 (40%)	18 (60%)
I am moderately anxious or depressed		15 (50.0%)	10 (33.3%)
I am extremely anxious or depressed		3 (10%)	2 (6.7%)
EuroQol VAS	Mean (SD)	52.3 (24.2)	51.4 (25.9)
EQ-5D score	Mean (SD)	0.49 (0.38)	0.36 (0.39)

VAS: Visual analogue scale

Table 7.4 Baseline health related quality of life measures

7.10 Outcomes measured

7.10.1 Medication errors

In total 438 discrepancies were identified in both groups of which 145 (26.3%) were unintentional errors. Inter-rater agreement kappa score of discrepancies identification was 0.66, indicating good agreement. Variances identified with discrepancy identification were discussed with the study principal investigator and consequently the process was standardised.

A total of 60 errors were identified at admission in the control group affecting 24 (80.0%) patients with a median (IQ) of 2 (1, 3). A total of 58 errors were identified at discharge affecting 20 (69%) patients with a median (IQ) of 2 (1, 3). Table 7.5 summaries the nature of unintentional errors in the control group. It can be seen; most unintentional errors occurred on admission and were due to omissions. Majority of admission omissions were carried on until discharge. Only 12 (20%) discrepancies, of which 10 omissions, affecting nine patients were resolved before discharge. Of these, four which occurred in three patients were intercepted by ward pharmacy staff during control MR.

In the control group, three months post discharge, 25 (56.8%) of errors occurred on discharge were translated into primary care. It was not possible to know the outcome of 16 errors because GP lists were not available at the time of this analysis:

- Three patients were deceased accounting for five errors
- One patient transferred to other hospital patient accounting for two errors.
- Three patients had their GP lists not received upto the time of this analysis, this accounted for nine errors.

Table 7.6 describes discharge errors at three months in the control group. Fifteen omissions identified at three months were confirmed by only one source of patient information. Nine of these omissions were listed by the GP list only, four omissions were identified from patient own drugs alone and in two discrepancies medicines were listed in repeat prescriptions only.

It can be seen in Table 7.6 that GPs often retained medicines as prescribed pre-admission presumably assuming changes or omissions were not intended.

Time point	Type of discrepancy	No. patients	N (%)	Examples
Within 24 hours of admission	Pre-admission medicine omitted from administration chart	22	58 (80.5%)*	**Pre-admission:** Simvastatin 40 mg OM **Inpatient:** omitted
	Dose, frequency or formulation inadvertently changed	2	2 (2.8%)	**Pre-admission:** Senna 2 tablet ON PRN **Inpatient:** Senna 2 tablet ON BD
Upon discharge	Pre-admission medicine omitted from discharge summary	17	49 (70.8%)†	**Pre-admission:** Alendronic Acid 70mg once weekly **Inpatient:** Omitted **Discharge:** Omitted
	Dose, frequency or formulation inadvertently changed	4	4 (5.6%)	**Pre-admission:** Amitriptyline 10mg OM **Inpatient:** Amitriptyline 10mg OM **Discharge:** Amitriptyline 20mg OM
	Prescribed medicine discontinued	1	3 (4.3%)	**Pre-admission:** Ezetimibe 10mg OD **Inpatient:** Ezetimibe 10 mg OD **Discharge:** Not prescribed
	New medicine incorrectly added to discharge summary	1	2 (2.8%)	**Pre-admission:** Digoxin 62.5 mcg OD **Medical note:** Digoxin stopped for bradycardia **Discharge:** Digoxin 62.5 mcg OD

*38 were omission stated by only one source of patient information. † 48 admission omissions continued until discharge. OD: Once a day. BD: Twice a day. OM: in the morning. ON: In evening time. PRN: as required

Table 7.5 Nature of unintentional errors in the control group

Error type	No. patients	N (%) n=44
Medicines omitted in discharge summary		
Medicine present in GP repeat list at 3 months post discharge	9	16 (36.4%)
Medicine not present in GP repeat list at 3 months post discharge, i.e. omission perpetuated	12	21*(47.7%)
Dose, frequency or formulation Changed in discharge summary		
Dose, frequency or formulation retained as pre-admission in GP repeat list at three months post discharge	3	3 (6.8%)
Dose, frequency or formulation changed in GP repeat list at three months post discharge, i.e. unintentional change perpetuated	1	1 (2.3%)
Discontinuation		
Medicine not present in GP repeat list at three months post discharge, i.e. discontinuation perpetuated	1	3 (6.8%)

*15 omissions identified by one source of patient information. GP: general practitioner

Table 7.6 Unintentional errors at three months post discharge in the control group

7.10.2 Clinical significance of medication errors

Medications errors in the control group were stratified by the type of error and the time at which the discrepancy occurred. A random selection of 20 was rated by an expert panel of four assessors from the following professions: one hospital consultants, one primary care pharmacist and two hospital pharmacists.

The mean (SD) of visual analogue scale (VAS) scores was 2.3 (1.16) indicating minor severity. No discrepancy was considered to cause severe harm, 5 (25%) discrepancies we scored with moderate potential of harm (score ≥ 3). Appendix 22 presents examples of errors in the control arm and their risk.

7.10.3 Medication errors in the interventions group

The MR pharmacist performed a total of 225 interventions intercepting medication discrepancies in the intervention group, median (IQ) was 7 (5, 10). Seventy three

interventions intercepted unintentional errors occurring in 22 (73.3%) patients. Table 7.7 describes the nature of the MR pharmacist interventions.

It can be seen that the majority of the MR pharmacists' interventions occurred at admission and were related to omissions or inaccuracies in medicines the patient is taking before admission. Upon discharge, the MR pharmacist frequently intervened to resolve unintentional therapy changes and discontinuation.

One medication error was not intercepted in the intervention group by the study MR pharmacists. Pre-admission, the patient was prescribed Seretide 500 Accuhaler® for Asthma; dose was two puffs twice a day. While the patient in hospital for 20 days, Seretide® was prescribed as one puff twice a day. Unintentionally this was continued upon discharge; Seretide® was transcribed into discharge prescription as one puff twice a day. At three months post discharge, this inadvertent dose change was not translated into primary care; the GP retained Seretide® as pre-admission dose (i.e. of two puffs twice a day).

7.10.4 Intentional medication discrepancies

In total there were 293 intentional discrepancies in both groups of which 141 (48.1%) discrepancies were identified in the control group with 91 (64.5%) undocumented intentional discrepancy.

In the intervention group, the MR pharmacists established intentional discrepancies by discussion with the medical team in 114 instances of which 56 (49.1%) discrepancies required further communication to the nursing team or the primary care to enable correct or safe prescribing. The majority of intentional discrepancies were performed upon discharge 33 (58.9%); the MR pharmacists prepared discharge medicines list, clarified all changes occurred during hospital stay and recorded clear instructions to primary care team. Appendix 23 presents examples of intentional discrepancies in the intervention group.

7.10.5 Post discharge medication changes

Three month post discharge, a total of 48 medicine changes were identified in both groups. The majority of changes occurred in the intervention group 36 (75%). Additionally, higher proportions of patients in the intervention group had at least one medicine changed 13 (43.3%) compared to 6 (23.3%) control patients. Changes in post discharge medicines occurring in the intervention groups were commonly in response to the MR pharmacists' discharge instructions.

Time point	Type of discrepancy	No. patients	N (%)	Examples
Within 24 hours of admission	Pre-admission medicine omitted from administration chart	15	25 (34.2%)	**Pre-admission:** Lisinopril 10 mg OD **Inpatient:** Omitted
	Dose, frequency or formulation inadvertently changed	8	17 (23.3%)	**Pre-admission:** Nicorandil 10mg BD **Inpatient:** Nicorandil 10mg OD
	Illegibility	2	2 (2.7%)	Dose of amlodipine was clarified
	Omitted dose, frequency	6	16 (21.9%)	Dose of chlordiazepoxide 10 mg was reconciled
	Wrong dose, formulation, frequency	2	2 (2.7%)	**Pre-admission:** Digoxin 6.25 Mcg od **Inpatient:** Digoxin 6.25 mg od
Upon discharge	Dose, frequency or formulation inadvertently changed	3	3 (4.1%)	**Pre-admission:** Sodium valproate MR 700 mg BD **Inpatient:** Sodium valproate MR 700mg BD **Discharge:** Sodium valproate 700 mg BD
	Prescribed medicine discontinued	2	6 (8.2%)	**Pre-admission:** Zopiclone 3.75 mg ON **Inpatient:** Zopiclone 3.75 mg ON **Discharge:** Not prescribed
	New medicine incorrectly added to discharge summary	1	1 (1.4%)	**Inpatient:** GTN spray 2 puffs PRN **Discharge:** GTN spray 2 puffs OD
	Wrong dose, formulation or frequency	1	1 (1.4%)	**Inpatient:** Domperidone 10 mg PRN for nausea **Discharge:** Domperidone 10 mg for regular use

BD: Twice a day. OD: once a day. PRN: as required. OM: In the morning. ON: In evening time. GTN: Glyceryl trinitrate. MR: Modified release

Table 7.7 Pharmacist interventions to resolve unintentional errors

7.10.6 Length of hospital stay

Distributions of length of hospital stay by study group are illustrated in Figure 7.3 and 7.4. It can be seen that length of hospital stay (hours) is positively skewed. The box plot presentation (Figure 7.4) shows that patients in the intervention group exhibited wider range of length of hospital stay with three patients outside the whiskers (i.e. beyond 800 hours). The distributions of log length of hospital stay are illustrated in Figure 7.5 and 7.6. Log transformation of length of hospital stay resulted in a more symmetric distribution for both groups. However, the intervention group yet exhibited wider variation compared to the control group.

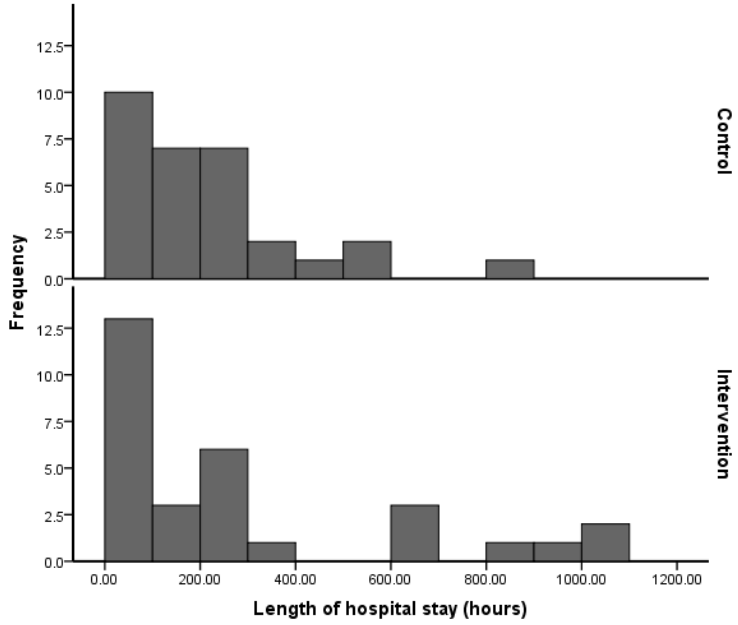


Figure 7.3 Histogram presentation of hospital stay in hours by study group

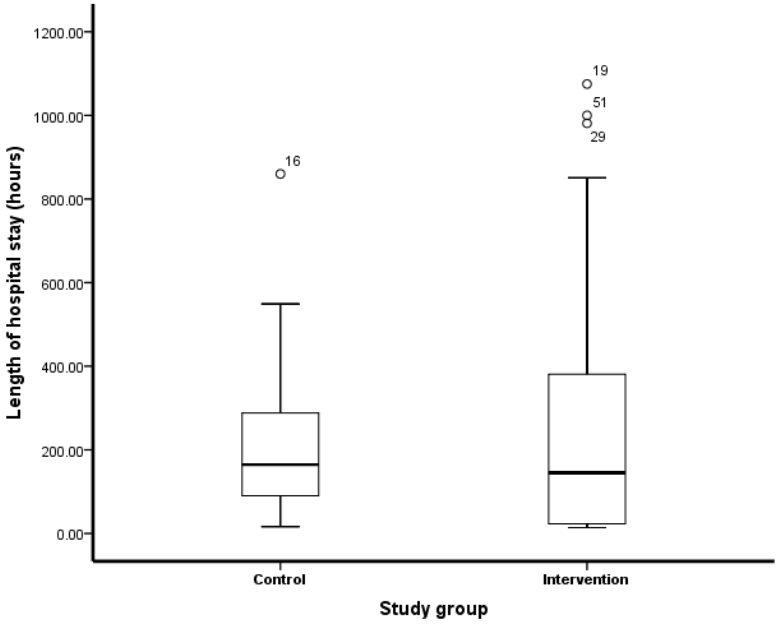


Figure 7.4 Box plot of hospital stay in hours by study group

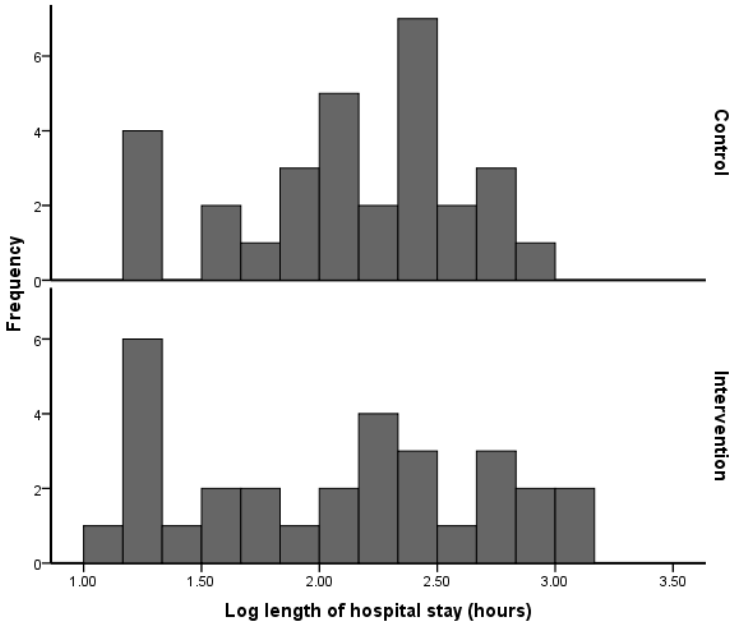


Figure 7.5 Histogram presentation of Log length of hospital stay in hours by study group

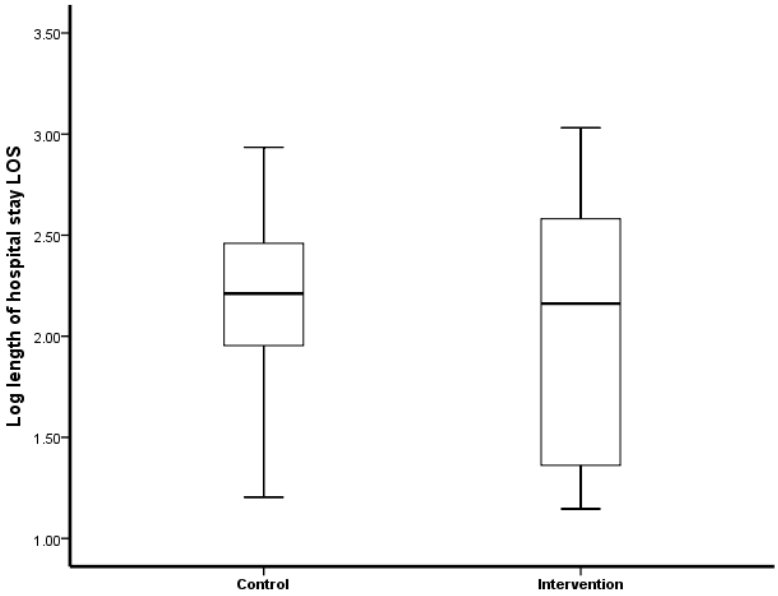


Figure 7.6 Box plot of Log length of hospital stay in hours by study group

It is shown from the box plot presentation, four outlaying data points might be suspected. Those appeared incompatible with the rest of the data. Table 7.8 summarises details related to these data points. Those data points were carefully reviewed; there was no evidence of a user or data entry errors. Therefore they were not altered or excluded

Study group	Study no.	Admitting diagnosis	Age (years)	Admitting Ward	Admission date	Admission discharge	Hospital stay (hours)
I	029	Bilateral leg ulceration	83	W1 [a]	24/08/2012	04/10/2012	981
I	051	Sepsis	85	W1	25/09/2012	Deceased 05/11/2012	1000
I	019	Bibasal pneumonia	40	W2[b]	09/08/2012	22/08/2012	1075
C	016	Exacerbation of heart failure and cellulitis	86	W1	02/08/2012	06/09/2012	860

[a]W1 care for the Elderly specialising in caring for dementia and Parkinson's disease. [b] W2 Renal and Diabetes & Endocrinology with general medicine.

Table 7.8 Details of suspected outlying data points

Mean (SD) Log length of hospital stay for the intervention and control groups were 4.9 days (4.26) and 5.49 days (1.11), $p > 0.05$. The estimated Coben's effect size of the MedRec intervention was 0.22 95% CI [-0.77-1.95] indicating a potential small effect size.

7.10.7 Readmission episodes identified by hospital records

In total 17 (28.3%) patients were readmitted on one or more episodes in both groups. Total number of readmissions was 50 episodes. Table 7.9 summarises readmissions between the study groups.

Higher number of readmissions occurred in the control group compared to intervention group. Median (IQ) of readmissions experienced by patient was 2 (1, 3) for the control group and 1 (1, 2) for intervention group. This effect was not statistically significant, $p > 0.05$.

Nevertheless, intervention patients took longer time to be readmitted compared to control patients with mean (SD) of 43.3 (20.2) and 34.3 (28.4) hours respectively. However, this was not statistically significant, ($p=0.46$). Number to treat in order to prevent one readmission was 7.5 patients.

Readmission	Intervention n=28	Control n=29
Total number of readmission	19	31
Patients readmitted	7 (25%)	10 (34.5%)
Planned readmission		
Number of planned readmissions	10	10
Patients readmitted with at least one planned admission	4 (14.3%)	4 (13.8%)
Unplanned readmission		
Number of unplanned readmissions	9	21
Patients readmitted with at least one unplanned admission	3 (10.7%)	11 (37.9%)

Table 7.9 Readmission episodes in both groups

The Kaplan-Meier estimate of readmission time is illustrated in Figure 7.7.

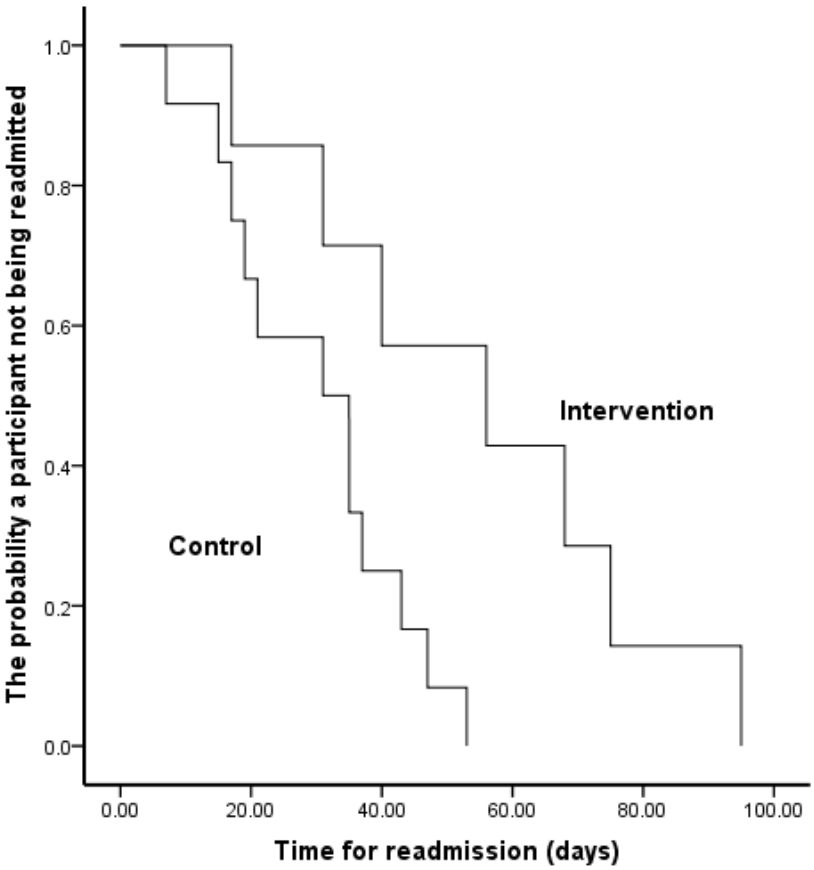


Figure 7.7 Kaplan-Meier survival function of time to readmission

Kaplan-Meier test showed that intervention patients took significantly longer time to be readmitted to the hospital compared to control patients.

The median [95% CL] survival function time, the smallest survival time for which the participant probability of being readmitted is more or equal to 0.5 was 56 days [14.9-97.1] for the intervention group and 31 days [15.2-46.8] for the control group; log rank test (p=0.016).

There were no significant differences between the number of planned admission neither the proportion of patients readmitted via planned admission in both the intervention and control groups. Whereas, there were significantly more unplanned admissions in the control group compared to intervention (p=0.028). Patient in the control group were three times more likely to experience at least one unplanned admission compared to the intervention arm. This effect almost approached statistical significance (p=0.07).

7.10.8 Patient self-reported use of NHS and personal and social services (PSS) in hospital

7.10.8.1 Readmission episodes reported by patients

Seventeen (28.3%) patients reported 34 readmissions; median (IQ) length of hospital stay of readmissions was 2.5 (0, 7). Table 7.10 summarises patient-reported readmissions in both study groups.

Control patients reported higher number of readmissions compared to intervention patients; 2.3 (0.43) and 0.79 (0.43) respectively (p=0.14). Additionally, on average those patients reported longer hospital stay; 5 (0.75, 9.8) days compared to intervention patients 3 (0.24, 2.6) days. This was not statistically significant (p=0.28).

Patients self-reported readmissions and readmissions identified by the hospital records were matched. Readmissions identified by reviewing the hospital system and reported by patients were not matching for 18 readmissions reported by seven patients of which four reported lower number compared to the number identified by the hospital system. Additionally, eight patients reported not being readmitted at all, but yet they were identified with at least one or more readmissions by the hospital record. This occurred with 15 readmissions of which four readmissions occurred in three intervention patients and the remainder occurred in five control patients. Eleven readmissions were reported by patients but not identified by the hospital record which occurred for seven intervention patients accounting for seven readmissions and with two control patients accounting for four readmissions.

7.10.8.2 Emergency department visits

Twelve patients reported 22 visits to emergency department of which twelve reported by five control patients and seven were reported by intervention patients (p=0.92). The proportions of patients reporting emergency department visits in both groups were similar (p=0.75).

7.10.8.3 NHS walk in centre

Only one control patient reported a visit to NHS walk in centre.

7.10.8.4 Outpatients visits

Nineteen patients reported attending outpatient clinics for at least or more visit in both groups in which nine were control patients. Patients in both study groups also reported similar number of outpatient visits (p=0.66).

Wards		Intervention N=18	Control N=17
General medicine			
	Number of readmissions	4	3
	Total length of hospital stay (day)	20	12
Oncology	Number of readmissions	1	2
	Total length of hospital stay (day)	9	23
Cardiology	Number of readmissions	1	1
	Total length of hospital stay (day)	9	14
Respiratory	Number of readmissions	1	-
	Total length of hospital stay (day)	7	-
GI& colorectal	Number of readmissions	2	4
	Total length of hospital stay (day)	9	16
Surgical	Number of readmissions	-	1
	Total length of hospital stay (day)	-	1
Others*	Number of readmissions	2	12
	Total length of hospital stay (day)	7	13
Total	Patient readmitted	9	8
	Total length of hospital stay (day)	11	23

*Observation and programmed investigation unit ward

Table 7.10 Patient self-reported readmissions and readmission duration

7.10.9 Patient self-reported use of NHS and personal social services in community

Intervention patients trended to have fewer number of visits to NHS and personal social services (PSS) workers 1.5 (0, 8.5) compared to control patients 3.5 (1.10). This was not statistically significant (p=0.29).

The most frequent health workers visited were GPs 116 (39.2%) followed by practice nurses 56 (18.9%). and often these visits took place in GP clinics. Table 7.11 summarises details of NHS and PSS visits in the intervention and control groups.

Worker		Measure	Intervention n=11	Control n=14
GP	Total number of GP visits	N	35	81
	Patient visited GP	N (%)	9 (81.8%)	11 (78.6%)
	Place of most visits	N (%)		
	GP clinic		7 (77.8%)	9 (81.8%)
	Home		2 (22.2%)	1 (11.1%)
	Telephone consultation		-	1 (11.1%)
Practice nurse	Total number of practice nurse visits	N	13	43
	Patient visited practice nurse	N (%)	5 (45.5%)	8 (57.1%)
	Place of most visits	N (%)		
	GP clinic		4 (80.0%)	8 (100%)
	Home		1 (20%)	-
District nurse	Total number of district nurse visits	N	26	29
	Patient visited district nurse	N (%)	3 (27.3%)	4 (28.6%)
	Place of most visits	N (%)		
	GP clinic		-	1 (25%)
	Home		3(100%)	3 (75%)
Specialist Nurse	Total number of specialist nurse visits	N	-	19
	Patient visited specialist nurse	N (%)	-	2(7.1%)
	Place of most visits	N (%)	-	-
	Hospital		-	2 (100%)
Dietician	Total number of dietician visits	N	1	4
	Patient visited dietician	N (%)	1 (9.1%)	3 (21.4%)
	Place of most visits	N (%)		
	GP clinic		1 (100%)	1 (33.3%)
	Telephone consultation		-	1 (33.3%)
	Hospital		-	1 (33.3%)
Physiotherapist	Total number of physiotherapist visits	N	4	5
	Patient visited physiotherapist	N (%)	1 (9.1%)	2 (14.3%)
	Place of most visits	N (%)		
	GP clinic		-	1 (50%)
	Home		1 (100%)	1 (50%)
Care assistant*	Total number of visits	N	31	5
	Patient visited other	N (%)	2 (9.1%)	1(33.3%)
	Place of most visits	N (%)		-
	Hospital		1 (50%)	-
	Home		1 (50%)	1 (100%)
Total NHS and PSS worker visits			**110**	**186**

GP: General practitioner

Table 7.11 NHS and PSS worker visits

7.10.10 Patient self-reported use of social and informal care

None of the patients were admitted to residential home, nursing home. Meanwhile, one patient in the control group reported six visits to a day centre. Four patients needed home help or community assistant, of which two patients were in the control group with an average time of 40 minute per visit. For intervention patients, the average time per visit was 25 minutes.

Eight patients of which four were control patients needed support with everyday activities from friend or relative carer who lives with them. This occurred in 24 times over a week with an average duration of 26 minutes. For intervention patients, this occurred in 34 times with an average duration of 44 minutes.

Four patients, two control and two intervention patients, needed help from a friend or a relative who does not live with them. This occurred in one and two times per week with average duration of 60 and 240 minutes for the control patients. For the intervention patients, this occurred one and six times with duration of 30 and 120 minutes. None of those carers had to take time off work. None of the patients reported using meals on wheels.

7.10.11 Health Related Quality of Life

Health related quality of life measures at three months post discharge are summarised in Table 7.12. No significant difference was seen between the study groups. Health status EuroQoL VAS and EQ-5D scores were higher for intervention patients compared to control patients. However, this was not statistically significant. Change on health related quality of life measures between baseline and three months post discharge was not significant for all measures too, all p values > 0.05.

However, intervention patients showed more profound but not significant change in EuroQoL VAS scores; mean change (SD) was 16.4 (22.4) compared to 12.2 (21.7) for control patient, p =0.58. Similarly, mean (SD) change in EQ-5D was slightly higher in intervention patients 0.22 (0.29) compared to 0.20 (0.38) for control patients, yet again this was not significant (p=0.85).

Health related quality of life	Measure	Intervention N=18	Control N=17	Sig
Mobility	N (%)			
No problem		9(50.0%)	9 (52.9%)	NS
Some problem		9 (50.0%)	8 (47.1%)	
Confide to bed		-	-	
Self-care	N (%)			
No problem		15 (83.3%)	14 (82.4%)	NS
Some problem		3 (16.7%)	3 (17.6%)	
Unable of self-care		-		
Usual activities	N (%)			
No problem		7 (38.9%)	9 (52.9%)	NS
Some problem		11 (61.1%)	7 (41.7%)	
Unable to perform any unusual activity		-	1 (5.9%)	
Pain & discomfort	N (%)			
No pain		6 (33.3%)	8 (47.1%)	NS
Moderate		11 (61.1%)	7 (41.2%)	
Extreme		1 (5.9%)	2 (11.8%)	
Depression/anxiety	N (%)			
I am not anxious or depressed		10 (55.6%)	11 (64.7%)	NS
I am moderately anxious or depressed		8 (44.4%)	4 (23.5%)	
I am extremely anxious or depressed		-	2 (8.3%)	
EuroQoL VSA score	Mean (SD)	71.3 (16.3)	68.9 (19.8)	NS
EQ-5D score	Mean (SD)	0.72 (0.22)	0.66 (0.31)	NS

NS: not statistically significant. SD: Standard deviation

Table 7.12 Health related quality of life measures three months post discharge in both groups

7.10.12 Mortality rate

Mortality rates were similar between groups; 6.7% for intervention group and 10% for control group, p >0.05.

7.11 Resources necessary to implement pharmacy led MR service

- **Pharmacist time**

The total time spent by the MR pharmacist implementing MR was 899 minutes, median (IQ) 29.5 (15.8-43.5) minutes per patient. Table 7.13 summarises details of the time spent implementing MR. It can be seen that admission MR took longer than discharge MR, with the largest proportion of MR pharmacist's time spent collecting and verifying medication histories. The MR pharmacist spent the time on discharge mainly reconciling medicine changes occurred during hospital stay into discharge prescriptions.

