

Chapter 30 Pharmacist support

Emergency and acute medical care in over 16s: service delivery and organisation

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1 30 Pharmacist support

2 30.1 Introduction

3 Increasing numbers of patients with multiple co-morbidities are being exposed to large numbers of
 4 medications designed to treat each of the conditions from which they may suffer. This, however, is
 5 associated with increasing numbers of drug interactions, difficulties with concordance and possible
 6 admissions or readmissions associated with drug errors or adverse effects. The introduction of
 7 clinical pharmacists has been designed to minimise these difficulties and, in particular, medicines
 8 reconciliation has been conducted for many patients to ensure clarity of the drugs prescribed and
 9 taken. The presence of a ward based pharmacist is common practice in the UK. However, the precise
 10 input required from pharmacy support is still not clear and this question is posed in an attempt to
 11 understand the best way in which pharmacy support is used.

12 30.2 Review question: Do ward-based pharmacists improve outcomes in 13 patients admitted to hospital with a suspected or confirmed acute 14 medical emergency?

15 For full details see review protocol in Appendix A.

16 **Table 1: PICO characteristics of review question**

Population	Adults and young people (16 years and over) admitted to hospital with a suspected or confirmed AME
Interventions	<ul style="list-style-type: none"> • Presence of medical ward based pharmacists <ul style="list-style-type: none"> ○ for 7 days a week ○ for less than 7 days a week
Comparison	No ward based pharmacists
Outcomes	Mortality (CRITICAL) Quality of life (CRITICAL) Patient and/or carer satisfaction (CRITICAL) Avoidable adverse events (CRITICAL) Length of stay in hospital (CRITICAL) Prescribing errors (CRITICAL) Missed medications (CRITICAL) Medicines reconciliation (CRITICAL) Readmissions up to 30 days (IMPORTANT) Future admissions to hospital (over 30 days) (IMPORTANT) Discharges (IMPORTANT) Staff satisfaction (IMPORTANT)
Study design	Systematic reviews (SRs) of RCTs, RCTs, observational studies only to be included if no relevant SRs or RCTs are identified.

17 30.3 Clinical evidence

18 Eighteen studies (20 papers) were included in the review^{1,3,8,13,15,17,18,21,31,35,37,39,44,46,57-59,62,69,69,70,70,}
 19 these were split into 3 strata: regular in-hospital pharmacy support (where the ward-based
 20 pharmacist intervention included in-patient monitoring, and typically an admission and discharge
 21 service), pharmacist at admission, and pharmacist at discharge. These are summarised respectively in
 22 Table 2, Table 3 and Table 4 below. Evidence from these studies is summarised in the clinical

1 evidence summary below (Table 5 to Table 7). See also the study selection flow chart in Appendix B,
 2 study evidence tables in Appendix D, forest plots in Appendix C, GRADE tables in Appendix F and
 3 excluded studies list in Appendix G.

4 **Table 2: Summary of studies included in the review (regular in-hospital pharmacy support)**

Study	Intervention and comparison	Population	Outcomes	Comments
Claus 2014 ¹³ RCT	Pharmacist present on the ward. Duties included making active recommendations and performing patient follow-up.	Surgical ICU admissions (n=69) within a university hospital in Belgium. Inclusion - over 16 years of age, length of stay greater than 48 hours. Exclusion - none stated.	In-hospital mortality.	No pharmacist screening or discharge services. Patients crossed to intervention group if the pharmacist was asked by the caregiver to give advice. Pharmacist saw all patients, but recommendations were not passed onto the caregiver in the control group. Intervention conducted by 1 of 2 clinical pharmacists.
Iowa Continuity of Care Study trial: Farris 2014 ¹⁸ (Farley 2014 ¹⁷) RCT	Pharmacy case manager. Duties included medication reconciliation, ward visits and discharge service. Versus Nurse based medication reconciliation and discharge service.	General medicine, family medicine, cardiology or orthopaedic admissions (n=631) within an academic tertiary care hospital in the USA. Inclusion - patients with certain disease classifications: hypertension, hyperlipidaemia, heart failure, coronary artery disease, myocardial infarction, stroke, transient ischemic attack, asthma, chronic obstructive pulmonary disease or receiving oral anticoagulation.	Preventable adverse drug events in-hospital; post-discharge (90 days) hospital Readmission at 30 days; Admission at 90 days Medication appropriateness index (MAI) at discharge; 30 days; 90 days.	Farley 2010 indicates that the initial medication reconciliation is normally undertaken by a nurse in the control group. Unclear number of pharmacists involved. Data was extracted from Farris 2014 MAI is based on 6 criteria.
Gillespie 2009 ²¹ RCT	Pharmacist present on the ward. Duties included taking part in the rounding team, documenting medication history, and discharge counselling.	Patients (n=400) admitted to the 2 acute internal study wards at a University teaching hospital in Sweden. Inclusion - 80 years of age. Exclusion - previously been	Overall survival at 12 months, reported as hazard ratio. Admission at 12 months	A follow-up telephone call to patients 2 months after discharge was conducted in the intervention group Admission and discharge

Study	Intervention and comparison	Population	Outcomes	Comments
	<p>Versus</p> <p>No pharmacist involvement in the healthcare team at the ward level.</p>	<p>admitted to the study wards during the study period or had scheduled admissions.</p>		<p>documentation filled by physicians and nurses in comparison group</p> <p>Intervention conducted by 1 of 3 clinical pharmacists.</p> <p>During follow-up period intervention patients received enhanced care again, but were excluded if admitted during the intervention period.</p>
<p>Kucukarslan 2003³⁵</p> <p>Quasi-RCT</p>	<p>Pharmacist present on the ward. Duties included taking part in the rounding team, documenting medication history, and discharge counselling.</p> <p>Versus</p> <p>Standard care from 1 pharmacist (implication in paper that this is not ward-based).</p>	<p>All patients (n=165) admitted to 1 of the 2 internal medicine study wards within a tertiary care hospital in the USA.</p> <p>Inclusion - admitted to the internal medicine service and remained in the same patient care unit until discharge.</p> <p>Exclusion – none given.</p>	<p>Avoidable adverse drug events until discharge.</p> <p>Length of stay in-hospital (reported as mean difference).</p> <p>Re-admission (unclear follow-up time, reported as percentage reduction).</p>	<p>Admitting process was based on the availability of beds and physician service.</p> <p>Pharmacist on the ward Mon-Fri.</p> <p>Intervention conducted by 1 of 2 clinical pharmacists.</p> <p>Usual care involved identification of medication problems retrospectively through records</p>
<p>Shen 2011⁵⁸</p> <p>China RCT</p>	<p>Clinical pharmacist part of the treating team – communicated any potentially inappropriate antibiotic use (indication, choice, dosage, dosing schedule, duration, conversion) with the physician to discuss and make recommendations.</p> <p>Versus.</p> <p>Standard treatment strategies performed</p>	<p>n=354 inpatients in 2 respiratory wards diagnosed with respiratory tract infections.</p> <p>Exclusion criteria: transferred from other medical departments; transferred to other medical departments for further treatment; already received antibiotics before admission; did not receive antibiotics during hospitalisation.</p>	<p>Length of stay.</p>	<p>Regular-in ward pharmacist support strata.</p>

Study	Intervention and comparison	Population	Outcomes	Comments
	by the physicians and nurses without pharmacist involvement.			
Scullin 2007 ⁵⁷ RCT	Pharmacist present on the ward. Duties included admission services, in-patient monitoring, and discharge services Versus Traditional clinical pharmacy services (no further details given).	Admitted patients (n=762) to the 4 medical study wards within 3 general hospitals in northern Ireland. One of the following criteria: taking at least 4 regular medication, were taking a high risk drug(s), were taking antidepressants and were 65 years old or older, had a hospital admission within the last 6 months, prescribed antibiotics on day 1 of admission. Exclusion - scheduled admissions and patients admitted from private nursing homes.	Admission at 12 months. Mortality at 12 months. Length of stay.	Intervention conducted by 1 of 4 clinical pharmacists/pharmacy technician pairs.
Spinewine 2007 ⁵⁹ RCT	Pharmacist present on the ward. Duties included taking part in the rounding team, documenting medication history, and discharge counselling. Versus Usual care (no details of any clinical pharmacist involvement).	All eligible patients (n=186) admitted to the Geriatric Evaluation and Management (GEM) unit within a university teaching hospital in Belgium. GEM unit accepted patients over 70 years of age.	Rate of death at 1 year follow-up. Satisfaction with information received. Admission at 12 months. Medical appropriateness index.	Pharmacist was on the unit for 4 days a week. Intervention conducted by a single clinical pharmacist. GEM team consisted of 2 geriatricians, 2 residents, nurses, 2 physiotherapists, a social worker, a psychologist, and an occupational therapist. MAI is based on 10 criteria (not defined).
Zhao 2015 ⁷⁰ & Zhao 2015B ⁶⁹ RCT	Interventions by clinical pharmacists including individual drug regimens, attending daily medical rounds, advice to physicians, education of medical staff, patient	n=90 patients admitted to the cardiology ward in a hospital in China. Inclusion criteria: diagnosis of CHD by physician, accepted ≥4 kinds of drugs, ≥18 years, primary high	Avoidable adverse events (adverse drug reactions). Patient and/or carer	

Study	Intervention and comparison	Population	Outcomes	Comments
	education on lifestyle changes, psychological interventions such as stress reduction, medication counselling at discharge, monthly follow up telephone calls post-discharge. Versus Conventional medical treatment without pharmacist participation.	school education, able to complete the study, available for telephone follow up. Exclusion criteria: pregnant/lactating women, patients enrolled in other studies, severe co-morbidities, family history of psychosis, and barriers to communication.	satisfaction.	

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Table 3: Summary of studies included in the review (pharmacist at admission)

Study	Intervention and comparison	Population	Outcomes	Comments
Aag 2014 ¹ RCT	Pharmacist medication reconciliation. Versus Nurse medication reconciliation.	Consecutively admitted patients (n=201) to the Cardiology study ward at a University hospital in Norway. Inclusion - aged 18 and over. Exclusion - terminal illness, isolated due to an infectious disease, unable to communicate in either Norwegian or English.	Medication discrepancies identified at admission. Prescribing physician agreement at admission.	Agreement with prescriber used as a surrogate outcome for staff satisfaction. Both pharmacists and nurses were taught and trained by an independent, experience clinical pharmacist both theoretically and practically in order to perform medicine reconciliation. Study involved 3 pharmacists and 3 nurses.
Khalil 2016 ³¹ Australia RCT	Pharmacist-initiated medication reconciliation – pharmacist obtained a ‘best possible medication history’ from the patient and/or other sources, undertook	n=110 adult medical patients admitted to the acute assessment and admission (AAA) unit via the ED during pharmacy operating hours (8.30am – 5pm). Exclusion criteria: not admitted to the AAA ward within 24 hours; no medications prior to admission; not a general medical patient.	Prescribing errors.	Pharmacist at admission strata.

Study	Intervention and comparison	Population	Outcomes	Comments
	<p>admission medication reconciliation, reviewed current medications and the need for new medications in relation to the admission diagnosis, developed a medication management plan with the referring senior medical officer and charted on the electronic medication administration record</p> <p>Versus</p> <p>Usual care – medication orders charted by medical staff.</p>			
<p>Lind 2016³⁷</p> <p>Denmark RCT</p>	<p>Clinical pharmacist intervention - obtaining medication history (using a minimum of 2 sources, 1 of which was an interview with the patient and/or relatives where possible), entering prescriptions into the electronic medication module (EMM), medication reconciliation, reviewing overall medication treatment and writing a note in the electronic medical record.</p> <p>Versus</p> <p>Standard care – on arrival, patients triaged by a nurse, then seen by a</p>	<p>n=448 patients arriving at the acute admission unit on weekdays 9am-4.15pm.</p> <p>Inclusion criteria: ≥18 years, taking ≥4 drugs daily (including over-the-counter, herbals and supplements).</p> <p>Exclusion criteria: terminal or intoxicated; assigned to triage level 1; referred to acute outpatient clinic; unable to give informed consent; interviewed by physician prior to giving informed consent; unexpected overnight stay.</p>	<p>Length of stay on the acute admission unit (defined as interval in minutes between arrival and discharge or transfer to a hospital ward).</p>	<p>Pharmacist at admission strata.</p>

Study	Intervention and comparison	Population	Outcomes	Comments
	physician who was responsible for obtaining medication history, reconciling and assessing medication treatment and entering prescriptions in the EMM.			
Lisby 2010 ³⁹ RCT	Pharmacist admission review. Versus Senior physician admission review.	Consecutively admitted patients (n=100) to acute internal medicine study ward within 1 regional hospital in Denmark. Inclusion - patients were 70 years or older.	Self-experienced quality of health at 3 months. Length of stay in hospital. Admission rate at 3 months. Mortality.	Unclear number of pharmacists involved.
Nester 2002 ⁴⁴ Quasi-RCT	Pharmacist medication reconciliation. Versus Nurse medication reconciliation.	Consecutively admitted patients (n=100) to a tertiary care referral centre in the USA. Inclusion - over 18, responsive and able to speak English. Exclusion - intensive care, ambulatory surgical and labour-and-delivery units.	Medication discrepancies identified at admission.	Nurses still performed medication history taking in the intervention group, but in all cases the intervention was conducted first. Unclear number of pharmacists involved. Allocation by alternation of consecutive admissions.
Tong 2016 ⁶² Australia RCT	Early medication review and charting on admission involving a partnership between a pharmacist and a medical officer – pharmacist took medical history, VTE risk assessment and discussed medical and	n=881 patients admitted to the general medical unit (GMU) and emergency short stay unit (ESSU) during pharmacist working hours (7am-9pm). Exclusion criteria: medication chart written by a doctor before pharmacist review; admitted to ESSU and not reviewed by a pharmacist.	Prescribing errors. (Pharmacist at admission strata.

Study	Intervention and comparison	Population	Outcomes	Comments
	<p>medication problems with admitting medical officer to agree a medication management plan.</p> <p>Versus</p> <p>Standard medication charting by medical officers of relevant teams, with subsequent medication reconciliation performed by pharmacist within 24 hours of admission.</p>			

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Table 4: Summary of studies included in the review (pharmacist at discharge)

Study	Intervention and comparison	Population	Outcomes	Comments
Al-Rashed 2002 ³ RCT	<p>Pre-discharge counselling (24 hours before discharge) by the clinical pharmacist attached to that ward.</p> <p>Versus</p> <p>Normal hospital discharge policy – all patients, their GPs, district nurses and carers received a copy of the patient’s medication and information discharge summary sheet (MIDS) and patients received a medicine reminder card. Nurse went through (MIDS) with patients.</p>	<p>n=83 patients admitted to 2 care of the elderly wards (UK).</p> <p>Inclusion criteria: >65 years, prescribed 4 or more regular items, were to be discharged to their own home and had an abbreviated mental score >7/10, English as a first language, and routine clinical pharmacist assessment that they could have problems with their medicines after discharge.</p>	Readmission.	

Study	Intervention and comparison	Population	Outcomes	Comments
Bladh 2011 ⁸ RCT	Pharmacist discharge review Versus Usual care, which was received from the same group of physicians and nurses. No other details given.	Patients (n=345) admitted on weekdays to the 2 internal medicine study wards at a university hospital in Sweden. Inclusion - capable of assessing their HRQL and giving written informed consent. Exclusion - poor Swedish language, planned discharge before intervention can be performed, transferred during their stay to other hospitals or wards not belonging to the Department of Medicine.	EQ-5D summarised index at 6 months follow-up.	Pharmacist not ward based (no patient contact) until discussion at discharge however, pharmacist performed "continuous medication reviews" from medical records compared with usual care where there was no "continuous medication review". Same physicians and nurses undertook care for the intervention and control. Intervention carried out by 1 of 3 pharmacists.
Eggink 2010 ¹⁵ RCT	Pharmacist discharge review. Versus Nurse discharge review.	Patients (n=89) to be discharged (no criteria given) in the Cardiology study ward within a teaching hospital in the Netherlands. Inclusion - patients have prescribed 5 or more medicines (from any class) at discharge. Exclusion - none stated.	Prescription errors identified during first outpatient follow-up.	Unclear number of pharmacists involved.
Nickerson 2005 ⁴⁶ RCT	Seamless care pharmacist at discharge including medication reconciliation, review of drug regime as part of comprehensive pharmaceutical care work-up, identification of problems and communication to community pharmacy, hospital staff and family physician, medication	n=253 patients admitted to 2 family practice units (Canada). Inclusion criteria: not discharged to another hospital, prescribed at least 1 medication at discharge, provided consent, agreement from community pharmacy, no previous study enrolment. Exclusion criteria: unable to answer study questions, unavailable for follow-up.	Prescriber errors- unresolved drug therapy inconsistencies and omissions.	

Study	Intervention and comparison	Population	Outcomes	Comments
	discharge counselling and a medication compliance chart Versus Standard care at discharge - discharge counselling and manual transcription of discharge notes from medical chart by nurse.			

Table 5: Clinical evidence summary: Regular in-hospital ward based pharmacy support compared to no ward-based pharmacist

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with no ward-based pharmacist	Risk difference with Regular in-hospital pharmacist support (95% CI)
Mortality	1060 (3 studies) 1 years	⊕⊖⊖⊖ VERY LOW ^{a,b} due to risk of bias, imprecision	RR 0.92 (0.72 to 1.16)	198 per 1000	16 fewer per 1000 (from 55 fewer to 32 more)
Survival	368 (1 study) 1 years	⊕⊖⊖⊖ VERY LOW ^{a,b} due to risk of bias, imprecision	HR 0.94 (0.65 to 1.36)	Control group risk not provided	Absolute effect cannot be calculated
Future admissions to hospital (over 30 days)	1892 (4 studies) 1 years	⊕⊕⊕⊖ MODERATE ^a due to risk of bias	RR 0.93 (0.83 to 1.04)	384 per 1000	27 fewer per 1000 (from 65 fewer to 15 more)
Readmission	592 (1 study) 30 days	⊕⊖⊖⊖ VERY LOW ^{a,b} due to risk of bias, imprecision	RR 0.92 (0.62 to 1.37)	146 per 1000	12 fewer per 1000 (from 55 fewer to 54 more)
Prescribing errors medication appropriateness index	811 (2 studies) at discharge	⊕⊕⊕⊖ LOW ^{a,c} due to risk of bias, inconsistency	-	-	The mean prescribing errors in the intervention groups was 0.02 lower (0.12 lower to 1.08 higher)
Prescribing errors medication appropriateness index	613 (1 study) 30 days	⊕⊕⊕⊖ MODERATE ^a due to risk of bias	-	The mean prescribing errors in the control groups was 9.6	The mean prescribing errors in the intervention groups was 2.1 higher (0.45 to 3.75 higher)
Preventable adverse drug events	790 (2 studies) until discharge	⊕⊖⊖⊖ VERY LOW ^{a,b,c} due to risk of bias, inconsistency, imprecision	RR 0.74 (0.06 to 8.57)	54 per 1000	14 fewer per 1000 (from 51 fewer to 409 more)

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with no ward-based pharmacist	Risk difference with Regular in-hospital pharmacist support (95% CI)
Preventable adverse drug events	588 (1 study) 90 days	⊕⊕⊕⊕ VERY LOW ^{a,b} due to risk of bias, imprecision	RR 0.77 (0.29 to 2.05)	31 per 1000	7 fewer per 1000 (from 22 fewer to 33 more)
Adverse drug reactions	85 (1 study) 6 months	⊕⊕⊕⊕ VERY LOW ^{a,b} due to risk of bias, imprecision	RR 1.47 (0.26 to 8.33)	48 per 1000	23 more per 1000 (from 36 fewer to 352 more)
Length of stay (days)	1116 (2 studies) in-hospital	⊕⊕⊕⊕ MODERATE ^a due to risk of bias		The mean length of stay in the control groups was 17.8 days	The mean length of stay in the intervention groups was 1.74 lower (2.76 to 0.72 lower)
Patient and/or carer satisfaction (1 month follow-up)	172 (1 study) 1 months	⊕⊕⊕⊕ LOW ^a due to risk of bias	RR 1.79 (1.38 to 2.32)	446 per 1000	352 more per 1000 (from 169 more to 589 more)
Patient and/or carer satisfaction (at discharge)	85 (1 study) at discharge	⊕⊕⊕⊕ LOW ^{a,b} due to risk of bias, imprecision	RR 1.49 (1.09 to 2.03)	548 per 1000	269 more per 1000 (from 49 more to 564 more)

(a) Downgraded by 1 increment if the majority of the evidence was at high risk of bias, and downgraded by 2 increments if the majority of the evidence was at very high risk of bias.