Point of care	Pharmacist activities	Mean (SD) per patient	% of MR pharmacist spent time	Range
Admission	Collection of data on medication history from source(s) other than patient own drugs*	11.5 (7.0)	31.3%	3-30
	Documentation of discrepancies	6.3 (4.1)	14.7%	2-15
	Discrepancies identification	4.0 (2.4)	10.1%	0-10
	Checking patient own drugs	3.6 (2.6)	6.8%	0-10
	Establishing unintentional discrepancies with medical staff	3.5 (1.5)	5.9%	2-5
	Rectifying unintentional discrepancies	3.0 (3.3)	6.7%	0-5
	Intentional discrepancies clarified with medical team as a result of the pharmacist query	2.3 (4.6)	0.8%	1-5
Discharge	Rectifying unintentional discrepancies with medical staff	2.3 (4.9)	12.2%	1-5
	Discrepancies identification	4.0 (4.2)	6.7%	1-15
	Clarification of discrepancies identified on discharge with medical staff	7.4 (4.6)	5.0%	5-10
	Documentation of discrepancies	3.9 (2.8)	3.9%	1-10
	Recording of any changes as a result of discussion with medical staff	3.8 (2.95)	1.8%	1-10
	Establishing unintentional discrepancies with medical staff	2.3 (1.9)	1.6%	1-6
	Intentional discrepancies clarified and recorded on electronic discharge summary	3.5 (4.4)	1.6%	1-10

*Mainly patient or carer interview. MR: Medicine reconciliation. SD; standard deviation

Table 7.13 Pharmacist time (minutes) spent on MR upon admission and discharge

- **Doctor time**

The doctors who were responsible for preparing admission charts spent approximately two minutes (range 1-5) per patient responding to the MR pharmacist interventions. Likewise, 1.5 minutes (range 1-3) were spent per patients by the doctors responsible for discharge.

7.12 Cost estimation

The MedRec study evaluated a broad scope of costs and consequences. The main costs consumed were related to the time commitment by MR pharmacists. Consequence costs included burden on hospital bed occupancy, NHS and PSS services worker visits, social and informal care.

The unit costs and assumptions used in cost estimation are presented in Tables 7.14, 7.18, 7.20 and 7.23.

Assumptions*	Cost unit†
Time commitment [a]	
Hospital pharmacist	£41 per hour
Foundation year doctor	£37.5 per hour [b]
Registrar	£58 per hour
Unintentional errors	
▪ 4.8% 95% CI [3.7-6.1] of errors occurring upon patient transfer of hospital lead to adverse drug events ▪ Patients admitted with an adverse drug events had a median stay (IQ) 8 [4,18] [11] ▪ The average cost of an excess bed day is £264	£2,112 per adverse drug event
Readmissions	
▪ The average cost of an elective inpatient stay excluding excess bed days	£3,215
▪ The average cost of a non-elective inpatient short and long stay combined excluding excess bed days	£1,436

* Costs estimate based on mean (SD). † Unit costs are taken from Personal Social Services Research unit (PSSRU) unit costs 2012 and Department of Health reference costs 2011-2012; financial year 2011/2012. [a] Costs without qualifications. [b] Mean foundation year 1 and year 2 doctors. MR: Medicine reconciliation. CI: Confidence interval. IQ: interquartile.

Table 7.14 Unit costs and assumptions for MR pharmacist time, doctor time, length of hospital stay, unintentional errors and readmissions

7.12.1 Costs associated with pharmacist time

Based on the unit costs and assumptions stated in Table 7.14, the costs associated with the MR pharmacists' activities are summarised in Table 7.15. The estimated cost attributed to the increased pharmacist time commitment is £23.59 per patient ranging between £0 to £54.83.

Point of care	Pharmacist activities (n=30)	Cost per patient	Range
Admission	Collection of data on medication history from source(s) other than patient own drugs*	£7.85	£2.34-£23.4
	Documentation of discrepancies	£4.28	£1.58-£11.7
	Discrepancies identification	£2.72	£0-£8.7
	Checking patient own drugs	£2.38	£0-£8.7
	Establishing unintentional discrepancies with medical staff	£2.38	£1.6-£3.9
	Rectifying unintentional discrepancies	£2.04	£0-£3.9
	Intentional discrepancies clarified with medical team as a result of the pharmacist query	£1.56	£0.8-£3.9
Discharge	Rectifying unintentional discrepancies with medical staff	£1.56	£0.8-£3.9
	Discrepancies identification	£2.72	£0.8-£11.7
	Clarification of discrepancies identified on discharge with medical staff	£5.03	£3.9-£7.8
	Documentation of discrepancies	£3.65	£0.8-£8.7
	Recording of any changes as a result of discussion with medical staff	£2.55	£0.8-£8.7
	Establishing unintentional discrepancies with medical staff	£ 1.56	£0.8-£4.7
	Intentional discrepancies clarified and recorded on electronic discharge summary	£2.38	£0.8-£8.7

*Mainly through patient or carer interview.MR: Medicine reconciliation

7.15 Cost associated with pharmacist time commitment

7.12.2 Costs associated with doctor time

The role of the person who prepared admission medical charts and discharge summaries was identifiable for 47 of medical charts and 25 of discharge summaries. Foundation doctors prepared admission charts in 76%, meanwhile registrar doctors prepared discharge summaries in 68%. The cost associated with doctor time upon admissions assumed based on the unit cost of a foundation doctor; whereas a registrar doctor unit cost was assumed upon discharge.

The cost associated with doctor time upon admission was £1.58 per patient ranging between £0.73 and £3.96. On discharge, the cost associated with the doctor time was £1.78 per patient ranging between £1.18 and £3.55.

7.12.3 Costs associated with unintentional errors

Costs of unintentional errors are summarised in Table 7.16. It can be seen, considerable costs were saved in the intervention group as errors were intercepted and resolved by the MR pharmacist.

Assumptions	Intervention Mean [95% CI] N=30	Control Mean [95% CI] N=30
Estimated number of adverse drug events contributed by unintentional discrepancies	3.50 [2.7-4.4]	3.46 [2.7-4.4]
Length of hospital stay in days of adverse drug events related admissions	28 [21.6-35.6]	27.6 [21.6-35.1]
Cost of unintentional discrepancies	£7,392 [5,702-9,398]	£7,286 [5,702-9,266]
Cost of unintentional discrepancies intercepted by routine care	-	£1,013 [781.44-1,288]
Cost of unintentional discrepancies intercepted by the MR pharmacists interventions	£7,392 [5,702-9,398]]	-
Overall cost of unintentional discrepancies	£7,392 [5,702-9,398]*	£6,273 [4,920-7,978]

*Cost saved as errors were intercepted. MR: Medicine reconciliation.

7.16 Costs of unintentional discrepancies in the control and intervention groups

7.12.4 Costs of hospital stay

Mean difference in length of hospital stay between intervention and control groups was 2.97 days. Excess bed stay cost is estimated on average £264 per day, and therefore the MR intervention constituted to additional cost of £784.08 per patient. When extrapolating the extra costs of length of hospital stay to include the 30 patient received MR, the costs of excess bed stay amounted to £23,522 in the intervention group.

7.12.5 Costs of readmissions

Cost related to readmissions identified from hospital records can be seen in Table 7.17. It can be seen that the cost of excess day bed in control group exceed the cost in the intervention group. This also can be seen when readmissions are differentiated into planned and unplanned. The cost of unplanned readmissions in the control group were more than two times the cost in the intervention group.

Readmissions	Intervention	Control
	N=7	**N=10**
Total number of readmissions	19	31
Total duration of readmission (days)	72.1	145.40
Mean per patient	10.3	13.20
Range	0.20-49.90	0.11-42.90
Total cost of readmissions excess bed day	£19,034.40	£38,385.6
Mean cost per patient	£2,719.20	£3,484.80
Range (days)	£52.80-£13,173.60	£27,04-£11,325.60
Planned admissions [a]	**N=**4	**N=4**
Total number of planned readmissions	10	10
Mean per patient	2.50	2.50
Range (days)	1-7	1-6
Total cost of planned admission excluding excess bed days	£32,150	£32,150
Mean cost per patient	£8,037.50	£8,037.50
Range (days)	£3,215-£22,505	£3,461-£19,29
Total duration of planned readmission (days)	14.30	31.20
Mean per patient	3.60	7.80
Range (days)	0.10-7	0.10-40.46
Total cost of planned inpatient stay including excess bed days	£35,925.20	£40,386.80
Mean cost per patient	£8,987.90	£10,096.70
Range (days)	£3,241.4-£24,353	£3,241.4-£29,971.44
Unplanned admissions [b]	**N=6**	**N=10**
Total number of unplanned readmissions	9	21
Mean per patient	1.5	1.9
Range (days)	1-2	1-4
Total cost of unplanned inpatient excluding excess bed days	£12,924	£30,156
Mean cost per patient	£2,154	£2,728.40
Range (days)	£1,436-£2,872	£1,436-£5,744
Total duration of unplanned readmission (days)	25.9	57.8
Mean per patient	8.6	19.3
Range(days)	1-14	0.60-49.9
Cost of unplanned inpatient including excess bed days	£19,761.60	£45,415.2
Mean cost per patient	£4,424.40	£7,823.60
Range	£1,700-£6,568	£1,594.40-£18,917.60

[a] Elective inpatient stay. [b] non-elective inpatient short and long stay combined.

Table 7.17 Cost related to readmissions in both study groups

7.12.6 Costs of NHS and PSS worker visits

The unit costs and assumptions for NHS and PSS worker visits are summarised in Table 7.18

Workers [a]	Place of most visits	Unit cost*	Cost per hour of employment	Assumptions and comments
GP	GP clinic	£23.01	£118	Per consultation lasting 11.7 minutes for general medical service
	home	£91.26		Per out of surgery visit lasting 23.4 minutes
				Including travel expense
	Telephone consultation	£22		Per telephone consultation lasting 7.1 minutes
Practice nurse	GP clinic	£6.83	£35	Assumed same duration of a GP consultation
	home	£13.65		Assumed same duration of a GP out of surgery visit
District Nurse	GP clinic	£12.04	£42	Assumed same duration of a GP consultation
	home	£16.38		Assumed same duration of a GP out of surgery visit
Specialist nurse	GP clinic	£13	£52	Assumed length of consultation 15 minutes
	Hospital	£8.75	£35	Assumed hospital staff nurse and assumed length of consultation 15 minutes
Dietician	GP clinic	£16.45	£30	Assumed same duration of hospital physiotherapist lasting 32.9 minutes
	Hospital	£11.65		Assumed same duration of hospital physiotherapist clinic visit lasting 23.3 minutes
	Telephone consultation	£6.55		Assumed same duration of hospital physiotherapist lasting 13.1 minutes
Physiotherapist	GP clinic	£16.45	£30	Assumed same duration of hospital physiotherapist lasting 32.9 minutes
	home	£12.09		Assumed same duration of GP out of surgery visit lasting 23.4 minutes
Care assistant	Home	£24.57	£63	Assumed same of health visitors per hour of home visit
				Assumed same duration of GP out of surgery visit lasting 23.4 minutes
				Including travel expense

*Unit costs are taken from Personal Social Services Research unit (PSSRU) unit cost of health and social care 2012, financial year 2011/2012. [a] Costs without qualification. GP: General practitioner.

Table 7.18 Units cost and assumptions related to NHS and PSS worker visits

Costs of NHS and PSS worker visits for both study groups are summarised in Table 7.19.

Workers	Intervention	Control
GP	**N=7**	**N=9**
Number of GP visits in GP Clinic	29	75
Mean per patient	4.14	8.33
Range	1-13	1-30
Total cost of GP visits in GP Clinic	£667.29	£1,725.75
Mean cost per patient	£95.26	£191.67
Range	£23.01-£299.13	£23.01-£690.3
	N=2	**N=1**
Number of GP visits at patient home	6	1
Mean per patient	3	-
Range	2,4	1
Total cost of GP visits in patient home	£547.56	£91.26
Mean cost per patient	£273.78	-
Range	£182.52,£365.04	£91.26
	-	**N=1**
Number of GP telephone consultation	-	1
Total cost of GP telephone consultation	-	£22
Practice Nurse	**N=5**	**N=2**
Number of practice nurse visits in GP clinic	12	33
Mean per patient	2.5	16.5
Range	1-7	3,30
Total cost of practice nurse visits in GP clinic	£120.36	£330.99
Mean cost per patient	£25.08	£165.50
Range	£10.03-£70.21	£30.09,£300.9
	N=1	**N=6**
Number of practice nurse visits at patient home	1	10
Mean per patient	-	1.7
Range	-	1-4
Total cost of practice nurse visits at patient home	£13.65	£136.50
Mean cost per patient	-	£23.21
Range	-	£13.65-£54.6

GP: General practitioner

Table 7.19 Costs of NHS and PSS worker visits

Workers	Intervention	Control
District nurse	**-**	**N=1**
Number of district nurse visits in GP clinic		
Total cost of district nurse visits in GP clinic	-	£12.04
	N=3	**N=4**
Number of district nurse visits at patient home	26	27
Mean per patient	8.7	7
Range	1-24	1-20
Total cost of district nurse visits at patient home	£425.88	£442.26
Mean cost per patient	£142.51	£114.66
Range	£16.38-£393	£16.38-£327.6
Specialist nurse	**-**	**N=1**
Number of specialist nurse visits in GP clinic	-	15
Total cost of specialist nurse visits in GP clinic	-	£195
	-	**N=1**
Number of specialist nurse visits in hospital	-	4
Total cost of specialist nurse visits in hospital	-	£35
Dietician	**N=1**	**N=1**
Number of dietician visits in GP clinic	1	1
Total cost of dietician visits in GP clinic	£16.45	£16.45
	-	**N=1**
Number of dietician visits in hospital	-	1
Total cost of dietician visits in hospital	-	£11.65
	-	**N=1**
Number of dietician telephone consultations	-	2
Total cost of dietician telephone consultations	-	£13.10
Physiotherapist	**-**	**N=1**
Number of physiotherapist visits in GP clinic	-	1
Total cost of physiotherapist visits in GP clinic	-	£17
	-	**N=1**
Number of physiotherapist visits at home	4	4
Total cost of physiotherapist visits at home	£48.36	£48.36

GP: General practitioner

Continued

Table 7.19 Costs NHS and PSS worker visits

Worker	Intervention	Control
Care assistant	**N=2**	**N=1**
Number of care assistant visits at home	31	5
Mean per patient	15.5	-
Range	6,25	-
Total cost of care assistant visits at home	£761.67	£122.85
Mean cost per patient	£380.84	-
Range	£147.42,£614.25	-

Continued
Table 7.19 Costs of NHS and PSS worker visits

The total cost associated with NHS and PSS worker visits in the intervention was £2,601.22; whilst the total cost in the control group was £3,185.21.

7.12.7 Costs of hospital service use

Unit costs and assumptions for hospital service use are summarised in Table 7.20.

Assumptions	Cost unit*
Weighted average of emergency department visit (not admitted)	£112 average visit
Weighted average of walk in service (not admitted)	£41 average visit
Weighted average of all outpatient procedures	£139

*Unit costs are taken from Personal social services research unit (PSSRU) unit cost of health and social care 2012, financial year 2011/2012.

Table 7.20 Units cost and assumptions for hospital service use

Costs of emergency department visits can be seen in Table 7.21.

Emergency visits	Intervention N=7	Control N=5
Total emergency department visits	10	12
Mean per patient	1.43	2.4
Range	1-3	1-3
Total cost of emergency department visits	£1,120	£1,344
Mean cost per patient		
Range	£160.16	£268.8
	£112-£336	£112-£336

Table 7.21 Costs of emergency department in both study group

The cost of emergency department visits in the control group exceeded the cost in the intervention group.

None of intervention patients used NHS walk in centre service, where one control patient visited NHS walk in centre with an estimated cost of £41.

Costs of outpatient visits are shown in Table 7.22.

Outpatient visits	Intervention N=10	Control N=9
Total outpatients visits	27	21
Mean	2.7	2.4
Range	1-8	1-3
Cost of outpatients visits	£3,753	£2,919
Mean	£375.3	£333.6
Range	£139-£1,112	£139-£417

Table 7.22 Cost of outpatient visits

The total weighted cost of outpatients' visits in the intervention group exceeded the cost in the control group.

7.12.8 Costs of social and informal carer

Cost units and assumptions related to social and informal care use can be seen in Table 7.23. No costs were associated with patients' admissions to residential or nursing home and the use of meal on wheels service in both groups. None of the informal carer took time off work and thus no costs valued for productivity loss. Costs associated with social and informal care use are shown in Table 7.24.

The costs of day centre attendance and home help in the control group exceeded the costs for intervention patients. The time spent by informal carers who live with patients amounted for more costs in the intervention group, whereas, the costs of the time spent by carers who do not live with patients, including travel expenses, were similar.

Social and informal care	Unit cost*	Assumption and comments
Day centre attendance	£41 per attendance	Assumed that the number of reported day centre attendances for the week in question was equivalent to the average per week across all weeks in the past 3 months
Home help or community care assistant	£23 per hour	Assume day time weekday visits [a] Face to face contact Assumed a visit lasted 30 minutes
Opportunity cost of the time spent by the informal care givers	£4.38 per hour [b]	Only includes costs attributed to carer time and excludes patient time. the value of the opportunities forgone by care givers as a result of time spent on care giving
Assumed travel cost for each visit for a friend or relative who don't live with the patient	£4[c]	Assumed the use of public transport, return journey

*Unit costs are taken from Personal Social Services Research unit (PSSRU) unit cost of health and social care 2012, financial year 2011/2012. [a] Higher fee for weekends. [b] Taken from the National Minimum Wage rates 2011/2012 available at: https://www.gov.uk/national-minimum-wage-rates . [c] Taken from the Annual Bus Statistics: Great Britain 2011/12: Table BUS0401b, published by the department of transport.

Table 7.23 Cost units and assumptions for social and informal care service use

Social and informal care	Intervention	Control
Social care		**N=1**
Day centre attendance	-	
Number of day centre attendance		6
Costs of day centre attendance		£216
Home help or community care assistant	**N=2**	**N=2**
Number of times home help or community care assistant needed per week	9	13
Total minutes	55	80
Mean duration per patient	27.5	40.0
Range	10,45	20,60
Total costs of home help or community care assistant	£21.08	£30.67
Mean cost per patient	£10.54	£15.33
Range	£3.83,£17.25	£7.67,£23[a]
Informal care (i.e. help with everyday activities)		
Carers who live with the patient	**N=3**	**N=3**
Number of times help needed per week	34	24
Total minutes	980	550
Mean duration per patient	44	26.3
Range	20-90	20-30
Total cost of time spent by carers who live with patients	£71.54	£40.15
Mean cost per patient	£3.21	£1.92
Rang	£1.46-£6.57	£1.5-£2.19
Carers who do not live with the patient [b]	**N=2**	**N=2**
Number of times help needed per week	7	3
Total minutes	300	360
Mean duration per patient	42.86	120
Range (minutes)	30, 120	60,240
Total cost of time spent by carers who don't live with the patient	£38.95	£38.28
Mean cost per patient	£7.13	£12.76
Rang	£26.19-£12.76	£12.38-£21.52

[a] One visit lasted one hour and 12 visits each in average lasted 20 minutes. [b] Travel expense added

Table 7.24 Costs of social and informal care service use

In response to the question on items incurred out of the patient pocket, i.e. paid by a patient as a result of his/her health in the last three months, twelve patients responded that they have incurred out of pocket expenses. Total expense for control patients was £104 and for intervention patients was £185. Details of incurred items can be seen in Table 7.25.

Out of pocket expenses	Intervention Per patient N=7	Control Per patient N=5
Bus tickets & transport	£3.86	£2.80
Car travel expenses	£3.57	£8.80
Car parking	£5.43	£4.20
Prescription and medicines	£13.14	£1
Mouth wash	-	£0.80
Bottle of sterile water	-	£1.20
Micropore	-	£0.40
Antiseptic wipes x4	-	£1.60

Table 7.25 Expenses incurred by patients in the intervention and control groups

It can be seen that intervention patients reported incurring more expenses with mean of £37.6 ranging between £5 and £85. Meanwhile, control patients incurred a mean of £15.6 ranging between £5 and £50.

7.12.9 Costs of control MR

To estimate the cost of MR received by control patients, it was assumed based on Table 7.2 that on average control MR took 20 minutes and was provided by pharmacy technicians. The unit cost assigned to one hour employment of pharmacy technician taken from the National Career Service information and based on an average earning of £23,000 per year [196] was £11.64.

The average cost of control MR was estimated as £3.88 per patient and ranging between £1.93 and £5.82. For the 24 patients received control MR, the total cost was estimated as £93.12 ranging from £46.32 and £139.68.

7.13 Cost-effectiveness of pharmacy led MR

Quality- adjusted life-year (QALY) gained diagram can be seen in Figure 7.8. Methods for QALY estimation with and without baseline estimation are illustrated in Box 7.1.

BOX 7.1 QALY estimation

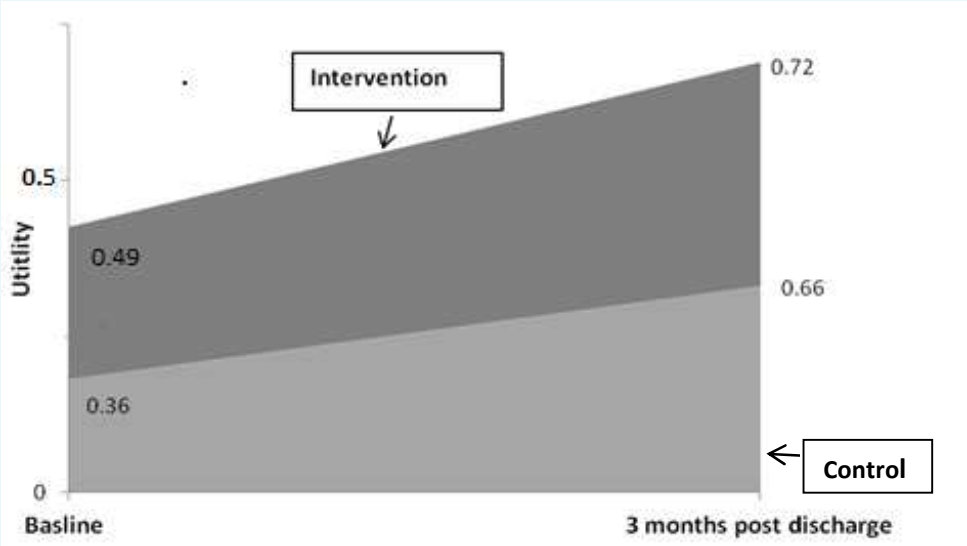


Figure 7.8 QALY gained over three months in both groups

- **Without baseline adjustment**

Total area under the curve (intervention) =0.5 (0.49+0.72) *0.25 = 0.15

Total area under the curve (control) =0.5 (0.36+0.66)*0.25 = 0.13

Incremental QALY gain/loss= QALY (intervention)-QALY (control) = 0.02

- **With baseline adjustment**

Total area under the curve (intervention) = 0.5(0.72-0.49) *0.25 =0.029

Total area under the curve (control) =0.5 (0.66- 0.36)*0.25 = 0.038

Incremental QALY gain/loss = QALY (intervention)-QALY (control) = - 0.0088

Table 7.26 summarises incremental costs/ savings (intervention –control) per patient. It can be seen, from NHS and PSS perspective, the MR intervention contributed to savings of almost £3,000 per patient.

Costs	Costs per patient Intervention	Cost per patient Control	Incremental cost/saving per patient
Time commitment			
Pharmacist time	£23.59	£3.88	19.71
Doctor time	£3.36	-	£3.36
Hospital service use			
Hospital stay costs	£3,102.30	£2,318.80	£783.50
Cost of unintentional errors burden on hospital bed	£70.40[a]	£209.10	-£138.70
Unplanned readmission [b,c]	£4,424.40	£7,823.60	-£3,399.20
Emergency department visits	£160.16	£268.80	-£108.64
Outpatients visits	£375.30	£333.60	£41.70
NHS walk in centre	-	£41	-£41
NHS and PSS workers			
GP visits	£369.04	£304.93	£64.11
Practice nurse visits	£38.73	£188.71	-£149.98
District nurse	£142.51	£126.70	£15.81
Specialist nurse	-	£230	-£230
Dietician	£16.45	£41.20	-£24.75
Physiotherapist	£48.36	£65.36	-£17
Care assistant	£380.48	£122.85	£257.63
Social care costs			
Day care	-	£216	£216
Home care	£10.54	£15.33	-£4.79
Total costs excluding informal care	**£9,213.56**	**£12,340.10**	**-£3,126.54**
Total costs including informal care and items incurred out of patient pocket	**9,213.56**	**£12,2994.10**	**-£3,085.54**

[a] one unintentional error was not intercepted in the intervention group. [b] Planned admissions were not a main cost drive. [245, 246] [c] Readmissions reported from the hospital record

Table 7.26 Summary of costs/saving associated with the intervention and control group

The MedRec intervention appeared less costly compared to the standard care. The costs saved were mainly attributed to savings in unplanned readmissions and NHS and PSS worker visits. The addition of informal care and items incurred out of patient pockets did not alter the finding. The change in utility was less evident, adjusting for baseline imbalances showed a change in QALY gained in favour of the control group. Incomplete outcome data on the use of health resources at three months (only 35 returned questionnaires in both groups) hindered precise estimate of utility change, it was agreed it would be too speculative to calculate an incremental cost-effectiveness ratio at this stage.

7.14 Summary of the MedRec interim analysis findings

This is mainly a descriptive analysis with the focus on the feasibility and integrity of the study protocol. Pilot studies by their nature and being of small scale may not produce significant results [169, 171] and it is important to interpret hypothesis testing with caution. Additionally, this was also focused on ensuring that the process of recruitment, intervention delivery and follow up all run smoothly. The reported results are not inclusive and the full analysis of the pilot will provide a further insight on the effects and the resources necessary to implement pharmacy led MR within inpatient settings.

Chapter 8

Discussion

Medicine reconciliation at the health interface: The MedRec Study

8.1 Feasibility of the MedRec study

Over all the study process, data collection and analysis all appeared feasible. Learning points on the feasibility of the MedRec study are summarised in BOX 8.1.

Recruitment rate was satisfactory; approximately two thirds of the approached patients consented. This rate increases when ineligible patients are excluded from the denominator, i.e. patients who were seen by ward pharmacy staff and/or prescribed no medicines. Without conversing with the patient and the nursing team it was not possible to identify the latter patients. Additionally, the research team needed to allocate time to perform administrative research activities which were time consuming. Within these limitations, it was not possible to exceed the recruitment target of five patients per week.

Time constraint was the main barrier for consenting patients. This was of particular concern with consultee recruitment. Previous reports have highlighted that patients with incomplete mental capacity are at frequent risk of inappropriate inclusion or exclusion from research.[247] This is due to variation in the extent and type of illness or methods for assessing mental capacity.[247, 248] This study is the first to highlight time constraints as a barrier to consent these patients; this could underline an important consideration when developing studies aiming to target such population.

Similarly, patient retention in the study was reasonable with death being the main reason for losing patients to follow up. Mortality rate was comparable between the study groups and there was no reason to believe that the intervention caused any significant burden or harm to patients.

Collection of outcome data at three months post discharge was also found feasible; practices responded to the study researcher requests for details on patient medicines at three months post discharge for almost 90% of patients (excluding deceased patients). It is notable that for 50% of patients, a second contact was required to prompt practices to send information requested. Follow up non-responders team increased responses by 20% but did not expedite responses. This again underlines an important time consideration when developing studies acquiring follow up data across healthcare settings.

The response rate of health related quality of life and health resource use questionnaires was again reasonable; three out of five patients returned the questionnaires within approximately two weeks. Notably, sending reminder letters and calling patients increased and expedited responses. This is consistent with a systematic review of methods to improve health questionnaires response rates, which found that the use of follow up contact significantly Improved the response rate.[249]

BOX 8.1 Feasibility of the MedRec study

- **Recruitment rate and MR implementation**

Recruitment and MR implementation were found feasible. The intended patient population can be identified following the study procedure. The delivery of MR was implemented well and in time manner. There are; however few unforeseen challenges warranted considerations:

- Consultee recruitment

Consultee recruitment was difficult to achieve; frequently this was limited by time constraints and unavailability of the research team.

- Proportion of patients approached/ recruited

Recruitment rate was satisfactory (68%) and fell only five patients below the target. It was not possible to exceed the agreed target per week mainly due to time constraints.

- **Data collection**

Data collection was found feasible, however, it is laborious and time consuming. Standard operating produces and personal communication and periodic meetings between the study team are required to ensure uniform data collection and entry.

- **Control MR**

Eighty percentage of control patients received control MR. This was believed due mainly to the pressure in the Trust to increase routine MR rate. It was, however, believed partially to be due to patients being highlighted to the ward staff by the study process. Control forms were relocated and patient study number was used in instead of name and date of birth. This would not make it obvious to the staff that MR had not been performed.

- **Database**

The study database was helpful and facilitated data analysis and processing. However, amendments are needed to optimise usability. Refinements to the MedRec database have been proposed.

BOX 8.1 Feasibility of the MedRec study (continued)

- **Follow up rate**

Attrition of participants was similar between groups (Figure 7.1).

  - Three months GP held medicine lists

Details of medicines the patient is taking three months post discharge was attainable to a reasonable extent (87.3%). A second contact by the study team increased response; however it did not expedite responses.

  - Health related quality of life and health resource use

Health related quality of life and resource use questionnaires returned within four weeks to six weeks by 63.6% of patients. The reminding letters sent to non-responders increased response but did not expedite responses. Phone contacts to non-respondents expedite the questionnaire return by three days on average.

- **Randomisation**

The study randomisation was successful; groups are comparable at baseline. However, baseline imbalances between groups with respect to EQ-5D were of note when the incremental QALY gained was estimated. This warrant adjustment to baseline imbalances if this continued to exist when the full data is available for full pilot analysis.

During the development of the MedRec study and before commencing the study, it was determined via an audit and formal discussion, that approximately 50% or less of patients at the study site receive MR as a part of the usual care. Additionally, the study wards were identified as those with less pharmacy staff cover; this was intended to keep MR contamination minimal in the control group. By the time the study was implemented 80% of control patients received control MR. Whilst this was mainly due to pressure within the trust to increase the MR rate, it was partially believed to be due to patients being highlighted to the ward staff by the study process. It is therefore important to ensure that such trials do not inadvertently highlight control patients and measures effectively introduced to prevent this. To resolve this, it was agreed to relocate the control MR forms and to use patient study number rather than full name and date of birth.

When MR took place within the control group it was limited frequently to patient own drugs check and medication history taking (Table 7.2). In addition, patient medicines were verified using one source of information and MR was frequently implemented beyond 24 hours of admission and by pharmacy technicians. Subgroup analysis of true and partial control patients is also planned at the time of the full pilot analysis.

Ensuring a standard delivery of the MedRec intervention is of need to enable future wide implementation of recommendations across NHS trusts. The MedRec pilot study tests a novel MR service described in (BOX 2.3.2). This service was informed by literature (chapter 1 and five) and discussion with care stakeholders. MR pharmacists were trained prior the study commencement by performing at least 30 MR episodes observed by the study principal investigator. The interim analysis aimed to develop and refine standard operating procedures and checklists for the delivery and documentation of MR, those were to ensure the intervention can be transferred and preformed consistently across settings or hospitals. The final pro-forma for optimum MR implementation and documentation still under development. Further refinement will be gained by the end of the full pilot study. Then, this will enable us to describe a standard pro-forma for MR implementation and documentation to promote widely across hospitals.

8.2 Initial findings of the MedRec study

Pharmacy led MR tended towards favourable effect on Log length of hospital stay, readmissions, medication errors, heath resources use and health related quality of life.

Length of hospital stay was the primary outcome. It could be seen from the small interim analysis that intervention patients had a shorter log hospital stay. Log transformation was planned a priori and was informed by a similar study in Dublin in 2007.[4] Additionally, Log transformation was justified by the skewed distribution of hospital stay and the variation seen between intervention patients.[250] Few data points were potential outliers; those suspected were reviewed to identify anomalies with data entry or user error but none was found. Findings from literature on the effect of MR on length of hospital stay are inconsistent. Scullin et al., in a Northern Ireland study, demonstrated a significant reduction in length of hospital stay [115] which is supported by findings from the USA,[251]. whilst Makowsky et al. in Canada showed a significant increase in length of hospital stay [230] and Stowasser et al. from Australia reported no significant effect on length of hospital stay.[226] In all these studies, the pharmacist completed discharge reconciliation upon consultation with patients, thus it is unclear whether this might have delayed the discharge process. The MR pharmacist in Makowsky et al's study provided patients or carers with counselling upon discharge and this might explain the significant increase in length of hospital stay. Nevertheless discharge counselling and patient consultation upon discharge was not a feature of the MedRec intervention. Thus, there is little reason to believe that this was caused by the MR pharmacist involvement in the discharge process. More insight can be gained on the change in the length of hospital stay when the full dataset is available for the full pilot analysis.

The study intervention group was associated with lower readmission rates; it also took longer for readmissions to occur in the intervention group compared to the control group. This is consistent with other studies.[115, 118] There was a significant difference in favour of the intervention group in the number of unplanned admissions which almost achieved statistical significance. This might have major cost and health implications; studies have demonstrated that adverse drug events are common cause of preventable unplanned admissions which are estimated to cost the NHS a total of £500 million annually.[11, 245, 246]

Consistent with previous studies showing medication errors at care transition are common,[17, 29, 31, 222, 231] the interim analysis highlighted high rates of medication errors at admission and discharge. The nature of these medication errors was also similar with omissions being the main type of unintentional errors which adds to the findings from previous studies.[29, 31, 32, 51, 163, 208, 209]

The majority of admission errors recurred in discharge summaries; 20% of MR related errors were intercepted by the ward pharmacy staff. This highlights that the MR pharmacist is useful in detecting and rectifying medication errors at the point of admission as well as preventing error recurrence in discharge summaries.

A novel aspect of this study is that discharge errors were assessed three months post discharge to identify the proportion of errors translated into primary care. When it was possible to identify the outcome of discharge errors at three months (n=44 errors), these were translated into primary care in almost 50% of cases. However, the majority of errors were omissions assumed by one source of information. And thus these should only be defined as errors after discussion with GPs. This is planned for the full pilot analysis.

A random selection of 20 errors, identified by the interim analysis, showed that the majority of errors were considered of minor severity. A similar study, by Grimes et al. in Ireland in 2011, employed the Dean and Barber approach to assess the potential harm of non-reconciled medicines at hospital discharge; the majority were regarded to be of moderate harm.[35] There are two important differences between the MedRec interim analysis and the aforementioned study; firstly, in Grimes et al. non-reconciliation medicines were judged with no reference to prescriber intention, meanwhile in the MedRec interim analysis intentional discrepancies were not considered errors. Secondly, the information on whether errors perpetuated at three months or not was not available for the assessors in the study by Grimes et al.; therefore they might have rated errors with higher clinical significance assuming discharge errors have reached patients.

Although few reports investigated the consequence of admission errors on patients during hospital stays and upon discharge,[17, 28, 29] to our knowledge this interim analysis is the

first to acquire information on discharge errors after three months. Therefore this can add new knowledge on whether it is appropriate to assume that errors in discharge summaries result in patient harm. A recent systematic review outlined that unintentional discrepancies are common but few have clinical significance.[138] With the knowledge of discharge error consequences in primary care, it would be possible to gain insight into actual patient harm and thus achieve a better understanding of the clinical implications and effects of MR on patient safety and continuity of care. Discussion with GPs is planned for the full pilot analysis which will enable us to evaluate actual patient harm and obtain a more realistic measure of MR clinical significance to patient care.

Intentional changes in medicines were often not documented; these were not considered errors. However absence of this information might create ambiguity and impede optimum continuity of patient care.[39, 50] It is noteworthy that 50% of undocumented intentional changes required subsequent actions or communication to nursing teams or GPs.

The MR pharmacist ensured complete and clear communication of undocumented changes to ward staff. Additionally, the MR pharmacist ensured comprehensive documentation of medicines changed in discharge summaries and prepared comprehensive discharge instructions sent promptly to primary care on the day of discharge. This highlights an added value of the MR pharmacist in enabling care coordination and appropriate prescribing.

In addition, enhancing the clarity of discharge information and ensuring a full record of discharge instructions could ensure continuity of care post discharge; this has been suggested in previous studies.[225, 226] Both studies highlighted that discharge MR improved the correlation between discharge lists and medicines prescribed post discharge. It was suggested that patient therapy was optimised by the pharmacist during hospital stay and thus GPs needed to do few number of changes to therapy. [225, 226] Those studies reported fewer numbers of post discharge changes, i.e. discharge lists and home medicines were more closely matched for intervention patients. However, the reasons underlying post discharge changes were not investigated. The interim analysis supports these suggestions; however, more medicines were changed in the intervention group compared to control patients at three months post discharge. These changes were mainly actions taken in response to the MR pharmacist discharge instructions; comprehensive discharge instructions and full details of medicine changes during hospital stays might have empowered GPs to make additional and appropriate changes when needed and thus enhanced effective continuity of care. Further insight on such an assertion can be gained after discussions with GPs.

The addition of the MR pharmacist appeared to improve health related quality of life measures; EQ-5D scores and EuroQol VAS scores were higher for intervention patients at three months post-discharge. However, this conclusion is limited by the fact that these were based on findings from only 35 patients. Additionally, baseline imbalances in EQ-5D scores is worthy of further consideration. Thus no firm conclusion can be drawn without gaining further insight into health related quality of life measures when the full pilot dataset is available.

The interim analysis also showed that intervention patients tended to have fewer visits to NHS and PSS workers and hospital service use at three months post discharge. The need to visit health professionals in community and in hospital might have been influenced by the MedRec intervention; the MR pharmacist verified medication histories and intercepted errors which potentially optimised patients' care during hospital stay and upon discharge. In addition, comprehensive and timely discharge information communication might have optimised post discharge management and thus minimised number of visits. This is supported by findings from other studies.[115, 118, 226]

Of note is the number of mismatches that were found between the number of readmissions identified by hospital records and those self-reported by patients. Byford et al. evaluated the accuracy of data collected from GP records and those reported by patients on the use of health services and reported variability in agreement across services.[176] Byford et al. suggested that there might be a systematic underestimation of inpatient visits in GP records compared to patient reports; GPs might be well aware of planned admissions but they might be less aware of other inpatient stays (unplanned admissions) unless informed by the hospital. Thus patient self-reports were suggested to provide a more accurate estimation of inpatient use compared to GP records. [176] A similar investigation comparing the accuracy of patient reports and hospital records on physiotherapy services use found patient self-reports a more reliable method.[252] The interim analysis found 44 discrepancies in readmissions data between hospital records and patient reports. It is not possible to comment on the accuracy of either source; readmissions data identified by hospital records was related to the complete dataset of the interim analysis (n=60) patients, while data from patient self-reports was related to 35 patients. Nevertheless, it is most likely that data obtained from the hospital records would capture patient readmissions to CUFHT but not readmissions to other hospitals in the area. It is possible also that patients might recall additional visits outside the reference period of three months. More insight will be gained once the full dataset is available for the full pilot analysis. Furthermore, details of patients' health resource use will be collected from GP practices at the end of the MedRec study which will provide valuable insight on the accuracy and comparability of these data sources.

8.3 Resources necessary to implement pharmacy led MR

The main resource requirement is the increased time commitment by the MR pharmacist. The interim analysis estimated that the MR pharmacist took half an hour on average to implement MR. This lies in the range reported by literature.[114, 228, 229]

The MedRec study is one of the few studies to describe the time spent by the MR pharmacist performing different MR tasks, [114, 229] this enables to highlight the most time consuming steps thus efficiently prioritising pharmacist time. Admission MR took longer time than discharge MR; the majority of the MR pharmacist time was spent verifying medication history during patient or carer interview. Findings on the MR pharmacist activities and the time spent for each MR step would help to identify how to implement MR optimally. This is of great implication where pharmacy services are limited.

It is important to note that the study researcher obtained information on patients' medicines from GP practices, medical notes, patient own drugs and hospital records in advance of the MR pharmacist visits and these were given to the MR pharmacist to avoid duplication of effort. Thus the time spent by MR pharmacist could have been longer if such time was considered. However, the use of administrative staff to collate information may be a more efficient use of resources and pharmacist's time could be prioritised to perform more patient centred MR tasks.

8.4 Cost-effectiveness of pharmacist-led MR

Patient safety continues to be a driving force in healthcare. Length of hospital stay, readmissions and emergency department visits and resource use in community are the major elements that make up the cost of patient care.[251]

Pharmacy led MR was associated with a longer mean length of hospital stay and hence increased costs related to increased hospital bed occupancy. More insight can be gained on length of hospital stay change and thus costs at the time of full pilot analysis.

The interim analysis showed that the MR intervention can preclude the burden of adverse drug events on bed occupancy and thus contribute to considerable cost savings for the NHS. This is in line with the cost savings estimated in literature.[107] However the cost of medicine use attributed to identifying omitted pre-admission medicines and patient own drugs use and the cost savings attributed to optimising therapy such us stopping unintentional addition of medicines were not estimated. The interim analysis aimed to provide a rough estimation of costs/savings related to medication errors; a broader scope of costs is planned for the full pilot analysis.

With the majority of hospital re-visits related to medicines being unplanned, [245, 246] it is expected that MR would demonstrate significant cost savings related to unplanned admissions. This is consistent with the findings from this interim analysis and other studies.[135, 232]

The estimated cost of pharmacist time was £23.59, adding in the time spent by doctors responding to the MR pharmacist' interventions resulted in a total cost of £27.22. This however did not increase the overall health expenditure. The MedRec intervention was less costly compared to usual care; overall savings were estimated as £3,000 per patient. This indicates that the MedRec intervention did not shift patient care to community; the number of visits and thus costs to NHS and PSS workers were reduced. The MedRec intervention reduced the cost of social care but not informal care; however there is little reason to believe that the MedRec intervention shifted care to the later carers.

No other study estimated the cost of pharmacy led MR intervention using similar broad scope of costs and consequences. Herein, the estimated savings associated with the MedRec intervention cannot be compared to those in a previous UK investigation.[136]

Nevertheless, the primary focus of this analysis was to identify whether it would be achievable to obtain data on the costs and consequences of MR to enable a robust economic evaluation. This analysis ensured feasibility of costing and a cost-effectiveness estimation. Broader costing strategies will be employed for the full pilot analysis. These are summarised in BOX 8.2.

BOX 8.2 Costing strategies planned for the full pilot analysis

- **Allowance for differential timing of cost**

Allowance will be needed to make for the differential timing of costs and consequence. This can be done by inflating unit costs using the predicted inflation indices for 2013.[175]

- **Systematic handling of missing data**

For the purposes of the interim analysis, "Available Case analysis" was used. This is considered a simple approach to handle missing data.[180] Available Case analysis estimates the mean for the complete cases for each variable. The major disadvantage is that different samples are used across the analysis, i.e. the sample base varies from one variable to another since a different set of patients contribute to the estimation of different variables. This leads to problems of comparability across variables.[180]

Another method which is also considered a naive method to handle missing data is "Complete Case analysis". Complete-case analysis or list wise deletion of cases is the default method in most statistical software packages. It involves discarding cases where any variables are missing. The advantages of using this method are that it is easy to do and that the same set of data (albeit a reduced set) is used for all analyses. However, it is inefficient in that it excludes data that are potentially informative for the analysis. Complete-case analysis will be biased if the complete cases systematically differ from the original sample. Complete Case analysis is an acceptable method with small amounts of missing information. Thus providing this would be the case at the time of the full pilot analysis, Complete Case analysis is planned. Otherwise missing data will be imputed to produce a complete dataset.

- **Estimating indirect or non-contact time of MR pharmacist**

There might be unmeasured costs of time spent by the MR pharmacist performing activities which do not include patients contact such MR interview preparation, team discussions, writing up notes. The estimation of non-contact time will help to provide more precise estimate of the time required for effective MR implementation. It is estimated for a hospital pharmacist that for each one hour of contact there is an additional 0.43 hours of non-contact time. [180]

Additionally, the time spent by the study researcher collecting relevant MR information, faxing and contacting primary care practices, that otherwise would have been spent by the MR pharmacist could add to the cost associated with the MedRec intervention. Those warrant valuation by the full pilot analysis.

Although the MedRec intervention appeared less costly, the conclusion on effectiveness should be drawn with tentative consideration. The value of QALY changed over time is highly correlated to baseline utility; baseline EQ-5D scores are a strong contributes to QALY calculation. Additionally, baseline utility is expected to be a predictive of individual's utility value at follow up time, this is because although some aspects of health would change but many others would not. Thus, imbalances in baseline utility should be handled explicitly. Failure to control for such imbalance can result in a misleading incremental cost effectiveness ratio as it can be very sensitive to quite small changes in its denominator.[199] There was a small imbalance between groups at baseline. Albeit, this was not significant it required careful notification. Estimating QALY gained without baseline adjustment resulted in mean incremental QALY gain in favour of pharmacy led MR intervention; QALY (intervention)-QALY (control) = 0.02. Whereas, when the main gain of QALY estimated with baseline adjustment, the incremental QALY gain was in favour of the control group, i.e. QALY (intervention)-QALY (control) = - 0.0088. It is important to note that both approaches led to opposite conclusions. The use of area under the curve approach where no allowance is made for imbalance in baseline utility can lead to incorrect results regardless of whether these differences are statistically significant.[35] Therefore, adjustment for baseline imbalances is warranted at the time of the full pilot analysis if such imbalances continue to exist when the full pilot data is available.

Multiple regression analysis is recommended to be a more appropriate method for dealing with baseline imbalances. It can be used to generate appropriate estimates of incremental QALYs gained and sampling variability while adjusting for differences in baseline utility between groups. The regression based approach generates unbiased estimates of incremental QALYs gain and increases the precision of the intervention effect size estimate.[253] This approach will be employed for the full pilot analysis if deemed appropriate.

8.5 Strengths and limitations

The interim analysis had clear aims; those kept on focus while performing the analysis and interpreting findings. It was understood that this was a pilot study which should be mainly descriptive. We were aware that this analysis was most likely not powered enough to detect statistically significant differences. Thus our focus was to gain insight on the study process and foresee any challenges if larger study would be warranted.

The MedRec study evaluated a full MR process implemented within 24 hours of patient admission. The process implemented in the study found feasible and implemented in time manner.[72] MR is the main focus of the MedRec study intervention, i.e. it was not supplemented with other additional non-MR care activities. Thus, it would be plausible to assume that observed benefits would be most likely contributed by MR.

Additionally, the MedRec study estimate the time spent by the MR pharmacist performing different tasks of MR, thus the best MR practice can be described and promoted across other care areas if proven cost-effective.

To date, up to the time of thesis synthesis, there is no other UK study of randomised controlled design employing similar broad scope of health outcomes, costs and consequences. MedRec also the first comprehensive cost-effectiveness analysis of pharmacy led MR within NHS setting which employs NHS and PSS perspective. In addition, the Med Rec study takes into consideration the possibility of shifting care cost to community, social and informal care. If a large scale study would be warranted, this would inform the decision whether to accept pharmacy led MR services across NHS.

However, the MedRec study has a number of potential limitations that warrant discussion. Although, recruitment rate was satisfactory, only three out of 20 admitted patients were approached which account in total to 15% of patients admitted in the first three months of the MedRec study. A greater proportion of patients approached might indicate better generalisability and more representative sample. Inevitably, it was not possible to approach a large proportion of patients due to time constraints. Additionally, the study wards were selected pragmatically and those wards were caring for general medicine and medicine for older patients. Thus, findings of the MedRec might not be generaliseable to other care areas such as paediatric or general surgery. However, it most likely to be generaliseable to trusts of similar resources and service profile in the area.[26]

Variability with length of hospital stay, the primary outcome, necessitated log transformation. In addition, outliers were suspected. However with small sample size, a small deviation within the data would exert more profound effect on data distribution. Such effect might disappear when the full pilot dataset is available for analysis. Worth noting, the MedRec is a pilot study with the aim of informing the design of a definitive trial if warranted and to determine the best outcome to measure. Thus, alternate primary outcomes, such as readmission rate, might be found more appropriate outcome for a definitive trial. This however, can be fully determined at the time of the full pilot analysis.

There were frequent ambiguities and omitted responses with retuned health resource use questionnaires. Mostly, those were related to the question on outpatient visits (Appendix 16).

There might be two factors contributed to variations and omissions; firstly, the relevant grid table layout might have been confusing to patients. Modification to simplify the questionnaire might be warranted. This can be investigated further through patients' discussion which is planned at the end of the MedRec study using focus group approach.

The second reason might be related to difficulties with patient recalling outpatient appointments; it might be difficult to recollect details of departments visited and procedures carried out. Nonetheless, the study researchers clarified ambiguities by phone calls when this was possible. Additionally, systematic approach for missing data imputation is planned for the full pilot analysis.

The MedRec obtained follow up data at three months post discharge. This time window was informed by the systematic literature search on pharmacy led MR (chapter five).[113, 225, 227, 230] It was believed that short follow up time such as 30 days might not be ample to assess the benefit of MR on patient safety and health resource use.[138] Three months in a pilot design was believed sufficient to explore the potential benefits and costs of MR as well as the feasibility of an incremental cost-effectiveness analysis. We are aware that a longer follow up period has been implemented up to 12 months,[115, 135, 138] this is warranted for consideration if a larger scale study is presumed feasible.

Concealing the study allocation was not possible for patients, doctors, the study researcher and MR pharmacists. The rest of the ward team and UEA team were blinded. The thesis author (EH) was not blind to patient allocation for the purpose of the interim analysis. However, the analysis was supported by members of the team who were blind to patient allocation (DW, IN, GB) and were not involved in the intervention. Efforts will be maintained to ensure the UEA team who will be involved in the full pilot analysis will be blinded to study allocation for the full pilot analysis. The data from the interim analysis was not presented to the hospital team or the principle investigator until after the study was finished to ensure that these did not alter the delivery of the intervention.

Identification of medication errors in the control group was done retrospectively and without interviewing patients or carers. Ethically, knowledge of errors or possible interventions that could optimise patient care cannot be withheld from the team caring for control patients. Thus, this was felt to be the best approach to identify discrepancies in control group with minimum risk of bias.

No data was collected on baseline use of health resources. It is plausible to assume that patients in both groups were comparable at baseline with respect to their use of health resources since their EQ-5D and EuroQol VAS scores were similar. However, obtaining baseline health resource use would enable more precise estimate of cost change between groups.[193] This might be considered if larger scale study deemed warranted.

The interim analysis attempted to produce a rough estimate of the costs associated with unintentional errors using assumptions based on related studies.[11, 197] However, it should be outlined that here is considerable uncertainty around these assumptions; firstly the proportion of unintentional errors at care transition that might lead to adverse drug events was based on a USA study; differences in the reporting system could influence transferability to the UK context. Additionally, equal weight was assumed for all type of adverse drug events, i.e. all events were assumed to lead to similar consequences on health care. Some type of adverse drug events might contribute to minor or minimum harm and thus will not require any intervention or care.[11] Secondly, the consequences of adverse drug events were assumed to place costs only on hospitals but not on community services or informal care. Nevertheless, those assumptions were justifiable by the lack of UK figures; however, more realistic and reliable estimate of the costs/savings related to medication errors is planned for the full pilot analysis.

8.6 Implications for the full pilot analysis

The interim analysis has several important implications that informed the full pilot analysis. Subgroup analysis of true and partial control patients is believed of value. The effect of the MedRec intervention might have been partially masked by a potential benefit of control MR.

Further qualitative research might be undertaken to gain insight on the time spent and the quality of control MR. Qualitative research also could be of value to assess why some practices responded promptly to the study researcher requests of patient information and the reasons underlying that other practices took longer time. It would be of value also to gain insight on why some patients returned the questionnaire promptly compared to others. This might inform the need to modify methods of data collection or mode of contact.[254]

Within the limited resources, it might be necessary to target patients at increased risk or most likely to benefit from pharmacy led MR. Multivariate and regression analysis to identify patient related risk factors is planned for the full pilot analysis. This would help to prioritise MR services were recourses are most constraints.

Cost related to medicine use and the use of patient own drugs managements were not estimated; these believed key contributors to costs/savings related to MR. Broader costing strategies are planned for the full pilot analysis (BOX 8.2). Additionally, although employing a broad-brush costs and consequences evaluation is an element of strength for the MedRec study, the selection of key cost drivers is necessary. This will help to focus data collection where data is more relevant and informative which would help to save research time and efforts. This might also help to improve response rate and thus result in more precise estimate for resource use; patients are more likely to complete short and concise questionnaires.[249]

Studies which aim to perform economic evaluation should account for uncertainty surrounding the key estimates and assumptions relating to costs and outcomes.[172, 173, 204] If dominance was not apparent at the time of the full pilot analysis, an incremental cost-effectiveness ratio will be estimated. Sensitivity analysis would be planned then to account for uncertainty around the point estimate of incremental cost-effectiveness ratio and cost-effectiveness acceptability curve would be constructed to assess uncertainty around the cost-effectiveness decision.

The interim analysis performed unadjusted comparisons of patient outcomes according to study group. This was useful to gain insight on the initial findings; however, adjustment of the outcome analysis for important predictors or factors to allow for chance imbalances between study groups at baseline is warranted for the full pilot analysis. Of most important, hence randomisation was stratified by ward, a factor that might contribute to imbalances between patients in the study groups, it is, therefore, planned to adjust the analysis with a factor for 'wards' included as an explanatory (or 'x') variable. It would be of interest to evaluate the effect of such adjustment on results or conclusions.

In summary, this interim analysis helped to gain insight on the initial findings of the MedRec study and plan the analysis of the full pilot. This also enabled to assess the feasibility of the study process and familiarised the research team with the protocol. The interim analysis was a starting point in the analysis of the MedRec study. A lot has been learned which improved the research team understanding of the MR process and enabled well preparation for the full pilot analysis. BOX 8.3 summarises gains from the interim analysis.

The journey of this thesis for answering the question on the methods for optimisation MR at the health interface finished with the interim analysis. The interim analysis findings offered new knowledge on the cost and effect of pharmacy led MR in the UK and added to the existing literature worldwide. However, these should be considered tentatively; lots

yet left to explore at the time of the full pilot analysis and if a definitive trial would be warranted of value.

BOX 8.3 Gains from the interim analysis

The MedRec interim analysis:

- Helped to plan the full pilot analysis
- Enabled to estimate recruitment, retention and follow up rates
- Familiarised of the research team with the study protocol
- Assisted to refine of the study design and measurements
- Helped to standardise the study intervention and data collection
- Assessed randomisation procedure
- Identified areas of ambiguity
- Identified possible key cost drivers
- Ensured MR acceptability
- Assessed the feasibility of cost analysis
- Assessed the feasibility of utility and QALY calculation

Chapter 9

Conclusions

9.1 Main findings

This thesis, when considered within the context of published UK and international research, adds to the existing evidence supporting pharmacy led MR practice and offers new knowledge regarding methods to optimise MR use at the healthcare interface.

National guidance for the minimum dataset of information transferred at care transition has been in existence for over four years. However, the Trust-wide evaluation of the quality of information received in primary care following patient discharge found frequent omissions and inaccuracies in discharge communication. These were similar to those identified by reports published pre- and post-national guidance implementation [10, 22-26, 44] Therefore, the lack of progress in UK practice of MR was of concern and warranted further investigation of methods to optimise MR use at the health interface.

In order to identify the most effective method to optimise MR, a systematic review to determine the effects and costs associated with pharmacy led MR was conducted. There were a limited number of studies implementing the full MR process; those available had methodological flaws that limited the ability to draw conclusions about MR effectiveness and the resources necessary for effective implementation. No study adopted outcomes that addressed both process and patients oriented outcomes. Additionally, the identified evidence was largely non-UK. There was, therefore, a need for more high quality, UK relevant data to define the most appropriate study design plus determine the effects and cost-effectiveness of pharmacy led MR interventions.

Chapter Seven reported the MedRec study which adopted a randomised controlled design informed by the findings of the pharmacy led MR systematic review. The MedRec study focused on implementing a full MR intervention led by a pharmacist within 24 hours of admission to hospital and investigated process and patient oriented outcomes, costs and consequences. Developing and evaluating a pharmacy led MR service was recognised as a complex process requiring careful consideration of the most appropriate intervention components and outcome measures. The Medical Research Council recommends piloting to gain insight on the effect size of the intervention and to determine whether a larger scale trial is feasible before large scale evaluation.[160] This thesis presented the findings from the interim analysis of the MedRec pilot study.

The interim analysis identified potential benefits of pharmacy led MR service compared to usual care in terms of enhancing the accuracy and transfer of information to primary care, prevention of potential harm associated with adverse drug events and reduction in use of health resources post discharge. This, however, required an increased time commitment by the pharmacist. It was difficult to draw a definitive conclusion on the cost-effectiveness without further analysis of the full dataset.

9.2 Lack of collaboration between secondary and primary care providers

Because a patient is attended by various health care providers in each setting, effective communication between providers is essential. Lack of communication might result in a patient receiving unintended therapy or missing out on a treatment altogether.[19, 21, 40] However, the interim analysis of the MedRec study highlighted that in many cases, GPs did not act upon information communicated from secondary care. This may be because the rationale for changes to pre-admission therapy were not expressly described and thus GPs might have presumed these were unintentional changes. This is of significance since most therapy changes at discharge are reported to be intentional despite rationale not being documented explicitly on the discharge summary.[17, 29, 222] The Trust-wide audit identified cases where information was explicitly provided by the discharge team but recommendations in some instances were not implemented in primary care. In many cases, lack of implementation was due to undocumented informed decisions by GPs but in some instances this was due to human error and shortcomings in the process of handling incoming communication from secondary care.

Withstanding the above, the MedRec study reflects the findings from the systematic review highlighting that the pharmacist has an important role in medication history verification using patient or carer interviewing and information from GPs or community pharmacies as well as providing comprehensive details of medicines prescribed and changed upon discharge. The poverty of explicit communication between providers on both sides of the health interface despite clear guidance regarding the set of minimum data to communicate requires consideration. Lack of formal training or education on medical note documentation, the lack of standardised methods of communication, the hurried environment and the assumption that changes can be deciphered by the recipient may be contributing factors.[21, 210] It is of great importance, therefore, to highlight gaps in communication between providers and identify barriers to effective communication.

9.3 Best possible medication history

The best possible medication history is considered the cornerstone MR. The World Health Organisation states “The key to the success of MR at all interfaces is to first have a process working effectively at admission to the healthcare facility”. Appropriate admission MR is the foundation to support and facilitate efficient and appropriate reconciliation at internal transfer and discharge.[99]

Accurate sources of information may be difficult to identify at the time of care transition unless one has taken the time to explore and test different sources of information.[73] The Trust-wide audit identified deficits in discharge information sent to the primary care team and also in the processing of discharge instructions by the primary care team. Similarly,

the MedRec study found disparities between different sources of patient information such as GP lists, patient own drugs and patients repeat prescriptions. Previous studies highlighted the lack of a gold standard list containing all medicines the patient is taking; none of the patient information sources including GPs records, which provide long term medication history, was found to be the most accurate source of information. Thus, it was recommended to use as many as possible sources to match patient information each time the patient transfer.[24, 25, 115, 225, 233] Variances between information sources could arise due to poorly informed patients, multiple prescribers or use of multiple pharmacies.[233, 255] This necessitates a change in the existing process for organising and sharing patient information between providers and to place recommendations to maintain a gold standard list of patient medicines transferred with the patient across health settings.

9.4 Optimising resource use for effective MR implementation

Evidence from pharmacy led systematic review and the MedRec study indicates that pharmacists need to invest additional time to implement full MR. Whilst providing a comprehensive pharmacy led MR service to all patients may be desirable, given limited resources, alternative strategies may be a current necessity.