(b) Downgraded by 1 increment if the confidence interval crossed 1 MID or by 2 increments if the confidence interval crossed both MIDs.

(c) Downgraded by 1 because: The point estimate varies widely across studies, unexplained by subgroup analysis.

Outcomes as reported in studies (not analysable):

- Length of stay: intervention group had on average a 0.3-day shorter stay.
- Readmission: intervention group had a 44% reduced readmission rate.

Table 6: Clinical evidence summary: Pharmacist at admission compared to no ward-based pharmacist

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with no ward-based pharmacist	Risk difference with pharmacist at admission (95% CI)
Medication errors identified at admission	293 (2 studies)	⊕⊕⊖⊖ LOW ^{a,b} due to risk of bias, imprecision		The mean medication errors identified in the control groups was 1.51	The mean medication reconciliation in the intervention groups was 0.36 higher (0.07 to 0.65 higher)
Quality of life EQ-VAS index	63 (1 study) 3 months	⊕⊕⊖⊖ LOW ^{a,b} due to risk of bias, imprecision		The mean quality of life in the control groups was 60.9	The mean quality of life in the intervention groups was 6.2 higher (5.7 lower to 18.1 higher)
Length of stay (hours)	99 (1 study) in-hospital	⊕⊕⊕⊖ MODERATE ^a due to risk of bias		The mean length of stay in the control groups was 239.9 hours	The mean length of stay in the intervention groups was 1.3 higher (108.96 lower to 111.56 higher)
Admissions	99 (1 study) 3 months	⊕⊕⊖⊖ LOW ^{a,b} due to risk of bias, imprecision		The mean admission in the control groups was 0.4 admissions per patient	The mean admission in the intervention groups was 0.1 lower (0.38 lower to 0.18 higher)
Mortality	99 (1 study) 3 months	⊕⊖⊖⊖ VERY LOW ^{a,b} due to risk of bias, imprecision	RR 1.57 (0.55 to 4.46)	102 per 1000	58 more per 1000 (from 46 fewer to 353 more)
Physician agreement	457 (1 study) at admission	⊕⊖⊖⊖ VERY LOW ^{a,b,c} due to risk of bias, indirectness, imprecision	RR 1.35 (1.13 to 1.63)	437 per 1000	153 more per 1000 (from 57 more to 275 more)
Length of stay in acute admissions unit (AAU) (minutes)	448 (1 study)	⊕⊕⊕⊖ MODERATE ¹ due to risk of bias	-	The mean length of stay in the control groups was 339 minutes.	The mean length of stay in intervention group was 3.2 min higher (26.49 lower to 32.89 higher)
Total medication errors	881	⊕⊕⊕⊖ MODERATE ¹	RR 0.05	787 per 1000	748 fewer per 1000 (from 772 fewer to

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with no ward-based pharmacist	Risk difference with pharmacist at admission (95% CI)
within 24 hours of admission	(1 study)	due to risk of bias	(0.03 to 0.08)		763 fewer)

(a) Downgraded by 1 increment if the majority of the evidence was at high risk of bias, and downgraded by 2 increments if the majority of the evidence was at very high risk of bias.

(b) Downgraded by 1 increment if the confidence interval crossed 1 MID or by 2 increments if the confidence interval crossed both MIDs.

(c) The majority of the evidence had indirect outcomes.

Table 7: Clinical evidence summary: Pharmacist at discharge compared to no ward-based pharmacist

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with no ward-pharmacist	Risk difference with pharmacist at discharge (95% CI)
Quality of life Global health index	204 (1 study) 6 months	⊕⊖⊖⊖ VERY LOW ^{a,b} due to risk of bias, imprecision		The mean quality of life in the control groups was 2.77	The mean quality of life in the intervention groups was 0.23 higher (0.02 lower to 0.48 higher)
Quality of life Summated EQ-5D index	204 (1 study) 6 months	⊕⊕⊖⊖ LOW ^a due to risk of bias		The mean quality of life in the control groups was 0.43	The mean quality of life in the intervention groups was 0.05 higher (0.05 lower to 0.15 higher)
Quality of life EQ-VAS index. Scale from: 0 to 100.	204 (1 study) 6 months	⊕⊕⊖⊖ LOW ^a due to risk of bias		The mean quality of life in the control groups was 56.3	The mean quality of life in the intervention groups was 2.8 higher (1.83 lower to 7.43 higher)
Prescription errors identification at outpatient follow-up	85 (1 study) 6 weeks	⊕⊖⊖⊖ VERY LOW ^{a,b} due to risk of bias, imprecision	RR 0.57 (0.37 to 0.88)	682 per 1000	293 fewer per 1000 (from 82 fewer to 430 fewer)
Readmission	83	⊕⊕⊖⊖	RR 0.36	325 per 1000	208 fewer per 1000

Outcomes	No of Participants (studies) Follow up	Quality of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with no ward-pharmacist	Risk difference with pharmacist at discharge (95% CI)
	(1 study) 15-22 days	LOW ^{a,b} due to risk of bias, imprecision	(0.14 to 0.91)		(from 29 fewer to 279 fewer)
Prescriber errors (drug therapy inconsistencies and omissions)	147 (1 study) at discharge	⊕⊕⊕⊖ MODERATE ^a due to risk of bias	RR 0.06 (0.01 to 0.44)	563 per 1000	529 fewer per 1000 (from 315 fewer to 557 fewer)

(a) Downgraded by 1 increment if the majority of the evidence was at high risk of bias, and downgraded by 2 increments if the majority of the evidence was at very high risk of bias.

(b) Downgraded by 1 increment if the confidence interval crossed 1 MID or by 2 increments if the confidence interval crossed both MIDs.

Outcomes reported that were not analysable

The study by Khalil 2016³¹ reported the total number of medication errors:

- Intervention: 29/56.
- Control: 238/54.

1 **30.4 Economic evidence**

2 **Published literature**

3 Seven economic evaluations were identified with the relevant comparison and have been included in
4 this review^{13,19-21,29,32,66}. Similar to the clinical evidence, these were split into 3 strata: regular ward-
5 based pharmacist support (where the ward-based pharmacist intervention included in-patient
6 monitoring, and typically an admission and discharge service) (n=5), pharmacist at admission (n=1),
7 and pharmacist at discharge (n=1). The studies are summarised in the economic evidence profiles
8 below (Table 8, Table 9 and Table 10) and the economic evidence tables in Appendix F.

9 The economic article selection protocol and flow chart for the whole guideline can found in
10 Appendix 41A and Appendix 41B.

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Table 8: Economic evidence profile: regular ward-based pharmacist support versus no ward-based pharmacist

Study	Applicability	Limitations	Other comments	Incremental cost	Incremental effects	Cost effectiveness	Uncertainty
Claus 2014 ¹³ [Belgium]	Partially applicable ^a	Potentially serious limitations ^b	<ul style="list-style-type: none"> • Within trial analysis of individual patient level data • Population: Critically ill patients (>16 years of age and with minimum length of ICU stay of 2 days) and in a 22-bed, surgical ICU at Ghent University Hospital, Belgium. • Comparators: <ul style="list-style-type: none"> ○ No clinical pharmacist direct involvement in patient care. ○ A clinical pharmacist is directly involved in patient care • Follow-up: ICU stay 	2 versus 1: Saves £159	2 versus 1: 0.057 in-hospital deaths 0.07 adverse events	Pharmacist intervention less costly and less effective	<p>Matched analysis: No significant difference in drug costs.</p> <p>Excluding liver transplantation and tracheostomy: difference in drug costs remained non-significant (p=0.78 and 0.88 respectively).</p> <p>Excluding outlier ICU drug costs (> 2SD): Difference in drug costs was significant after excluding patients with outlier drug costs (p<0.001) in the randomised analysis. In the matched analysis (comparing the matched before- and after-groups with the intervention 1), the difference in drug costs was significant (p<0.001 for both groups).</p>
Ghatnekar 2013 ²⁰ [Sweden]	Partially applicable ^c	Potentially serious limitations ^d	<ul style="list-style-type: none"> • Decision tree model • Population: hospital inpatients • Comparators: <ul style="list-style-type: none"> ○ Standard care ○ Multidisciplinary team including clinical pharmacist undertakes systematic medication review and reconciliation from admission to discharge (the 	2 versus 1: Saves £280	2 versus 1: 0.005 QALYs gained	Pharmacist intervention dominant	<p>Both the admission and discharge parts of the model showed that the LMM model was dominant.</p> <p>The following sensitivity analyses were reported:</p> <ul style="list-style-type: none"> -assuming no quality control of the discharge medication report - reduction in hospitalisation cost by 50%

Study	Applicability	Limitations	Other comments	Incremental cost	Incremental effects	Cost effectiveness	Uncertainty
			<p>Lund Integrated Medicines Management [LIMM])</p> <ul style="list-style-type: none"> • Follow-up: 3 months 				<p>-hospitalisation cost 38% higher in intervention arm</p> <p>-admission part probability for hospitalisation in intervention arm increased to 100%</p> <p>-intervention cost (time) 50% higher</p> <p>-cost (time) for physicians and nurses administration reduced by 50%</p> <p>All SAs found the LIMM model to be dominant.</p>
Gillespie 2009 ²¹ [Sweden]	Partially applicable ^e	Potentially serious limitations ^f	<ul style="list-style-type: none"> • Within-trial analysis • Population: Elderly inpatients (80 years or older) admitted to 2 acute internal medicine wards at a University Hospital of Uppsala, Sweden. • Comparators: <ul style="list-style-type: none"> ○ No pharmacist involvement in the healthcare team at the ward level. ○ Pharmacist present on the ward. • Follow-up: 12 months 	2 versus 1: Saves £122	2 versus 1: 10 deaths averted per 1000	Pharmacist intervention dominant	None reported
Karnon 2008 ²⁹ [UK]	Partially applicable ^g	Potentially serious limitations ^h	<ul style="list-style-type: none"> • Decision tree model • Population: inpatients at 400 beds acute hospital (average hospital size) with around 14 wards 	2 versus 1: £ 0.18 million per hospital over 5 years	2 versus 1: 285 QALYs gained per hospital over 5 years	Pharmacist intervention cost effective (ICER: £631.57 per QALY)	The analysis was run using the lower and upper estimates of the intervention cost, which were calculated assuming an average of 2.5 and 1.5 wards per morning per

Study	Applicability	Limitations	Other comments	Incremental cost	Incremental effects	Cost effectiveness	Uncertainty
			<ul style="list-style-type: none"> • Comparators: <ul style="list-style-type: none"> ○ No ward-based pharmacist (a pharmacist covers 2 wards of about 30 patients over a morning to provide basic level of pharmaceutical care and in the afternoons they have departmental commitments) ○ Ward-based senior pharmacist (grade 7/8a) attends rounds with residents, nurses, attending staff each morning; is present in the ward for consultation and assistance to nursing staff during the rest of the morning and is available on call as necessary during the rest of the day. • Time horizon: 5 years 			gained)	<p>pharmacist in the intervention 1 scenario.</p> <p>The authors presented another analysis including the cost of treating pADEs only but not the monetary valuation of the health outcomes (QALYs), which showed that the ward-based pharmacist intervention had small expected negative NMB for the minimum and maximum intervention cost scenario.</p>
Klopotowska 2010 ³² [Netherlands]	Partially applicable ⁱ	Potentially serious limitations ^j	<ul style="list-style-type: none"> • Before and after comparative interventional study • Population: patients in an adult surgical and medical 28-bed ICU of the academic Medical Centre • Comparators: <ul style="list-style-type: none"> ○ Standard pharmacy services provided by the hospital pharmacy department. ○ Two experienced hospital 	2 versus 1: Saves £108	2 versus 1: 0.38 less prescribing errors per patient 0.009 less prescribing errors that resulted in patient	Pharmacist intervention dominant	<p>No sensitivity analysis reported</p> <p>Subgroup analysis: comparing first half of the intervention period (4 months) versus the second half showed significant difference in outcomes between the 2 periods, with the second period showing better outcomes</p>

Study	Applicability	Limitations	Other comments	Incremental cost	Incremental effects	Cost effectiveness	Uncertainty
			pharmacists present on the ICU daily and attending multidisciplinary patient review meeting. <ul style="list-style-type: none"> • Time horizon: ICU stay. 		harm (pADEs) per patient 0.552 less potentially harmful pADEs per patient 0.263 less prescribing errors that did not result in harm per patient		

Abbreviations: ICER: incremental cost-effectiveness ratio; ICU: intensive care unit; n/a: not applicable; pADE: preventable adverse events; QALY: quality-adjusted life years; RCT: randomised controlled trial; SD: standard deviation.

- (a) QALYs were not used as an outcome measure and only costs and cost savings were included as outcomes. Some uncertainty regarding the applicability of resource use and costs from Belgium (2013) to current NHS context. The intervention is delivered by a junior and a senior clinical pharmacist; which may not be the same as in NHS hospitals.
- (b) The study is a comparative cost analysis with no health outcomes. The costs included were only pharmacist time and ICU drug costs while the cost of hospital stay and other staff time were not included. The study follow-up is short (ICU stay) and may not capture the difference in all relevant costs. Limited sensitivity analysis is reported.
- (c) The standard care arm in the study is not clearly described. Some uncertainty regarding the applicability of resource use and costs from Sweden (2009) to current NHS context. Changes in quality of life are based on the literature and assumptions and not reported directly from patients.
- (d) The model has a short time horizon and does not capture differences in downstream costs and outcomes between the comparators. The baseline and relative treatment effectiveness estimates are based on a series of non-randomised studies conducted to evaluate the LIMM model and source the input parameters for the model, hence by definition, does not reflect all evidence in the area. Local costs appear to have been used and it is not clear whether these costs reflect national costs. A potential conflict of interest might exist given that the study is funded by a pharmacy company with commercial interest in disseminating the LIMM model.
- (e) QALYs were not used as an outcome measure. Some uncertainty regarding the applicability of resource use and costs from Sweden (2008) to current NHS context. The intervention is delivered by pharmacists with postgraduate training in clinical pharmacy but no specialist status which may not reflect the situation in UK hospitals.
- (f) Relative effectiveness evidence is based on a single RCT, so by definition does not reflect all evidence in the area. Follow-up for 12 months which may not capture all relevant costs and outcomes. Primary care visits, medication costs and cost of other staff time were not included in the analysis. No sensitivity analysis is reported.

- (g) *Some uncertainty regarding the applicability of resource use and costs from the literature, which were converted to 2006 UK pounds and adjusted for inflation. No discounting was applied despite using a 5-year time horizon. Utility decrements due to medication errors are based on estimates reached at through discussion within the research team and not based on data collected from patients.*
- (h) *The model has a relatively short time horizon and may not capture all the relevant costs and outcomes, given the potential for preventing fatal medication errors. The health outcomes assessed included only QALY gains from prevention of medication errors. The authors reported that the estimates of baseline and relative effectiveness are "subjectively defined by the authors based on evidence from the literature and qualitative findings from an expert elicitation workshop involving mixture of human factors experts and health professionals to estimate individual error incidence and detection rates" however, no detail is given regarding how the evidence has been identified or reviewed. Costs relating to the time of other health care professionals, which might be affected by more pharmacist involvement, have not been included.*
- (i) *QALYs were not used as an outcome measure and only costs and cost savings were included as outcomes. Some uncertainty regarding the applicability of resource use and costs from the Netherland (2007) to current NHS context. The intervention is delivered by senior clinical pharmacists but with limited ICU experience, which may not be the same as in NHS hospitals.*
- (j) *The study is a cost-consequences analysis with only patient harm as a health outcome. The costs included were limited to staff time and potential saving from pADEs, while the cost of hospital stay and medication were not included. The study follow-up is short (ICU stay) and may not capture all relevant costs and outcomes. No sensitivity analysis is reported.*

Table 9: Economic evidence profile: Pharmacist support at admission versus no ward-based pharmacist

Study	Applicability	Limitations	Other comments	Incremental cost	Incremental effects	Cost effectiveness	Uncertainty
Fertleman 2005 ¹⁹ [UK]	Partially applicable ^a	Potentially serious limitations ^b	<ul style="list-style-type: none"> • Before-and-after observational study • Population: medical patients admitted within the preceding 24 hours to a general medical ward at a district general hospital (Northwick Park hospital in north-west London) • Comparators: <ul style="list-style-type: none"> ○ Ward-based pharmacist provide pharmaceutical care for 1-2 hours at some time during the day (usual care) ○ Senior pharmacist present on post-admission (post-take) ward rounds (PTWR) in addition to the usual care • Follow-up: 3 days 	2 versus 1: Saves £142 in the increase in drug costs between admission and discharge	2 versus 1: n/a	Pharmacist presence during ward round cost saving	None reported.

Abbreviations: ICER: incremental cost-effectiveness ratio; ICU: intensive care unit; n/a: not applicable; pADE: preventable adverse events; QALY: quality-adjusted life years; RCT: randomised controlled trial; SD: standard deviation.

(a) QALYs were not used as an outcome measure. Some uncertainty regarding the applicability of resource use and costs from 2003 to current NHS context.

(b) Observational study with no adjustment for confounders, so by definition not reflecting all evidence in this area. The study has a very short follow-up time for both the pre- and post-intervention phases (3 ward rounds each) and the calculated cost-saving was extrapolated over a year. Long-term impact on costs and outcomes has not been assessed. Additionally, limited costs were included in the analysis (medication costs and pharmacist time). No sensitivity analysis is reported.