A potential strategy could be reallocation of existing resources by involving less costly administrative staff such as ward clerks or receptionists to deliver the non-clinical MR tasks. Those could include collecting information from GPs or community pharmacies, obtaining previous medicine or allergy information from hospital records and faxing discharge summaries to primary care practices. This may improve the cost-effectiveness of MR by ensuring pharmacist time is dedicated to the patient centred, clinical aspects of MR.

Additionally, identifying the situations most likely to benefit from pharmacy led MR would enable targeting the areas where impact would be maximised. The pharmacy led MR systematic review identified no study investigating the patient characteristics associated with greatest benefit from MR. The Trust-wide audit did, however, explore the factors associated with increased risk of discharge discrepancy and identified that patients prescribed more than five medicines and discharged from specific wards such orthopaedics are at increased risk. Further investigation to identify other patient-related factors and highlight areas where there is the potential for maximal benefit from pharmacy led MR is warranted for the full dataset of the MedRec study. This would inform the decision of prioritising MR services where benefit is most pronounced.

9.5 Thesis recommendations

Despite the potential for improved outcomes, there are many challenges to effectively executing MR.[7, 149, 150] This thesis informs the following recommendations:

- The use of a standardised electronic pro-forma that complies with the national guidance for information transfer at care transition points.

- Patients who are prescribed more than five medicines are recommended to receive attention at care transition; one useful suggestion might be the use of reminders placed in medical notes or inpatient charts to highlight these patients for the care team. A similar approach could be used to highlight medicines requiring titration plans, specified durations, frequently associated with omissions and considered of potential for patient harm.

- The Trust-wide audit showed that the process in place to transfer information at healthcare interfaces is insufficient. Lack of clear agreement on the process of MR and lack of national legislation to formalise MR as well as the lack of linking MR to funding decisions might be contributing to this insufficiency. In the USA, MR is designated as a national safety goal and considered one of the criteria for health organisation accreditation.[97] Similar linking of MR to funding and commissioning decisions in the UK NHS such as the Quality and Outcomes Framework scheme for primary care practices and NHS incentive schemes for hospitals, may enforce better implementation.

- Highlighting organisations that have successfully implemented MR implementation through a national reward scheme may encourage more organisations to define their MR process and adopt MR within their routine workflows.

- Promoting the use of MR via a monthly bulletin highlighting examples of good clinical practice might also help organisations to share experience of optimum use of MR. Additionally, national workshops or discussion forums engaging professionals from primary and secondary care might enhance continuity of care and collaboration between care providers; this could raise awareness of the effects of MR on patient outcomes

- The development of an NHS universal secure interactive medical record system that can be viewed by all care providers at any time during the patient care journey between health settings may resolve many of the information transfer issues. Studies have highlighted the usefulness of similar applications,[141, 142] however, user training and IT support would be of great importance to achieve successful implementation.

- The development of guidance in primary care might minimise inadvertent shortcomings in discharge instruction reconciliation and enable effective sharing of information between providers. This guidance must be based on discussions with managerial, administrative and clinical staff from practices of different size and workflows to account for the variation between practices in processing and sharing information.

- More UK studies of robust design, larger and multi-centred should be conducted to confirm whether the benefits of pharmacy led MR services are generaliseable across institutions and trusts.

- The National Institute for Health and Care Excellence (NICE) guidance *Principles for Best Practice in Clinical Audit* provides valuable guide through the development and conduction of clinical audits.[158] The NICE guidance also provide valuable guide on data analysis; however, we would recommend NICE to place an emphasis within this guide on the usefulness and importance of evaluating variation in clinical audits data.

- The interim analysis of the MedRec study was useful to identify unforeseen challenges with the process and measurement of the intervention. It also helped to ensure feasibility of data collection and cost-effectiveness analysis. In line with the Medical Research Council recommendations,[160] a lesson from this thesis is that piloting is an important step to ensure effective evaluation of complex clinical interventions.

9.6 Research needs

The Trust-wide investigation presented an indication of the predictors of adherence to the NPC minimum dataset and medication discrepancies, however, further work remains. More research is needed to better understand the effect of profession type and ward speciality and determine the reasons underlying substandard areas of practice. Subgroup analyses of ward and profession types were limited by the available number of data points. Merging of small subgroups led to loss of valuable information on factors contributing to variation in practice between wards and professionals. Larger studies are therefore necessary to ensure better representation of these smaller groups.

Furthermore, qualitative investigations with managerial, administrative and clinical staff to describe current practice across different wards and professions plus explore barriers to effective information transfer may inform effective MR practice guidance. Conduct of such qualitative studies would be of value from both the primary and secondary care perspective of the health interface.

Additionally, given that a high proportion of discharge summaries are written by foundation year doctors,[13, 21] investigation of any changes in quality of information sent to primary care between the period when foundation doctors start their training (August) and a few months later after gaining knowledge and experience on wards (January/February) may be of value.

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Appendices

Appendix 1 Literature variation in discrepancy classification, clinical significance and inter-rater agreement assessment

Author, year	country	Discrepancy classification	Clinical relevant or impact	Inter-rater reliability
Perren [1] 2009	Switzerland	**Omitted medication**: Unintentionally not prescribing a drug for a clinical condition for which medication is indicated; the judgement was based on common recommendations or online literature **Defendable omission:** Intentional omission, that is, omission justified by a potential and documented contraindication **Un-defendable omission:** Omission without documented contraindication **Potentially harmful omission:** Omission presumably leading to increased mortality or morbidity **Unjustified medication:** Prescribing a drug for which there is no indication for that patient **Potentially harmful unjustified medication:** A medication which, for a given patient, could have resulted in an ADE **Harmless unjustified medication:** Largely prescribed and generally well-tolerated medication	Medication errors were judged to be potentially harmful if it could result in increased mortality /morbidity or ADE: into fatal, life threatening, serious or significant.	Two internists independently examined the same 40 discharge summaries. Reliability across reviewers was subsequently assessed by a third doctor and scored utilising a previous reported scale. Agreement was determined to be nearly equivalent for the classification of unjustified medication (k=0.85), and substantial for the reviewers' judgements of diagnoses implicating rug therapy and diagnoses with drug omission (k=0.74 and 0.76, respectively). Reliability was only moderate for the reviewers' classification of defendable drug omission (k=0.39).Two internists jointly performed the analysis in order to improve agreement of low k-values (defendable drug omission). Thus, differences between the reviewers' judgements were resolved by discussion, and a consensus was achieved
Kwan [2] 2007	USA	Postoperative discrepancy defined as any medication clarification related to home medications that were made. Medication discrepancies associated with any of the following: drug, dosage, duration, frequency, formulation, route of administration, and appropriateness of restarting medications, orders requesting the pharmacist to clarify medications, illegible orders, and miscellaneous items. **Discrepancy need clarification**: • Omission of medication • Commission of medication • Different dosage, route or frequency Different medication	Independently by 3 pharmacy clinician evaluators. For each postoperative medication discrepancy, the degree of effect was based on the potential that the discrepancy could result in "**unlikely**," "**possible**," or "**probable**" patient discomfort and/or clinical deterioration if the discrepancy was not identified and addressed.	Inter-rater reliability for assessing the severity of the medication discrepancy was analysed using the mean of Cohen k scores; Pairwise k scores for a sample of 46/ n=464 medication discrepancies were calculated and ranged from 0.78 to 0.89; the mean k score was 0.84.

ADE: Adverse drug event. 1. Perren A, Previsdomini, M., Cerutti, B., Soldini, D., Donghi, D., Marone, C. Omitted and unjustified medications in the discharge summary. Quality and Safety in Health are. 2009;18(3):205. 2. Kwan Y, Fernandes OA, Nagge JJ, et al. Pharmacist Medication Assessments in a Surgical Pre-admission Clinic. Arch Intern Med. May 28, 2007 2007;167(10):1034-1040

Author, year	country	Discrepancy classification	Clinical relevant or impact	Inter-rater reliability
Bergkvist [3] 2009	Sweden	Defined as: occurrence of discrepancy with the lack of documentation to indicate that change was deliberately; • medication was **missed** in the medication list from the community health care. • medication had been **added** to the medication list from the community health care. • The total dosage over 24 h had been **changed** in the medication list from the community health care. • Generic substitution of a medication was not considered an error in the reconciliation process. • **Reason** for change not reported • **Indication** of new medication not reported	-	Identification of discrepancies was done by two pharmacists independently, disagreement resolved by consensus
Grimes [4] 2008	Ireland	**No doses** specified on discharge summary **No frequencies** specified on discharge summary **No medication** listed on discharge summary Discharge summary **not completed** **Drug omission** **Strength inconsistency** Choice of drug inconsistency **Strength omission** **Frequency inconsistency** **Frequency omission** **Commission discrepancy** **Prescription of discontinued medicines**	**Validated VAS** scale between 1 (no harm) and 10 (death) The mean score for each error was calculated and categorised as: potential to cause **none or minor** (mean score <3), **moderate** (mean score 3–7), or **severe** (mean score >7patient harm	Five healthcare professionals independently scored the clinical importance of every error. (no inter-rater agreement assessed)

3.Bergkvist A, Midlöv, P., Höglund, P., Larsson, L., Bondesson, Å., Eriksson, T. Improved quality in the hospital discharge summary reduces medication errors—LIMM: Landskrona Integrated Medicines Management. *European Journal of Clinical Pharmacology.* 2009;65(10):1037-1046. 4. Grimes T, Delaney, T., Duggan, C., Kelly, J., Graham, I. Survey of medication documentation at hospital discharge: Implications for patient safety and continuity of care. *Irish Journal of Medical Science.* 2008;177(2):93-97 VAS: Visual analogue scale .

Author, year	country	Discrepancy classification	Clinical relevant or impact	Inter-rater reliability
Pippins [5] 2008	USA	**Intentiona**l: Documented vs. Undocumented **Unintentional**: No potential for harm vs. potential for harm **Potential for harm**: History error vs. Reconciliation error	**1. Potential for harm** Confidence about that the identified error had the potential to cause harm if not corrected i. **Little or no confidence** (e.g., omission of multivitamin) ii. **Slight to modest confidence** iii. **Less than 50–50 but close call** iv. **More than 50–50 but close call** v. **Strong confidence** vi. **Virtually certain confidence** **2. Potential severity:** significant , serious, life threatening	Two pharmacists independently. Disagreement was resolved by consensus or third assessor. Kappa= 0.95
Wong [6] 2008	USA	**Unintended** vs. **undocumented** intended Unintentional : actual vs. potential **Actual** unintentional: made by physician to add or change or omit **Potential** unintentional: direction on home medicine were omitted or not explicitly. • Omission: formulation, frequency or route • No indication: medication no longer required was reordered on hospital discharge. • Therapeutic duplication • Inappropriate route • Need of prescription refill was not addressed • Inappropriate duration • Incorrect dose • Dose not renally adjusted • Incorrect frequency • Incomplete prescription that may lead to delay in starting medication. • Misspelled drug name • Illegible order	**Unlikely** to cause patient **discomfort and/or clinical deterioration** if not identified or addressed **Possible** to cause patient **discomfort and/or clinical deterioration** if not identified or addressed **Probable** to cause patient **discomfort and/or clinical deterioration** if not identified or addressed	Three independent raters (two pharmacists and one general internist) who were blind, a majority consensus was required. kappa was sustainable. Pair wise k score.72-.8

5. Pippins JR, Gandhi, T. K., Hamann, C., Ndumele, C. D., Labonville, S. A., Diedrichsen, E. K., Carty, M. G., Karson, A. S., Bhan, I., Coley, C. M.,. Classifying and predicting errors of inpatient medication reconciliation. Journal of general internal medicine. 2008;23(9):1414-1422. 6. Wong JD, Bajcar, J.M., Wong, G.G., Alibhai, S.M.H., Huh, J.H., Cesta, A., Pond, G.R., Fernandes, O.A. Medication Reconciliation at Hospital Discharge: Evaluating Discrepancies (October). The Annals of pharmacotherapy. 2008;42:1373-1379

Appendix 2 Discharge information audit tool

Medication discrepancies assessment tool				
Patient audit number		**Date**		
Age				
Gender	Male ☐		Female ☐	
Ward specialty	Medicine for elderly ☐		Orthopaedic ☐	
	General medicine ☐		Gastroenterology ☐	
	General surgery ☐		Cardiology ☐	
	Urology ☐		Unspecified ☐	
	If other please specify:			
Hospital name	NNUH ☐		West Suffolk Hospital ☐	
	QEH ☐		James Paget ☐	
	Addenbrooks ☐		Papworth ☐	
	Hellesdon ☐		community hospital ☐	
	If other please specify:			
Type of admission	Emergency ☐		Planned ☐	
	Unspecified ☐			
Is the discharge summary typed?	Yes ☐	No ☐		
If the discharge summary is handwritten, is it:				
Illegible (most or all words impossible to identify)	☐	*Comment in discharge summary legibility if hand written*		
Most words illegible; meaning of report unclear	☐			
Some words illegible, but report can be understood by a clinician	☐			

Medicines reconciliation Items	**Specify whether the following information was stated in the discharge summary**		**Details**
Admission date	Yes ☐	No ☐	*Enter the admission date*
Admission time	Yes ☐	No ☐	*Enter the admission time*
Discharge date	Yes ☐	No ☐	*Enter the discharge date*
Discharge time	Yes ☐	No ☐	*Enter the discharge time*
Name of professional responsible for discharge	Yes ☐	No ☐	*Enter name if provided*
Role of professional responsible for discharge	Yes ☐	No ☐	*Enter the role of person Dr., FY1, Pharmacist.*
Contact name to be used by GP if information regarding hospitalization required	Yes ☐	No ☐	*Enter Name if different from professional responsible for discharge*
Contact number to be used by GP if information regarding hospitalization required	Yes ☐	No ☐	*Enter Contact number to be used by GP*
Was the discharge summary received within 2 working days?	Yes ☐	No ☐	*Enter number of working days post discharge*
Patient name	Yes ☐		No ☐
Patient name **is correct?**	Yes ☐		No ☐
Date of Birth	Yes ☐		No ☐
Date of Birth **is correct**?	Yes ☐		No ☐
Consultant name	Yes ☐		No ☐
Ward contact number	Yes ☐		No ☐
Allergy status	Yes ☐		No ☐
ADR during hospitalization	Yes ☐		No ☐

Presenting medical complaint on admission	Yes ☐	No ☐
Past medical history/co-morbidities	Yes ☐	No ☐
Complete past drug history and current medications	Yes ☐	No ☐

Does the discharge summary clearly state all medication that has been changed including (dose, formulation,...)?	Yes ☐	No ☐	If any, is (are) the reason(s) reported/ specified?	Yes ☐	No ☐
Does the discharge summary clearly state all medication that has been stopped?	Yes ☐	No ☐	If any, is (are) the reason(s) reported/specified?	Yes ☐	No ☐
Does the discharge summary clearly state all medication that has been started?	Yes ☐	No ☐	If any, is (are) the reason(s) reported/specified?	Yes ☐	No ☐

Medication	**Name**	**Dose**	**Frequency**	**Route**	**Duration**	**Formulation**
1- E.g. Bisoprolol	Generic Brand Both	Yes No	Yes No	Yes No	Yes No Pre admission drug	Yes No
2-	Generic Brand Both	Yes No	Yes No	Yes No	Yes No Pre admission drug	Yes No
3-	Generic Brand Both	Yes No	Yes No	Yes No	Yes No Pre admission drug	Yes No

State if procedures have been reported on the discharge summary						Name	Results & Comments
Procedure (s) name		Result(s)		Hospital practitioner remarks		*E.g.ECG*	*Atrial fibrillation, warfarin therapy was commenced*
Yes	No	Yes	No	Yes	No		
Yes	No	Yes	No	Yes	No		
Yes	No	Yes	No	Yes	No		

Post admission complications; please indicate if any of the following have been reported			Complication/management *E.g. Patient had experienced chest infection; proper management with antibiotics was commenced.*
Infection	Yes	No	
Bleeding	Yes	No	
DVT	Yes	No	
Others	Yes	No	

Please indicate if you expect or need any additional laboratory assessment or monitoring for this patient, you believe it is required by the primary health care team to achieve the optimum continuity of care.
E.g. A patient with CKD admitted due to a potential drug induced worsening of kidney function. Would therefore have expected to see renal function test results.
Any additional comments on discharge summary information:
E.g. Bendroflumethiazide was missed from discharge summary medications list, yet was not specified among stopped drugs. A call for hospital staff was needed to clarify that it was unintentionally omitted from the list.

Appendix 3 Discharge information audit guidance

Overview
You will be recording the information that is provided on discharge summaries that you receive during the audit period. Ideally, this information is recorded in an excel spreadsheet to allow the data to be collated.

STEP 1 – Identification of patients

1.1 Based on list sizes, each practice has been allocated a number of discharge summaries to audit. If you do not know what the number is for your practice, please your NHS Norfolk Prescribing Advisor.

1.2 Set a start date for the audit in January 2011.

1.3 From the practice designated start date, ask the member(s) of the practice team responsible for receiving and sorting discharge summaries to set them aside once they have been processed.

1.4 Collect the discharge summaries until the allocated target number is reached.

1.5 The audit is only of discharge summaries where the patient was hospitalized for longer 24 hours. Please check admission dates and discharges dates to determine patient hospital stay, exclude all other discharge summaries.

STEP 2 – Audit guidance

2.1 You have been sent an electronic folder which includes the required number of excel documents for the number of discharge summaries you need to audit. You must complete one document for each discharge summary.

2.2 The document has option boxes for you to click and in some cases, specific details are required. These cases are indicated by the boxes which are shaded gray and guidance regarding the information required in these boxes is in italic font. You can simply type over this writing.

2.3 Use the guidance below for the following questions:

2.3.1 **Is the discharge summary typed?**
You do not need to complete rows 20-30 if the discharge summary is typed.

2.3.2 **Was the discharge summary received within 2 working days?**
Please exclude weekends and public holidays.

2.3.3 **Allergy status**
From your records, indicate in the grey box whether or not the patient has any allergies.

2.3.4 **Past medical history/co-morbidities**

2.3.4.1 Answer yes only if **all** patient co-morbidities are stated on the discharge summary.
2.3.4.2 If no, from your records, indicate in the grey box whether or not the patient has any past co-morbidity. Type “no co- morbidities” if none are present.

2.3.5 **Complete past drug history**

2.3.5.1 Answer yes only if **all** patient pre admission medications are stated on the discharge summary.
2.3.5.2 If no, from your records, indicate in the grey box whether or not the patient had any prescribed medication prior to hospital admission. Type “no pre-admission medication” if none were prescribed.

2.3.6 **Medication**
In the grey box, fill in the name of medications as provided on the discharge summary. See box 53.

2.3.7.1 **Does the discharge summary clearly state all medication that has been changed?**
Answers yes only, if all change (s) is (are) clearly stated on the discharge summary.

2.3.7.2 **If any, is (are) the reason(s) reported/ specified?**
Answer yes only, if reason (s) for **all** change (s) is (are) clearly stated on the discharge summary.

2.3.8.1 **Does the discharge summary clearly state all medication that has been stopped?**
Answer yes only, if **all** medication (s) stopped is (are) clearly stated on the discharge summary.

2.3.8.2 **If any, is (are) the reason(s) reported/ specified?**
Answer yes only, if the reasons for all medication (s) stopped is (are) clearly stated on the discharge summary.

2.3.9.1 **Does the discharge summary clearly state all medication that has been started?**
Answers yes only, if **all** medication(s) started is (are) clearly stated on the discharge summary.

2.3.9.2 **If any, is (are) the reason(s) reported/ specified?**
Answer yes only, if the reason(s) for **all** medication (s) started is (are) clearly stated on the discharge summary.
2.4 If you feel that the discharge summary information is lacking in some way that was not identified above please add details about the information that would have been beneficial to you in box 93 and 95.

Step 3 – Submitting your audit
3.1 Once you have completed a spreadsheet for each of your discharge summaries, return them electronically via NHS Eman Hammad e.hammad@uea.ac.uk

3.2 You do not need to do anything further with your data. The results will be collated with other practices and a report produced.

3.3 Please retain all hard copies of the discharge summaries that you have included in your audit until you are advised that they can be disposed of.

3.4 Maintain and retain a list of patients audit ID & NHS numbers to allow subsequent quality assurance following the audit

Appendix 4 Discharge information reconciliation sheet

Collated patient medications list *							GP action+				
Drug code	**Drug name**	**Dose**	**Frequency**	**Route**	**Formulation**	**Duration**	**A**	**B**	**C**	**Discrepancy type**	**Comments**

*Medication were listed from discharge letter and compared with GP record; all medication omissions, changes, additions or discontinuations were evaluated and described: +GP action were classified into 3 types (A, B and C), each action was evaluated in repose to each medication as appropriate using the following coding system:

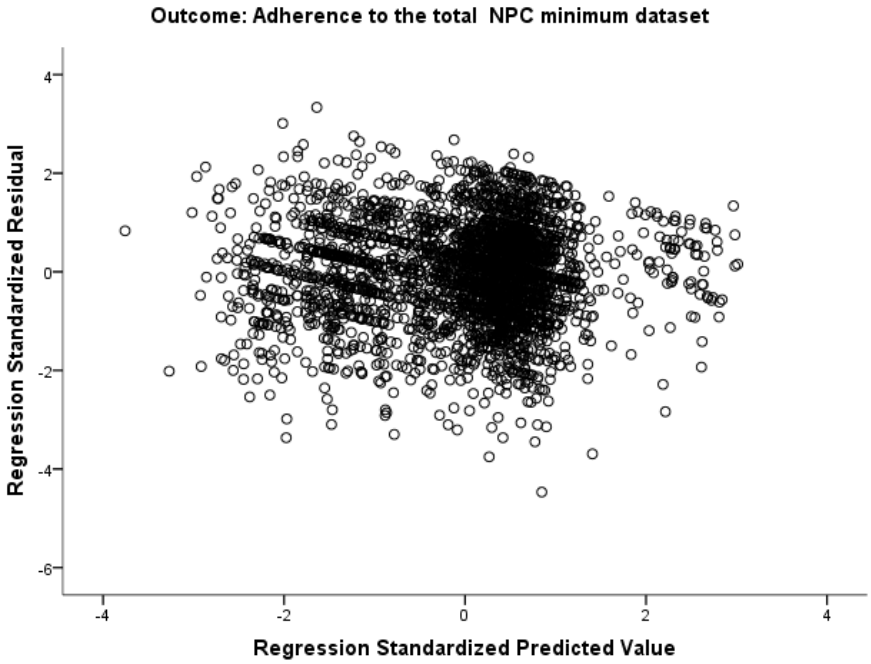
- GP action A: assesse GP action in response to hospital recommendation with regard therapy duration, monitoring, titration and changes if applicable.
- GP action B: assesse GP action in response to hospital recommendation with regard therapy initiation and discontinuation if applicable.
- GP action C: assess GP action in response to hospital recommendation with regard documenting hospitalization event, new diagnosis and indicating therapy changes source as per hospital if applicable.

Appendix 5 Multiple and logistic regression assumption check

Checking assumptions* of the multiple regression model presented in Table 3.17:

Assumption	Assumption met/violated	Comment
All predictors are continuous or categorical in two categories	Met	Dummy variable used for categorical variable >2
No perfect multicollinearity (i.e. no perfect linear relationship between two or more predictors)	Met	- **Correlation matrix:** checked none of the predictors highly correlated, i.e. r>0.8 - **VIF****: None of VIF values > 10. The Average VIF 2.03 which is not substantially greater than 1
Homoscedasticity (i.e. equality of residual variances)	Met	- **Plot of standardised residuals vs. standardised predicted values:** No funnelling of data point (Figure A). ZRESID vs. ZPRED appeared like a random array of dots evenly distributed around zero.
Linearity (i.e. the mean value of the outcome for each increment of the predictor lie along a straight line) the relation that is modelled is a linear one	Met	- **Plot of standardised residuals vs. standardised predicted values:** No curviness (Figure A) ZRESID vs. ZPRED showed no trend of the data points for curvilinear relationship
Independence	Met	- Data points are not related to the same patient in different occasion or time
Independent of the errors (i.e. for any two observation the errors or residual are independent)	Met	- **Durbin-Watson test**: None of the values were <1 or >3. The model value =1.75 (the closer to 2 is better) no concerns
Normally distributed errors (residuals)	Met	- Bell shaped curve (normal distribution) of the histogram of residuals (Figure B) - All points lie in the line indicating limited deviation of residual from Normality (Figure C)

*Based on: Field A. Discovering statistics using SPSS statistics. Third edition, 2009.** VIF: Variance inflation factor



ZRESID: The standardised residuals or errors

ZPRED: The standardised predicted values of the dependent variable based on the model

Figure A: Plot of ZRESID vs. ZPRED for modelling adherence to the total NPC minimum dataset

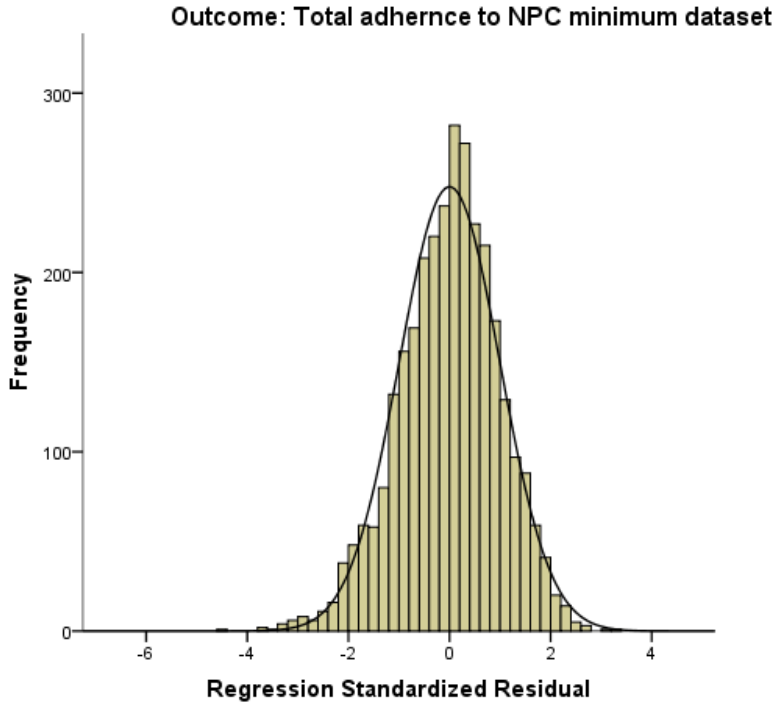


Figure B: Histogram presentation of residuals of total adherence to NPC minimum dataset

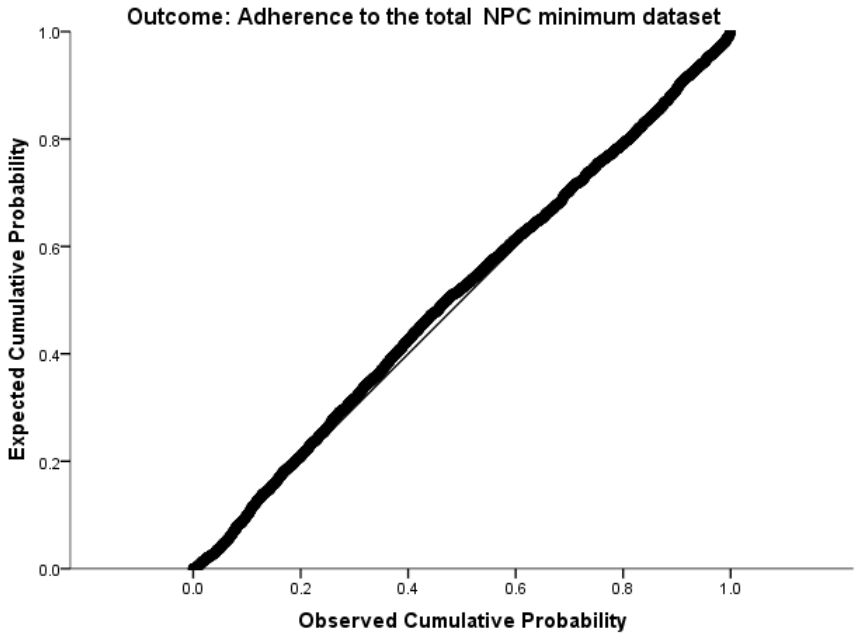


Figure C: Normal P-P Plot (probability–probability plot) of Regression Standardized Residual

Checking assumptions* of the multiple regression model presented in Table 3.18:

Assumption	Assumption met/violated	Comment
All predictors are continuous or categorical in two categories	Met	Dummy variable used for categorical variable >2
No perfect multicollinearity (i.e. no perfect linear relationship between two or more predictors)	Met	- **Correlation matrix:** checked none of the predictors highly correlated, i.e. r>0.8 - **VIF****: None of VIF values > 10. The Average VIF 1.94 which is not substantially greater than 1
Homoscedasticity (i.e. equality of residual variances)	Met	- **Plot of standardised residuals vs. standardised predicted values:** No funnelling of data point (Figure D). ZRESID vs. ZPRED appeared like a random array of dots evenly distributed around zero.
Linearity (i.e. the mean value of the outcome for each increment of the predictor lie along a straight line) the relation that is modelled is a linear one	Met	- **Plot of standardised residuals vs. standardised predicted values:** No curviness (Figure D) ZRESID vs. ZPRED showed no trend of the data points for curvilinear relationship
Independence	Met	- Data points are not related to the same patient in different occasion or time
Independent of the errors (i.e. for any two observation the errors or residual are independent)	Met	- **Durbin-Watson test**: None of the values were <1 or >3. The model value =1.67 (the closer to 2 is better) no concerns
Normally distributed errors (residuals)	Met (some concern)	- Bell shaped curve (normal distribution) of the histogram of residuals (Figure E) - All points lie in the line indicating limited deviation of residual from Normality (Figure F)

*Based on: Field A. Discovering statistics using SPSS statistics. Third edition, 2009.** VIF: Variance inflation factor

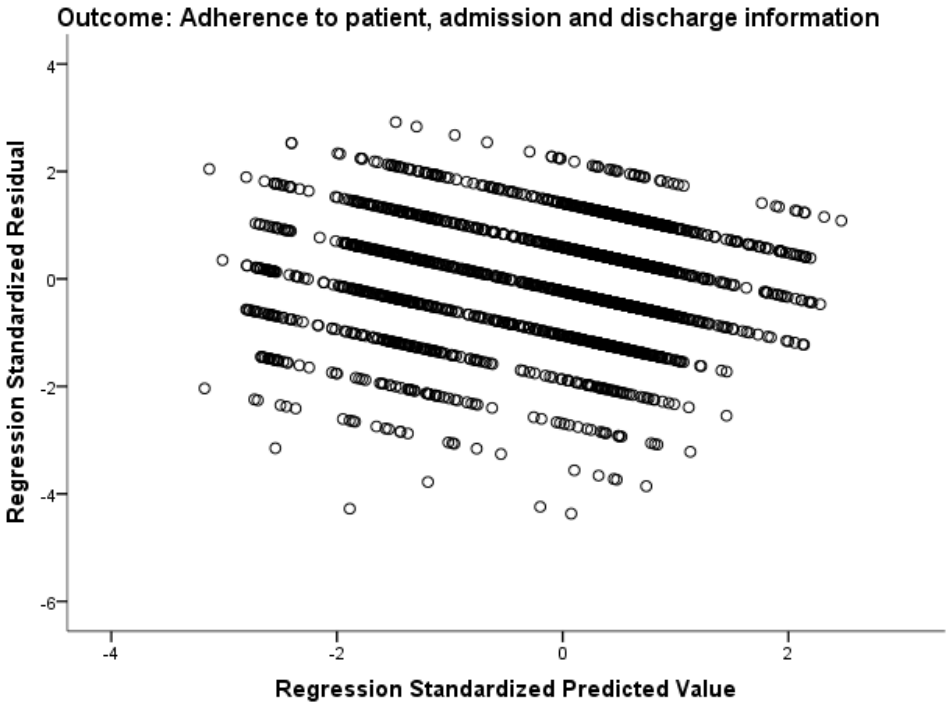


Figure D: Plot of ZRESID vs. ZPRED for modelling adherence to patient, admission and discharge information

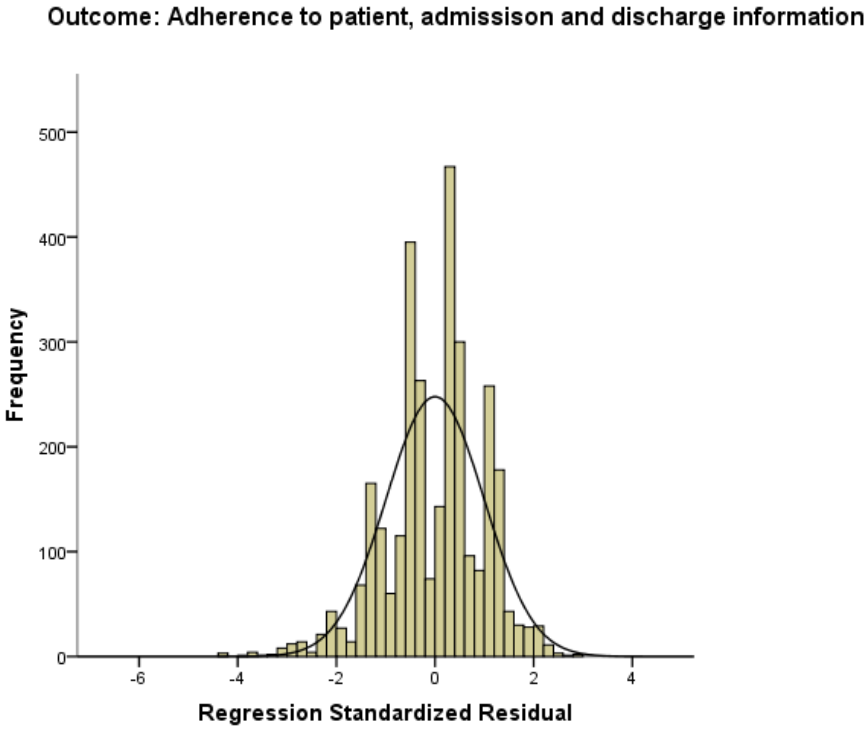


Figure E: Histogram presentation of residuals of patient, admission and discharge information

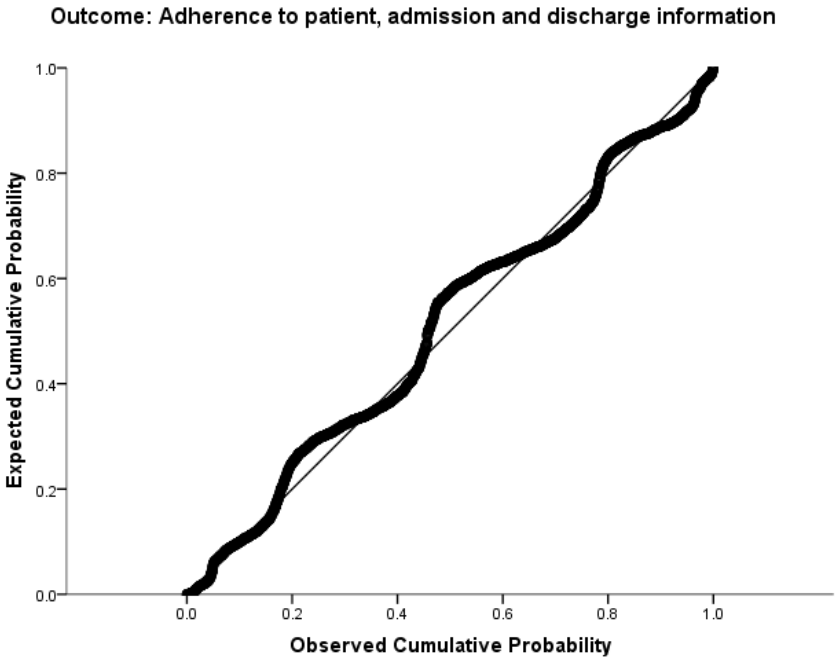


Figure F: Normal P-P Plot (probability–probability plot) of Regression Standardized Residual of patient, admission and discharge information

Checking assumptions* of the multiple regression model presented in Table 3.19:

Assumption	Assumption met/violated	Comment
All predictors are continuous or categorical in two categories	Met	Dummy variable used for categorical variable >2
No perfect multicollinearity (i.e. no perfect linear relationship between two or more predictors)	Met	- **Correlation matrix:** checked none of the predictors highly correlated, i.e. r>0.8 - **VIF****: None of VIF values > 10. The Average VIF 1.86 which is not substantially greater than 1
Homoscedasticity (i.e. equality of residual variances)	Met	- **Plot of standardised residuals vs. standardised predicted values:** No funnelling of data point (Figure G). ZRESID vs. ZPRED appeared like a random array of dots evenly distributed around zero.
Linearity (i.e. the mean value of the outcome for each increment of the predictor lie along a straight line) the relation that is modelled is a linear one	Met	- **Plot of standardised residuals vs. standardised predicted values:** No curviness (Figure G) ZRESID vs. ZPRED showed no trend of the data points for curvilinear relationship
Independence	Met	- Data points are not related to the same patient in different occasion or time
Independent of the errors (i.e. for any two observation the errors or residual are independent)	Met	- **Durbin-Watson test**: None of the values were <1 or >3. The model value =1.48 (the closer to 2 is better) no concerns
Normally distributed errors (residuals)	Met	- Bell shaped curve (normal distribution) of the histogram of residuals (Figure H) - All points lie in the line indicating limited deviation of residual from Normality (Figure I)

*Based on: Field A. Discovering statistics using SPSS statistics. Third edition, 2009.** VIF: Variance inflation factor

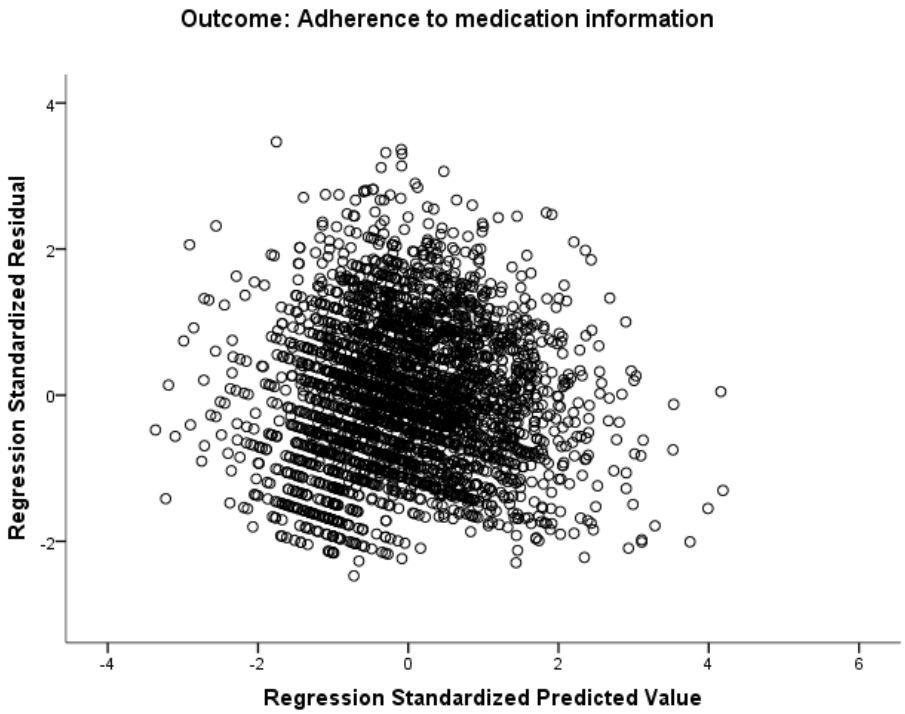


Figure G: Plot of ZRESID vs. ZPRED for modelling adherence to medication information

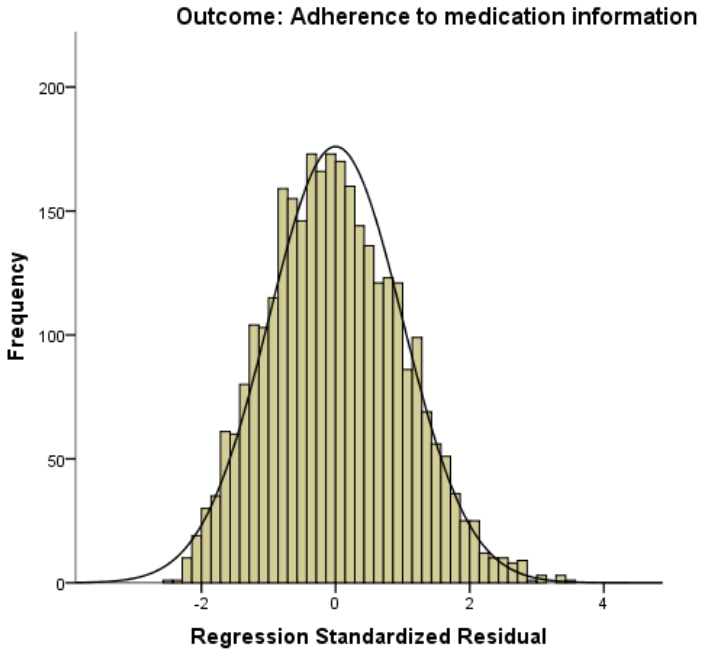


Figure H: Histogram presentation of residuals of medication information

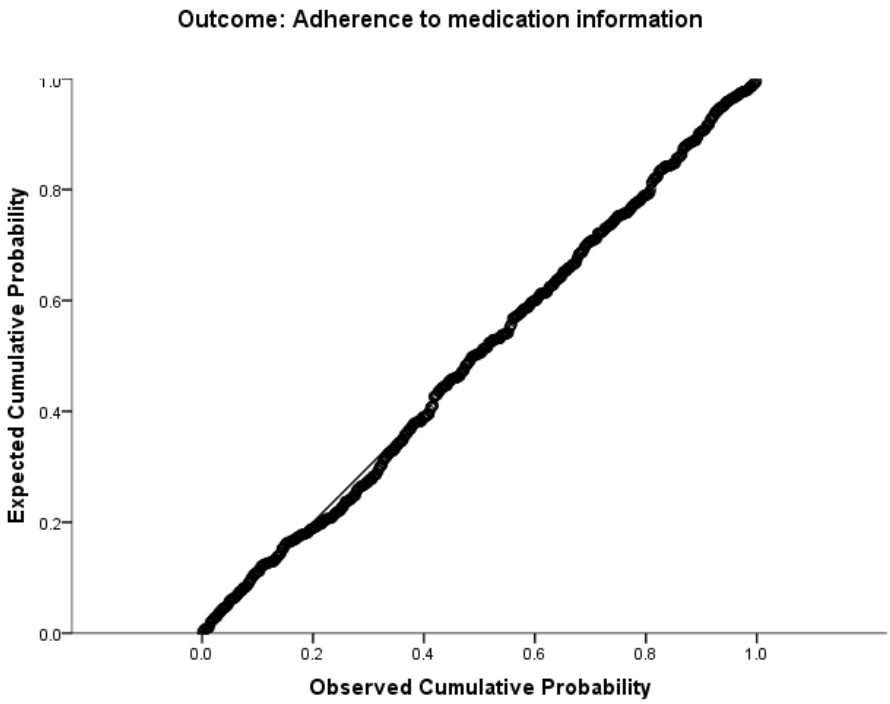


Figure I: Normal P-P Plot (probability–probability plot) of Regression Standardized Residual of medication information

Checking assumptions* of the multiple regression model presented in Table 3.20:

Assumption	Assumption met/violated	Comment
All predictors are continuous or categorical in two categories	Met	Dummy variable used for categorical variable >2
No perfect multicollinearity (i.e. no perfect linear relationship between two or more predictors)	Met	- **Correlation matrix:** checked none of the predictors highly correlated, i.e. r>0.8 - **VIF****: None of VIF values > 10. The Average VIF 1.96 which is not substantially greater than 1
Homoscedasticity (i.e. equality of residual variances)	Met	- **Plot of standardised residuals vs. standardised predicted values:** No funnelling of data point (Figure J). ZRESID vs. ZPRED appeared like a random array of dots evenly distributed around zero.
Linearity (i.e. the mean value of the outcome for each increment of the predictor lie along a straight line) the relation that is modelled is a linear one	Met	- **Plot of standardised residuals vs. standardised predicted values:** No curviness (Figure J) ZRESID vs. ZPRED showed no trend of the data points for curvilinear relationship
Independence	Met	- Data points are not related to the same patient in different occasion or time
Independent of the errors (i.e. for any two observation the errors or residual are independent)	Met	- **Durbin-Watson test**: None of the values were <1 or >3. The model value =1.76 (the closer to 2 is better) no concerns
Normally distributed errors (residuals)	Met	- Bell shaped curve (normal distribution) of the histogram of residuals (Figure K) - All points lie in the line indicating limited deviation of residual from Normality (Figure L)

*Based on: Field A. Discovering statistics using SPSS statistics. Third edition, 2009.** VIF: Variance inflation factor

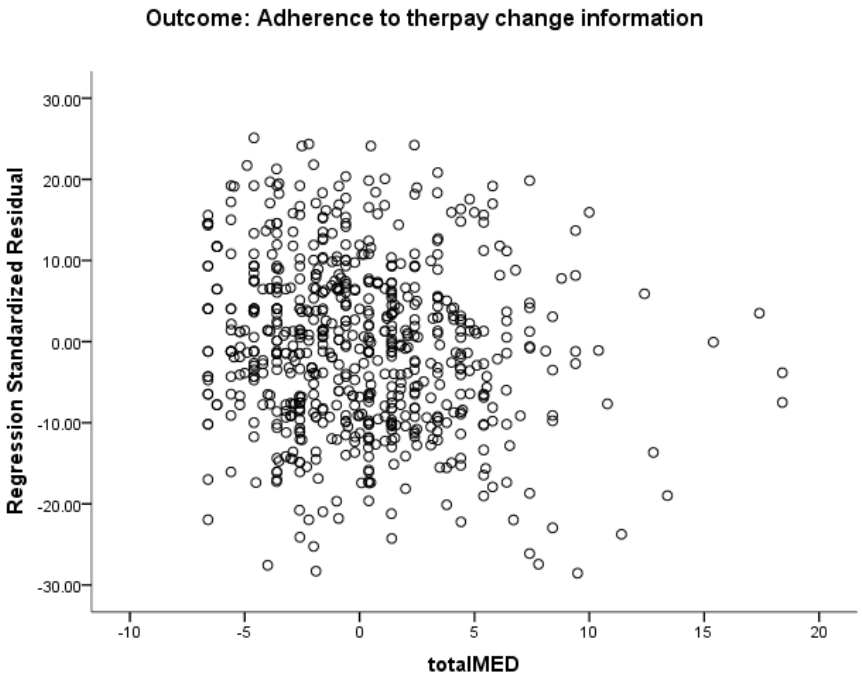


Figure J: Plot of ZRESID vs. ZPRED for modelling adherence to therapy change information

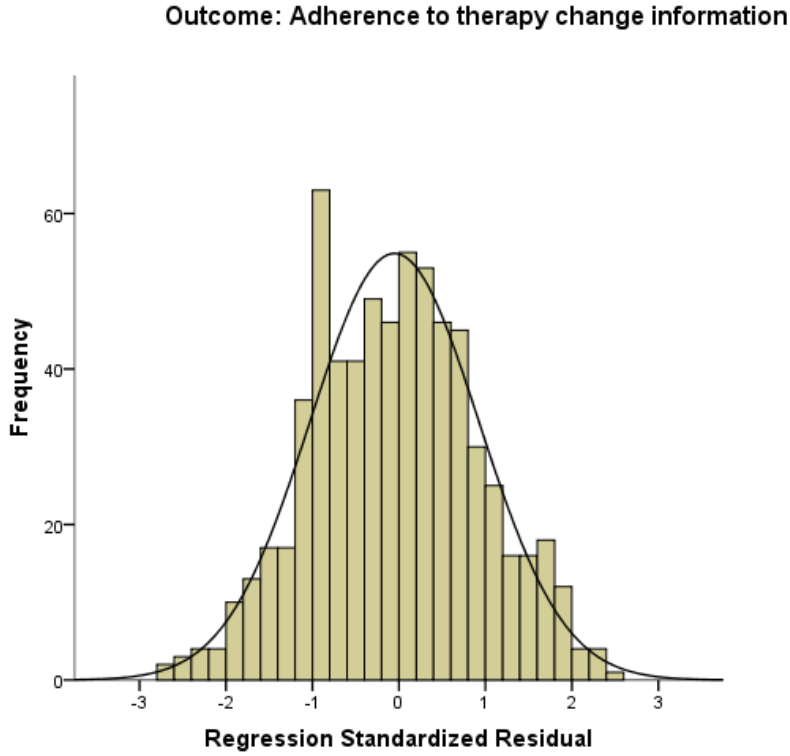


Figure K: Histogram presentation of residuals of therapy change information

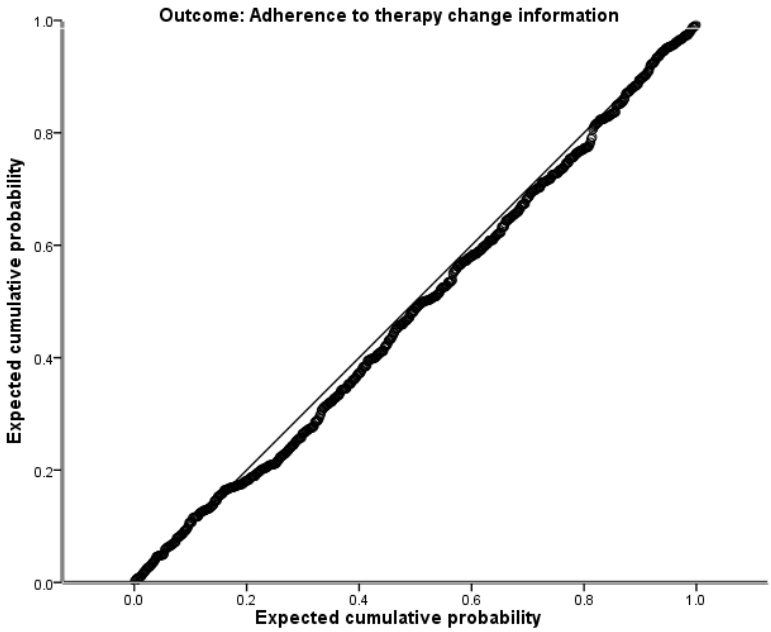


Figure L: Normal P-P Plot (probability–probability plot) of Regression Standardized Residual of therapy change information

Checking assumptions* of the logistic regression model presented in Table 3.39:

Assumption	Assumption met/violated	Comment
All predictors are continuous or categorical in two categories	Met	Dummy variable used for categorical variable >2
No perfect multicollinearity (i.e. predictors should not be highly correlated.	Met	- **Collinearity diagnostics** Eigenvalues were fairly similar - **VIF****: None of VIF values > 10. The Average VIF 2.01 which is not substantially greater than 1
Linearity (i.e. there is a linear relationship between continues predictors and the logit of the outcome.	Met	**Log interaction terms** The interaction terms of continues variable (age, no. of medications and hospital stay) with their logs were checked; all p >0.05 indicating assumption met
Independent of the errors (i.e. for any two observation the errors or residual are independent)	Met	- **Data points are not related and**

*Based on: Field A. Discovering statistics using SPSS statistics. Third edition, 2009.** VIF: Variance inflation factor

Appendix 6 Pharmacy led medicine reconciliation systematic review search strategies

Appendix 6A: Search terms applied for EMBASE and MEDLINE Ovid database in 23.03.2012

	Search terms	Number of retrievals
1.	medicine$.ti,ab.	655,284
2.	Medication$.ti,ab.	375,197
3.	drug$.ti,ab.	2,184,362
4.	medicament$.ti,ab	9,837
5.	prescription$.ti,ab.	111,893
6.	(medic$ adj2 chart$).ti,ab.	8,620
7.	(medic$ adj2 record$).ti,ab.	113,559
8.	1 or 2 or 3 or 4 or 5 or 6 or 7	3,233,797
9.	((medicine$ or medication$ or drug$ or medicament$ or prescription$ or (medic$ adj2 chart$) or (medic$ adj2 record$)) adj2 reconciliation).ti,ab.	807
10.	((medicine$ or medication$ or drug$ or medicament$ or prescription$ or (medic$ adj2 chart$) or (medic$ adj2 record$)) adj2 management).ti,ab.	9,874
11.	((medicine$ or medication$ or drug$ or medicament$ or prescription$ or (medic$ adj2 chart$) or (medic$ adj2 record$)) adj2 assessment).ti,ab.	5,111
12.	((medicine$ or medication$ or drug$ or medicament$ or prescription$ or (medic$ adj2 chart$) or (medic$ adj2 record$)) adj2 review$).ti,ab.	40,775
13.	((medicine$ or medication$ or drug$ or medicament$ or prescription$ or (medic$ adj2 chart$) or (medic$ adj2 record$)) adj2 histor$).ti,ab.	15,931
14.	information.ti,ab.	1,410,099
15.	(information adj2 transfer$).ti,ab.	6,930
16.	information adj2 continu$).ti,ab.	1,625
17.	((medicine$ or medication$ or drug$ or medicament$ or prescription$ or (medic$ adj2 chart$) or (medic$ adj2 record$)) adj2 system$).ti,ab.	44,490
18	((medicine$ or medication$ or drug$ or medicament$ or prescription$ or (medic$ adj2 chart$) or (medic$ adj2 record$)) adj2 congruence$).ti,ab.	23
19	((medicine$ or medication$ or drug$ or medicament$ or prescription$ or (medic$ adj2 chart$) or (medic$ adj2 record$)) adj2 communication).ti,ab.	1,151
20	(information adj2 communication).ti,ab.	4,803
21	((medicine$ or medication$ or drug$ or medicament$ or prescription$ or (medic$ adj2 chart$) or (medic$ adj2 record$)) adj2 liaison).ti,ab.	100
22	care.ti,ab.	1,643,248

23	(seamless adj2 care).ti,ab.	328
24	discrepanc$.ti,ab.	4,102,001
25	Error$.ti,ab.	346,734
26	transition$.ti,ab.	404,601
27	9 or 10 or 11 or 12 or 13 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 23 or 25 or 26	965,588
28	Secondary adj1 care).ti,ab.	6,717
29	hospital$.ti,ab.	1,639,428
30	inpatient$.ti,ab.	123,976
31	interface$.ti,ab.	189,253
32	dicharge$.ti,ab.	57
33	admission$.ti,ab.	271,361
34	28 or 29 or 30 or 31 or 32 or 33	1,993,872
35	pharmacist$.ti,ab.	50,114
36	pharmacy.ti,ab.	58,512
37	pharmacies.ti,ab.	14,249
38	35 or 36 or 37	102,050
39	27 and 34 and 38	4,608
40	Remove duplicate from 39	3,046
41	Export to Endnote and further remove of duplicate	2,981

Appendix 6B: Search terms applied CINAHL database in 19.04.2012

	Search terms	Number of retrievals
1.	TI Medicine OR AB Medicine	62,405
2.	TI Medication OR AB Medication	45,882
3.	TI drug OR AB drug	102,505
4.	TI medicament OR AB medicament	185
5.	TI prescription OR AB prescription	14,745
6.	TI (medic* N2 chart) OR AB (medic* N2 chart)	15
7.	TI (medic* N2 record) OR AB (medic* N2 record)	474
8.	1 or 2 or 3 or 4 or 5 or 6 or 7	201,986
9.	TI (8 N2 reconciliation) OR AB (8 N2 reconciliation)	298
10.	TI (8 N2 management) OR AB (8 N2 management)	2,648
11.	TI (8 N2 assessment) OR AB (8 N2 assessment).	731
12.	TI (8 N2 review*) OR AB (8 N2 review*)	2,627
13.	TI (8 N2 histor*) OR AB (8 N2 histor*)	1,563
15.	TI (information N2 transfer*) OR AB (information N2 transfer*)	464
16.	TI (information N2 contin*) OR AB (information N2 contin*)	359
17.	TI (8 N2 system*) OR AB (8 N2 system*)	2,664
18	TI (8 N2 congruence*) OR AB (8 N2 congruence*)	3
19	TI (8 N2 communication) OR AB (8 N2 communication)	196
20	TI (information N2 communication) OR AB (information N2 communication)	1095
21	TI (8 N2 liaison) OR AB (8 N2 liaison)	31
23	TI (seamless N2 care) OR AB (seamless N2 care)	186
24	TI Discrepanc* OR AB Discrepanc*	4,690
25	TI Error* OR AB Error*	20,468
26	TI transition* OR AB transition*	16,239
27	9 or 10 or 11 or 12 or 13 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 23 or 25 or 26	52,242
28	TI (Secondary N1 care) OR AB (Secondary N1 care)	1,450
29	TI hospital* OR RA hospital*	165,610
30	TI inpatient* OR RA inpatient*	16,853
31	TI interface* OR RA interface*	5,092

32	TI discharge* OR AB discharge*	525,523
33	TI admission* OR AB admission*	24,989
34	28 or 29 or 30 or 31 or 32 or 33	198,196
35	TI Pharmacist OR AB Pharmacist	5,388
36	TI pharmacy OR AB pharmacy	6,506
37	TI pharmacies OR AB pharmacies	1,317
38	35 or 36 or 37	11,592
39	27 and 34 and 38	565

Appendix 6C: Search terms applied in Cochrane library which included Cochrane Database of Systematic Review (CDSR), Database of Abstracts of Reviews of Effects (DARE) and the NHS Economic Evaluation Database (NHSEED) database in 26.04.2012

Search term	Retrieval
(((medication*or medicine*or drug*or medicament*or prescription* or (medic* NEAR/2 chart*) or (medic* NEAR/2 record*)) NEAR/2 (reconciliation or management or assessment or review*or histor* or system*or congruence*or communication or liaison)) or (information NEAR/2 (transfer or continu* or communication)) or (seamless NEAR/2 care) or discrepanc* or error* or transition*) AND ((secondary NEAR/1 care) or hospital* or inpatient* or interface* or discharge* or admission*) AND (Pharmacist* or pharmacy or pharmacies)	48
Remove duplicate	45
Export to collated data and remove duplicate	6

Appendix 6D: Search terms applied in the centre of Reviews and Dissemination (CRD); search date in 28.04.2012

Search term	Retrieval
((medication*or medicine*or drug*or medicament*or prescription* or (medic* NEAR/2 chart*) or (medic* NEAR2 record*)) NEAR2 (reconciliation or management or assessment or review*or histor* or system*or congruence*or communication or liaison)) or (information NEAR2 (transfer or continu* or communication)) or (seamless NEAR2 care) or discrepanc* or error* or transition* AND (secondary NEAR1 care) or hospital* or inpatient* or interface* or discharge* or admission* AND Pharmacist* or pharmacy or pharmacies	193
Export to the collated database and remove duplicate	183*

Note: Using any field (Title, author, journal, keywords) because there was no search within abstract choice

Appendix 6E: Search terms applied in PHARMLINE which is provided by the National electronic Library for Medicines (NeLM); search date in 2/05/2012

Search term	Retrievals
medic* reconciliation OR drug* reconciliation OR prescription*reconciliation OR medic* management OR drug* mamangement OR prescription*management OR medic* assessment or drug* assessment OR prescription* assessment OR medic* review* OR drug* review* OR prescription*review* OR medic* histor* OR drug* history* OR prescription* histor* OR medic* system* OR drug* system* OR prescription* system* medic* congruence* OR drug* congruence* OR prescription* congruence* OR medic* communication* OR drug* communication* OR prescription* communication* OR medic* liaison* OR drug* liaison* OR prescription* liaison* OR information transfer* OR information continu* OR “information communication” OR “seamless* care” OR discrepac* OR error* OR transition* Pharamc*	32,197
NelM area: evidence > Medicines management	22,599
NelM category: National Health service > hospital trust	261
NelM category: National Health service > hospital trust > hospital pharmacy	219
Remove duplicate	216
Remove duplicate from collated data file	161