Table 10: Economic evidence profile: Pharmacist support at discharge versus no ward-based pharmacist

Study	Applicability	Limitations	Other comments	Incremental cost	Incremental effects	Cost effectiveness	Uncertainty
Wallerstedt 2012 ⁶⁶ [Sweden]	Partially applicable ^a	Minor limitations ^b	<ul style="list-style-type: none"> • Within-trial analysis (linked trial: Bladh 2011⁸) • Population: Elderly inpatients on 2 internal medicine wards at Sahlgrenska University Hospital, Sweden. • Comparator: <ul style="list-style-type: none"> ○ Usual care, which was received from the same group of physicians and nurses. ○ Clinical pharmacists delivering a composite intervention consisting of medication review including feedback to physicians on prescribing, drug treatment discussion with the patient at discharge, medication report including summary of drug treatment changes to be sent to the GP • Follow-up: 6 months 	2 versus 1: £1,050	2 versus 1: 0.0035	Pharmacist intervention not cost effective with ICER £327,378 per adjusted QALY gained	<p>Probability Intervention 2 cost-effective (£20K/30K threshold): NR/NR</p> <p>Probability Intervention 2 cost-effective (£35,326 (50,000 Euro) threshold): 20%</p> <p>Two sensitivity analyses were reported:</p> <ul style="list-style-type: none"> -Subgroup of deceased (terminally ill) and alive patients - Missing data for EQ-5D were imputed using a regression model (multiple imputation) <p>-Terminally ill patients: ICER for deceased (terminally ill) patients-baseline-adjusted analysis: dominant (£56,946 saved per QALY gained) 95% CI: NR</p> <p>ICER for alive patients-baseline-adjusted analysis: £125,856 per QALY gained 95% CI: NR</p> <p>ICER for alive patients- unadjusted analysis: £179,748 per QALY gained</p>

Study	Applicability	Limitations	Other comments	Incremental cost	Incremental effects	Cost effectiveness	Uncertainty
							95% CI: NR -Imputed dataset: ICER – using baseline-adjusted analysis: £81,377 per QALY gained. 95% CI: NR ICER – unadjusted analysis: £117,681 per QALY gained. 95% CI: NR

Abbreviations: ICER: incremental cost-effectiveness ratio; ICU: intensive care unit; n/a: not applicable; pADE: preventable adverse events; QALY: quality-adjusted life years; RCT: randomised controlled trial; SD: standard deviation.

(a) Some uncertainty regarding the applicability of resource use (2007-2008) and costs (2011) from Sweden to the current NHS context. It is not clear which EQ-5D tariff was used for calculating utilities. The intervention is delivered by junior pharmacists, which may not be the same to clinical pharmacist services delivered at UK hospitals.

(b) Relative effectiveness evidence is based on a single RCT, so by definition does not reflect all evidence in the area. Short follow-up, 6 months, so may not capture all relevant costs and outcomes.

1 30.5 Evidence statements

2 Clinical

3 Stratum - Regular in-hospital ward based pharmacy support

4 Eight randomised controlled trials comprising 2,303 people evaluated the role of regular in-
 5 hospital pharmacist support for improving outcomes in secondary care, in adults and young
 6 people at risk of an AME, or with a suspected or confirmed AME. The evidence suggested that
 7 regular in-hospital pharmacist support may provide a benefit for reduced mortality (3 studies,
 8 very low quality), reduced preventable adverse drug events in hospital (2 studies, very low
 9 quality) and at 90 days follow up (1 study, very low quality) and length of stay (2 studies,
 10 moderate quality) and increased patient and/or carer satisfaction at discharge and at one month
 11 follow-up (1 study, low quality). The evidence suggested that regular in-hospital pharmacist
 12 support has no effect on readmission (1 study, very low quality), adverse drug events at 3 to 6
 13 months post discharge (1 study, very low quality) and admission (4 studies, moderate quality).
 14 Evidence suggested no difference between the groups for the outcome of reducing prescribing
 15 errors at discharge (2 studies, low quality) ; however there were increased prescribing errors at 30
 16 days in regular in-hospital pharmacist support group compared to no pharmacist support group (1
 17 study quality, moderate quality).

18 Stratum - Pharmacist at admission

19 • Six randomised controlled trials comprising 401 people evaluated the role of pharmacists at
 20 admission for improving outcomes in secondary care, in adults and young people at risk of an
 21 AME, or with a suspected or confirmed AME. The evidence suggested that pharmacists at
 22 admission may provide benefit for reduced medicine errors (2 studies, low quality), total
 23 medication errors within 24 hours of admission (1 study, moderate quality) and physician
 24 agreement (1 study, very low quality). However, there was no difference for quality of life (1
 25 study, low quality), length of stay (1 study, moderate quality), or future hospital admissions (1
 26 study, low quality) and a possible increase in mortality at 3 months (1 study, very low quality).

27 Stratum - Pharmacist at discharge

28 • Four randomised controlled trials comprising 770 people evaluated the role of pharmacists at
 29 discharge for improving outcomes in secondary care, in adults and young people at risk of an
 30 AME, or with a suspected or confirmed AME. The evidence suggested that pharmacists at
 31 discharge may provide a benefit for reduced prescription errors (1 study, low quality), reduced
 32 readmissions up to 22 days post discharge (1 study, very low quality) and reducing prescriber
 33 errors (drug therapy inconsistencies and omissions) at discharge (1 study, moderate quality). The
 34 evidence suggested that pharmacists at discharge have no effect on quality of life scales (1 study,
 35 very low to low quality).

36 Economic

37 Stratum - Regular ward-based pharmacist support

38 • Three economic evaluations reported that the ward-based pharmacist intervention was
 39 dominant (more effective and less costly) compared to usual care. One of these economic
 40 evaluations was a cost-utility analysis reporting a QALY gain of 0.005. These analyses were
 41 assessed as partially applicable with potentially serious limitations.

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- One cost-utility analysis showed that the ward-based pharmacist intervention was cost-effective with an ICER of £632 per QALY gained (as calculated by the NGC). The analysis was assessed as partially applicable with potentially serious limitations.
 - One economic evaluation showed that regular ward-based pharmacist support was less effective and less costly, with no clear conclusion regarding cost effectiveness given the absence of a cost-effectiveness threshold for the reported outcomes. The analysis was assessed as partially applicable with potentially serious limitations.

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Stratum – pharmacist at admission

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- One comparative cost analysis showed that pharmacist support at admission was cost saving compared to usual care. The analysis was assessed as partially applicable with potentially serious limitations.

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Stratum – pharmacist at discharge

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- One cost-utility analysis showed that the ward-based pharmacist support at discharge was not cost effective, with an ICER of £327,378 per adjusted QALY gained. The analysis was assessed as partially applicable with minor limitations.

1 30.6 Recommendations and link to evidence

Recommendations	17. Include ward-based pharmacists in the multidisciplinary care of people admitted to hospital with a medical emergency.
Research recommendation	-
Relative values of different outcomes	<p>Mortality, avoidable adverse events, quality of life, patient and/or carer satisfaction, length of stay in hospital, prescribing errors, missed medications, and medicines reconciliation were considered by the guideline committee to be critical outcomes.</p> <p>Readmissions, admissions to hospital, discharge from hospital and staff satisfaction were considered by the committee to be important outcomes.</p>
Trade-off between clinical benefits and harms	<p>A total of 18 studies (20 papers) were identified that assessed ward based pharmacist support. They were split into three categories:</p> <p><u>Regular in-hospital ward based pharmacy support compared to no ward-based pharmacist</u></p> <p>Eight randomised controlled trials were identified. The evidence suggested that regular in-hospital pharmacist support may provide benefit for reduced mortality, reduced preventable adverse drug events in hospital and at 90 days, length of stay and increased patient and/or carer satisfaction. However, there was no effect on readmission, adverse drug events at 3 to 6 months post discharge and admission. Evidence for the outcome prescribing errors at discharge suggested no difference between the groups for the outcome of reducing prescribing errors at discharge; however there were increased prescribing errors at 30 days in regular in-hospital pharmacist support group compared to no pharmacist support group. No evidence was found for quality of life, missed medications, medicines reconciliation, admissions to hospital, discharges or staff satisfaction.</p> <p><u>Pharmacist at admission compared to no ward-based pharmacist</u></p> <p>Six randomised controlled trials were identified. The evidence suggested that pharmacists at admission may provide benefit by reduced medicine errors, total medication errors within 24 hours of admission and physicians agreement. However, there was no difference for quality of life, length of stay, or future hospital admissions and a possible increase in mortality at 3 months. However, the mortality outcome was graded very low quality and the committee interpreted this with caution as it was from 1 small study with low events and wide confidence intervals. No evidence was found for avoidable adverse events, patient and/or carer satisfaction, readmissions, prescribing errors, missed medications or discharges.</p> <p><u>Pharmacist at discharge compared to no ward-based pharmacist</u></p> <p>Four randomised controlled trials were identified. The evidence suggested that pharmacists at discharge may provide benefit for reduced prescription errors, reduced readmissions up to 22 days post discharge and prescriber errors (drug therapy inconsistencies and omissions) at discharge. The evidence suggested that pharmacists at discharge have no effect on quality of life scales. No evidence was found for mortality, patient or staff satisfaction, length of stay, future hospital admissions, missed medications, avoidable adverse events or discharges.</p> <p><u>Summary</u></p> <p>Overall the evidence demonstrated some potential benefits for ward-based pharmacists supplementing the prescribing and drug delivery activities provided by physicians and nurses. The mechanism by which pharmacists might improve patient outcomes would most likely be through minimising prescribing errors and drug interactions, by ensuring appropriate prescribing or discontinuation of drugs. Pharmacist education and support is likely to improve patient and/or carer</p>

Recommendations	17. Include ward-based pharmacists in the multidisciplinary care of people admitted to hospital with a medical emergency.
Research recommendation	-
	<p>satisfaction.</p> <p>Evidence was found for these outcomes, though not in all populations and with some inconsistencies. No evidence was found relating to 7 day provision of a ward pharmacist.</p> <p>The committee decided to make a strong recommendation for ward based pharmacists because there was evidence of benefit in many of the facets of pharmacists' work even though overall the evidence was relatively weak. The economic evidence was also in favour of the provision of pharmacy support. In addition, the presence of a ward based pharmacist is common practice in the UK and the experience of the committee was positive overall. The committee noted that studies involving the pharmacist at hospital discharge may have reduced the need for junior doctors to explain prescribing regimens, and the need for the patient to visit their general practitioner following discharge for drug review, which may have improved patient and/or carer satisfaction and which would have had a potential cost benefit.</p> <p>The committee also discussed the added value of having a pharmacist as part of daily MDTs (see Chapter 29 on MDTs). Prescription and administration errors are amongst the most commonly identified adverse events during a patient's stay in hospital. Pharmacists as part of the MDT can reduce these errors and ensure that the patient gets the correct treatment in a time effective manner, as well as discontinuing drugs which are no longer required. The pharmacist has an important educational role which will be likely to improve patients' compliance after discharge. These activities allow doctors to prioritise other tasks.</p>
Trade-off between net effects and costs	<p><u>Regular in-hospital pharmacy support compared to no ward-based pharmacist</u></p> <p>Five economic evaluations were identified.</p> <ul style="list-style-type: none"> - Three economic evaluations reported that the ward-based pharmacist intervention was dominant (more effective and less costly) compared to usual care. - One UK cost-utility analysis showed that the ward-based pharmacist intervention was cost-effective with an ICER of £632 per QALY gained (as calculated by the NGC). - One economic evaluation showed that pharmacist support was less effective and less costly, with no clear conclusion regarding cost effectiveness given the absence of a cost-effectiveness threshold for the reported outcomes. <p><u>Pharmacist at admission compared to no ward-based pharmacist</u></p> <p>One UK comparative cost analysis, which showed that the ward-based pharmacist intervention was cost saving compared to usual care.</p> <p><u>Pharmacist at discharge compared to no ward-based pharmacist</u></p> <p>One cost-utility analysis showed that the ward-based pharmacist intervention was <u>not</u> cost effective, with an ICER of £327,378 per adjusted QALY gained. There was a suggestion that the lack of seniority of the pharmacists and lack of integration in the ward team reduced the effectiveness in that study.</p> <p>The committee noted that clinical pharmacists in the UK studies were generally experienced (band 7/8) and have specialist knowledge in the medications they managed. This may not be the same profile in all the other non-UK studies.</p>

Recommendations	17. Include ward-based pharmacists in the multidisciplinary care of people admitted to hospital with a medical emergency.
Research recommendation	-
	<p>Additionally, standard care/control arm in the included studies was not always clearly defined and was variable in terms of clinical pharmacist input. Some studies included a specified level of clinical pharmacist input in the control group which was enhanced in the intervention group (for example, by attendance at ward rounds) while others described the introduction of a de-novo service.</p> <p>With the exception of the UK modelling study (Karnon 2008²⁹); all studies had a follow-up of 12 months or less and hence would not have assessed the long term impact of the ward based pharmacist intervention. Additionally, the majority of the studies assessed a limited number of cost categories; focusing on medication costs, pharmacist time and less on other staff time and patient-related downstream costs.</p> <p>The committee felt there was evidence that pharmacist support throughout the stay would achieve saving in terms of medications costs, which was the most frequently assessed cost category in the included studies. One study found the pharmacist cost was completely offset by medication cost savings. The evidence was less clear in terms of impact on other staff time as well as the impact on long-term patient outcomes, which were not always assessed in the included studies. However, in those studies that assessed impact on other staff time and long-term outcomes, the results showed potential for cost saving that could be extrapolated to the other studies. Avoiding medication errors and litigation costs was raised by the committee as another potential positive outcome. Overall, the committee felt that this could be a cost saving intervention.</p> <p>Overall, the committee concluded that the use of ward-based pharmacists throughout the hospital stay is cost-effective. Pharmacist support only at discharge was shown to be not cost effective but the evidence was limited.</p>
Quality of evidence	<p>The evidence reviewed for in-hospital pharmacist support was of very low to moderate quality due to risk of bias, imprecision and inconsistency.</p> <p>The evidence reviewed for pharmacist at admission was of very low to moderate quality due to risk of bias, imprecision and outcome indirectness. The outcome 'agreement with prescriber' which was used as a surrogate outcome for staff satisfaction was considered an indirect outcome.</p> <p>The evidence for pharmacist at discharge was of very low to moderate quality due to risk of bias and imprecision.</p> <p>The committee noted the improved benefits shown in the UK studies compared to other countries and felt this was due to the fact that ward-based pharmacists are already well embedded in UK practice. However, the committee did note that these studies did not report the level of pharmacist experience and this may limit the interpretation of benefit.</p> <p>The health economic evidence was assessed to be partially applicable (with only 1 study from the UK and only 1 reporting QALYs). The evidence was also considered to have potentially serious limitations with none of the studies being based on a review of the evidence base and the cost components included being variable.</p>
Other considerations	<p>There was no evidence specifically to support 7 day provision of ward based pharmacists. The committee therefore chose a general recommendation, recognising that pharmacy services would need to be scaled up in parallel with other services in the transition to a 7 day service.</p> <p>Currently medical wards in the UK do have access to a pharmacist. However, the pharmacist may be responsible for covering several areas concurrently; limiting the</p>

Recommendations	17. Include ward-based pharmacists in the multidisciplinary care of people admitted to hospital with a medical emergency.
Research recommendation	-
	<p>level of detail they can bring to medicines reconciliation and patient and staff communication. This is particularly important for an ageing population with multiple co-morbidities for whom polypharmacy adds complexity and may indeed be the cause of the acute admission. In this situation the pharmacist plays a vital role advising the medical team regarding the interactions of drugs and how to prescribe treatment optimally.</p> <p>Pharmacists are gradually acquiring independent prescribing rights. This allows them (following consultation with the prescribing doctor) to correct prescribing errors or make changes to better agents, relieving doctors of this task. Prescribing drugs to take home at the end of a person’s hospital stay could also facilitate earlier discharge from hospital and allow junior doctors to focus on other tasks such as the ward rounds. Assessment of the cost-effectiveness of prescribing pharmacists in hospital should include these considerations.</p>

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1 Appendices

2 Appendix A: Review protocols

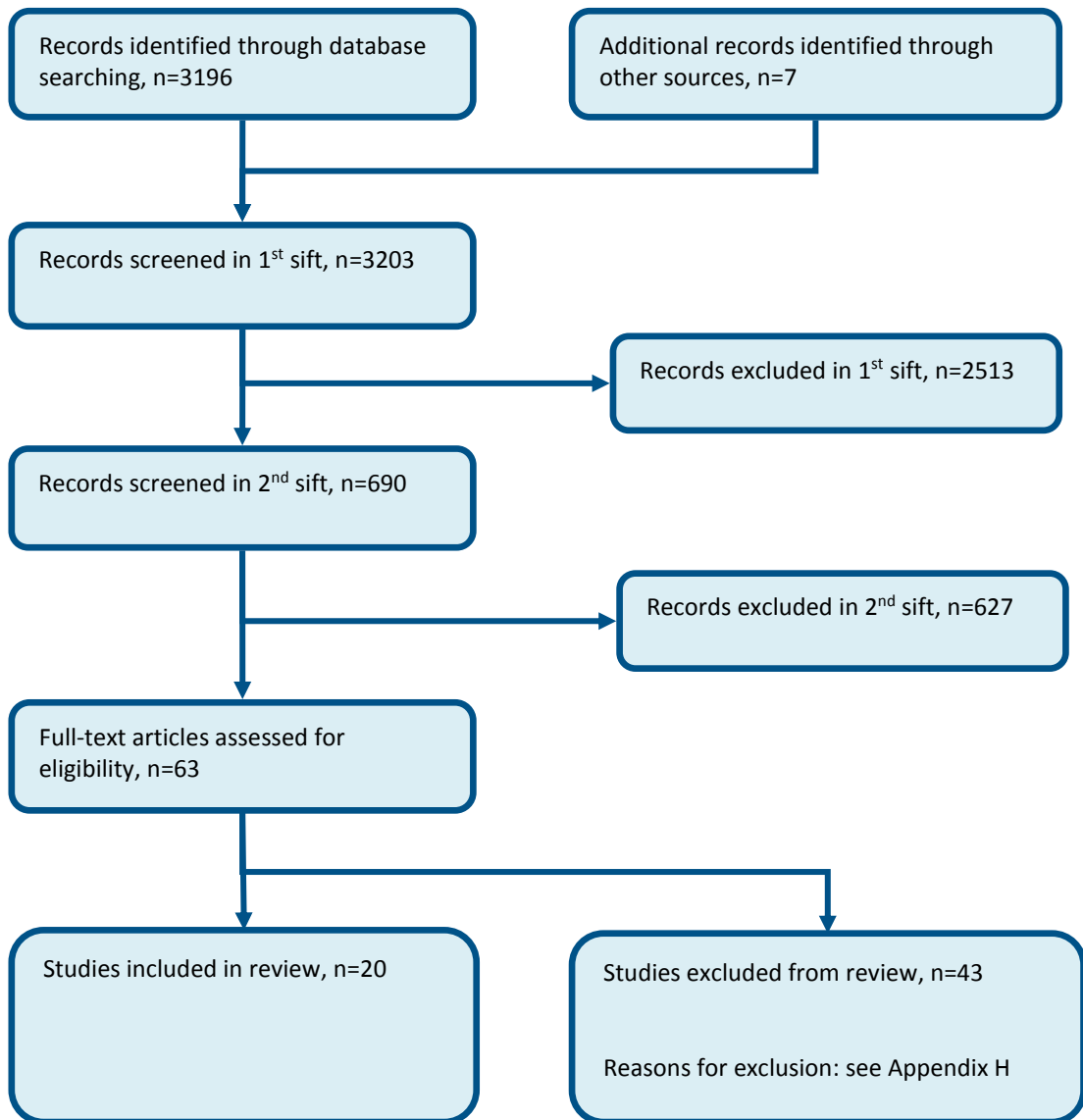
3 **Table 11: Review protocol: Pharmacist support**