Appendix 7 Pharmacy led medicine reconciliation review screening tools

Abstract screening tool (in MS Excel sheet)

End note ID	Authors	Year	Title	Intervention included all MR elements	led by Pharmacy Intervention a pharmacist or pharmacy technician or pharmacy student	Implemented in inpatient setting	Qualitative evaluation	Decision
				Y/N	Y/N	Y/N	Y/N	Y/N

Full text screening tool (in MS Excel sheet)

Endnote ID	Author	Year	Title	Confirm: Intervention includes all MR elements	Confirm: Intervention is pharmacy led	Confirm: Intervention in inpatient setting?	Provide any report of costs associated with the intervention	Decision
				Y/N	Y/N	Y/N	Y/N	Y/N

Appendix 8 Pharmacy led medicine reconciliation review extraction tool

Please complete details as appropriate	**Study details**	Endnote ID	
		Author	
		Year	
		Country	
		Language	
		Study design	
		Study period (Month)	
		Randomisation if any	
		Randomisation description	
		unit of allocation	
	Intervention	Person led MR	
		Time to initiate MR	
		Service cover days/week	
	Control or comparator		
	Sample size	Sample size (no. patients for analysis)	
		Intervention (no. patients for analysis)	
		Control (no. patients for analysis)	
		Inclusion Criteria	
		Exclusion criteria	
Please complete age average estimate indicating whether measure is mean or median as appropriate	**Age**	Average Age (over all sample)	
		Average Age intervention	
		Average Age control	
Please complete in the gender & planned admission proportions as appropriate	**Gender**	Intervention % male	
		control male%	
	Admission	Planned %	
Number of medications might be reported as total number prescribed or broke down into regular or PRN use and admission, inpatient or discharge; please complete details as appropriate	**No. meds**	Intervention	
		Control	
Please complete speciality proportions as appropriate	**Speciality**		
Medication discrepancies might be reported as total number of discrepancies or broke down into admission, inpatient or discharge discrepancies; please complete details as appropriate. All rates to be recorded per patient (no. of discrepancies/no. patients)	**Medication discrepancies**	Intervention	
		control	

Nature of medication discrepancies might be differentiated into admission, inpatient, discharge or post discharge discrepancies; Please complete details on the nature of discrepancies, all rates to be reported per patient (no. of discrepancies/no. patients)	**Nature of discrepancy**	Intervention	
		control	
Discrepancy severity might be reported employing many tools. In texts please describe all rates per patient (no. of discrepancies/no. patients) for intervention and control group	**Discrepancy severity**	Tool used	
		n. Rater(s)	
		Inter-rater agreement	
Hospital visits might be reported as total hospital visits or broke down into inpatient readmission and ED. This might be reported at different follow up time, i.e. 3 months, 6 months, etc. Please complete details and all rates to be recorded per patient (no. of discrepancies/no. patients)	**Hospital visit (Readmission & ED or both as appropriate)**	Intervention	
		Control	
Please complete the details of other health care professional visits. In texts please describe all rates per patient (no. of discrepancies/no. patients) for intervention and control group	**Other health professional (HCP) visits**	Intervention	
		Control	
Please complete the average estimate of length of hospital stay for the index admission and readmission(s) as appropriate	**length of hospital stay**	Intervention	
		Control	
	Readmission duration	Intervention	
		Control	
Please complete details on rate of death in both group, all rates per patient (no. of discrepancies/no. patients)	**Death 12 months n/patient**	intervention	
		control	
Please complete details of health related quality of life. In texts please describe different measures of quality of life for intervention and control group	**health related quality of life**	Tool used	
		Intervention	
		Control	
Please complete details related to cost saving if reported. Saving might be reported at different follow up time, i.e. 3 months, 6 months. All savings to be reported per patient (total saving / no. patients)	**Cost saving**		

Please complete details related to costs per patients as appropriate.	**Perspective of cost if applicable e.g. NHS/ societal**	Unit cost	
		Currency	
		n. Patient included in cost analysis	
Please complete details related to time spent by MR pharmacist per patients as appropriate.		Mean time	
		range min	
		range max	
Please complete details related to time spent/saved by other professionals per patients as appropriate.	**Time saved/spent**		

Appendix 9 Pharmacy led medicine reconciliation review risk assessment tool

Domain	Low risk	High risk	Unclear

1. Design bias (focus study question & design)	• The study clearly described all of the following:
	  • Targeted population
	  • The intervention
	  • The comparator
	  • Outcomes measured
	• The study design is the best to answer the question, e.g. RCT for intervention
	• The study addressed the intended research question
		The study is not fulfilling any of these criteria	Insufficient information to permit judgment of 'Low risk' or 'High risk'

2. Selection bias (external and internal variations)	• The study sample is representative of the intended population • There is nothing special about the sample with any potential to effect intervention or outcomes • All patients were included/ excluded as per the stated inclusion and exclusion criteria • The study groups are comparable at baseline	The study is not fulfilling any of these criteria	Insufficient information to permit judgment of 'Low risk' or 'High risk'[1]
3. Selection bias (randomisation)	The investigators describe a random component in the sequence generation process [2]	The description of the sequence generation involve some systematic but non-random approach [3]	Insufficient information permit judgment of 'Low risk' or 'High risk'
4. Selection bias (allocation concealment)	Participants and investigators enrolling participants could not foresee the study group assignment [4]	Participants and investigators enrolling participants could possibly foresee the study group assignments [5]	Insufficient information permit judgment of 'Low risk' or 'High risk'
5. Performance bias (Standardised intervention delivery)	The investigators used a standardised process which followed by all the service providers delivering the intervention [6]	The process of intervention delivery was not standardised	Insufficient information to permit judgment of 'Low risk' or 'High risk'
6. Performance bias (Standardised outcome measurement)	The investigators used a standardised process which followed by all investigators recording and measuring t outcomes[7]	The process for recording /measuring outcomes was not standardised	Insufficient information to permit judgment of "'Low risk' or 'High risk'

1.For example, groups were reported comparable but with no evidence to support this or groups reported different but no way of knowing if this is significant. 2.For example referring to a random number table, using a computer random number generator, coin tossing, shuffling cards or envelopes, throwing dice or drawing of lots. 3. For example generating sequence by odd or even date of birth, sequence generated by some rule based on date (or day) of admission, sequence generated by some rule based on hospital or clinic record number or other non- random approaches such as allocation by judgment of the clinician, the preference of the participant, on the results of a laboratory test or a series of tests or the availability of the intervention. 4.For example the study allocation was concealed by central allocation (including telephone, web-based and pharmacy – controlled randomisation), sequentially numbered drug containers of identical appearance or sequentially numbered, opaque, sealed envelopes. 5.For example the study allocation based on using open random allocation schedule (e.g a list of random numbers), assignment envelopes were used without appropriate safeguards (e.g. if envelopes were unsealed or nonopaque or not sequentially numbered, alternation or rotation, date of birth, case recorded number or any other explicitly unconcealed procedure. 6. For example the investigator used a standardised form or checklist or undertook a training. 7. I.e. the investigators used a structured review of medical chart, independent and double identification of medication discrepancies and demonstrate satisfactory agreement between the intervention assessors

Domain	Low risk	High risk	Unclear
1. Detection bias (Blindness of the outcomes)	• Blinding of outcome assessment ensured, and unlikely it was broken. • No blinding of the outcome assessment, but this unlikely to influence outcome assessment	Outcomes measurement was not blind [8]	Insufficient information to permit judgement of 'Low risk' or 'High risk'
2. Incomplete outcome data	• No missing outcome data and all study participants accounting for at conclusion [9] • All pre-specified (primary and secondary) outcomes have been reported • The reported outcomes are appropriate to answer the study question	The study is not fulfilling one or more of these criteria	Insufficient information to permit judgement of 'Low risk' or 'High risk'
3. Adequacy of study power (appropriate Statistical analysis)	• The study used appropriate/justifiable statistical testing • Power calculation or sample size calculation was performed • Results do not match up or add up but with no major concern	The study is not fulfilling one or more of these criteria	Insufficient information to permit judgement of 'Low risk' or 'High risk'

8.Detection bias criteria related to blinding of outcomes is considered of importance in assessing the measurement of medication discrepancies and their clinical significance. However, blinding of outcome assessors not particularly relevant to the end-points of hospital revisits or deaths and therefore it was assessed whether studies confirmed outcome data by using a subjective standardised reporting system such as hospital data or self-report data. 9.I.e. attrition rate is similar between study groups, the study follow up is complete, patients were analysed as allocated at the study commencement, reasons for missing outcome data unlikely to be related to true outcome , missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups. In case of dichotomous outcome data, the proportion of missing outcomes compared with observed event risk not enough to have a clinically relevant impact on the intervention effect estimate. For continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes not enough to have a clinically relevant impact on observed effect size and missing data have been imputed using appropriate methods.

Additional criteria for Economic evaluation : Validity of the economic evaluation

	Low risk	High risk	Unclear risk	NA
1. Perspective	The investigator(s) specified/established the perspective of the economic evaluation	The study is not fulfilling one or more of these criteria	Insufficient information to permit judgement of 'Low risk' or 'High risk'.	Study is not an economic evaluation
2. Cost measure	• capital costs as well as operating costs were included • Appropriate cost unit was used • The unit(s) used was of a realistic value (s) • Appropriate method(s) was employed to drive the value(s) of costs and consequences • All the study assumptions with respect to cost estimation are reported and justified	The study is not fulfilling one or more of these criteria	Insufficient information to permit judgement of 'Low risk' or 'High risk'.	Study is not an economic evaluation
3. Variability of the estimate	Adequate sensitivity analysis was reported for the primary estimate	Sensitivity analysis of the primary estimate was not performed	Insufficient information to permit judgement of 'Low risk' or 'High risk'.	Study is not an economic evaluation

Appendix 10 Medicine Reconciliation at the health interface patient information leaflet

Medicines reconciliation at the interface: A pilot randomised controlled trial to determine the costs and effects of a pharmacy provided service

Patient Information Leaflet

Cambridge University Hospitals NHS Foundation Trust

NHS National Institute for Health Research

University of East Anglia

Invitation:

You are invited to take part in a clinical research study. To help you decide if you want to take part in the study, it is important for you to understand why the study is being done and what it will involve. Please take your time to read the following information carefully before making up your mind. Please ask about anything that is not clear or if you would like more information.

What is the purpose of the study?

The purpose of the study is to carry out a small project to see whether it is a good use of NHS money for a pharmacist to check patients' medicines history when they come into hospital. All patients are seen by a Doctor and their medicines are prescribed. We are trying to find out whether it is a good idea that all medicines are also checked by a Pharmacist. The results of the study will be used to inform the best design of a larger study to look at the cost and effect of an extended pharmacy service.

Why have I been chosen?

You have been chosen because you have been admitted to the ward within the previous 24 hours under the care of a medical team at Addenbrooke's hospital and have not yet had your medicines history looked at by a pharmacist.

Do I have to take part?

No. Your participation in this study is voluntary and it is entirely up to you if you decide to take part or not. If you do decide to take part you will be given this information sheet to keep and will be asked to sign a consent form to confirm that you understand what is involved in the study. If you decide to take part but later change your mind during the study, you are free to withdraw at anytime without giving a reason. This will not in any way affect the care or services you subsequently receive by Addenbrooke's hospital staff.

How many patients will be in the study?

This is a relatively small pilot study involving 200 patients. One hundred patients will receive usual care and 100 will have their medicine history taken by a pharmacist in addition to that taken by a doctor.

Which group I will be in?

All patients who consent to take part will be randomly allocated (like flipping a coin) to receive the pharmacist service or usual care. By agreeing to take part in the study you have a 50/50 chance of receiving the extra pharmacist service

For all patients in both groups

- A research assistant will talk with you about your medicines (including any medicines that you might buy over the counter at a pharmacy or from a health shop)
- Your own medicines will be checked and the boxes copied
- Your prescription charts while you are in hospital will be copied
- Your GP will be contacted to obtain details of your medicines

- Relevant data will be collected from your hospital records
- Your hospital record and discharge letter will be reviewed 3 months after discharge
- You will be asked to complete a health-related quality of life questionnaire which consists of five questions following your consent to be in the study
- You may receive a copy of your discharge letter and you may receive a copy of a medication chart. A medication chart summarises the drugs you are taking and at what time of day you should take them
- The same health-related quality of life questionnaire as previously will be sent to you three months after discharge from hospital. We will also send a questionnaire asking about your use of any health or social care services since discharge. This will be followed up with a letter or a phone call
- Some patients who were recruited in the first 3 months of the study will be invited to take part in a discussion group to help us better understand how the project has worked. This will be a meeting with other patients where you will be asked for your comments about the experience of being in the trial. Participation in this is entirely voluntary. Your travel expenses and use of the car park will be reimbursed. Audio recordings of the discussion group will be stored in a secure location at the UEA and destroyed no later than five years after the study has finished

If you receive the pharmacy service

- A Pharmacist will talk with you so that he or she can produce a complete list of all the medicines that you are taking
- Any differences between medicines taken before admission and those currently being taken will be discussed with your GP/and or your Doctor on the ward
- You will receive a copy of your discharge letter and you will receive a medication chart.

Will my GP be informed that I am taking part?

Yes, your GP will be informed that you are taking part in a study.

What are the risks involved/disadvantages in taking part in the study?

We do not anticipate any risks or disadvantages to you taking part in this study.

What are the benefits?

Taking part in this study may not be of direct benefit to you. The information we gain from this study may improve the future management of medicines in the NHS. It will also help to inform the running of a large scale trial. The results may be published in scientific journals or presented at meetings. A summary of the study results will be sent to you if you wish after the research has been completed.

After 3 months, we will check your discharge letter with our records to see if errors occurred at the time of discharge. If we find any, we will contact your doctor to make sure

that you are receiving the correct medications. Also at 3 months, we will post a questionnaire and short survey, which may be followed up with a telephone call.

What if something goes wrong ?

In the very unlikely event of any harm occurring by taking part in this research study there are no special compensation arrangements. If you are harmed as a result of someone's negligence then you may have grounds for legal action but you may have to pay for it. Regardless of this, if you wish to make a complaint or have any concerns about any aspect of the way in which you have been approached or treated during the course of this study, the normal National Health Service complaints mechanisms are available to you. You can contact the local

Patient Advice Liaison Service at: pals@addenbrookes.nhs.uk or Tel: 01223 216 756.

Has the study been approved?

This study has been developed by a team from Cambridge University Hospitals and University of East Anglia. This study has been approved by Essex Ethics Committee.

Who is paying for the study?

National Institute for Health Research: Research for Patient Benefit Programme

www.nihr.ac.uk.

Are there any payments to subjects?

You will receive no payment for taking part in this study. There will be expenses available for travelling to any discussion group at the end of the study.

Will my participation in the study be kept confidential?

Yes. If you consent to taking part in this study, your medical records will only be accessible to study clinical or research staff involved in the research. Non-clinical research staff will have access only to anonymised information from medical records. The data will be stored in a computer for research purposes and won't be in any way directly linked or identify you.

As part of European law it may be necessary for details of your treatment to be disclosed to an official body. Even so, confidentiality will be maintained and your identity will not be disclosed. The results of the meeting may be used in presentations or be published in scientific reports. Any presentation report based about the study will not name or otherwise identify you. The focus group discussion will be tape-recorded and listened to by the research team at the UEA. Any data that can identify you will **not** be published and no-one outside the research team will be able to access any information you give us.

Where can I get more information?

If you have any concerns about any aspect of this research then please contact either Amanda Bale, Senior Research Assistant, Cambridge University Hospitals NHS Foundation Trust on 01223 217980 or email: amanda.bale@addenbrookes.nhs.net OR Brit Cadman, Consultant Pharmacist, Cambridge University Hospitals NHS Foundation Trust on 01223 217980 or email: brit.cadman@addenbrookes.nhs.ne

Appendix 11 Medicine Reconciliation at the health interface patient informed consent form

Cambridge University Hospitals
Foundation Trust

Hills Road
Cambridge
CB2 0QQ
Phone: 01223 245151

School of Pharmacy

University of East Anglia

Norwich

NR4 7TJ

Patient Consent Form

Medicines reconciliation at the interface: A pilot randomised controlled trial to determine the costs and effects of a pharmacy provided service

Please initial each box and sign at the bottom if you agree to participate

1.	I confirm that I have read and understand the Patient Information Sheet (version 2, date 1 may 2012), for the above study. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily.	☐
2.	I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason.	☐
3.	I agree to take part in the above study	☐
4.	I have been informed that the confidentiality of the information I will provide will be safeguarded.	☐
5.	I understand that I am free to ask any question at any time before and during the study, and I have the contact details of the researchers if I wish to discuss any aspect of the study	☐
6.	I understand that relevant sections of my data collected during the study may be looked at by individual from regulatory authorities where it is relevant to my participation in this research. I give permission for these individuals to have access to my records.	☐
7.	I understand that a letter will be sent to my GP to inform them of my participation in the study.	☐
8.	I understand that I will be asked to complete a quality of life questionnaire upon admission to hospital. A questionnaire and survey will be posted 3 months after discharge. This will be followed up with a telephone call	☐
9.	I have been provided with a copy of this form and the participant information sheet.	☐

Participant number: _____

Name: Signature Date

Please tick the box if you would like to receive details of the results of the study ☐

Appendix 12 Medicine Reconciliation at the health interface consultee information leaflet

Medicines reconciliation at the interface:

A pilot randomised controlled trial to determine the costs and effects of a pharmacy provided service

Consultee Information Leaflet

Cambridge University Hospitals NHS Foundation Trust

NHS National Institute for Health Research

UEA University of East Anglia

Invitation:

We feel that your relative/friend is unable to decide for him/herself whether to participate in this research project so we'd like to ask your opinion as to whether or not they would want to be involved. You will be acting as a Personal Consultee under the Mental Capacity Act 2005. It is important for you to understand why the study is being done and what it will involve. Please take your time to read the following information carefully before making up your mind. Please ask about anything that is not clear or if you would like more information.

Personal Consultees under the Mental Capacity Act 2005

You are being asked to consider whether your friend or relative would be content to take part or whether doing so might upset them. You are being asked to give your opinion on what the past and present feelings and wishes of your relative or friend may be about taking part in the study. You are asked to consider the risks, benefits and practicalities of what taking part will mean for him/her.

You are not being asked for your personal views on participation in the project, or on research in general. You must set aside any views that you may have about the research and consider only the views and interests of your friend or relative.

At any stage you can advise the researcher that your friend or relative would not want to remain in the project. Your advice will be respected by the researcher.

We are asking you because you are interested in your friend/relative's welfare.

If you feel unable to give this advice then please tell the Research Assistant or a member of the care team.

You may want to seek further advice regarding this role. More information can be gained by contacting your GP. You could also discuss the role with an Independent Mental Capacity Advocate- one can be contacted through the Patient Advice and Liaison Service on 01223 216 756.You could also contact Voice ability on 01223 555800 or the Department of Health Public Guardian on 0845 330 2900.

What is the purpose of the study?

The purpose of the study is to carry out a small project to see whether it is a good use of NHS money for a Pharmacist to check patients' medicines history when they come into hospital. All patients are seen by a Doctor and their medicines are prescribed. We are trying to find out whether it is a good idea that all medicines are also checked by a Pharmacist. The results of the study will be used to inform the best design of a larger study to look at the cost and effect of an extended pharmacy service.

Why has my relative/friend been chosen?

Your relative/friend has been chosen because he/she has been admitted to the ward within the previous 24 hrs under the care of a medical team at Addenbrooke's hospital. He/she has not yet had their medicines history looked at by a pharmacist.

Does my relative/friend have to take part?

No. If however you do decide that he/she would take part you will be given this information sheet to keep and will be asked to sign a consultee declaration form to confirm that you understand what is involved in the study and to say that you think that your relative/friend would want to take part in the study. If you later change your mind during the study, you are free to withdraw your relative/friend at anytime without giving a reason. This will not in any way affect the care or services you or your relative/friend subsequently receive from Addenbrooke's hospital staff.

How many patients will be in the study?

This is a relatively small pilot study involving 200 patients. One hundred patients will receive usual care and one hundred will have their medicine history taken by a pharmacist in addition to that taken by a doctor.

Which group will my relative/friend be in?

All patients who take part will be randomly allocated (like flipping a coin) to receive the pharmacist service or usual care. By agreeing to their taking part in the study they have a 50/50 chance of receiving the extra pharmacist service

For all patients in both groups

- Their own medicines will be checked and the boxes copied
- Their prescription charts while they are in hospital will be copied
- Their GP will be contacted to obtain details of their medicines
- Relevant data will be collected from their hospital records
- Their hospital record and discharge letter will be reviewed 3 months after discharge
- You will be asked to complete a health-related quality of life questionnaire which consists of five questions following your agreeing to your relative/friend being involved in the study. This questionnaire has been approved for use by patients' relatives or friends
- The same health-related quality of life questionnaire as previously will be sent to you three months after discharge from hospital. We will also send a questionnaire asking about your relative/friend's use of any health or social care services since discharge. This will be followed up with a phone call

If your relative/friend receives the pharmacy service

- Any differences between medicines taken before admission and those currently being taken will be discussed with his/her GP and/or the Doctor on the ward

Will my relative/friend's GP be informed that they are taking part?

Yes, their GP will be informed that they are part of a study.

What are the risks involved/disadvantages in being involved in the study?

We do not anticipate any risks or disadvantages to being involved in this study.

What are the benefits?

Taking part in this study may not be of direct benefit to your relative/friend. The information we gain from this study may improve the future management of medicines in the NHS. It will also help to inform the running of a large scale trial. The results may be published in scientific journals or presented at meetings. A summary of the study results will be sent to you or your relative/friend if you wish after the research has been completed.

After 3 months, we will check your relative/friend's discharge letter with our records to see if errors occurred at the time of discharge. If we find any, we will contact their GP to make sure that they are receiving the correct medications

What if something goes wrong ?

In the very unlikely event of any harm occurring by taking part in this research study there are no special compensation arrangements. If your relative or friend is harmed as a result of someone's negligence then you or they may have grounds for legal action but you or they may have to pay for it. Regardless of this, if you wish to make a complaint or have any concerns about any aspect of the way in which you or they have been approached or treated during the course of this study, the normal National Health Service complaints mechanisms are available to you. You can contact the local Patient Advice Liaison Service at: pals@addenbrookes.nhs.uk or Tel: 01223 216 756.

Has the study been approved?

This study has been developed by a team from Cambridge University Hospitals and University of East Anglia. This study has been approved by Essex Ethics Committee.

Who is paying for the study?

National Institute for Health Research: Research for Patient Benefit Programme.

Are there any payments to subjects?

Neither you nor your relative/friend will receive payment for being part of this study. There will be expenses available for travelling to any discussion group at the end of the study.

Will my relative/friend's participation in the study be kept confidential?

Yes. Their medical records will only be accessible to study clinical or research staff involved in the research. Non-clinical research staff will have access only to anonymised information from medical records. The data will be stored in a computer for research purposes and won't be in any way directly linked to or identify you or your relative/friend.

As part of European law it may be necessary for details of your relative/friend's treatment to be disclosed to an official body. Even so, confidentiality will be maintained and their

identity will not be disclosed. The results of the meeting may be used in presentations or be published in scientific reports. Any presentation report based about the study will not name or otherwise identify them. The focus group discussion will be tape-recorded and listened to by the research team at the UEA. Any data that can identify them will **not** be published and no-one outside the research team will be able to access any information you or they give us.

Where can I get more information?

If you have any concerns about any aspect of this research then please contact either Amanda Bale, Senior Research Assistant, Cambridge University Hospitals NHS Foundation Trust on 01223 217980 or email: amanda.bale@addenbrookes.nhs.net OR Brit Cadman, Consultant Pharmacist, Cambridge University Hospitals NHS Foundation Trust on 01223 217980 or email: brit.cadman@addenbrookes.nhs.net

Appendix 13 Medicine Reconciliation at the health interface consultee declaration form

Cambridge University Hospitals
Foundation NHS Trust

Hills Road
Cambridge
CB2 0QQ
Phone: 01223256256

School of Pharmacy

University of East Anglia

Norwich

NR4 7TJ

Consultee Declaration Form

Version 2, 1 may 2012

Title of the project:
Medicines reconciliation at the interface: A pilot randomised controlled trial to determine the costs and effects of a pharmacy provided service

Please initial each box and sign at the bottom if you agree

1. I, ……....., have been consulted about ……..’s participation in this research project. I have had the opportunity to ask questions about the study and understand what is involved. ☐ ☐
2. In my opinion he/she would wish to take part in the above study
3. I understand that I can request that he/she is withdrawn from the study at any time, without giving any reason and without his/her care or legal rights being affected. ☐
4. I understand that relevant sections of his/her care record and data collected during the study may be looked at by responsible individuals from Cambridge University Hospitals NHS Foundation Trust or from regulatory authorities, where it is relevant to their taking part in this research. I give permission for these individuals to have access to his/her records ☐ ☐
5. I understand that I am free to ask any question at any time before and during the study, and I have the contact details of the researchers if I wish to discuss any aspect of the study ☐
6. I agree to their GP being sent a letter informing them of participation in the study ☐
7. I agree that, if he/she becomes able to consent then consent will be sought
8. I have been provided with a copy of this form and the “Consultee information sheet” (version 2, dated 1 may 2012.) I have read and understood this information sheet ☐

Name of Consultee

Signature Date: Relationship to participant

Please tick the box if you would like to receive details of the results of the study ☐

Appendix 14 Medicine Reconciliation at the health interface pharmacist time recording form

Subject number: _____

Name of pharmacist

RECORDING DURATION OF INTERVENTION ACTIVITY			
Job title	**Actions**	**Time spent on activity (minutes)**	**Comments**
Pharmacist	**Admission**		
	Checking of patients own medication (POD)		
	Collection of data on medication history from source(s) other than PODs (record source in comment section)		
	Discrepancies identification		
Job title	**Actions**	**Time spent on activity (minutes)**	**Comments**
	Documentation of discrepancies		
	Establishing unintentional discrepancies with medical staff		
	Rectifying unintentional discrepancies with medical staff		
	Establishing allergies/sensitivities		
	Discharge		
	Discrepancies identification		
	Documentation of discrepancies (amendment of discharge letter, new copy printed)		
	Establishing unintentional discrepancies with medical staff		
	Rectifying unintentional discrepancies with medical staff		
	Intentional discrepancies clarified and recorded on EDS following discussion with medical staff		
	Recording of any changes as a result of discussion with medical staff		

Medical doctor	**Admission**		
	Rectifying unintentional discrepancies as a result of the intervention pharmacist query		
	Intentional discrepancies clarified as a result of the intervention pharmacist query		
	Discharge		
	Discrepancies on discharge clarified and amended as appropriate as a result of intervention pharmacist query		
	Confirming/clarifying allergies/sensitivities information		
Administrator	Discrepancies identification		
Job title	**Actions**	**Time spent on activity (minutes)**	**Comments**
	Documentation of discrepancies		
	Establishing unintentional discrepancies with medical staff		
	Rectifying unintentional discrepancies with medical staff		
	Intentional discrepancies clarified and recorded on EDS		
	Clarification of discrepancies identified on discharge with medical staff		
	Recording of any changes as a result of discussion with medical staff		

Appendix 15 Medicine reconciliation at the health interface control MR form

Patient addressograph:

Date patient admitted:……

Time patient admitted:……

Time when MR delivered following patient admission:

Please tick

<24 hours	<48 hours	<72 hours	>72hours

Time taken to deliver MR

Please tick

10 minutes	<30 minutes	>30 minutes	>60 minutes

Comments:

Completed by:

……Pharmacist

Appendix 16 Medicine reconciliation at the health interface three month health related quality of life and health resource use questionnaire

Medicines reconciliation at the interface: A pilot randomised controlled trial to determine the costs and effects of a pharmacy provided service

Three months follow up questionnaire

For Patient and Consultee

Guidance on completing this questionnaire

- This questionnaire is designed to take 20 minutes to compete
- This questionnaire consists of three sections
- Please complete all sections in the questionnaire to the best of your knowledge
- Once completed please return questionnaire in the stamped

Cambridge University Hospitals NHS Foundation Trust

NHS National Institute for Health Research

UEA University of East Anglia

Section 1: Health Related Quality of Life

The following questions ask about your health status today, please indicate which statements best describe your own health state today.

1 Mobility

I have no problems in walking about ❑
I have some problems in walking about ❑
I am confined to bed ❑

2 Self-Care

I have no problems with self-care ❑
I have some problems washing or dressing myself ❑
I am unable to wash or dress myself ❑

3 Usual Activities (*e.g. work, study, housework, family or leisure activities)*

I have no problems with performing my usual activities ❑
I have some problems with performing my usual activities ❑
I am unable to perform my usual activities ❑

4 Pain/Discomfort

I have no pain or discomfort ❑
I have moderate pain or discomfort ❑
I have extreme pain or discomfort ❑

5 Anxiety/Depression

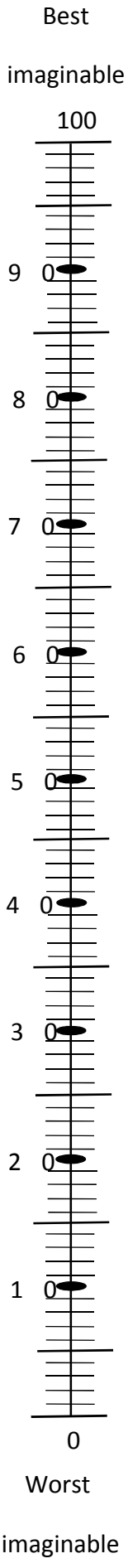
I am not anxious or depressed ❑
I am moderately anxious or depressed ❑
I am extremely anxious or depressed ❑

- To help you say how good or bad your health state is, we have drawn a scale (rather like a thermometer) on which the best state you can imagine is marked 100 and the worst state you can imagine is marked 0.

- We would like you to indicate on this scale how good or bad your own health is today, in your opinion

Please do this by drawing a line from the box below to whichever point on the scale indicates how good or bad your health state is today.

Your own health state today



Section 2A Health care service use: Community

The following questions ask about health care services you may have used in the community.

6.During the last 3 months have you seen, or been visited by, a health or social care worker?

Yes ☐ No ☐

If Yes, please complete the table below. If No, please go to question 7.

	Number of visits in the previous 3 months	Place of most visits (1= GP clinic; 2 = Home; 3 = telephone consultation)
E.g. GP	*6*	*1*
GP (General practitioner)		
Practice nurse		
District nurse		
Care assistant		
Dietician		
Physiotherapist		
Occupational therapist		
Social worker		
Speech and language therapist		

Section 2B Health care service use: Hospital services

The following questions ask about health care services you may have used from hospital services.

7.How many times have you been admitted to the hospital in the last 3 months? [If none, please put '00' in the boxes and go please to question 8] ☐☐

If you have been admitted to hospital, please complete the following for each inpatient stay.

Admission number	Ward admitted to	Length of stay in hospital
1	*e.g. respiratory ward*	*4 days*
2		
3.		
4.		

8.How many times have you visited the Accident and Emergency department ('Casualty') in the last 3 months? [If 'none, please put '00' in the boxes and go please to question 9]

9.How many times have you visited an NHS 'walk-in' centre in the last 3 months? [If none please put '00' in the boxes and go please to question 10]

10.How many times have you had an appointment in an outpatient clinic in the last 3 months? [If none, please put '00' in the boxes and go to question 11]

If you have been to an appointment, please complete the following for each outpatient appointment.

Number	Hospital department visited	if you had to have an investigation e.g. x-ray, ct scan, blood test etc please state these as well
1	*e.g. respiratory clinic*	*Chest X-ray*
2		
3		
4		

Section 3 Social care service

The following questions ask about services you may have used from social care services.

11.How many times have you been admitted to a residential home in the last 3 months? [if none, please put '00' in the boxes and go please to question 12] ☐☐

12.How many times have you been admitted to a nursing home in the last 3 months? [If none, please put '00' in the boxes and go please to question 13] ☐☐

On average, how long was each stay? ☐☐ Days

13. How many times per week have you attended a day centre in the last 3 months? [If 'NO', put '00' in the boxes and go please to question 14] ☐☐

14.How many times per week have you had a home help or community care assistant in the last 3 months? [If not at all, answer '00' in the boxes and go please to 15] ☐☐

How long do they stay? ☐☐ mins

(minutes approx., average time per visit, last week)

15.In the past week, how many times has anyone who lives with you had to help you with everyday activities (For example, housework, shopping, and taking you to appointments)? [If none, please put '00' in the boxes and go please to 16]

For how long?) ☐☐ mins ☐☐

(minutes approx., on average, last week)

Did they have to take time off work to help you? Yes ☐ No ☐ N/A ☐

16.In the past week, how many times has a friend or relative who does not live with you had to come and help you with everyday activities (For example, personal care tasks, housework, shopping and taking you to appointments)? [If none, please put '00' in the boxes and go please to question 18]

For how long? mins

(minutes approx., average time per visit, last week)

Did they have to take time off work to help you? Yes ☐ No ☐ N/A ☐

17.Has a relative or friend had to give up work completely to look after you in the last 3 months?

Yes ☐ No ☐

18.How many meals on wheels have you had in the past week? [If none, please put '00' in the boxes and please go to 20]

If you had to pay for these yourself, how much did they cost you? £_____

19.Have you incurred any out of pocket expenses (those you have had to pay for yourself) as a result of your health in the last 3 months? This could include travel or parking costs to attend health care visits, over the counter medications, equipment etc) Yes ☐

No ☐

If yes, please specify the item and cost incurred by you in purchasing it

Item	Estimate of the cost incurred by you (£)
E.g. Bus ticket	*£4.20*

Thank you for completing the questionnaires. Please place the questionnaire booklet in the envelope and post back to the research team

Appendix 17 Summary of auditors' comments on the discharge information audit

Examples of auditors' commonts on the process and handling the discharge information tool

Question	Auditor	Comment
It would be valuable if you could share with us your thoughts on the audit. Clarity of aims (what do you think it was designed to achieve?	Ph1	The audit was detailed enough to pick the quality of hospital information.
	Ph2	Where students did the audit practice staff have not been informed well with regard the audit
Audit importance to the current practice (how it may affect your practice?)	PT1	Surgeries will benefit when report disseminated
Please comment on the ease of audit tool completion and handling Excel sheet format (Check boxes) vs. paper form	PT2	Was bit tricky as formulation check boxes were out of the page screen scale. However, it is nice not to have pile of paper.
	GP1	Switching between screens was hard (practices print out discharge summaries)
Exchange, transfer, return	Ph2	Small practice needed small folders had no trouble but larger folders needed to learn how to use zip software
Order and nature of questions	Ph2	Make sense with the way discharge summary was written
If any, additional questions (missed or were not adequately addressed	PT1	Time when discharge summary was sent from hospital (how long it took for hospital staff to process)
	PT2	If patient was readmitted to hospital would have been of interest. Time frame to audit was not stipulated (how long following discharge to audit discharge summary
	Ph2	If they were clinically checked by pharmacist before being sent to practices
Roughly, how long did it take you to complete each audit?	GP,PT,PH	10-45 minutes
Which parts needed the most time and effort o Number of medications, o Hospital stay o Specialty o Other factors	GP 1	Medications list, it was hard to know which to list
	GP2	No. of medication , style of DS , number of medication changes, surgical and orthopaedic were simpler and more straight forward compared to medical wards
	PT1	Cardiology and orthopaedic wards needed longer time, they weren't clear

Examples of auditors' commonts on the process and handling the discharge information tool

Question	Auditor	Comment
Specifically, can you describe your answers with regard the following felids: o Type of admission, where it was not specified but can be known by the clinical context	GP1	For unspecified speciality or type of admission commented on the commentary box
	PT1	I worked out speciality and type of admission from the clinical history in discharge summary and recorded this what I was able
o Ward specialty (ward number or name) o Medicines whether listed as per discharge summary or GP record	GP, Ph, PT	Medicines as listed in discharge summary
There were 3 questions following the medications part about drugs changed, started and stopped; would you please describe any uncertainty you may have in answering them? o All changes stated and all reasons o Answer where no medicine changed, initiated or discontinued	GP1	Not sure/ remember, No, will be the answer if some changes are not stated
	Ph2	Yes,only if all changes (start or stop) were stated
	PT2	If hospital stated 'no regular changes to medication' she picked no. Same response if no actual changes was done and hospital stated no thing
	GP2	Yes, checked discharge list with our record
o Identifying drug changes , initiation or discontinuation (comparing against GP held record)	Ph2	Cross refreshing with GP record and was time consuming
The audit tool contains many free text fields that required you to type in details such as PMH, presenting diagnosis, etc. Could you tell please how you responded to them?	PT, GP, Ph	Missing ones were listed
o Missing PMH , pre admission medication	PT2	Summary of main results not too much detailed
o Procedures and tests	PT1	Cut and paste was possible all details were included but if not she typed in that results were in DS

Examples of auditors' commonts on the process and handling the discharge information tool

Question	Auditor	Comment
Legibility of handwritten DSs was scored using a 4 point scale (illegible 1 to 4 legible)	PT1	It was fine, majority of discharge summary were electronic
o Do you recollect any uncertainty in determining the legibility?	GP2	All were handwritten (legality was not poor as usual)
o Were the distinction between 4 &3 or 2 &3 clear to you?	GP2	It was clear to distinguish between , the hard bit was related to DS themselves not to the scoring points
Do you have any other thoughts or comments that you would like to add related to the audit?	Ph1	Differences between practices as different person completed (some had help and some had not), the result will be interesting to know

GP: General practitioner, Ph: Primary care pharmacist. PT: Pharmacy technician

Appendix 18 Pharmacy led medicine reconciliation systematic review description of risk of bias assessment

Karapinar-Carkit et al. 2012

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	High risk	This a uncontrolled study from one department (i.e. Pulmonology)
Selection bias	External and internal variations of study sample	High risk	**Sampling method** No details on how patients were identified and screened for study legibility. Quote “In brief, all adults discharged with at least one prescribed drug from the Department of pulmonology were included” For labour related cost the data used were for 59/262 patient, there was no sufficient details on the rational and the selection of such subset sample. Quote “The pharmaceutical consultants recorded the time needed for reconciliation of the drugs of 59 patients by using a stopwatch”
	Randomisation	High risk	No randomisation
	Allocation concealment	High risk	No Allocation
Performance bias	Standardised intervention delivery	Unclear	No sufficient details to establish whether delivery of MR intervention was standardised between the team of the study pharmaceutical consultants. Quote “In this study the medication reconciliation process was carried out by a team of pharmaceutical consultants who were trained in medication reconciliation before this study was conducted”
	Standardised outcome measurement	Unclear	No sufficient details to establish whether identification and classification of intervention was standardised. Quote “After medication reconciliation, the pharmaceutical consultant registered every change made by the hospital physician to the pharmacotherapy at hospital admission and discharge and after patient counselling. The classification of interventions was based on the first 2 steps in medication reconciliation that could influence medication costs”
Detection bias	Blinding of outcome measurement	High risk	Uncontrolled study and potentially there was no blinding for the study pharmaceutical consultants, recording and classification of the intervention which is the main contribute for the main outcome (i.e. medication related cost) was done by the study pharmaceutical consultants. Quote:” After medication reconciliation, the pharmaceutical consultant registered every change made by the hospital physician to the pharmacotherapy at hospital admission and discharge and after patient counselling. The classification of interventions was based on the first 2 steps in medication reconciliation that could influence medication costs”

Karapinar-Carkit et al. 2012 (continued)

Domain	Bias	Author judgement	Support of judgement
Selective reporting	Incomplete outcome data	High risk	Outcome data for labour costs were based on 59/262 patients as such not all study participants accounting for study conclusions. Quote: "The pharmaceutical consultants recorded the time needed for reconciliation of the drugs of 59 patients by using a stopwatch" Thought it was not considered of real cost, errors relating to preventions of medication discrepancies between pre-admission and inpatient medications was not described in sufficient details. Quote:" Eliminating discrepancies is an important aspect of medication reconciliation but does not represent real costs for society. Therefore, these interventions were not included in the cost calculation. ..... Estimates of costs per adverse drug event range from €900 to €1800. For our study this would mean an additional cost savings of €18,000-€36,000 (€69-137/patient), as we eliminated 409 discrepancies, of which 20 would theoretically cause an adverse drug event"
Adequacy of study power & analysis	Powered and appropriate statistical analysis	Unclear	There is no sufficient information to establish whether the study was sufficiently powered.
Validity of economic evaluation	Perspective	High risk	Very limited perspective though it was clearly established. Quote "The medication-related costs were analysed from a health insurer's perspective. In the Netherlands, the health insurer pays for most medications except over-the-counter drugs and herbal products. The payments made to dispensing community pharmacies by health insurers are based on the cost of the medication dispensed plus a fixed dispensing fee of €6.10 to cover the routine pharmaceutical services"
	Cost identification, measurement and valuation	Unclear-high risk	Labour costs were estimated based on a selected sample of the study patients without enough information regarding patient selection or characteristics. Thus, the quality of the cost measurement is unknown. Quote "To estimate the costs, the mean yearly salary of a pharmaceutical consultant (€50,000) was used. When assuming 46 annual working weeks and an efficiency rate of 70%, the 1-hour salary was€ 39.25. The efficiency rate of 70% was based on time not directly related to specific medication reconciliation activities, such as courses, meetings, and instructions to new hospital physicians". Valuation process was considered of law risk

Karapinar-Carkit et al. 2012 (continued)

Domain	Bias	Author judgement	Support of judgement
Validity of economic evaluation cont.	Variability within the estimate	Low risk	Adequate sensitivity analysis was described. Quote "We performed a sensitivity analysis to examine best and worst-case scenarios. To investigate the robustness of the assumptions regarding the medication costs, we varied the factors on reducing the medication costs with 50%. Thus, for the sensitivity analysis, 10% and 30% reduction on medication costs was applied for hospital formulary–induced interventions (initial reduction was 20% based on previous studies"

Perennes et al. 2012

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	High risk	Uncontrolled study in a general medicine ward on army hospital
Selection bias	External and internal variations of study sample	Unclear	No details on how patients were identified and screened for study legibility. Quote "patients of 65 years old or more hospitalised in the ward were included in the study."
	Randomisation	High risk	No randomisation
	Allocation concealment	High risk	No Allocation concealment
Performance bias	Standardised intervention delivery	Low risk	The study described a standardised method for interviewing patient during admission and discharge reconciliation. Quote: "the meeting with patient was done in a standardised manner with a succession of open and closed questions alternatively"
	Standardised outcome measurement	Low risk	There is no sufficient details to establish whether identification of discrepancies was standardised however it was done by single reviewer. Additionally, unintentional discrepancies were confirmed at least by a minimum of two information sources

Karapinar-Carkit et al. 2012 (continued)

Detection bias	Blinding of outcome measurement	Unclear	As uncontrolled design, potentially there was no blinding while the evaluation of the potential clinical impact of discrepancies. This was done by with two assessors; a doctor and a pharmacist. There is no details whether the assessors where independent of the study neither a measure for the extent of agreements between raters.
Selective reporting	Incomplete outcome data	Low risk	There are no concerns with regard any incomplete outcome data
Adequacy of study power & analysis	Powered and appropriate statistical analysis	High risk	No details whether sample size or power calculation was performed by the study investigators. There are potential high risk for bias with relatively small sample size (n=61) No concerns related to the statistical analysis used

Boso-Ribelleset al. 2011

Domain	**Bias**	**Author judgement**	**Support of judgement**
Design bias	Focus study question & design	High risk	This is a prospective and not a real controlled study design carried out in cardiology and cardiovascular surgery department.
Selection bias	External and internal variations of study sample	High risk	**Sampling method** Patient were identified and screened for study by means that potentially contribute to high risk of bias. There is no details to establish whether the sample obtained by these means is a proper representation of the population Quote:" Patients were identified by means of an electronic prescription program and selected by date of admission, clinical service and more than four drugs listed in the first hospital prescription" **Baseline comparability** Comparator was a sample of patients not included in the study. there is no enough details to establish whether this comparison is valid Quote:" Patients with respect comparing the number of emergency visits and hospitalisations over the first trimester of 2007 which were experienced by the patients included in the programme against those experienced by

Boso-Ribelles et al. 2011

Domain	Bias	Author judgement	Support of judgement
Selection bias cont.	External and internal variations of study sample	High risk	Patients excluded from the programme due to a lack of resources. Baseline comparability Quote:" Two hundred and sixty-four patients were admitted to the cardiology department in the first trimester of 2007; 151 of them were included in the pharmaceutical care programme (average age 67.7 ± 14.5 years) versus 113 patients (average age 69.1 ± 13.9 years) who were excluded"
	Randomisation	High risk	No randomisation Quote:" Patients were identified by means of an electronic prescription program and selected by date of admission, clinical service and more than four drugs listed in the first hospital prescription"
	Allocation concealment	High risk	No allocation concealment
Performance bias	Standardised intervention delivery	Unclear	There is no enough details to establish whether the delivery of MR was standardised
	Standardised outcome measurement	Unclear	There is no enough details to establish whether the identification of discrepancies was standardised Quote: "Discrepancies were evaluated as 'justified' or 'not justified'. Discrepancies which were not justified were discussed with the prescribing physician or nurse" Quote:" A global analysis and validation of the prescribed treatment was carried out and the discharge medication list was compared with the last hospital prescription" There is no details on the means of obtaining outcome data related to emergency department visits and hospitalisation
Detection bias	Blinding of outcome measurement	Unclear	There are no details on the means of obtaining outcome data related to emergency department visits and hospitalisation. Blinding of such measures were agreed not to influence reported outcomes (methods, 3.2.9) DRP and medication errors classification and pharmaceutical interventions were done by the study pharmacist and consulted with physicians, nurse and patients who are not part of the study personal. This could potentially preclude bias but there are no enough details confirming whether this was the case or not.

Boso-Ribelles et al. 2011

Domain	Bias	Author judgement	Support of judgement
Selective reporting	Incomplete outcome data	Low risk	There are no concerns with regard any incomplete outcome data
Adequacy of study power & analysis	Powered and appropriate statistical analysis	Unclear	No details whether sample size or power calculation was performed by the study investigators. The study was of large sample size (n=675). There are no sufficient details however to establish whether study was powered to detect differences related to readmissions and emergency department visits. There was no statistical testing of significance reported for these outcomes Quote "Two hundred and sixty-four patients were admitted to the cardiology department in the first trimester of 2007; 151 of them were included in the pharmaceutical care programme (average age 67.7 ± 14.5 years) versus 113 patients (average age 69.1 ± 13.9 years) who were excluded"

Hellstrom et al. 2011

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	High risk	This is "before and after" study design. The authors reported a controlled prospective deign with patient receiving the study intervention upon admission. However, patient was identified for study participation by retrospective review Quote "All patients in wards A, B and C received the intervention after it had been implemented, but the patients evaluated retrospectively for eligibility for inclusion"
Selection bias	External and internal variations of study sample	High risk	**Sampling method** No enough details to establish whether the sample is representative of the patients received the service or admitted to study wards. Variations can be contributed by sampling at different time periods from each of the study wards, i.e. March 2007 to April 2008.

Hellstrom et al. 2011

Domain	Bias	Author judgement	Support of judgement
Selection bias cont.	Randomisation	High risk	No randomisation
	Allocation concealment	High risk	No allocation concealment
Performance bias	Standardised intervention delivery	Low risk	The investigators described a standardised delivery of intervention using questionnaire which was previously published Quote:" The admission medication reconciliation was performed on weekdays, shortly after the patient had been admitted, using the LIMM Medication Interview Questionnaire parts 1-3".
	Standardised outcome measurement	Low risk	The investigators described a standardised collection of outcome data related to drug related hospital visits Quote:" In the reviewing process, we combined clinical judgment with the use of predetermined triggers, namely combinations of drugs and symptoms or certain 'high-alert' medications.... The cases were further classified by using the World Health Organisation criteria for causality"
Detection bias	Blinding of outcome measurement	Low risk	The reviewers were blind to study allocation Quote: "All reviewers in the initial and final reviews were blinded to group allocation"
Selective reporting	Incomplete outcome data	Low risk	There were no concern on missing data outcomes; intention to treat analysis was performed as well as pre protocol. Similar attrition rates were found between two groups Quote: "Fifteen patients in the intervention group did not receive the complete intervention due to a short length of stay in hospital, the absence of a clinical pharmacist during the weekends or closed wards due to an infection outbreak among the patients. In addition, 12 intervention patients (including 2 who did not receive the complete intervention) and nine control patients died during the initial hospital stay. Eighty-four intervention patients and 92 control patients were therefore included in the per protocol.
Adequacy of study power & analysis	Powered and appropriate statistical analysis	Low risk	Power of calculation was performed for the primary outcome (MAI) using ITT as the MAI analysis as well as per protocol analysis No concerns on analysis related to drug related hospital visits

MAI: Medication Appropriateness Index. ITT: Intentional to treat

Makowsky et al. 2009

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	Unclear	It is a multi-centre randomised and controlled study. Randomisation is on the level the care team rather than patient level Quote:" a 2 site "on-off" study design for 4 sites (ie, 4 teams). This design was chosen to allow for the presence of a comparable control group. Two pharmacists were recruited and each was assigned to rotate between a CTU team and PHCT team. For 3 months at a time in sequential order patients admitted to the CTU team received team care ("On" period) while patients on the corresponding PHCT team received usual care ("Off" period). At the end of each 3 month block, the status was reversed, and the patients admitted to the PHCT team received team care while patients admitted under the CTU team received usual care. Since the intervention was team-based care, the unit of randomization was at the level of the team rather than the patient"
Selection bias	External and internal variations of study sample	High risk	**Sampling method** Patients were allocated to either care teams per the usual hospital procedures and they were recruited in sequential order upon admission over 3 months period of time. Though allocation of care team was randomised, patients were not and this might contributes to selection bias. **Baseline comparability** Quote "Baseline demographic and clinical characteristics were similar in the 2 groups, however, there were more internal medicine patients and fewer patients admitted with a most responsible or primary diagnosis of HF in the usual care group"
	Randomisation	High risk	Randomisation was on the level of care team rather than patients Quote" The unit of randomization was at the level of the team rather than the patient and the participating teams were randomized as to which would receive pharmacist team care first by flip of a coin.

CTU: Clinical teaching unit. PHCT: Family medicine primary care team

Makowsky et al. 2009

Domain	Bias	Author judgement	Support of judgement
Selection bias cont.	Randomisation	High risk	The unit of randomization was at the level of the team rather than the patient and the participating teams were randomized as to which would receive pharmacist team care first by flip of a coin. However, no randomisation on patient level
	Allocation concealment	High risk	Allocation was not concealed to on or of study period Quote "Allocation of patients to specific patient care teams occurred as per usual hospital procedures"
Performance bias	Standardised intervention delivery	Low risk	Period to study commencing the pharmacists undertook educational sessions Quote "A series of education sessions led by local pharmacist experts (1 on each target disease state and 1 on documentation of clinical care activities), was conducted with the team-based pharmacists prior to commencing the study"
	Standardised outcome measurement	Low risk	A standardised process was described for secondary outcomes related to readmission data outcome and pharmacist intervention were collected Quote "3-month and 6-month all-cause hospital readmission was determined prospectively via linkage with the Capital Health regional admissions database. The number, type, acceptance rate, and expected clinical impact of pharmacist recommendations for the 2 team-based pharmacists was reported. This descriptive data were captured prospectively using the Regional Pharmacy Services Benchmarking form"

Makowsky et al. 2009

Domain	Bias	Author judgement	Support of judgement
Detection bias	Blinding of outcome measurement	Low risk	Blinded reviewer was reported for primary outcomes related to quality of care indicators. No details on who recorded the data related to readmission and emergency department neither whether if it was by blind reviewers. However, unbinding unlikely to influence the report of readmission or emergency department visits.
Selective reporting	Incomplete outcome data	Low risk	There are no concerns about missing data outcomes
Adequacy of study power & analysis	Powered and appropriate statistical analysis	Low risk	The investigators perform sample size calculation; a sample size of 650 patients was aimed however this number was not achieved (=452) due to funding. The findings were found statistically significant though which indicates a true difference between groups. There are no concerns about the appropriateness of statistical testing, OR analysis was used adjusting to confounding factors.

Koehler et al. 2009

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	Low risk	A randomised controlled study
Selection bias	External and internal variations of study sample	High risk	**Sampling method** Patient were screened daily to establish eligibility of study, which was done by study personal Quote " Study personnel performed daily chart review to establish eligibility criteria” **Baseline comparability** Groups were comparable in general. However, the intervention group trended toward higher severity of illness and mortality and more patient prescribed medications commonly implicated in adverse events (65% vs. 45%). The later was not significant. These variation might influence readmissions/ED

Koehler et al. 2009

Domain	Bias	Author judgement	Support of judgement
Selection bias cont.	External and internal variations of study sample	High risk	Quote "...on APR-DRG measures relating to acuity of illness and mortality risk, patients in the intervention group trended toward higher severity. Likewise, although it was not a statistically significant difference, 13 of 20 patients in the intervention group were taking medications from >2 drug classes commonly implicated in adverse drug events (warfarin, insulin, diuretics, sedating agents) as part of their discharge medication regimen compared to 10 of 21 patients in the control group"
	Randomisation	Low risk	No concerns about the random component described by investigators Quote "patients were randomized to intervention or usual care arms in permuted blocks of 8 via a random number generator and sealed opaque envelopes"
	Allocation concealment	Low risk	No concerns about the allocation concealment component described by investigators
Performance bias	Standardised intervention delivery	Low risk	The process described for the study intervention was standardised between the service providers. Quote "training for both study CCs and CPs was limited to a series of 3 meetings (each 45 minutes in duration) regarding the intent and delivery of the supplemental care bundle, including use of study forms"
	Standardised outcome measurement	Low risk	There are no concerns on the process by which data outcomes related to readmissions or emergency department visits obtained. Quote "Data on length of hospital stay, illness severity (APR-DRGs), and unplanned hospital readmission or emergency department visitation at 30 and 60 days post discharge were collected via Boston University Medical Centre electronic reporting systems"
Detection bias	Blinding of outcome measurement	Low risk	Unbinding likely not to influence recording outcome data related to readmission or emergency department visit

CC: Care coordinator. CP; clinical pharmacist

Koehler et al. 2009

Domain	Bias	Author judgement	Support of judgement
Selective reporting	Incomplete outcome data	Low risk	No concerns about missing outcome data
Adequacy of study power & analysis	Powered and appropriate statistical analysis	High risk	It is a pilot study of small size; It is most likely not statistically powered. Insufficient power for statistical comparison was reported. the overall sample size is small (n=41) Quote “Resource and time constraints necessitated a sample size that would allow implementation of the intervention despite a limited number of study CCs and pharmacists. To accommodate these conditions while still generating pilot data, and priori decision was made to enrol up to 80 patients”

CC: Care coordinator

Rabi and Dahdal. 2007

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	High risk	This is uncontrolled observational study in cardiology consult service
Selection bias	External and internal variations of study sample	High risk	**Sampling method** All admitted patients provided the service using admission list each morning. However, pharmacist provided a cover of 10 days and there is no way to establish the variation between included and excluded patients Quote “Each morning the pharmacist would obtain the admission list for the unit and conduct the service on all patients admitted that day and the previous day..... At the end of the 4 weeks, the pharmacist provided a total of 10 days of coverage. Fifty-six medication admission histories were conducted from the 150 patients who were admitted during the 4 weeks (28 days)”
	Randomisation	High risk	No randomisation
	Allocation concealment	High risk	No allocation concealment

Rabi and Dahdal. 2007

Domain	Bias	Author judgement	Support of judgement
Performance bias	Standardised intervention delivery	Low risk	No details whether the process of intervention delivery was standardised. However, this was done by a single reviewer (i.e. college-based primary care pharmacist resident)
	Standardised outcome measurement	Unclear	No details to establish whether the process of intervention recording and classification
Detection bias	Blinding of outcome measurement	Unclear	No details on who did the intervention classification or any effort which probably done by the study pharmacist.
Selective reporting	Incomplete outcome data	High risk	Though 56 medication histories were conducted, there was only 40 discharge counselling sessions reported. There are no enough details to establish whether this might influence outcome or the time estimated for discharge counselling or whether the reported sessions are different to one that are not (n=16). Investigators reported no rational for the mission 16
Adequacy of study power & analysis	Powered and appropriate statistical analysis	High risk	No power of calculation. This also a with a small sample size study (n=56) comprising only 37.3% of patients admitted and 35.7% of days over the study period.

Bayley et al. 2007

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	High risk	Uncontrolled prospective design study
Selection bias	External and internal variations of study sample	High risk	Sampling method Quote "Potential study subjects were identified from the hospitalist admitting census list, and were assigned for evaluation and follow-up by a study pharmacist.... During the course of the study, 105 patients were eligible or treatment by the study pharmacist, ninety-nine (99) of these patients were seen "
	Randomisation	High risk	No randomisation
	Allocation concealment	High risk	No allocation concealment
Performance bias	Standardised intervention delivery	Unclear	The study pharmacist role was developed from two pilot projects. However, there are no details if the delivery was standardised. Quote "Their role was developed from two pilot projects and an FMEA (Failure Mode and Effects Analysis) on medication information transfer across care settings"

Bayley et al. 2007 (continued)

Bias	Author judgement	Support of judgement	
Performance bias cont.	Standardised outcome measurement	Low risk	Intervention classification followed a scheme previously published. Estimating the time needed by the study pharmacist was recorded using two methods. Quote “Interventions made by the pharmacist were classified using a scheme adapted from Hatoum et al (1988)” Quote “Time spent on TCP interventions was assessed mid-point in the study period using two methods. First, the TCP was queried to estimate the time spent on each of the above activities in a typical day. She reviewed her work over a 1-week time period and approximated the amount of time on each activity, providing a range, e.g. 30 to 45 minutes. Second, a trained observer shadowed the TCP for a day to understand these estimates and identify any time commitments the TCP had overlooked. Time estimates were revised at study close, to take into account feedback from these observations and also the increased efficiency with the maturation of the TCP program
Detection bias	Blinding of outcome measurement	High risk	The process of rating intervention was standardised using a sample of 20 patients. Nevertheless this is done by the study pharmacist Quote “Classification into the “prevented serious morbidity” versus “prevented potential ADE” was based on the pharmacist’s judgment as to both the severity of potential harm to the patient and the probability that a specific c medication would result in harm.
	Blinding of outcome measurement	High risk	The clinical pharmacist performed all of these ratings. The process was standardised "To verify the reasonableness of the ratings, ratings for the first 20 patients in the study were independently reviewed by the pharmacy manager and study author"
Selective reporting	Incomplete outcome data	Low risk	No concerns about missing data outcome
Adequacy of study power & analysis	Powered and appropriate statistical analysis	High risk	There is no power or sample size estimation reported. No statistical comparison was attempted and all descriptive estimate related to time were reported as average with no measure of variation (SD, CI)

TCP: Transitional care pharmacist. SD: standard deviation. CI: Confidence Interval. ADE: adverse drug events

Scullin et al. 2007

Domain	Bias	Author judgment	Support of judgment
Design bias	Focus study question & design	Low risk	Randomised controlled study
Selection bias	External and internal variations of study sample	Low risk	Patient selection was randomised and both groups appeared similar at baseline
	Randomisation	Low risk	No concerns about the randomisation component described Quote “Patients meeting the eligibility criteria were randomly assigned to the study group or normal care group, using block randomization coupled with a closed envelope technique. Randomization was carried out in blocks of 20 (each block contained 10 intervention and 10 normal care allocations).
	Allocation concealment	Low risk	Allocation concealment was done by closed envelop technique
Performance bias	Standardised intervention delivery	Low risk	Through all the study process the use of SOPs and customised data collection form was reported Quote “For each stage, standard operating procedures and customized data collection forms were used”
	Standardised outcome measurement	Low risk	Intervention grading was audited by a pharmacist independent of the study. The outcome data related to readmission obtained from the hospital system. Quote “The grading of all interventions was independently audited and reviewed by a non-project clinical pharmacist....12-month follow-up period, readmission data for the two groups were collected from the hospital computer system and included assessment of the time to a further hospital admission as well as the number of readmissions”
Detection bias	Blinding of outcome measurement	Low risk	Intervention grading was audited by a pharmacist independent of the study. Unbinding unlikely to influence outcome data related to readmission (methods 2.4.9)
Selective reporting	Incomplete outcome data	Low risk	No concerns about missing outcome data
Adequacy of study power & analysis	Powered and appropriate statistical analysis	Low risk	No power or sample size calculation reported however the pilot of the service indicate providing service for 50%. Though there is no enough details to estimate study power, sample size is large (n=762) and differences were found statistically significant indicating a potential real effect the study was able to detect

Bolas et al. 2003

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	Low risk	Randomised controlled design
Selection bias	External and internal variations of study sample	Low risk	Both study group were comparable Quote “Patients were matched in the study and control group for sex, age length of hospital stay, social circumstances, average number of drugs on admission, average number of drugs on discharge and the number of changes made to therapy during the hospital stay”
	Randomisation	Low risk	No concerns about the randomisation component reported by investigators Quote “patients were randomized into study or control group by allocation of a computer generated random number”
	Allocation concealment	Low risk	It was not possible to foresee the study allocation
Performance bias	Standardised intervention delivery	Low risk	Medication history and data collection was standardised. Quote “drug history data collection form was used to record details of drug treatment. A standard drug history data collection form.... A form was designed to assess patient recall of their treatment and the labelling of dispensed medication under the same headings for the follow up”
	Standardised outcome measurement	Low risk	Interventions were graded using a validated tool and this was done independently by a hospital pharmacist and medical consultant. However, the study provided no estimate of assessor agreement Quote “Interventions made during the preparation of the medication history were graded using the Eadon system (0 being detrimental to patient health through to 6 which is potentially lifesaving). The outcome scores were awarded independently by a hospital pharmacist and medical consultant”
Detection bias	Blinding of outcome measurement	Unclear	No details whether assessors of interventions were blind to study allocation
Selective reporting	Incomplete outcome data	Low risk	Data outcomes related to ED rates was not reported completely. Investigators only reported statistical significance Quote “There was no significant differences (P > 0.05) in the number of readmissions between groups nor in the average length of stay during readmission”
Adequacy of study power & analysis	Powered and appropriate statistical analysis	High risk	No power or sample size calculation reported.