Review question	Do ward-based pharmacists improve outcomes in patients admitted to hospital with a suspected or confirmed acute medical emergency?
Guideline condition and its definition	Acute medical emergencies. Definition: People with suspected or confirmed acute medical emergencies or at risk of an acute medical emergency
Review population	Adults and young people (16 years and over) admitted to hospital with a suspected or confirmed AME
	Adults and young people (16 years and over)
	Line of therapy not an inclusion criterion
Interventions and comparators: generic/class; specific/drug (All interventions will be compared with each other, unless otherwise stated)	<ul style="list-style-type: none"> • Presence of medical ward based pharmacists <ul style="list-style-type: none"> ○ for 7 days a week ○ for less than 7 days a week • No ward based pharmacists
Outcomes	<ul style="list-style-type: none"> - Mortality during the study period (Dichotomous) CRITICAL - Avoidable adverse events during the study period (Dichotomous) CRITICAL - Quality of life during the study period (Continuous) CRITICAL - Patient and/or carer satisfaction during the study period (Continuous) CRITICAL - Length of stay in hospital during the study period (Continuous) CRITICAL - Readmissions within 30 days (Dichotomous) IMPORTANT - Future admissions to hospital (over 30 days) (Dichotomous) IMPORTANT - Discharges during the study period (Dichotomous) IMPORTANT - Prescribing errors during the study period (Dichotomous) CRITICAL - Missed medications during the study period (Dichotomous) CRITICAL - Medicines reconciliation during the study period (Dichotomous) CRITICAL - Staff satisfaction during the study period (Continuous) IMPORTANT
Study design	Systematic reviews (SRs) of RCTs, RCTs, observational studies only to be included if no relevant SRs or RCTs are identified.
Unit of randomisation	Patient Hospital Ward
Crossover study	Not permitted
Minimum duration of study	Not defined
Subgroup analyses if there is heterogeneity	<ul style="list-style-type: none"> - Frail elderly (Frail elderly; No frail elderly); Effects may be different in this subgroup - Haematology or oncology patients (Haematology or oncology patients; Not haematology or oncology patients); Effects may be different in this subgroup
Search criteria	Databases: Medline, Embase, the Cochrane Library Date limits for search: No date limits Language: English

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Appendix B: Clinical article selection

Figure 1: Flow chart of clinical article selection for the review of pharmacy support



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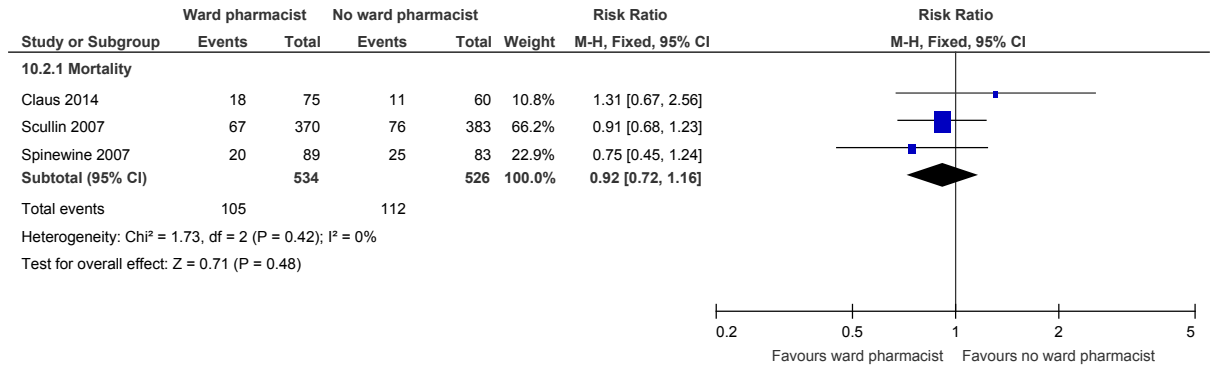
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Appendix C: Forest plots

C.1 Regular in-hospital pharmacist support

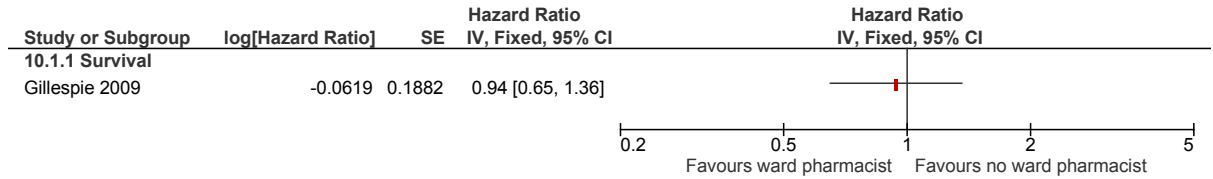
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Figure 2: Mortality



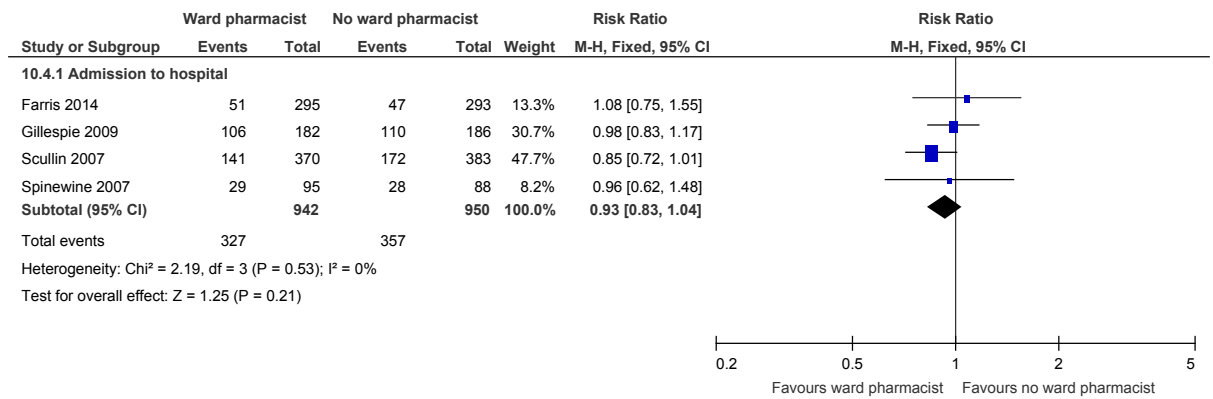
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Figure 3: Survival



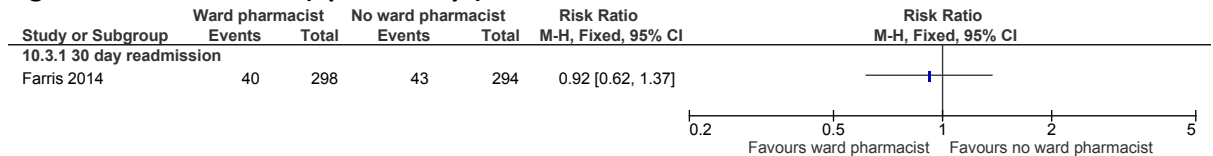
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Figure 4: Admission to hospital



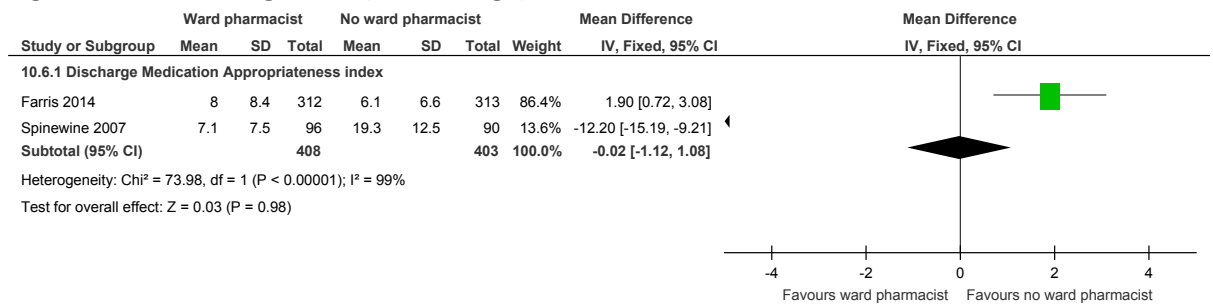
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Figure 5: Readmission (up to 30 days)



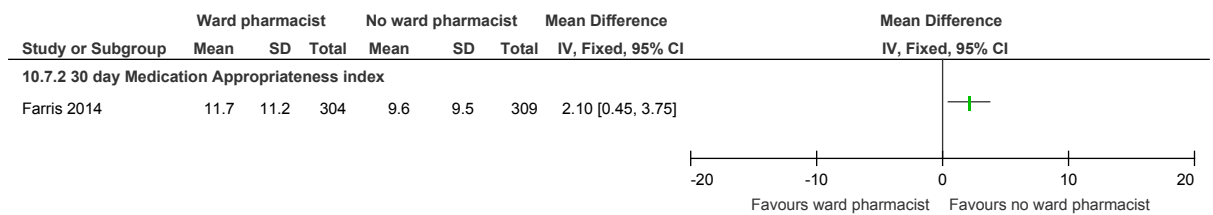
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Figure 6: Prescribing errors (at discharge)



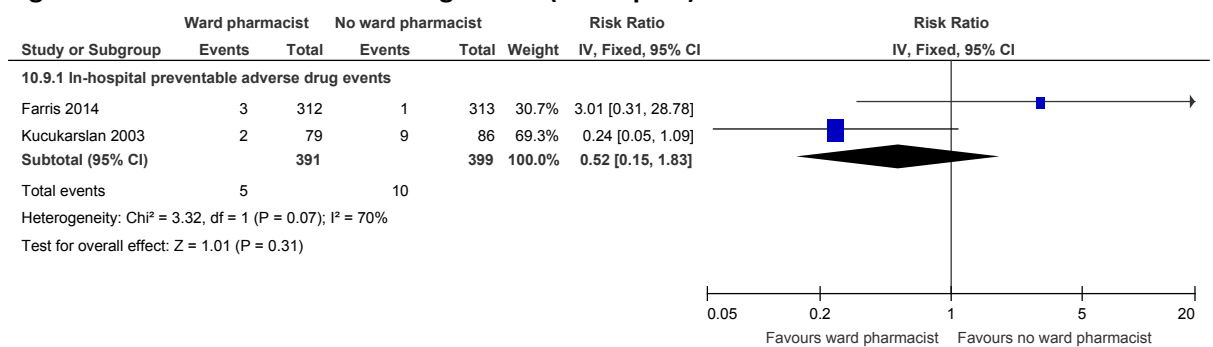
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Figure 7: Prescribing errors (30 day)



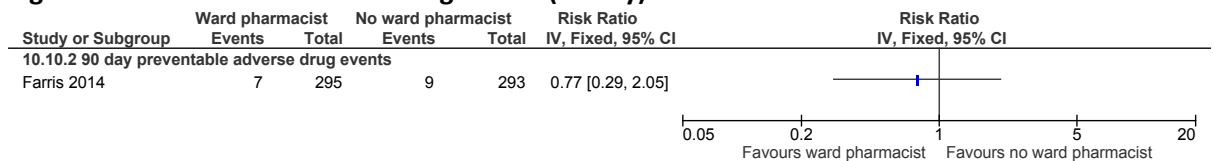
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Figure 8: Preventable adverse drug events (in-hospital)



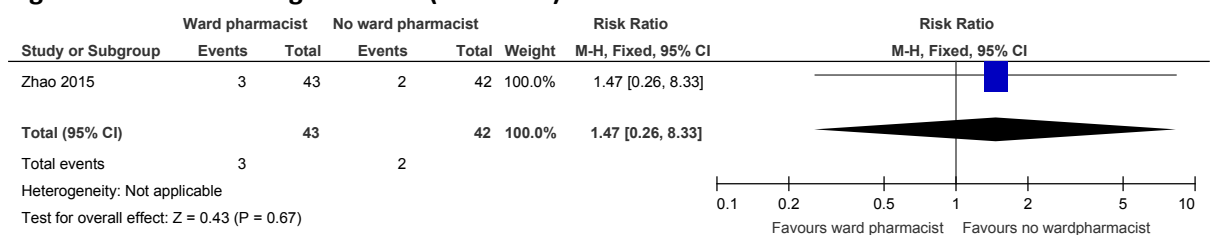
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Figure 9: Preventable adverse drug events (90 day)



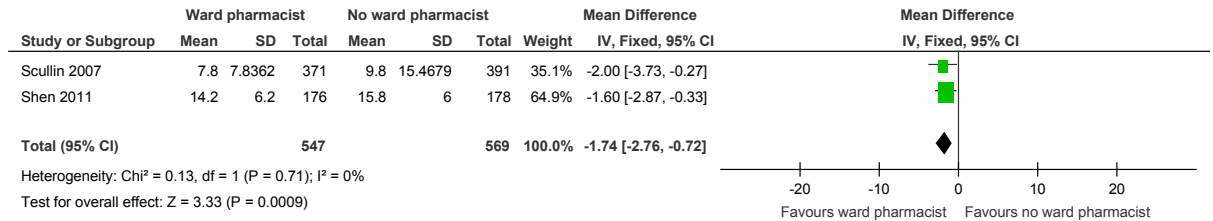
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Figure 10: Adverse drug reactions (6 months)



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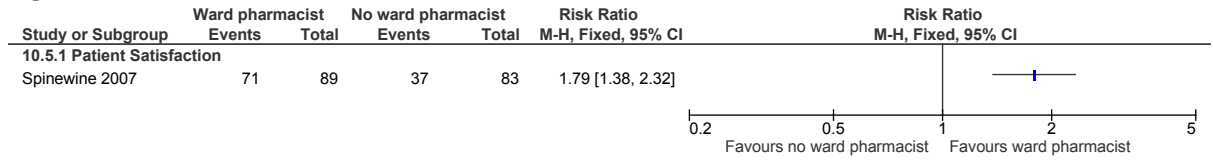
Figure 11: Length of stay



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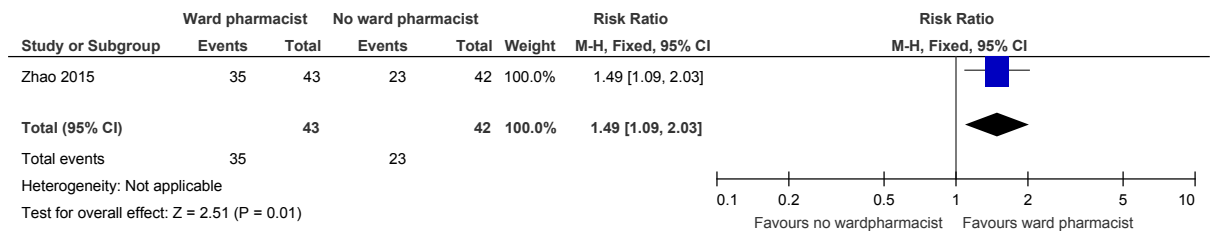
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Figure 12: Patient satisfaction



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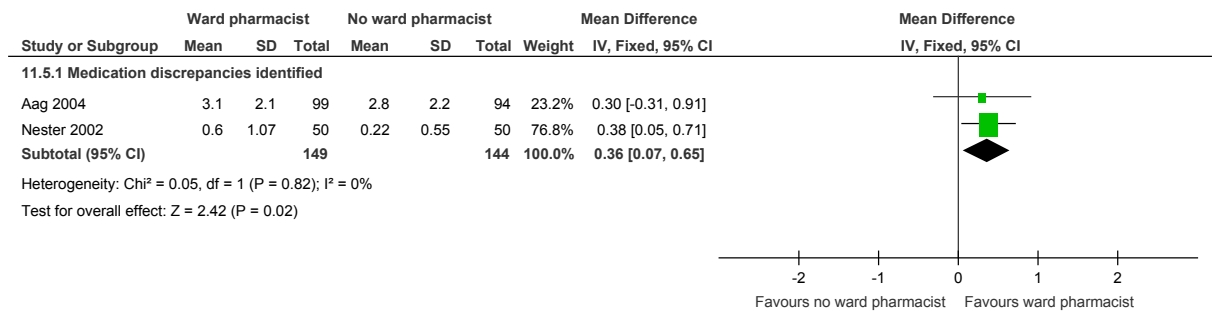
Figure 13: Patient and/or carer satisfaction



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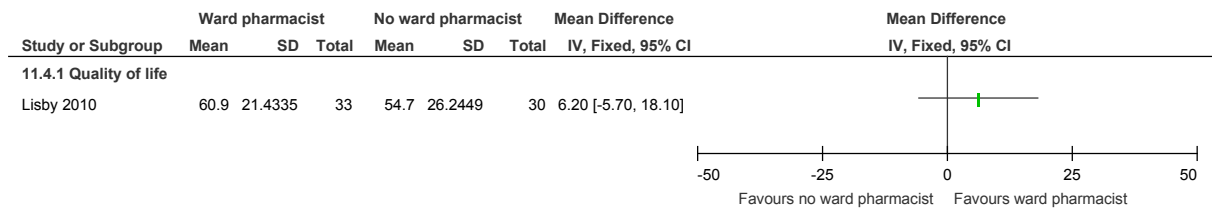
6 **C.2 Pharmacist at admission**

Figure 14: Medication errors identified



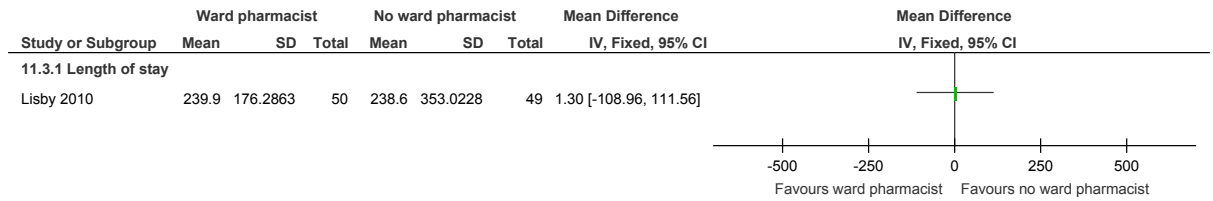
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Figure 15: Quality of life



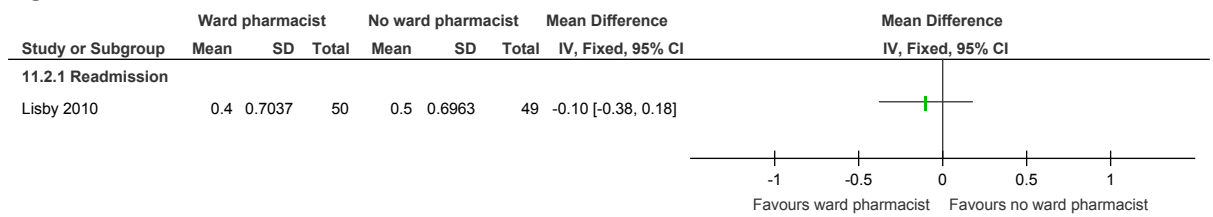
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Figure 16: Length of stay



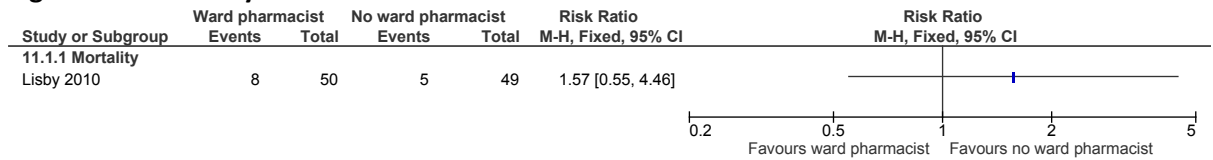
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Figure 17: Admission



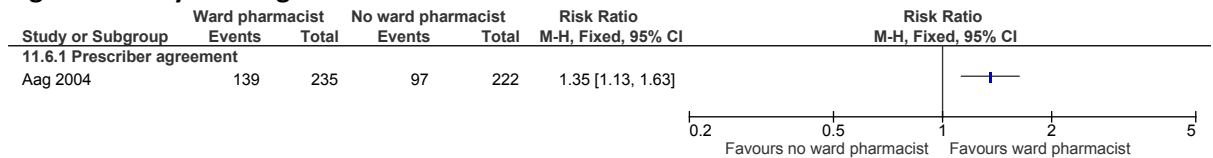
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Figure 18: Mortality



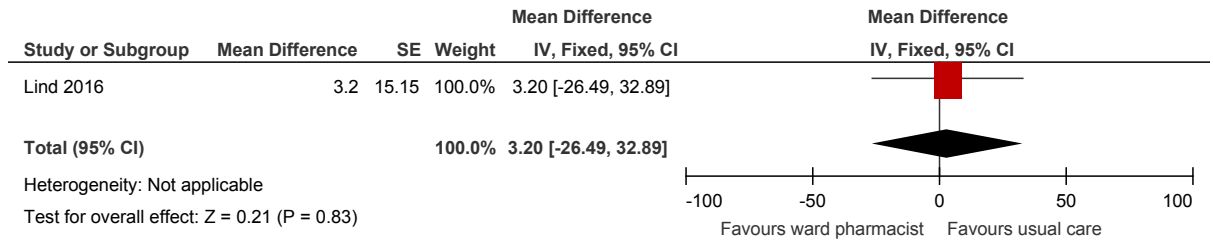
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Figure 19: Physician agreement



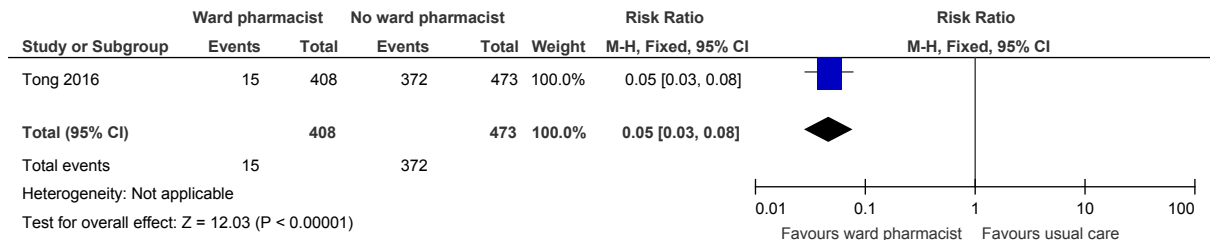
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Figure 20: Length of stay in acute admission unit (minutes)



1

Figure 21: Total medication errors within 24 hours of admission

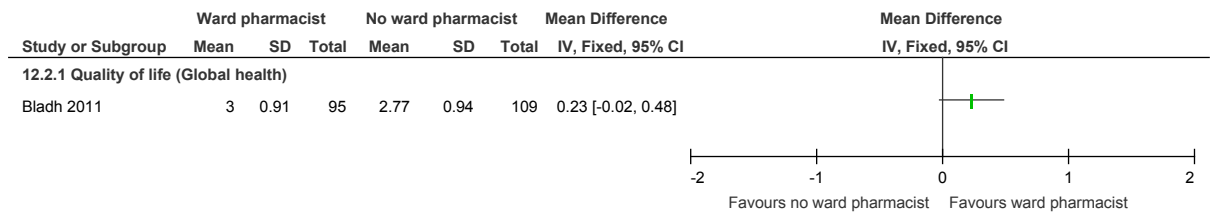


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3 C.3 Pharmacist at discharge

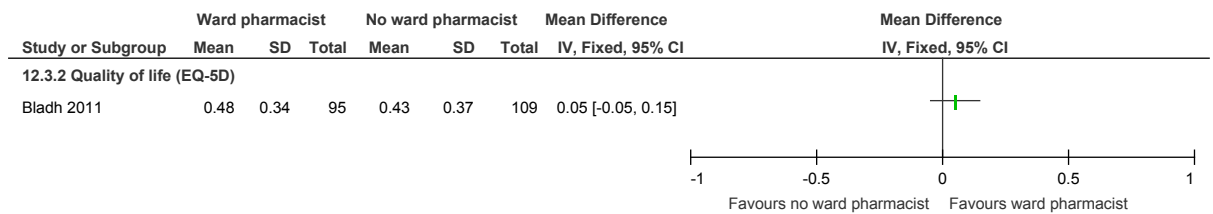
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Figure 22: Quality of life (Global health)



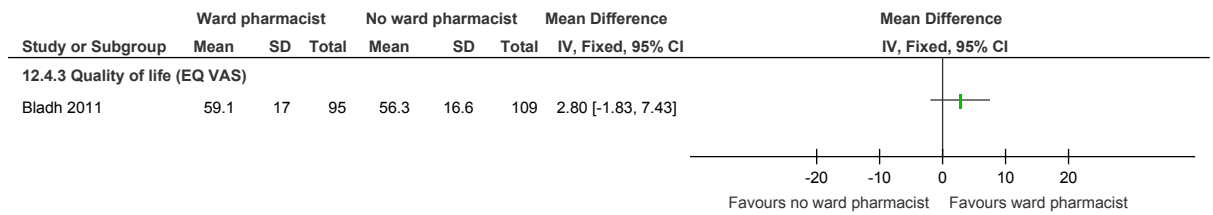
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Figure 23: Quality of life (EQ-5D)



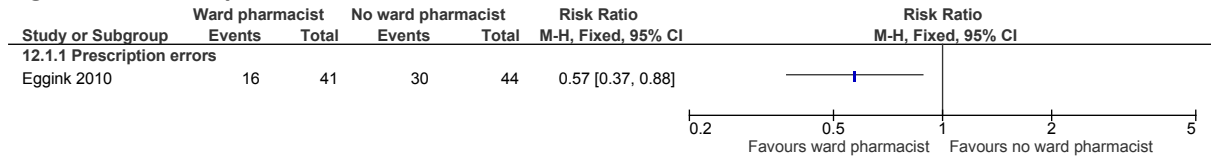
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Figure 24: Quality of life (EQ-VAS)



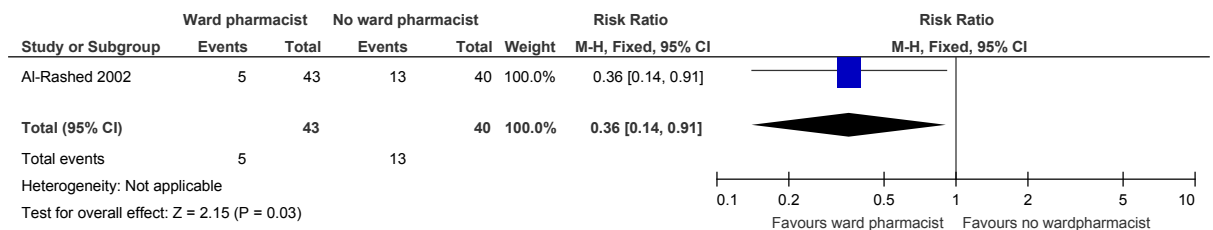
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Figure 25: Prescription errors



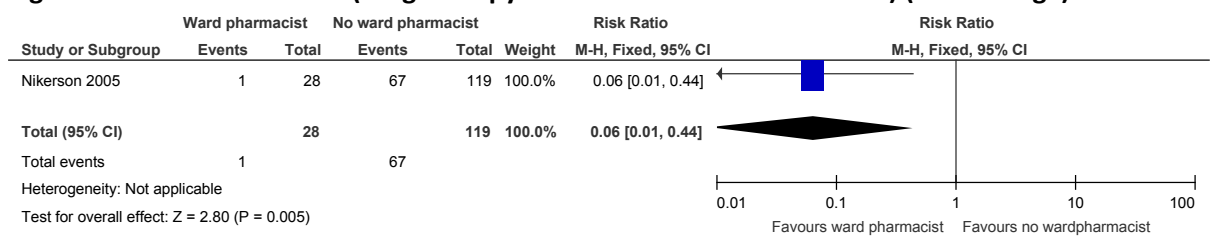
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Figure 26: Readmission (15-22 days)



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Figure 27: Prescriber errors (drug therapy inconsistencies and omissions) (at discharge)



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5

Appendix D: Clinical evidence tables

Study	Aag 2014 ¹
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=201)
Countries and setting	Conducted in Norway; Setting: One cardiology ward at a university hospital
Line of therapy	1st line
Duration of study	Intervention time: 5 weeks
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Cardiology patients
Subgroup analysis within study	Not applicable
Inclusion criteria	Aged 18 and over
Exclusion criteria	Terminal illness, isolated due to an infectious disease, unable to communicate in either Norwegian or English.
Recruitment/selection of patients	Consecutively admitted patients
Age, gender and ethnicity	Age - Mean (SD): Group 1: 68.9 (14.0), Group 2: 67.5 (11.6). Gender (M:F): 134:67. Ethnicity: NR
Further population details	Not stated
Indirectness of population	No indirectness
Interventions	<p>(n=100) Intervention 1: Presence of medical ward based pharmacists. Medication reconciliation at admission performed by a clinical pharmacist using a structured interview to obtain medication history as well as additional sources (patient's own medication lists, relatives, other care givers, the patient's general practitioner or the community pharmacy). Medication was reconciled with the hand written medication charts. Duration unclear (patients for inclusion identified by principal investigator every morning during weekdays). Concurrent medication/care: usual care.</p> <p>(n=101) Intervention 2: No ward based pharmacists. Medication reconciliation at admission performed by a nurse using a structured interview to obtain medication history as well as additional sources (patient's own medication lists, relatives, other care givers, the patient's general practitioner or the community pharmacy). Medication was reconciled with the hand written medication charts. Duration: unclear (patients for inclusion identified by principal investigator every morning during weekdays). Concurrent medication/care: usual care</p> <p>Comments: Both pharmacists and nurses were taught and trained by an independent, experience clinical pharmacist</p>

Study	Aag 2014¹
	both theoretically and practically in order to perform medicine reconciliation.
Funding	Funding not stated
RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS AT ADMISSION versus NO WARD BASED PHARMACISTS	
<p>Protocol outcome 1: Medicines reconciliation during the study period - Actual outcome: Medication discrepancies identified at admission; Group 1: mean 3.1 discrepancies per patient (SD 2.1); n=99, Group 2: mean 2.8 discrepancies per patient (SD 2.2); n=94; Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: -- ; Baseline details: Pharmacist had greater number of patients arriving from home (60% vs 29%); Group 1 Number missing: 1, Reason: 'dropouts' (1); Group 2 Number missing: 7, Reason: 'dropouts' (7)</p> <p>Protocol outcome 2: Staff satisfaction during the study period - Actual outcome: Prescribing physician agreement at admission; Group 1: 139/235, Group 2: 97/222; Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: Serious indirectness, Comments: Surrogate outcome for staff satisfaction; Baseline details: Pharmacist had greater number of patients arriving from home (60% vs 29%); Group 1 Number missing: 1, Reason: 'dropouts' (1); Group 2 Number missing: 7, Reason: 'dropouts' (7)</p>	
Protocol outcomes not reported by the study	Mortality during the study period; Avoidable adverse events during the study period; Quality of life during the study period; Patient and/or carer satisfaction during the study period; Length of stay in hospital during the study period; Readmissions within 30 days; Discharges during the study period; Prescribing errors during the study period; Missed medications during the study period

Study	Al-rashed 2002³
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=83)
Countries and setting	Conducted in United Kingdom; Setting: Care of the elderly wards
Line of therapy	Not applicable
Duration of study	Intervention + follow up: Follow-up- 3 months post-discharge
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable

Study	Al-rashed 2002 ³
Inclusion criteria	All patients admitted to care of the elderly wards who were >65 years, prescribed 4 or more regular items, were to be discharged to their own home and had an abbreviated mental score >7/10, English as a first language, and routine clinical pharmacist assessment that they could have problems with their medicines after discharge
Exclusion criteria	Not stated
Recruitment/selection of patients	Not stated
Age, gender and ethnicity	Age - Mean (SD): Intervention - 80.2 (5.7) years; control-81.1 (5.8) years. Gender (M:F): not stated. Ethnicity: Not stated
Further population details	Not stated
Extra comments	There was no statistical difference in gender between the groups. There was no statistical difference for the drugs on admission between the 2 groups and those prescribed during their hospital stay and at discharge
Indirectness of population	No indirectness
Interventions	<p>(n=43) Intervention 1: Presence of medical ward based pharmacists - Presence of medical ward based pharmacists for 7 days a week.</p> <p>The intervention group received pre-discharge counselling (24 hours before discharge) by the clinical pharmacist attached to that ward. During this counselling session (approximately 30 minutes per patient), patients received information about their medicines. This included why each item had been prescribed, other uses and side-effects. Doses and dosage times were stressed with the aid of the medicine reminder card together with instructions to keep this card with their medicines as a constant reminder. The importance of compliance was stressed together with the consequences of under and over use of their medicines. The pharmacist asked the patient appropriate questions to ensure that the patient had remembered the information. This counselling session was planned for the 24 hour period before the patient was planned to be discharged. Duration Admission (in-patient). Concurrent medication/care: Not stated.</p> <p>Comments: At discharge all control and study group patients were given 2 envelopes. Each envelope contained a questionnaire to obtain feedback on the information discharge system that had been implemented. Also on discharge all patients were informed that a research pharmacist would contact them within 7 days to arrange a visit at their home to 'check how they were coping with their medicines'. This visit was planned between 15 and 22 days post-discharge. A second visit was arranged for 3 months post-discharge.</p> <p>(n=40) Intervention 2: No ward based pharmacists. Normal hospital discharge policy – all patients, their GPs, district nurses and carers received a copy of the patient's medication and information discharge summary sheet (MIDS). This hand written sheet included data on the date of admission and discharge, reasons for admission, diagnosis and other problems together with their major in-patient events and follow-up procedure. Patients received a medicine reminder</p>

Study	Al-rashed 2002³
	card. On this card the generic name for each drug prescribed was stated together with other common names given to the drug and what it was prescribed for. The number of doses together with the times of day was also included. All patients were given 14 days of medication on discharge and informed to show their GP and community pharmacist the MIDS and medicine card during their first visit post-discharge. Normal discharge was provided to control patients. At this point the nurse went through their discharge medicines and explained that a new supply (via their GP) should be arranged within 14 days. They used the medicine reminder card and each dispensed item when explaining the prescribed drugs and doses. Duration Admission (in-patient). Concurrent medication/care: Not stated.
Funding	Funding not stated
RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS FOR 7 DAYS A WEEK versus NO WARD BASED PHARMACISTS	
Protocol outcome 1: Readmission - Actual outcome: Re-admission at 15-22 days post-discharge ; Group 1: 5/43, Group 2: 13/40; Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness	
Protocol outcomes not reported by the study	Mortality; Avoidable adverse events; Quality of life; Patient and/or carer satisfaction; Length of stay in hospital; Discharges; Prescribing errors; Missed medications; Medicines reconciliation; Staff satisfaction

Study	Bladh 2011⁸
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=345)
Countries and setting	Conducted in Sweden; setting: 2 internal medicine wards at a university hospital
Line of therapy	1st line
Duration of study	Follow up (post intervention): 6 months
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	Capable of assessing their HRQL and giving written informed consent
Exclusion criteria	Poor Swedish language, planned discharge before intervention can be performed, transferred during their stay to other hospitals or wards not belonging to the Department of Medicine

Study	Bladh 2011 ⁸
Recruitment/selection of patients	patients admitted on weekdays
Age, gender and ethnicity	Age - Median (IQR): group 1: 82 (75-86), group 2: 81 (72-87). Gender (M:F): 137:208. Ethnicity: NR
Further population details	1. Frail elderly: Not applicable/Not stated/Unclear 2. Haematology or oncology patients: Not applicable/Not stated/Unclear
Indirectness of population	No indirectness
Interventions	<p>(n=199) Intervention 1: Presence of medical ward based pharmacists. Pharmacists performed continuous medication reviews (not ward-based) including oral feedback on prescribing to physicians; drug treatment discussion with the patient at discharge; a medication report given to the patient's GP. Duration till discharge. Concurrent medication/care: A regular discharge summary was sent to the patient's GP independent of the study. Patients received usual care. Comments: data on prescribing obtained from medical records, and no medication history was taken by the pharmacist</p> <p>(n=181) Intervention 2: No ward based pharmacists. Usual care, no clinical pharmacist involvement. Duration till discharge. Concurrent medication/care: regular discharge summary sent to the patient's GP Comments: same physicians and nurses undertook care for the intervention and control</p>
Funding	Funding not stated
RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS versus NO WARD BASED PHARMACISTS	
<p>Protocol outcome 1: Quality of life during the study period</p> <p>- Actual outcome: Summated EQ-5D index at 6 months follow-up; Group 1: mean 0.48 (SD 0.34); n=95, Group 2: mean 0.43 (SD 0.37); n=109; EQ-5D summarised index - 1-1 Top=High is good outcome; Risk of bias: All domain - Very high, Selection - Low, Blinding - Very high, Incomplete outcome data - High, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Blinding details: Intervention group also recieved continuous medication reviews'; Group 1 Number missing: 104, Reason: During hospital: death (10), transfer (21) discharge (3), other (1); Follow-up: death (20), declined (7) not reached (42); Group 2 Number missing: 92, Reason: During hospital: death (5), transfer (11), other (4); Follow-up: death (15), declined (6) not reached (51)</p> <p>- Actual outcome: Global Health at 6 months follow-up; Group 1: mean 3 (SD 0.91); n=95, Risk of bias: All domain - Very high, Selection - Low, Blinding - Very high, Incomplete outcome data - High, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Blinding details: Intervention group also recieved continuous medication reviews'; Group 1 Number missing: 104, Reason: During hospital: death (10), transfer (21) discharge (3), other (1); Follow-up: death (20), declined (7) not reached (42); Group 2 Number missing: 92, Reason: During hospital: death (5), transfer (11), other (4); Follow-up: death (15), declined (6) not reached (51)</p> <p>- Actual outcome: EQ-VAS at 6 months follow-up; Group 1: mean 59.1 (SD 17); n=95, Risk of bias: All domain - Very high, Selection - Low, Blinding - Very high, Incomplete outcome data - High, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Blinding details:</p>	