Stowasser et al. 2002

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	Low risk	Random controlled study from 12 medical and 5surgical units
Selection bias	External and internal variations of study sample	Low risk	No significant differences between groups at baseline. Quote " At baseline there were no significant differences between study intervention group and control with respect to demographic and clinical variables, number of medications, medications omitted from the discharge summary and SF-36 scores"
	Randomisation	Low risk	Patient were randomly selected Quote " patient was selected from daily admissions list using a random number generation and systematic sampling"
	Allocation concealment	Unclear	There are no enough details to establish allocation concealment. Using systematic sampling might allow the foresee of allocation
Performance bias	Standardised intervention delivery	Low risk	A clinical pharmacist obtained a comprehensive medication history on admission which was confirmed by the admitting doctors.
	Standardised outcome measurement	Low risk	There are no concerns about outcome measurement. Outcome data was obtained via postal questionnaires and computer system check Quote "Computer information system were reviewed one month after discharge to identify any readmission within 30 days. Subject who died were identified through this computer system or through notification by the carer"
Detection bias	Blinding of outcome measurement	Low risk	No details whether obtaining outcome data was done by blind assessor. However, this unlikely to influence outcomes. Quote "Post discharge outcome were obtained by postal survey. Computer information systems were reviewed one month after discharge to identify any readmission within 30 days. Subject who died were identified through this computer system or through notification by the carer.
Selective reporting	Incomplete outcome data	High risk	Missing outcome data related to emergency department visits
Adequacy of study power & analysis	Powered and appropriate statistical analysis	High risk	No power or sample size calculation reported

Hick et al. 2001

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	High risk	Non-randomised controlled observational study
Selection bias	External and internal variations of study sample	Unclear	Both groups were matched; however there was high potential for selection bias. Patients in both groups were selected from different consultant list, and selected consecutively. Quote "For the intervention (PAC) group, a sample of consecutive eligible patients was taken from one consultant's list. The first fifty patients on that list (aged over 29 years) were seen by a pharmacist in the PAC. For the control (ward) group, an equal number of consecutive eligible patients were taken from the list of another consultant with similar case mix. Control and intervention groups were matched as far as possible for type of procedure and age, and the same pharmacist was responsible for their pharmaceutical care"
	Randomisation	High risk	No randomisation
	Allocation concealment	High risk	No allocation
Performance bias	Standardised intervention delivery	Low risk	Intervention delivery was standardised Quote "Pharmaceutical PAC assessment comprised: taking a written patient medication history using standard documentation; writing each patient's usual"
	Standardised outcome measurement	Unclear	Interventions was rated using two tools; VAS and Modified Hatoum scale. Though using two tools was aimed to minimise potential bias plus using four senior pharmacists rating every intervention. Agreement was found not significant for VAS. The second tool was modified and thus it is unclear whether it would be valid to give reproducible results. Quote "Analysis of variance (ANOVA) showed no significant agreement between different assessors' VAS scores ($p<0.001$). Second panel (comprising four senior pharmacists, with equal experience to the first) graded interventions using a 1 (adverse effect on patient) to 6 (potentially lifesaving) scale..... the modal grade obtained from three assessors was deemed the severity index for each intervention. The fourth assessor's mark was used as a casting vote where there was no agreement".

Hick et al. 2001

Domain	Bias	Author judgement	Support of judgement
Selective reporting	Incomplete outcome data	Low risk	No concerns about missing outcome data
Adequacy of study power & analysis	Powered and appropriate statistical analysis	High risk	No power or sample size calculation.

Brookes et al. 2000

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	High risk	Non randomised and uncontrolled design
Selection bias	External and internal variations of study sample	Unclear	No details on who and how patients were identified or screened Quote “The patients in the study (109) contributed 15% of all patients over 60 years of age admitted”
	Randomisation	High risk	No randomisation
	Allocation concealment	High risk	No allocation concealment
Performance bias	Standardised intervention delivery	Unclear	There are no details whether the intervention delivery was standardised.
	Standardised outcome measurement	Unclear	There are no details whether the outcome measurement was standardised. No details how outcome data related to readmission data was obtained
Detection bias	Blinding of outcome measurement	Low risk	There are no details whether outcome measurement was blinded. However this unlikely to influence outcomes measured related to readmission rate
Selective reporting	Incomplete outcome data	Low risk	There are no concerns about missing outcome data
Adequacy of study power & analysis	Powered and appropriate statistical analysis	High risk	Power or sample size calculation was not reported.

Kramer et al. 2007

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	High risk	Before and after design
Selection bias	External and internal variations of study sample	High risk	Patient selection and screening was guided by triggering question by study nurse. There were differences between the two phases patients at baseline related to no. of medication Quote “Potential study participants were identified through a set of trigger questions that the nurse asked patients during the admission assessment” Quote “significantly more patients in the post-implementation group were taking seven or more Medications ($p < 0.0001$; 95% CI, 0.5284–0.7604) and had a history of coronary artery disease (CAD) ($p < 0.0001$; 95% CI, 0.3274–0.5444)”
	Randomisation	High risk	No randomisation
	Allocation concealment	High risk	No allocation concealment
Performance bias	Standardised intervention delivery	Low risk	The study intervention was standardised via educational session for all health care staff involved. Quote “nurses and pharmacists attended education sessions before study initiation. A flow chart was created to guide nurses through the admission and discharge medication reconciliation documentation process. All pharmacists attended a three-hour, hands-on computer education session”
	Standardised outcome measurement	Low risk	Outcome measurement was standardised Quote “The number and type of potential errors prevented at admission and discharge were identified by the mean number and type (intervention subcategory) of reconciliation interventions or discrepancies documented in the computerized database. Severity of potential errors prevented were categorized using the hospital’s policy for categorizing medication errors and the 30-day readmission rate”

Kramer et al. 2007

Domain	Bias	Author judgement	Support of judgement
Detection bias	Blinding of outcome measurement	High risk	This is after and before study, blinding is not possible as such for data on intervention categorisation though it was using the hospital policy and 30 day readmission rate.
Selective reporting	Incomplete outcome data	High risk	Missing details on medication errors and potential impact. Quote “attempts were made to determine potential medication errors, the effect of the medication reconciliation process on medication errors could not be determined due to the lack of intervention documentation in both study phases”
Adequacy of study power & analysis	Powered and appropriate statistical analysis	High risk	No power or sample size calculation

Gillespie et al. 2009

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	Low risk	Randomised controlled design
Selection bias	External and internal variations of study sample	Unclear	Differences between the two groups related to no. of prescribed medication and history cerebral vascular lesion. However, this was one medication difference on average Quote “The groups were well balanced except in 2 respects. First, more patients in the intervention group had a history of cerebral vascular lesions (20.9% vs. 10.2%, *P*=.006). Second, the intervention group patients were taking more prescription drugs (8.7 vs. 7.3, *P*=.004).
	Randomisation		No concerns about randomisation component Quote “Randomization was performed in blocks of 20 (each block contained 10 intervention and 10 control allocations) and using closed-envelope
	Allocation concealment	Low risk	Closed-envelope technique was used

Gillespie et al. 2009

Domain	Bias	Author judgement	Support of judgement
Performance bias	Standardised intervention delivery	Low risk	Intervention delivery was standardised. Quote "Standard operating procedures for the enhanced service were prepared by the study pharmacists (U.G. and A.A.) during the preceding pilot study and were peer reviewed in an open forum multi-professional discussion and revised accordingly.
	Standardised outcome measurement	Low risk	Classification of related to drug related readmission were performed by a blind assessor. Additionally, analysing readmission data was done by blind researchers. Quote "The electronic medical records were used to establish the reasons for readmission and the current medication list for each readmission. The physician in charge of the patient was required to document in the medical record if readmissions were drug related. The physicians making this decision were blinded as to whether the patients were study participants. The researchers (U.G. and A.A.) responsible for analysing readmission data were blinded regarding the group to which the patients had been randomized"
Detection bias	Blinding of outcome measurement	Low risk	Rating and analysing readmission outcome data was done by blind investigators
Selective reporting	Incomplete outcome data	High risk	There are missing outcome data related to transcription errors and omission Quote "Transcription errors and faulty omission or addition of drugs were frequently detected by the pharmacists. There was limited information in the case notes about reasons for visits and about patients' medication use before visits. Therefore, analyses of drug-related emergency department visits were not possible"
Adequacy of study power & analysis	Powered and appropriate statistical analysis	Low risk	The sample size calculations were based on results from a previously performed pilot investigation and from a study conducted by Scullin et al. To detect a 15% reduction in hospital visits with 80% power, we needed to enrol 162 patients in each group. As such the study was sufficiently powered

Vira T et al. 2006

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	High risk	Patient were selected randomly but the study is not controlled
Selection bias	External and internal variations of study sample	Low risk	Patients were randomly selected with 60 patients selected from 168 admissions.
	Randomisation	Low risk	Random number table was used Quote “A random number table was used to select patients from all new admissions to the units in the previous 24 hours”
	Allocation concealment	High risk	No allocation concealment
Performance bias	Standardised intervention delivery	unclear	No details whether intervention delivery was standardised.
	Standardised outcome measurement	Unclear	No details whether outcomes measurement was standardised
Detection bias	Blinding of outcome measurement	High risk	No details whether the assessor of discrepancies was blind but the study is not controlled as such there was no blinding Quote “An internist reviewed each unintended variance to assess the potential and/or actual clinical importance. Unintended variances were classified as clinically important if they caused or had the potential to cause death, permanent or temporary disability, prolonged hospital stay, readmission, or the need for additional treatment or monitoring to protect the patient from harm”
Selective reporting	Incomplete outcome data	Low risk	No concerns about missing outcome data. Quote “Of the 60 patients enrolled, 56 were followed until discharge, two had not been discharged at the end of the study period, and two died in hospital; the latter four patients were excluded from discharge medication reconciliation analysis.
Adequacy of study power & analysis	Powered and appropriate statistical analysis	High risk	No sample size calculation

Spinewine et al. 2007

Domain	Bias	Author judgement	Support of judgement
Design bias	Focus study question & design	Low risk	Randomised controlled design study
Selection bias	External and internal variations of study sample	Low risk	Both group comparable and where screened by independent person Quote "A pharmacist external to the main study checked inclusion criteria and assigned participants to their groups.... No significant differences were present in the characteristics of patients at baseline"
	Randomisation	Low risk	Randomization was alternate and stratified for age (<85 vs.≥ 85), number of prescribed medicines (<5 vs. ≥5), and identity of the resident in charge of the patient
	Allocation concealment	Low risk	Using alternate and stratified selection might undermine concealment, however screening against inclusion and exclusion criteria was done by person independent from the study
Performance bias	Standardised intervention delivery	Low risk	The study pharmaceutical care from admission to discharge according was performed by a validated scheme Quote "The intervention consisted of a clinical pharmacist (AS) providing pharmaceutical care from admission to discharge according to a validated scheme described in detail elsewhere"
	Standardised outcome measurement	Low risk	The process followed for outcomes measurement was standardised Quote "Additional outcome measures were collected after discharge. All patients were followed up 1 month, 3 months, and 1 year post-discharge through telephone calls performed by two trained hospital pharmacists (SA and SB) who were blinded to group assignment and not involved in patient care. One of these two pharmacists (SA) and the main investigator (AS) developed the questionnaire"

Spinewine et al. 2007

Domain	Bias	Author judgement	Support of judgement
Detection bias	Blinding of outcome measurement	Low risk	Outcome measurement was blinded and collected by two pharmacists. Outcome data related to hospital revisits were also doubled checked when applicable. Quote "All patients were followed up 1 month, 3 months, and 1 year post-discharge through telephone calls performed by two trained hospital pharmacists (SA and SB) who were blinded to group assignment and not involved in patient care. Data, which the person preparing the medications (patient or caregiver) provided, included the following: mortality, readmission or visit to an emergency department (double checked with the hospital record when applicable)"
Selective reporting	Incomplete outcome data	Low risk	No concern about missing outcome data, attrition rate was similar between groups. Attrition rates for both groups (control vs. intervention) was; (10% vs. 6.8% lost to follow up), (2.2% vs. 1%) at 1 month, (2.2% vs. 1.1%) at 3 month (3.5% vs. 5.3%) at 1year.
	Incomplete outcome data	Low risk	Quote "The percentages of patients for whom data were available after discharge were as follows: at 1 month, 98% (88/90) of control and 99% (95/96) of intervention patients for clinical data and 84% (72/86 patients alive) of control and 83% (79/95 patients alive) of intervention patients for pharmaceutical data; at 3 months, these percentages were 96% (86/90) and 98% (94/96) and 86% (68/79 patients alive) and 85% (75/88 patients alive), respectively; and at 12 months, 92% (83/90) and 93% (89/96)
Adequacy of study power & analysis	Powered and appropriate statistical analysis	Low risk	Sample size calculation was performed. ITT analysis was not performed; however differences between groups for outcomes related to mortality, readmissions and emergency department visits were found not statistically significant.

ITT: Intention to treat.

Appendix 19 Medicine reconciliation at the health interface data collection and recuitement barriers

Data collection process challenges

Process	Issue	Solution
Control MR forms	Higher number than anticipated for patients possibly receive usual care MR.	Control forms relocated so as not to make it oblivious to the staff that MR had not been performed
	Uncompleted (blank) control MR forms	The study researchers realised that they need to check medical notes in addition to MR forms as these very often not completed
Allergy information	Lack of a field in the intervention form to record the time spent by the pharmacist clarifying allergy information	The form was amended to record details of allergy interventions.
Time to photocopy post intervention notes and charts	The study researchers photocopied post intervention charts shortly after the MR pharmacist visit.	The study researchers realised that they need to photocopy post intervention charts allowing ample time After MR intervention
Obtaining at least two updated sources of patient information	It was not accessible to obtain GP lists during weekends.	The study researchers attempted to identify other sources of information.
	No other updated source was attainable (i.e. only very old discharge letter, no patient own drugs). Patient had no previous admissions or had been discharged over one year ago.	The MR pharmacist relied on patients or carers and obtained the GP list on Monday and re-checked the history reconciled. It was agreed that a discharge letter dated more than one year ago from the study admission not to be considered an updated source of medicine information.
	Discrepancies between patient sources of information identified three month post discharge in control patients, i.e. absences of a third source of information	An omission discrepancy was considered if the medicine was listed by at least two sources. Omissions of pre-admission medicine identified by only one source of information were considered with caution as that patient might be no longer taking it.
Post discharge health resource use	Omissions and ambiguities within the returned questionnaire	The study researchers called patients to clarify the omitted or unclear responses.
	Mismatches in readmissions identified by hospital system details between self- reported and	The study researchers called patients to clarify the discrepancy in the information

MR: medicine reconciliation. GP: General practitioner

Data collection process

Process	Issue	Solution
Post discharge health related quality of life	Patient was in hospital at the time 3 month health related quality of life was due.	The questionnaire was not sent until patient discharged. This was two weeks beyond the intended time point.
	GP practice took 6 weeks (4 weeks when adjusting for Christmas and new year holidays) to confirm patient not being deceased	questionnaire was sent 6 weeks beyond the intended time point
	One patient withdrawn beyond the three months point of his discharge	Questionnaire was sent to the patient on time. Beyond the point he withdrawn no future contact was intended.
	One patient died beyond the 3-months point of his discharge	Questionnaire was posted to the patient at the time it was due. Beyond the point he was deceased no further contact was done.

GP: General practitioner

Barriers to recruitment related to patient identification and time constraints

Process	Issue	Solution
Patient identification	Lack of hospital system update and inaccuracies	The study researcher to contact ward clerks to clarify patient eligibility for the study.
	Confirming a patient was prescribed at least one medicine or not seen by a pharmacy staff was not possible without conversing with patient	The nurse was asked to obtain a verbal consent from the patient enabling the study team to approach patients.
Patient and nurses unavailability	patient meals, sleeping, medicines, medical rounds, procedures or self-care	-
	Busy nursing staff	-
Obtaining patient information from the GP	GP practices did not response promptly	The study researchers initiate one or more phone contacts and/ or fax to obtain the GP list
Obtaining patient Medical notes and medicine chart	Obtaining the patient medical notes and medicine charts	The study was not to interfere with the medical rounds or the clinical team use of medical notes and medicine charts.
	It was time consuming to locate the medical notes of discharged or transferred patients; this required the	The study researchers sought an access to the hospital medical notes library or/and contacting the ward clerks and outpatient clinics.
Photocopying, scanning and fax use	Photocopying and scanning of medical notes, medicine charts, patient own drugs was time consuming	Liaison with the wards clerks or the nursing staff to facilitate the use of the ward fax machine.
	Shortcoming with paper, ink or maintenance added to the time consumed by the study the study researchers to perform these tasks.	
Outcomes data collection and entry	The task of inputting outcomes data to the database was laborious.	Time was committed to develop standard operating procedure guiding the data collection and entry.
	The study database was underdevelopment with respect to layout and user utility.	The study researchers devoted time to test the database by inputting actual data followed by feedback and discussion with the IT supporting team
Communication with other health professionals and patients	Considerable time was committed to communicate with the ward nurses or pharmacy staff to facilitate recruitment or consenting.	-
	Time was spent posting follow up questionnaires and contacting GP practices to obtain a list of medicines the patient is taking 3 month	
	In addition, time was spent by the RAs posting letters to informing the GPs of the patient enrolment.	

GP: General practitioner

Appendix 20 Amendments suggested for the MedRec database

Issue	Description	Suggestion/ solution
No opt to construct a standard goal list of patient medicines collated from the different sources	This is mainly relevant for control patients, without constructing this list the patient's medication history can't be verified efficiently. For the interim analysis these lists were constructed manually.	Modify database to facilitate construction of gold standard medicines list collating information from different sources
Instability of the database	System errors frequently occurred and as a consequence the user ought to restart the Internet Explore application	Issue has been reported to the IT team
User entry errors	The first three months data was inputted by the study RAs and the thesis author (EH). Upon the discrepancies analysis inaccuracies with medicines information entry was found common and related mainly to differences between users inputting similar details in different ways, human errors and typo errors.	o Standard operating procedures were developed to guide data entry; however, user training is crucial. o A part- time researcher joined the study to support administrative tasks related to data entry o Database user interface should be revised and organised in simpler, easy to fill manner o The database is equipped with an option to copy medicine lists across the different study time points, i.e. admission, discharge and three months post discharge. Inappropriate use of this option contributed to errors and inaccuracies. The usability of the copy option should be revised
Data extraction	The database is equipped with an extraction option into an excel format. This assisted data analysis to a great extent; however, the excel output can be refined	o Medicines details are extracted into columns; transposing extracted data into rows would be easier to analyse and export to data processing software

Issue	Description	Suggestion/ solution
Data extraction cont.		o Details on duration, readmissions, person prepared admission chart and discharge letter, allergy and co-morbidities cannot be extracted. An extraction option to these detailed is desired
Maintenance support	System errors and unavailability of maintenance support hindered recruitment in few instances. Additionally, IT support was not available during weekends or out of working hours.	o Maintenance and IT helpline to cover weekends is demanded

Appendix 21 Details of unreturned health related quality of life and health resoucre use questionniares

Issue*	No. of patient	Description
Address changed	Two patients	Patients moved and consequently the contact details of those patients and the GP practices were lost to follow up. One of those two patients was readmitted and an updated contact address was obtained from the hospital system. The questionnaire was posted to the patient new address at the point of 6 weeks of his discharge. For the other patient, a phone contact was available and the questionnaire was re-sent upon confirming the new address. However, this was 4 weeks beyond the intended time point.
Hospitalisation	One patient	The patient was in hospital at the time health related quality of life and health resource use was due. As such, the questionnaire was not sent until patient discharged. This was two weeks beyond the intended time point.
GP practice delayed response	One patient	The GP practice took 6 weeks (4 weeks when adjusting for Christmas and new year holidays) to confirm patient not being deceased and therefore the questionnaire was sent beyond the intended time point.
Withdrawn	One patient	The patient Withdrawn beyond the three months point of his discharge, the questionnaire was sent to the patient on time. Beyond the point he withdrawn no future contact was intended.
Death	One patient	One patient died beyond the three months point of his discharge and similarly the questionnaire was posted to the patient at the time it was due. Beyond the point he was deceased and no further contact was done

*Up to the time of this analysis none of these patients returned the questionnaires. GP: General practitioner

Appendix 22 Examples of medication errors identified by the MedRec interim analysis

Description of errors				Score
Patient: *Age:* 86 years; *Co-morbidities*: Type 2 diabetes mellitus, hypercholesterolemia & osteoporosis; *Presenting diagnosis*: chronic cardiac failure; *Length of hospital stay*: 12 days **Point of care:** Admission **Error type:** Changed dose **Error Details:**				**3.5**
Pre-admission (PODs, GP list):	Metformin	1000 mg	2 tablets	bd
Inpatient &Discharge	Metformin	1000 mg	1 tablets	bd
GP list 3 months post discharge:	Metformin	1000 mg	2 tablets	bd
Patient: *Age:* 74 years; *Co-morbidities*: hypertension, chronic kidney disease & history of deep vein thrombosis; *Presenting diagnosis*: Acute gout; *Length of hospital stay*: 4 days **Point of care:** Discharge **Error type:** Changed dose **Error Details:**				**3.5**
Pre-admission (GP list only):	Doxazosin	4 mg	2 tablets	om
Inpatient &Discharge:	Doxazosin	4 mg	1 tablets	om
GP list 3 months post discharge:	Doxazosin	4 mg	2 tablets	om
Patient: *Age*: 71 years; *Co-morbidities*: chronic cardiac failure hypothyroidism, recurrent falls & atrial fibrillation; *Presenting diagnosis*: Shortness of breath; *Length of hospital stay:* 23 days **Point of care:** Discharge **Error type:** Addition **Error Details:**				**4.75**
Inpatient:	Spironolactone	25 mg	1 tablet	od
Medical notes:	Start Spironolactone by cardiology team			
Discharge:	Omitted			
Patient: *Age*: 86 years; *Co-morbidities*: Type 2 diabetes mellitus, hypercholesterolemia & osteoporosis; *Presenting diagnosis*: Chronic heart failure ; *Length of hospital stay*: 12 days **Point of care:** Admission **Error type:** Omission **Error Details:**				**2**
Pre-admission (GP list only):	Tolterodine tartrate MR		4 mg capsule	od
Inpatient & Discharge:	Omitted			
GP list 3 months post discharge:	Not prescribed			
Patient: *Age*: 53 years; *Co-morbidities:* End stage renal failure, ischaemic heart disease, Chronic pancreatitis, hypertension, Type 2 diabetes mellitus; *Presenting diagnosis:* Troponin negative chest pain; *Length of hospital stay*: 3 days **Point of care:** Discharge **Error type:** Changed formulation **Error Details:**				**2.75**
Inpatient:	Oxycodone MR	40 mg	1 tablet	bd
Discharge:	Oxycodone	40 mg	1tablet	bd
GP list 3 months post discharge:	Oxycodone	40 mg	1tablet	bd

POD: Patient own drugs. bd:twice daily.od: once daily. MR: modified release.od:once daily

Description of errors				score
Patient: *Age*: 66 years; *Co-morbidities*: Diverticular disease, Previous transient ischemic accident, hypertension, hypercholesterolemia & left total knee replacement; *Presenting diagnosis*: Bleeding, abdominal pain, dizziness; *Length of hospital stay*: 4days **Point of care:** Discharge **Error type:** Discontinuation **Error Details:**				**4.5**
Pre-admission (PODs, GP list):	Exemestane	25 mg	1tablet	om
Inpatient:	Exemestane	25 mg	1tablet	om
Discharge:	Omitted			
Patient: *Age*: 71 years; *Co-morbidities*: Parkinson's disease, Previous chronic cardiac failure; presenting diagnosis: shortness od breath; length of hospital stay: 9days **Point of care:** Admission **Error type:** Changed dose **Error Details:**				**2**
Pre-admission (PODs, GP list):	Amitriptyline	10 mg	1 tablet	on
Inpatient & Discharge:	Amitriptyline	20 mg	1 tablet	on
GP list 3 months post discharge:	Amitriptyline	20 mg	1 tablet	on
Patient: *Age*: 66 years; *Co-morbidities*: Diverticular disease, breast cancer (mastectomy) & hypertension; *Presenting diagnosis*: Fall; *Length of hospital stay*: 4 days **Point of care:** Discharge **Error type:** Discontinuation **Error Details:**				**1**
Pre-admission (PODs, GP list):	Piroxicam	gel	bd	
Inpatient:	Piroxicam	gel	bd	
Discharge:	Omitted			
GP list 3 months post discharge:	Piroxicam	gel	bd	
Patient: *Age*: 86 years; *Co-morbidities*: Chronic cardiac failure., prostate cancer, Type 2 diabetes mellitus, peripheral neuropathy & hypertension; *Presenting diagnosis*: Exacerbation of chronic cardiac failure; *Length of hospital stay*: 4 days **Point of care:** Admission **Error type:** Omission **Error Details:**				**2**
Pre-admission (GP list, previous discharge summary):	Latanoprost	eye drop	2 drops	both eyes
Inpatient & Discharge:	Omitted			
GP list 3 months post discharge:	Latanoprost	eye drop	2 drops	both eyes

om: in morning. on: in evening. bd: twice daily

Appendix 23 Examples of intentional discrepancies

Description of discrepancy	Classification
Patient: *Age*: 87 years; *Co-morbidities*: Atrial fibrillation; *Presenting diagnosis*: Collapse of unknown reason; *Length of hospital stay*: 3 days **Point of care:** Discharge **Discrepancy type:** Discontinuation **Discrepancy Details:** **Inpatient:** Codeine phosphate 30-60 mg as required **Discharge:** Omitted **GP list 3 months post discharge:** -	**Undocumented**
Patient: *Age*: 87 years; *Co-morbidities*: Atrial fibrillation; *Presenting diagnosis*: Collapse of unknown reason; *Length of hospital stay*: 3 days **Point of care:** Discharge **Discrepancy type:** Change **Discrepancy Details:** **Inpatient:** Chlordiazepoxide 10mg qds **Discharge:** Chlordiazepoxide 10 mg bd **GP list 3 months post discharge:** Not known	**Documented**
Patient: *Age*: 65 years; *Co-morbidities*: Pancreatic cancer, previous pericarditis, obstructive jaundice stent; *Presenting diagnosis*: Stent related infection/sepsis; *Length of hospital stay*: 8 days **Point of care:** Discharge **Discrepancy type:** Change **Discrepancy Details:** **Inpatient:** Dalteparin 5000 unit SC od **Discharge:** Omitted **GP list 3 months post discharge:** -	**Undocumented**
Patient: *Age*: 65 years; *Co-morbidities*: Pancreatic cancer, previous pericarditis, obstructive jaundice stent; *Presenting diagnosis*: Stent related infection/sepsis; *Length of hospital stay*: 8 days **Point of care:** Discharge **Discrepancy type:** Discontinuation **Discrepancy Details:** **Inpatient** Cyclizine 50 mg tds as required **Discharge:** Omitted **GP list 3 months post discharge:** -	**Undocumented**
Patient: *Age*: 86 years; *Co-morbidities*: Diverticular disease, previous transient ischemic accident, hypertension, Hypercholesterolemia & Left total knee replacement; *Presenting diagnosis*: Abdominal pain/ dizziness; *Length of hospital stay*: 4 days **Point of care:** Discharge **Discrepancy type:** substitution **Discrepancy Details:** **Pre-admission** Navispare 2.5mg/250mcg od **Inpatient** Navispare 2.5mg/250mcg od **Discharge:** Substitution into co-amilofruse 5/40 od **GP list 3 months post discharge:** Co-amilofruse 5/40 mg od	**undocumented**

GP: General practitioner. qds: four times a day. Bd: twice time a day. SC: subcutaneous. tds: three times a day