Study	Bladh 2011 ⁸
	Intervention group also received continuous medication reviews ¹ ; Group 1 Number missing: 104, Reason: During hospital: death (10), transfer (21) discharge (3), other (1); Follow-up: death (20), declined (7) not reached (42); Group 2 Number missing: 92, Reason: During hospital: death (5), transfer (11), other (4); Follow-up: death (15), declined (6) not reached (51)
Protocol outcomes not reported by the study	Mortality during the study period; Avoidable adverse events during the study period; Patient and/or carer satisfaction during the study period; Length of stay in hospital during the study period; Readmissions up to 30 days; Discharges during the study period; Prescribing errors during the study period; Missed medications during the study period; Medicines reconciliation during the study period; Staff satisfaction during the study period

Study	Claus 2014 ¹³
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=135)
Countries and setting	Conducted in Belgium; Setting: 22 bed Surgical ICU within a university hospital
Line of therapy	1st line
Duration of study	Intervention time: 2 months
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	Over 16 years of age, length of stay greater than 48 hours
Exclusion criteria	None stated
Recruitment/selection of patients	Admission to the Surgical ICU on screening days
Age, gender and ethnicity	Age - Mean (SD): Group 1: 61.1 (2.0), Group 2: 58.0 (2.3). Gender (M:F): 91:44. Ethnicity: NR
Further population details	Not stated
Indirectness of population	No indirectness
Interventions	(n=69) Intervention 1: Presence of medical ward based pharmacists. Patients received active recommendations and follow-up from the pharmacist. Duration 2 months. Concurrent medication/care: No related patient rounds were followed and usual care

Study	Claus 2014 ¹³
	(n=66) Intervention 2: No ward based pharmacists. Pharmacist was present on the ward, but recommendations were not passed on to the primary care giver. Duration 2 months. Concurrent medication/care: No related ward rounds were followed, and usual care Comments: Patients crossed over to the intervention group if the caregiver specifically requested the project's pharmacist to provide advice (n=6)
Funding	
RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS versus NO WARD BASED PHARMACISTS	
Protocol outcome 1: Mortality during the study period - Actual outcome: In-hospital mortality until discharge; Group 1: 14/75, Group 2: 11/60; Risk of bias: All domain - High, Selection - Low, Blinding - High, Incomplete outcome data - High, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: -6; Group 2 Number missing: 6	

Study	Eggink 2010 ¹⁵
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=89)
Countries and setting	Conducted in Netherlands; Setting: Cardiology ward at a teaching hospital
Line of therapy	1st line
Duration of study	Intervention + follow up: 14 months + 6 weeks
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Heart failure patients
Subgroup analysis within study	Not applicable
Inclusion criteria	Over 18 years of age, admitted with a diagnosis of heart failure and prescribed 5 or more medicines (from any class) at discharge
Exclusion criteria	Living in a nursing home, unable to give informed consent or terminal illness
Recruitment/selection of patients	Patients to be discharged
Age, gender and ethnicity	Age - Mean (SD): Group 1: 72 (10), Group 2: 74 (12). Gender (M:F): 57:28. Ethnicity: NR
Further population details	Not stated

Study	Eggink 2010 ¹⁵
Indirectness of population	No indirectness
Interventions	<p>(n=41) Intervention 1: Presence of medical ward based pharmacists. A clinical pharmacist identified potential prescription errors in the discharge medication and discussed them with the cardiologist in order to generate a final discharge medication list. Patients received written and verbal information about (side) effects of, and changes in, their hospital drug therapy from the clinical pharmacist upon hospital discharge and the discharge medication list was faxed to the community pharmacy and given as written information to the patient to hand to their GP. Duration at discharge. Concurrent medication/care: usual care.</p> <p>(n=48) Intervention 2: No ward based pharmacists. Verbal and written information given by a nurse at hospital discharge, and discharge prescription was made by the physician to be given to the GP by the patient. Duration at discharge. Concurrent medication/care: usual care.</p>
Funding	No funding
RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS AT DISCHARGE versus NO WARD BASED PHARMACISTS	
<p>Protocol outcome 1: Prescribing errors during the study period - Actual outcome: prescription errors identified during first outpatient follow-up at within 6 weeks; Group 1: 16/41, Group 2: 30/44; Risk of bias: All domain - Very high, Selection - High, Blinding - Very high, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 0; Group 2 Number missing: 4, Reason: lost to follow-up (2), died (2)</p>	
Protocol outcomes not reported by the study	Mortality during the study period; Avoidable adverse events during the study period; Quality of life during the study period; Patient and/or carer satisfaction during the study period; Length of stay in hospital during the study period; Readmissions up to 30 days; Discharges during the study period; Missed medications during the study period; Medicines reconciliation during the study period; Staff satisfaction during the study period

Study	Gillespie 2009 ²¹
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=400)
Countries and setting	Conducted in Sweden; Setting: University teaching hospital
Line of therapy	1st line
Duration of study	Intervention + follow up: 9 months + 12 months

Study	Gillespie 2009 ²¹
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	over 80 years of age and capable of giving informed consent
Exclusion criteria	Previously been admitted to the study wards during the study period or had scheduled admissions.
Recruitment/selection of patients	Admission to the 2 study acute internal wards
Age, gender and ethnicity	Age - Mean (SD): Group 1: 86.4 (4.2), Group 2: 87.1 (4.1). Gender (M:F): 152:216. Ethnicity: NR
Further population details	Not stated
Indirectness of population	No indirectness
Interventions	<p>(n=199) Intervention 1: Presence of medical ward based pharmacists. A comprehensive list of current medications was compiled on admission. A drug review was performed, and advice was given to the patient's physician on drug selection, dosages, and monitoring needs, with the final decision made by the physician in charge. Patients were educated and monitored throughout the admission process, and received discharge counselling. A follow-up telephone call to patients 2 months after discharge was conducted. Duration in-hospital plus 2 months post-discharge. Concurrent medication/care: usual care.</p> <p>(n=201) Intervention 2: No ward based pharmacists. Standard care without pharmacist involvement in the health care team at the ward level. Standard care usually included the same elements as those of the intervention but was less extensive, focusing mainly on the cause of admission, and was performed by physicians and nurses. Duration until discharge. Concurrent medication/care: usual care.</p>
Funding	Academic or government funding (Uppsala County Council, University Hospital of Uppsala, Uppsala University, Apoteket AB, and Swedish Society of Pharmaceutical Sciences)

RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS versus NO WARD BASED PHARMACISTS

Protocol outcome 1: Mortality during the study period

- Actual outcome: Overall survival at 12 months; HR 0.94 (95%CI 0.65 to 1.36); Risk of bias: All domain - Very high, Selection - High, Blinding - Very high, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low, Other 1 - Low; Indirectness of outcome: No indirectness, Comments: Intervention includes follow-up telephone call at 2 months post-discharge; Baseline details: intervention group had higher prescription drug use; Blinding details: During follow-up period intervention patients received intervention again, but were excluded during the intervention period; Group 1 Number missing: 17, Reason: 13 died before discharge, 4 withdrew; Group 2 Number missing: 15, Reason: 14 died before discharge, 1 withdrew

Study	Gillespie 2009 ²¹
<p>Protocol outcome 2: Future admissions (over 30 days) during the study period - Actual outcome: Admission by 12 months; Group 1: 106/182, Group 2: 110/186; Risk of bias: All domain - High, Selection - High, Blinding - Very high, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low, Other 1 - Low; Indirectness of outcome: No indirectness, Comments: Intervention includes follow-up telephone call at 2 months post-discharge; Baseline details: intervention group had higher prescription drug use; Group 1 Number missing: 17, Reason: 13 died before discharge, 4 withdrew; Group 2 Number missing: 15, Reason: 14 died before discharge, 1 withdrew</p>	
Protocol outcomes not reported by the study	Avoidable adverse events during the study period; Quality of life during the study period; Patient and/or carer satisfaction during the study period; Length of stay in hospital during the study period; Discharges during the study period; Prescribing errors during the study period; Missed medications during the study period; Medicines reconciliation during the study period; Staff satisfaction during the study period

Study	Iowa Continuity of Care Study trial: Farris 2014 ¹⁸ (Farley 2014 ¹⁷)
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	2 (n=631)
Countries and setting	Conducted in USA; Setting: Tertiary care
Line of therapy	1st line
Duration of study	Intervention + follow up: 6 years
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	English or Spanish speaker, 18 years or older, admitted with a diagnosis of hypertension, hyperlipidaemia, heart failure, coronary artery disease, myocardial infarction, stroke, transient ischemic attack, asthma, chronic obstructive pulmonary disease or receiving oral anticoagulation.
Exclusion criteria	Could not use the telephone had a life expectancy under 6 months, had dementia or cognitive impairment, had a severe psychiatric diagnosis or were admitted to psychiatry, surgery or haematology/oncology services.
Recruitment/selection of patients	General medicine, family medicine, cardiology or orthopaedic admissions
Age, gender and ethnicity	Age - Mean (SD): Group 1: <45= 12.2%, 45-54= 16.7%, 55-64= 30.8%, 65-74= 27.2%, >74= 13.1, Group 2: <45= 9.3%, 45-54= 15.7%, 55-64= 35.1%, 65-74= 27.2%, >74= 12.8. Gender (M:F): Define. Ethnicity: NR
Further population details	Not stated

Study	Iowa Continuity of Care Study trial: Farris 2014 ¹⁸ (Farley 2014 ¹⁷)
Indirectness of population	No indirectness
Interventions	<p>(n=315) Intervention 1: Presence of medical ward based pharmacists. Immediately after randomisation a visit from a pharmacist case manager (PCM) who verifies admission medications with community pharmacy. PCM makes visits every 2-3 days and makes recommendations to the inpatient medical team and educates patient during hospitalisation, provides discharge medication counselling and wallet card medication list. Strategies are reviewed to enhance self-management. Duration until discharge. Concurrent medication/care: A unit pharmacist performs medication reconciliation. Usual care. Comments: unclear if initial visit is unit pharmacist or PCM, or if medicine reconciliation happens twice from both.</p> <p>(n=316) Intervention 2: No ward based pharmacists. Medication reconciliation at admission according to hospital policy (unit pharmacist), nurse discharge counselling and a discharge medication list for patients. Duration until discharge. Concurrent medication/care: usual care. Comments: implication that there is a ward-based unit pharmacist present for some periods.</p>
Funding	Academic or government funding (National Institute of Health)

RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS FOR LESS THAN 7 DAYS A WEEK versus NO WARD BASED PHARMACISTS

Protocol outcome 1: Avoidable adverse events during the study period

- Actual outcome: Preventable adverse drug events in-hospital; Group 1: 3/312, Group 2: 1/313; Risk of bias: All domain - High, Selection - Low, Blinding - Very high, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - High, Crossover - Low, Subgroups - Low, Other 1 - Low; Indirectness of outcome: No indirectness ; Baseline details: Intervention had greater number of medications and lower self-reported medication adherence compared to control; Group 2 Number missing: 3, Reason: 1 found ineligible early the study; 2 did not have baseline evaluator data

- Actual outcome: Preventable adverse drug events at 90 days follow-up; Group 1: 7/295, Group 2: 9/293; Risk of bias: All domain - High, Selection - Low, Blinding - Very high, Incomplete outcome data - High, Outcome reporting - Low, Measurement - Very high, Crossover - Low, Subgroups - Low, Other 1 - Low; Indirectness of outcome: No indirectness ; Baseline details: Intervention had greater number of medications and lower self-reported medication adherence compared to control; Group 1 Number missing: 6, Reason: 2 found ineligible early the study; 1 did not have baseline evaluator data; 3 unclear; Group 2 Number missing: 5, Reason: 1 found ineligible early the study; 2 did not have baseline evaluator data; 2 unclear

Protocol outcome 2: Readmissions up to 30 days

- Actual outcome: hospital Admission at 30 days; Group 1: 40/298, Group 2: 43/294; Risk of bias: All domain - High, Selection - Low, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Very high, Crossover - Low, Subgroups - Low, Other 1 - Low; Indirectness of outcome: No indirectness ; Baseline details: Intervention had greater number of medications and lower self-reported medication adherence compared to control; Group 1 Number missing: 17,

Study	Iowa Continuity of Care Study trial: Farris 2014 ¹⁸ (Farley 2014 ¹⁷)
	<p>Reason: 2 found ineligible early the study; 1 did not have baseline evaluator data; 5 deceased; 2 withdrew; 8 lost to follow-up; 1 other; 6 unclear; Group 2 Number missing: 22, Reason: 1 found ineligible early the study; 2 did not have baseline evaluator data; 7 deceased; 1 withdrew; 5 lost to follow-up; 15 unclear</p> <p>Protocol outcome 2: Future admissions (over 30 days) during the study period - Actual outcome: Admission by 90 days; Group 1: 51/295, Group 2: 47/293; Risk of bias: All domain - High, Selection - Low, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Very high, Crossover - Low, Subgroups - Low, Other 1 - Low; Indirectness of outcome: No indirectness ; Baseline details: Intervention had greater number of medications and lower self-reported medication adherence compared to control; Group 1 Number missing: 20, Reason: 2 found ineligible early the study; 1 did not have baseline evaluator data; 5 deceased; 2 withdrew; 8 lost to follow-up; 1 other; 8 unclear; Group 2 Number missing: 23, Reason: 1 found ineligible early the study; 2 did not have baseline evaluator data; 7 deceased; 1 withdrew; 5 lost to follow-up; 16 unclear</p> <p>Protocol outcome 3: Prescribing errors during the study period - Actual outcome: Medication appropriateness index (MAI) at 30 days; Group 1: mean 11.7 (SD 11.2); n=304, Group 2: mean 9.6 (SD 9.5); n=309; medication appropriateness index 0-12 Top=High is poor outcome; Risk of bias: All domain - High, Selection - Low, Blinding - Very high, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low, Other 1 - Low; Indirectness of outcome: No indirectness ; Baseline details: Intervention had greater number of medications and lower self-reported medication adherence compared to control; Group 1 Number missing: 11, Reason: 2 found ineligible early the study; 1 did not have baseline evaluator data; 5 deceased; 8 lost to follow-up; 2 withdrew; 1 other; Group 2 Number missing: 7, Reason: 1 found ineligible early the study; 2 did not have baseline evaluator data; 7 deceased; 5 lost to follow-up; 1 withdrew</p> <p>- Actual outcome: Medication appropriateness index (MAI) in-hospital; Group 1: mean 8 (SD 8.4); n=312, Group 2: mean 6.1 (SD 6.6); n=313; medication appropriateness index 0-12 Top=High is poor outcome; Risk of bias: All domain - High, Selection - Low, Blinding - Very high, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low, Other 1 - Low; Indirectness of outcome: No indirectness ; Baseline details: Intervention had greater number of medications and lower self-reported medication adherence compared to control; Group 1 Number missing: 3, Reason: 2 found ineligible early the study; 1 did not have baseline evaluator data; Group 2 Number missing: 3, Reason: 1 found ineligible early the study; 2 did not have baseline evaluator data</p>
Protocol outcomes not reported by the study	Mortality during the study period; Quality of life during the study period; Patient and/or carer satisfaction during the study period; Length of stay in hospital during the study period; Discharges during the study period; Missed medications during the study period; Medicines reconciliation during the study period; Staff satisfaction during the study period

Study	Khalil 2016 { Khalil 2016 }
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Study	Khalil 2016 { Khalil 2016}
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=110)
Countries and setting	Conducted in Australia; Setting: Acute Assessment and Admission Unit via the ED at a metropolitan Australian hospital
Line of therapy	Not applicable
Duration of study	Intervention + follow up:
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall: NA
Subgroup analysis within study	Not applicable: NA
Inclusion criteria	adult medical patients admitted to the Acute Assessment and Admission Unit
Exclusion criteria	not admitted to Acute Assessment and Admission Unit within 24 hours, did not have any medications prior to admission, not a general medical patient
Recruitment/selection of patients	consecutive
Age, gender and ethnicity	Age - Other: Intervention average 65.1 years (95% CI 60-69), Control average 74.83 (95% CI 70-79). Gender (M:F): Intervention 1.24, Control 1.45. Ethnicity: not reported
Further population details	Not stated
Indirectness of population	No indirectness: NA
Interventions	(n=56) Intervention 1: Presence of medical ward based pharmacists - Presence of medical ward based pharmacists for 7 days a week. pharmacist-initiated medication reconciliation - pharmacist obtained a 'best possible medication history' from the patient and/or other sources, undertook admission medication reconciliation, reviewed current medications and the need for new medications in relation to the admission diagnosis, developed a medication management plan with the referring senior medical officer and charted on the electronic medication administration record. Duration 6 weeks. Concurrent medication/care: not reported. (n=54) Intervention 2: No ward based pharmacists. Usual care - medication orders charted by medical staff. Duration 6 weeks. Concurrent medication/care: not reported.
Funding	Academic or government funding (Victorian Department of Health and Human Services for the Advanced Practice Allied Health Workforce Program)

RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS FOR 7 DAYS A WEEK versus NO WARD

Study	Khalil 2016 { Khalil 2016}
BASED PHARMACISTS	
Protocol outcome 1: Prescribing errors at end of follow-up - Actual outcome: number of errors at 24 hours.; Group 1: 29/56, Group 2: 238/54; Risk of bias: All domain - High, Selection - High, Blinding - Low, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness :	
Protocol outcomes not reported by the study	Mortality; Avoidable adverse events; Quality of life; Patient and/or carer satisfaction; Length of stay in hospital; Readmission; Discharges; Missed medications; Medicines reconciliation; Staff satisfaction

Study	Kucukarslan 2003 ³⁵
Study type	Quasi-RCT
Number of studies (number of participants)	(n=165)
Countries and setting	Conducted in USA; Setting: 2 internal medicine wards within a 802-bed tertiary care hospital
Line of therapy	1st line
Duration of study	Intervention time: 3 months
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	Admitted to the internal medicine service and remained in the same patient care unit until discharge
Exclusion criteria	No reported exclusion criteria
Recruitment/selection of patients	All patients admitted to 1 of the 2 wards
Age, gender and ethnicity	Age - Mean (SD): group 1: 53.94 (18.95), group 2: 56.49 (19.6). Gender (M:F): 72:93. Ethnicity: African American - 81%, White - 18%, Other - 1%
Further population details	Not stated
Extra comments	Admitting process was based on the availability of beds and physician service
Indirectness of population	No indirectness
Interventions	(n=86) Intervention 1: Presence of medical ward based pharmacists. Two clinical pharmacists assigned to provide patient care at the bedside from Monday through to Friday. Pharmacist's

Study	Kucukarslan 2003³⁵
	<p>evaluated patients' medications during the round with physicians. Duration until discharge. Concurrent medication/care: usual care + pharmacists identified medication-related problems through the review of medication orders (that is, medication administration records) every morning. Also, a list of medications, which require evaluation because of cost or safety, was used to identify potential medication-related problems.</p> <p>(n=79) Intervention 2: No ward based pharmacists.</p> <p>Pharmacists identified medication-related problems through the review of medication orders (that is, medication administration records) every morning. Also, a list of medications, which require evaluation because of cost or safety, was used to identify potential medication-related problems. Duration until discharge. Concurrent medication/care: usual care.</p>
Funding	Funding not stated
<p>RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS FOR LESS THAN 7 DAYS A WEEK versus NO WARD BASED PHARMACISTS</p> <p>Protocol outcome 1: Avoidable adverse events during the study period - Actual outcome: Preventable adverse drug events until discharge; Group 1: 2/79, Group 2: 9/86; Risk of bias: All domain - Very high, Selection - Very high, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 0; Group 2 Number missing: 0</p> <p>Protocol outcome 2: Length of stay in hospital during the study period - Actual outcome: Reduction in length of stay in-hospital; Mean study group mean was 0.3 days shorter; Risk of bias: All domain - Very high, Selection - Very high, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 0; Group 2 Number missing: 0</p> <p>Protocol outcome 3: Readmissions up to 30 days - Actual outcome: Reduction re-admission (unclear study period); Other: study group readmission rate was 44% less; Risk of bias: All domain - Very high, Selection - Very high, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 0; Group 2 Number missing: 0</p>	
Protocol outcomes not reported by the study	Mortality during the study period; Quality of life during the study period; Patient and/or carer satisfaction during the study period; Discharges during the study period; Prescribing errors during the study period; Missed medications during the study period; Medicines reconciliation during the study period; Staff satisfaction during the study period

Study	Lind 2016 ³⁷
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=448)
Countries and setting	Conducted in Denmark; Setting: Acute admission unit via ED at Randers Regional Hospital, Denmark
Line of therapy	Not applicable
Duration of study	Intervention time:
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall: NA
Subgroup analysis within study	Not applicable: NA
Inclusion criteria	Patients 18 years and over, taking at least 4 drugs daily
Exclusion criteria	Terminal or intoxicated, assigned to triage level 1, referred to acute outpatient clinic, unable to give informed consent, interviewed by physician prior to giving informed consent, unexpected overnight stay
Recruitment/selection of patients	Consecutive
Age, gender and ethnicity	Age - Mean (SD): intervention 70.9 (13.8), control 69.8 (12.7). Gender (M:F): 216/232. Ethnicity: not reported
Further population details	Not stated
Indirectness of population	No indirectness
Interventions	(n=216) Intervention 1: Presence of medical ward based pharmacists - Presence of medical ward based pharmacists for

	<p>less than 7 days a week.</p> <p>Clinical pharmacist intervention - obtaining medication history (using a minimum of 2 sources, 1 of which was an interview with the patient and/or relatives where possible), entering prescriptions into the electronic medication module, medication reconciliation, reviewing overall medication treatment and writing a note in the electronic medical record. The clinical pharmacist intervention replaced the physician's task related to medication apart from assessing and approving the suggested prescriptions in the electronic medication module. Duration 126 weekday shifts. Concurrent medication/care: not reported.</p> <p>(n=232) Intervention 2: No ward based pharmacists.</p> <p>Standard care – on arrival, patients triaged by a nurse and then seen by a physician who was responsible for obtaining medication history, reconciling and assessing medication treatment and entering prescriptions in the EMM. Duration 126 weekday shifts. Concurrent medication/care: not stated.</p>
Funding	Academic or government funding (Research Centre for Emergency Medicine at Aarhus University Hospital)
<p>RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS FOR LESS THAN 7 DAYS A WEEK versus NO WARD BASED PHARMACISTS</p> <p>Protocol outcome 1: Length of stay in hospital at end of follow-up - Actual outcome: Length of stay in AAU at end of study; Mean 3.2 (95%CI -25.2 to 34.2); Risk of bias: All domain - Low, Selection - Low, Blinding - Low, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness</p>	
Protocol outcomes not reported by the study	Mortality at Define; Avoidable adverse events at end of follow-up; Quality of life at end of follow-up; Patient and/or carer satisfaction at end of follow-up; Readmission at end of follow-up; Discharges at end of follow-up; Prescribing errors at end of follow-up; Missed medications at end of follow-up; Medicines reconciliation at end of follow-up; Staff satisfaction at end of follow-up

Study	Lisby 2010 ³⁹
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=100)
Countries and setting	Conducted in Denmark; Setting: acute ward of internal medicine within 1 regional hospital
Line of therapy	1st line

Study	Lisby 2010 ³⁹
Duration of study	Intervention + follow up: 1 year + 3 month follow-up
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	70 years or older who were taking at least 1 drug daily and were expected to be admitted for more than 24 hours.
Exclusion criteria	Suicidal, dying and patients unable to give written consent
Recruitment/selection of patients	Consecutively admitted patients
Age, gender and ethnicity	Age - Mean (SD): Group 1: 80.2 (6.69), Group 2: 78.2 (6.96). Gender (M:F): 40:60. Ethnicity: NR
Further population details	Not stated
Indirectness of population	No indirectness
Interventions	<p>(n=50) Intervention 1: Presence of medical ward based pharmacists. Systematic medication review and drug counselling by a clinical pharmacist and a clinical pharmacologist after the usual routine medication in the ward had been conducted. Duration within 24 hours of admission or by first-coming day of the week. Concurrent medication/care: Usual care + usual routine medication review.</p> <p>(n=50) Intervention 2: No ward based pharmacists. Usual routine medication review: review by junior physician on admission and within 24 hours an assessment by a senior physician, specialised in internal medicine. Duration 24 hours. Concurrent medication/care: usual care.</p>
Funding	Academic or government funding (ALIS, Amgros I/S)
<p>RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS AT ADMISSION versus NO WARD BASED PHARMACISTS</p> <p>Protocol outcome 1: Mortality during the study period - Actual outcome: Mortality at 3 months; Group 1: 8/50, Group 2: 5/49; Risk of bias: All domain - High, Selection - Low, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: ; Group 2 Number missing: 1, Reason: withdrew (1)</p> <p>Protocol outcome 2: Quality of life during the study period - Actual outcome: EQ-VAS at 3 months; Group 1: mean 60.9 (SD 21.4335); n=33, Group 2: mean 54.7 (SD 26.2449); n=30; EQ VAS 0-100 Top=High is good outcome; Risk of bias: All domain - High, Selection - Low, Blinding - Very high, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low;</p>	

Study	Lisby 2010 ³⁹
Indirectness of outcome: No indirectness ; Group 1 Number missing: ; Group 2 Number missing: 1, Reason: withdrew (1)	
Protocol outcome 3: Length of stay in hospital during the study period - Actual outcome: Length of stay until discharge; Group 1: mean 239.9 hours (SD 176.28); n=50, Group 2: mean 238.6 hours (SD 353.02); n=49; Risk of bias: All domain - High, Selection - Low, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 0; Group 2 Number missing: 1, Reason: withdrew (1)	
Protocol outcome 4: Future admissions (over 30 days) during the study period - Actual outcome: Admissions per patient at 3 months; Mean 0.4 (95%CI 0.3 to 0.6); Risk of bias: All domain - High, Selection - Low, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: ; Group 2 Number missing: 1, Reason: withdrew (1)	
Protocol outcomes not reported by the study	Avoidable adverse events during the study period; Patient and/or carer satisfaction during the study period; Discharges during the study period; Prescribing errors during the study period; Missed medications during the study period; Medicines reconciliation during the study period; Staff satisfaction during the study period

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Study	Nester 2002 ⁴⁴
Study type	Quasi-RCT
Number of studies (number of participants)	1 (n=100)
Countries and setting	Conducted in USA; Setting: Tertiary care referral centre
Line of therapy	1st line
Duration of study	Not clear:
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	Over 18, responsive and able to speak English
Exclusion criteria	Intensive care, ambulatory surgical, and labour-and-delivery units
Recruitment/selection of patients	Consecutive admissions on weekdays between 0700 and 1530
Age, gender and ethnicity	Age - Mean (SD): Group 1: 67 (18), Group 2: 56 (21). Gender (M:F): 46:54. Ethnicity: NR
Further population details	1. Frail elderly: Not applicable/Not stated/Unclear 2. Haematology or oncology patients: Not applicable / Not stated /

Study	Nester 2002⁴⁴
	Unclear
Indirectness of population	No indirectness
Interventions	<p>(n=50) Intervention 1: Presence of medical ward based pharmacists - Presence of medical ward based pharmacists for 7 days a week.</p> <p>Medication reconciliation within 2 hours of admission performed by a clinical pharmacist using a standardised medication history form as well as additional sources (admitting physician or community pharmacy). Medication history was given to the order-entry pharmacist to compare with the medications ordered later by physicians. Duration within 2 hours of admission. Concurrent medication/care: usual care.</p> <p>Comments: Nurses still performed medication history taking, but in all cases the intervention was conducted first.</p> <p>(n=50) Intervention 2: No ward based pharmacists.</p> <p>Medication reconciliation within performed by a nurse using a standardised medication history form as well as additional sources (admitting physician or community pharmacy). Medication history was given to the order-entry pharmacist to compare with the medications ordered later by physicians. Duration unclear. Concurrent medication/care: usual care.</p>
Funding	
RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS AT ADMISSION versus NO WARD BASED PHARMACISTS	
<p>Protocol outcome 1: Medicines reconciliation during the study period</p> <p>- Actual outcome: Medication discrepancies identified at admission at admission; Group 1: mean 0.6 discrepancies identified per patient (SD 1.07); n=50, Group 2: mean 0.22 discrepancies identified per patient (SD 0.55); n=50; Risk of bias: All domain - Very high, Selection - Very high, Blinding - Very high, Crossover - Low; Indirectness of outcome: No indirectness ; Baseline details: Age significantly different between the groups; Group 1 Number missing: 0; Group 2 Number missing: 0</p>	

Study	Nickerson 2005⁴⁶
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=253)
Countries and setting	Conducted in Canada; Setting: The Moncton Hospital, South East Health Regional Health Authority, Moncton. The Moncton Hospital is a 381 bed regional hospital that provides tertiary care services.
Line of therapy	1st line

Study	Nickerson 2005 ⁴⁶
Duration of study	Intervention + follow up: 9 months (6 month follow-up)
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	Family practice patient discharged from 3600 or 4200 (family practice patient units), discharged between 8h00 and 14h00, not discharged to another hospital, prescribed at least 1 prescription medication at discharge, completion of informed consent, patient's community pharmacy had signed study participation agreement, no previous enrolment
Exclusion criteria	Not able to answer the questions needed to complete the study or if they would not be available for follow up after discharge
Recruitment/selection of patients	Patients admitted to 1 of 2 family practice units from September 2000 to June 2001 were screened to participate in the study.
Age, gender and ethnicity	Age - Other: Mean age (years): intervention -67.3; control-61.8. Gender (M:F): Define. Ethnicity: not stated
Further population details	Not stated
Extra comments	The intervention group had a statistically significant greater number of home medication changes, and their mean age, number of medications upon admission and number of co-morbidities were marginally significantly greater.
Indirectness of population	No indirectness
Interventions	<p>(n=134) Intervention 1: Presence of medical ward based pharmacists - Presence of medical ward based pharmacists for 7 days a week.</p> <p>Patients in the intervention group were subject to an intervention conducted by a clinical pharmacist (seamless care pharmacist) at the time of discharge. The seamless care pharmacist carried out medication reconciliation process by reviewing discharge prescriptions and compared these with Medical Administration Record (MAR) and the patients' medical chart to identify any discrepancies in the discharge orders. This pharmacist also reviewed the intervention patient's drug regime as part of comprehensive pharmaceutical care work-up. The pharmacist also identified problems with drug therapy and communicated these to community pharmacy, hospital staff and family physician. The pharmacist also performed the medication discharge counselling and a medication compliance chart. Duration 3 months. Concurrent medication/care: Mean number of prescriptions at hospital admission – 6.94; control- 6.03. No further details.</p> <p>(n=119) Intervention 2: No ward based pharmacists.</p> <p>The control patients received standard care at discharge - discharge counselling and manual transcription of discharge notes from medical chart by nurse. Duration 3 months. Concurrent medication/care: Mean number of prescriptions at</p>

Study	Nickerson 2005⁴⁶
	hospital admission – 6.94; control- 6.03. No further details.
Funding	Funding not stated.
RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS FOR 7 DAYS A WEEK versus NO WARD BASED PHARMACISTS	
Protocol outcome 1: Medicines reconciliation - Actual outcome: Unresolved drug therapy inconsistencies and omissions (DTIOs) at the time of discharge; Group 1: 53/134, Group 2: 67/119; Risk of bias: All domain - High, Selection - High, Blinding - Low, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low, Other 1 - Low, Other 2 - Low, Other 3 - Low, Comments - Every 6th chart reviewed in the intervention group; Indirectness of outcome: No indirectness ; Group 1 Number missing: ; Group 2 Number missing:	
Protocol outcomes not reported by the study	Mortality; Avoidable adverse events; Quality of life; Patient and/or carer satisfaction; Length of stay in hospital; Readmission; Discharges; Prescribing errors; Missed medications; Staff satisfaction

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Study	Shen 2011 { Shen 2011 }
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=354)
Countries and setting	Conducted in China; Setting: Tertiary teaching hospital
Line of therapy	Not applicable
Duration of study	Intervention time: 10 months
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	Define
Exclusion criteria	Define
Recruitment/selection of patients	Between July 2009 and April 2010 all inpatients who were diagnosed with RTI were eligible for the study
Age, gender and ethnicity	Age - Mean (SD): Intervention-60.3 (18.1); control- 59.8 (17.6). Gender (M:F): Define. Ethnicity: not stated
Further population details	Not stated

Study	Shen 2011 { Shen 2011}
Indirectness of population	No indirectness
Interventions	(n=176) Intervention 1: Presence of medical ward based pharmacists - Presence of medical ward based pharmacists for 7 days a week. Clinical pharmacist part of the treating team – communicated any potentially inappropriate antibiotic use (indication, choice, dosage, dosing schedule, duration, conversion) with the physician to discuss and make recommendations. Duration 10 months. Concurrent medication/care: not reported (n=178) Intervention 2: No ward based pharmacists. Standard treatment strategies performed by the physicians and nurses without pharmacist involvement. Duration 10 months. Concurrent medication/care: not reported
Funding	No funding
RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS FOR 7 DAYS A WEEK versus NO WARD BASED PHARMACISTS	
Protocol outcome 1: Length of stay in hospital at end of follow-up - Actual outcome: Length of stay at end of study; Group 1: mean 14.2 (SD 6.2); n=176, Group 2: mean 15.8 (SD 6); n=178; Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low, Other 1 - Low, Other 2 - Low, Other 3 - Low; Indirectness of outcome: No indirectness	
Protocol outcomes not reported by the study	Mortality at Define; Avoidable adverse events at end of follow-up; Quality of life at end of follow-up; Patient and/or carer satisfaction at end of follow-up; Readmission at end of follow-up; Discharges at end of follow-up; Prescribing errors at end of follow-up; Missed medications at end of follow-up; Medicines reconciliation at end of follow-up; Staff satisfaction at end of follow-up

Study	Scullin 2007 ⁵⁷
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=762)
Countries and setting	Conducted in United Kingdom; Setting: Medical wards within 3 general hospitals
Line of therapy	1st line
Duration of study	Intervention time: 1.5 years
Method of assessment of guideline condition	Adequate method of assessment/diagnosis

Study	Scullin 2007 ⁵⁷
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	One of the following criteria: taking at least 4 regular medication, were taking a high risk drug(s), were taking antidepressants and were 65 years old or older, had a hospital admission within the last 6 months, prescribed antibiotics on day 1 of admission
Exclusion criteria	Scheduled admissions and patients admitted from private nursing homes
Recruitment/selection of patients	All admitted patients
Age, gender and ethnicity	Age - Mean (SD): Group 1: 70.3 (13.8), Group 2: 69.9 (14.8). Gender (M:F): 359:403. Ethnicity: NR
Further population details	Not stated
Indirectness of population	No indirectness
Interventions	<p>(n=371) Intervention 1: Presence of medical ward based pharmacists. Patients received integrated management service, which consisted of 5 pairs of clinical pharmacists and pharmacy technicians with each pair assigned to a particular ward. Duties included admission, inpatient monitoring and discharge. Admission: medicine reconciliation during admission using patient's admission prescription list, the patient's GP, the patient's own drugs, information obtained from the patient or their carer, and from the patients community pharmacist. In-patient monitoring: drug treatment was reviewed daily (unclear if ward-based) and counselling tailored to suit the needs of each individual patient. Discharge: IMM pharmacist generated and authorised a discharge prescription and a medicines record sheet. Duration until discharge. Concurrent medication/care: usual treatment.</p> <p>(n=391) Intervention 2: No ward based pharmacists. Traditional clinical pharmacy services which were in place across the participating hospitals (no further details given). Duration until discharge. Concurrent medication/care: usual care.</p>
Funding	Academic or government funding (Northern Ireland Department of Health and Social Services)
RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS versus NO WARD BASED PHARMACISTS	
<p>Protocol outcome 1: Mortality during the study period - Actual outcome: Mortality at 12 months; Group 1: 67/370, Group 2: 76/383; Risk of bias: All domain - Very high, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Very high, Measurement - Low, Crossover - Low, Subgroups - Low,; Indirectness of outcome: No indirectness ; Baseline details: not comparable for gender, not many factors listed; Group 1 Number missing: 1, Reason: no reasons stated; Group 2 Number missing: 7, Reason: no reasons stated</p>	

Study	Scullin 2007 ⁵⁷
Protocol outcome 2: Length of stay in hospital during the study period - Actual outcome: Length of stay until discharge; Group 1: mean 7.8 days (SD 7.8362); n=371, Group 2: mean 9.8 days (SD 15.4679); n=391; Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness ; Baseline details: not comparable for gender, not many factors listed; Group 1 Number missing: 0; Group 2 Number missing: 0	
Protocol outcome 3: Future admissions (over 30 days) during the study period - Actual outcome: Admission by 12 months; Group 1: 141/370, Group 2: 172/383; Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low;; Indirectness of outcome: No indirectness ; Baseline details: not comparable for gender, not many factors listed; Group 1 Number missing: 1, Reason: no reasons stated; Group 2 Number missing: 7, Reason: no reasons stated	
Protocol outcomes not reported by the study	Avoidable adverse events during the study period; Quality of life during the study period; Patient and/or carer satisfaction during the study period; Discharges during the study period; Prescribing errors during the study period; Missed medications during the study period; Medicines reconciliation during the study period; Staff satisfaction during the study period

Study	Spinewine 2007 ⁵⁹
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=203)
Countries and setting	Conducted in Belgium; Setting: 27 bed acute Geriatric Evaluation and Management (GEM) unit within a university teaching hospital
Line of therapy	1st line
Duration of study	Intervention + follow up: 1 year
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	Pharmacist external to the main study checked inclusion criteria. No further details reported
Exclusion criteria	Terminal illness with a life expectancy of less than 3 months; refusal to participate; expected length of stay of 48 hours or less; pharmacist unable to perform an abstracted chart within 3 days of admission because of time constraints; patient transferred from another acute unit where he or she had been cared for by geriatrician(s); and inclusion during previous admission
Recruitment/selection of patients	All patients admitted to the unit

Study	Spinewine 2007 ⁵⁹
Age, gender and ethnicity	Age - Mean (SD): Group 1: 81.9 (6.2), Group 2: 82.4 (6.9). Gender (M:F): 57:129. Ethnicity: NR
Further population details	Not stated
Indirectness of population	No indirectness
Interventions	<p>(n=103) Intervention 1: Presence of medical ward based pharmacists. Pharmacist was present on the unit for 4 days per week. Duties included: participating in medical and multidisciplinary rounds; direct contact with patients and caregivers; performing a medication history on admission and preparation of a patient record with clinical and pharmaceutical data; preparation of a pharmaceutical care plan; answering all questions that healthcare professionals asked about medication; identifying any optimisations and discussing with the prescriber, who could accept or reject the recommendation; providing at discharge written and oral information on treatment changes to the patient or caregiver, as well as written information to the general practitioner. Duration until discharge. Concurrent medication/care: usual care.</p> <p>(n=100) Intervention 2: No ward based pharmacists. Usual care. Duration until discharge. Concurrent medication/care: - Comments: unclear if there was any clinical pharmacist involvement, for example, medication reviews from medical records.</p>
Funding	Academic or government funding (National Institutes of Health, Grants RO1 AI 5535901 and K23 AI068582-01)

RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS FOR LESS THAN 7 DAYS A WEEK versus NO WARD BASED PHARMACISTS

Protocol outcome 1: Mortality during the study period

- Actual outcome: Mortality at 1 year follow-up; Group 1: 20/89, Group 2: 25/83; Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 14, Reason: 2 transferred, 5 died in-hospital; 7 unclear; Group 2 Number missing: 17, Reason: 5 transferred, 5 died in-hospital; 7 unclear

Protocol outcome 2: Patient and/or carer satisfaction during the study period

- Actual outcome: satisfaction with information received at 1 month follow-up; Group 1: 71/95, Group 2: 37/88; Risk of bias: All domain - Very high, Selection - High, Blinding - Very high, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 8, Reason: 2 transferred, 5 died, 1 unclear; Group 2 Number missing: 12, Reason: 5 transferred, 5 died, 2 unclear

Protocol outcome 3: Future admissions (over 30 days) during the study period

- Actual outcome: Admission by 12 months; Group 1: 29/89, Group 2: 28/83; Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 14, Reason: 2 transferred, 5 died, 7 unclear; Group 2 Number missing: 17, Reason: 5 transferred, 5 died, 7 unclear

Study	Spinewine 2007 ⁵⁹
<p>Protocol outcome 4: Prescribing errors during the study period</p> <p>- Actual outcome: Medical appropriateness index at discharge; Group 1: mean 7.1 (SD 7.5); n=96, Group 2: mean 19.3 (SD 12.5); n=90; Risk of bias: All domain - Very high, Selection - High, Blinding - Very high, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low; Indirectness of outcome: No indirectness ; Group 1 Number missing: 7, Reason: 2 transferred, 5 died; Group 2 Number missing: 10, Reason: 5 transferred, 5 died</p>	
Protocol outcomes not reported by the study	Avoidable adverse events during the study period; Quality of life during the study period; Length of stay in hospital during the study period; Discharges during the study period; Missed medications during the study period; Medicines reconciliation during the study period; Staff satisfaction during the study period

Study	Tong 2016{Tong 2016}
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=881)
Countries and setting	Conducted in Australia; Setting: Adult major referral hospital
Line of therapy	Not applicable
Duration of study	Intervention time: 4 months
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	Patients admitted to the general medical unit (GMU) and emergency short stay unit (ESSU) during pharmacist working hours (7am-9pm)
Exclusion criteria	Medication chart written by a doctor before pharmacist review; admitted to ESSU and not reviewed by a pharmacist
Recruitment/selection of patients	The evaluation included patients' medication charts written in the period 16 March 2015 to 27 July 2015.
Age, gender and ethnicity	Age - Mean (SD): intervention 75 (16.3); control 71.5 (18.4). Gender (M:F): males- intervention 42.9%; control 46.1%. Ethnicity: not stated
Further population details	Not stated
Indirectness of population	No indirectness
Interventions	(n=408) Intervention 1: Presence of medical ward based pharmacists - Presence of medical ward based pharmacists for 7 days a week. Early medication review and charting on admission involving a partnership between a pharmacist and a medical

Study	Tong 2016{Tong 2016}
	<p>officer – pharmacist took medical history, VTE risk assessment and discussed medical and medication problems with admitting medical officer to agree a medication management plan. Appropriate pre-admission medications and VTE prophylaxis were charted by the pharmacist on the inpatient medication record from which nurses administered medications. This was followed by a discussion between the treating nurse and pharmacist about the medication management plan, including any urgent medications to be administered, drug-related monitoring and reasons for any changes to medications. A second pharmacist independently reviewed all medications charted by a pharmacist within 24 hours to provide a second check. Duration 4 months. Concurrent medication/care: Number of regular medication - mean (range) 8 (5-11).</p> <p>(n=473) Intervention 2: No ward based pharmacists. Standard medication charting by medical officers of relevant teams, with subsequent medication reconciliation performed by pharmacist within 24 hours of admission. Duration 4 months. Concurrent medication/care: Number of regular medication- mean (range) 7 (4-11).</p>
Funding	Academic or government funding
RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS FOR 7 DAYS A WEEK versus NO WARD BASED PHARMACISTS	
<p>Protocol outcome 1: Prescribing errors at end of follow-up</p> <p>- Actual outcome: Medication error detected within 24 hours of patients admission at Please enter a time period; Group 1: 15/408, Group 2: 372/473; Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness</p>	
Protocol outcomes not reported by the study	Mortality at Define; Avoidable adverse events at end of follow-up; Quality of life at end of follow-up; Patient and/or carer satisfaction at end of follow-up; Length of stay in hospital at end of follow-up; Readmission at end of follow-up; Discharges at end of follow-up; Missed medications at end of follow-up; Medicines reconciliation at end of follow-up; Staff satisfaction at end of follow-up

Study (subsidiary papers)	Zhao 2015⁶⁹ (Zhao 2015⁷⁰)
Study type	RCT (Patient randomised; Parallel)
Number of studies (number of participants)	1 (n=90)
Countries and setting	Conducted in China; Setting: 49 bed cardiology ward of the Peoples Hospital of Henan Province, China.

Study (subsidiary papers)	Zhao 2015 ⁶⁹ (Zhao 2015 ⁷⁰)
Line of therapy	Not applicable
Duration of study	Intervention + follow up: Follow-up 6 months after discharge
Method of assessment of guideline condition	Adequate method of assessment/diagnosis
Stratum	Overall
Subgroup analysis within study	Not applicable
Inclusion criteria	To participate in the study, patients needed to: have already been diagnosed with coronary heart disease by their physician, have accepted ≥ 4 kinds of drugs for heart conditions (for example, antiplatelet agents, B-blockers, ACE inhibitors and statins) and be 18 years of age or older.
Exclusion criteria	The following were excluded from the study: pregnant or lactating women, patients who were enrolled in other research projects, severe co-morbidities such as liver failure, kidney failure or lung failure, patients with a family history of psychosis, patients with barriers to communication and patients unable to complete the study.
Recruitment/selection of patients	Eligible patients who were discharged from the People's Hospital of Henan Province between 1 January and 30 June 2012.
Age, gender and ethnicity	Age - Mean (SD): Number patients- above 60 years: Intervention- 24 (53.3%); control-23 (51.1%). Gender (M:F): Intervention- 19/26; control-17/28. Ethnicity: not stated
Further population details	Not stated
Extra comments	The pharmacists (3 clinical pharmacists and 2 pharmacy students) taking part in the study had at least 2 years of experience in coronary heart disease and could spend the entire day on the cardiology ward.
Indirectness of population	No indirectness
Interventions	<p>(n=45) Intervention 1: Presence of medical ward based pharmacists - Presence of medical ward based pharmacists for 7 days a week.</p> <p>The intervention group received conventional medical treatment plus interventions by clinical pharmacists. The clinical pharmacists developed individual drug regimens based on each patient's needs and condition. The pharmacists attended daily medical rounds and advised physicians on the risk factors and clinical manifestations of CHD, possible complications and treatment principles. The pharmacists also educated medical staff on the properties and possible adverse drug reactions of the medications given to the patient and the properties and possible adverse drug reactions. The pharmacists provided patient education on lifestyle changes, psychological interventions, such as stress reduction, and medication counselling at discharge. The pharmacist called the patient on the telephone every month to check on changes in the patients' disease status and the patients' compliance with doctors' orders. Duration In-hospital stay. Concurrent medication/care: multi-drug therapy (4-6 types): 24 (53.3%)</p>

Study (subsidiary papers)	Zhao 2015⁶⁹ (Zhao 2015⁷⁰)
	(n=45) Intervention 2: No ward based pharmacists. The control group received conventional medical treatment without pharmacist participation. Duration In-hospital stay. Concurrent medication/care: Multi-drug therapy (4-6 types): 26 (57.78%)
Funding	No funding
RESULTS (NUMBERS ANALYSED) AND RISK OF BIAS FOR COMPARISON: PRESENCE OF MEDICAL WARD BASED PHARMACISTS FOR 7 DAYS A WEEK versus NO WARD BASED PHARMACISTS	
<p>Protocol outcome 1: Avoidable adverse events - Actual outcome: Adverse drug reactions at 6 months; Group 1: 3/43, Group 2: 2/42; Risk of bias: All domain - High, Selection - High, Blinding - Low, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness</p> <p>Protocol outcome 2: Quality of life - Actual outcome: Self-care ability and Quality of life - satisfaction self-evaluation (scale not specified) at discharge; Group 1: 35/43, Group 2: 23/42; Risk of bias: All domain - High, Selection - High, Blinding - High, Incomplete outcome data - Low, Outcome reporting - Low, Measurement - Low, Crossover - Low, Subgroups - Low; Indirectness of outcome: No indirectness</p>	
Protocol outcomes not reported by the study	Mortality; Patient and/or carer satisfaction; Length of stay in hospital; Readmission; Discharges; Prescribing errors; Missed medications; Medicines reconciliation; Staff satisfaction

Appendix E: Economic evidence tables

E.1 Regular ward-based pharmacist support

Study	Claus 2014 ¹³			
Study details	Population & interventions	Costs	Health outcomes	Cost effectiveness
<p>Economic analysis: CCA (health outcomes: in-hospital mortality, adverse drug events)</p> <p>Study design: Randomised controlled trial (RCT) with propensity score matched before-and-after cohort.</p> <p>Approach to analysis: comparative cost analysis was undertaken to calculate the difference between pharmaceutical investment (intervention cost) and mean daily ICU drug cost and the cost: benefit ratio of the intervention. Propensity score matched before and after cohort were also used (matching variables including age, main diagnostic category, ICU length of stay, in-hospital mortality and severity index). The results reported here are for the</p>	<p>Population: Critically ill patients (>16 years of age and with minimum length of ICU stay of 2 days) in a 22-bed, surgical ICU at Ghent University Hospital, Belgium.</p> <p>Cohort settings: (n=135[randomised], 109[matched, before-group] and 111[matched after-group]) Mean age: Intervention 1= 58 years Intervention 2= 61.1 years</p> <p>Male: Intervention 1= 58.3% Intervention 2= 74.4%</p> <p>Intervention 1: (n=60) No clinical pharmacist direct involvement in patient care. Pharmacist drug recommendations were</p>	<p>Total costs (mean per patient)^(a): Intervention 1: £354 Intervention 2: £195 Incremental (2–1): -£159 (95% CI: NR; p=NR)</p> <p>Pharmacist time costs (mean per patient): Incremental (2–1): £13 (95% CI: NR; p=NR)</p> <p>Total drug costs (mean per patient): Intervention 1: £354 Intervention 2: £182 Incremental (2–1): -£172 (95% CI: NR; p=0.87)</p> <p>Currency & cost year: 2013 euros (presented here as 2013 UK pounds^(b))</p> <p>Cost components incorporated:</p>	<p>In-hospital mortality: Intervention 1: 18.3% Intervention 2: 24% Incremental (2–1): 5.7% (95% CI: NR; p=0.53)</p> <p>Adverse events rate (mean per patient): Intervention 1: 0.12 Intervention 2: 0.19 Incremental (2–1): 0.07 (95% CI: NR; p=0.34)</p>	<p>ICER (Intervention 2 versus Intervention 1): The paper reports unadjusted mean benefit: cost ratio: 25:1 (95% CI: -5:1 to 94:1)</p> <p>Taking outcomes into account: Clinical pharmacist intervention less costly and less effective</p> <p>Analysis of uncertainty: - RCT analysis: bootstrapping was used to generate replications of the cost differences. Mean cost-benefit ratio was calculated from these replications. The percentage of replications that showed benefit :cost ratio ≥ 1 was calculated. In the base case analysis, the intervention was found to be cost-beneficial in 53.8% of the replications. - Matched analysis: No significant difference in drug costs was found when comparing the before-group or the after-group with intervention 2 group (p=0.94 and p=0.65, respectively) or intervention 1 group (p=0.37 and 0.12, respectively).</p> <p>-Adjustment for patient characteristics: Analysis was repeated excluding liver transplantation and tracheostomy. In both cases, the difference in drug costs remained</p>

<p>randomised part of the study.</p> <p>Perspective: Belgian healthcare payer</p> <p>Follow-up: ICU stay</p> <p>Treatment effect duration: same as follow-up</p> <p>Discounting: Costs: n/a; Outcomes: n/a</p>	<p>documented by the pharmacist but not communicated to the ICU caregiver.</p> <p>Intervention 2: (n=75)</p> <p>A clinical pharmacist is directly involved in patient care, providing active recommendations regarding drug therapy and follow-up. The current pharmacy staff carried out the recommendation (1 junior pharmacist with basic level clinical pharmacy and 1 senior pharmacist with advanced training in clinical pharmacy). Pharmacist recommendations focused on antimicrobial therapy, total parenteral nutrition, drugs with potential for significant interactions, drugs with equal intravenous and oral bioavailability, drugs requiring dose adaptations or follow-up.</p>	<p>Pharmacist time (chart analysis, consultation, researching and follow-up)</p> <p>Drug costs</p>		<p>non-significant ($p=0.78$ and 0.88 respectively) and the intervention was cost beneficial in 62% and 74.1% of the replications, respectively.</p> <p>-Excluding outlier ICU drug costs (> 2SD [standard deviation]):</p> <p>Difference in drug costs was significant after excluding patients with outlier drug costs ($p<0.001$) in the randomised analysis. The intervention was cost beneficial in 95.2% of the replications.</p> <p>In the matched analysis (comparing the matched before- and after-groups with the intervention 1), the difference in drug costs was significant ($p<0.001$ for both groups). This showed high baseline expenses which may have reduced the influence of the clinical pharmacy service.</p>
<p>Data sources</p>				
<p>Health outcomes: data collected during the before and after periods on adverse drug events and in-hospital mortality during the ICU stay. Quality-of-life weights: n/a. Cost sources: Local sources were used of pharmacist time (gross salary of Ghent University Hospital pharmacist with 5 years' experience). ICU drug costs were based on national tariff prices (RIZIV-INAMI).</p>				
<p>Comments</p>				

Source of funding: NR **Applicability and limitations:** QALYs were not used as an outcome measure and only costs and cost savings were included as outcomes. Some uncertainty regarding the applicability of resource use and costs from Belgium (2013) to current NHS context. The intervention is delivered by a junior and a senior clinical pharmacist; which may not be the same as in NHS hospitals. The study is a comparative cost analysis with no health outcomes. The costs included were only pharmacist time and ICU drug costs while the cost of hospital stay and other staff time were not included. The study follow-up is short (ICU stay) and may not capture the difference in all relevant costs. Limited sensitivity analysis is reported.

Overall applicability(c): partially applicable **Overall quality^(d):** potentially serious limitations

Abbreviations: CCA: cost-consequences analysis; 95% confidence interval; ICER: incremental cost-effectiveness ratio; ICU: intensive care unit; n/a: not applicable; NR: not reported; pa: probabilistic analysis; QALYs: quality-adjusted life years.

(a) Calculated by NGC.

(b) Converted using 2013 purchasing power parities⁵⁰.

(c) Directly applicable/Partially applicable/Not applicable.

(d) Minor limitations/Potentially serious limitations/Very serious limitations.

Study	Ghatnekar 2013 ²⁰			
Study details	Population & interventions	Costs	Health outcomes	Cost effectiveness
<p>Economic analysis: CUA (health outcome: QALYs)</p> <p>Study design: Decision tree model</p> <p>Approach to analysis: Probabilistic decision tree model to assess the cost utility of the study intervention. The model focused on prevention of medication error as an outcome. The occurrence of medication errors was linked to increased resource use in order to model the downstream cost implications of treatments.</p>	<p>Population: Elderly inpatients</p> <p>Cohort settings: Mean age: NR Male: NR</p> <p>Intervention 1: Standard care (not defined).</p> <p>Intervention 2: Multidisciplinary team including clinical pharmacist undertakes systematic medication review and reconciliation from admission to discharge (the Lund Integrated Medicines</p>	<p>Total costs (mean per patient)</p> <p>Intervention 1: £520 Intervention 2: £239 Incremental (2–1): -£280 (95% CI: NR; p=NR)</p> <p>Currency & cost year: 2009 euros (presented here as 2009 UK pounds^(b))</p> <p>Cost components incorporated: Pharmacist time Physician time Nurse time Hospital readmissions</p>	<p>QALYs (mean per patient):</p> <p>Intervention 1: -0.009 Intervention 2: -0.004 Incremental (2–1): 0.005 (95% CI: NR; p=NR)</p>	<p>ICER (Intervention 2 versus Intervention 1): Clinical pharmacist intervention dominant</p> <p>Analysis of uncertainty: Results were presented separately for the admission and discharge parts of the model. For the admission part, the L IMM intervention was dominant with lower cost (incremental cost: -£225) and QALY gain (0.004). For the discharge part, the L IMM intervention was also dominant with lower cost (incremental cost: -£54) and QALY gain (0.001).</p> <p>A number of probabilistic sensitivity analyses were reported: -assuming no quality control of the discharge</p>

Perspective: Swedish healthcare Follow-up: 3 months Treatment effect duration^(a): 3 months Discounting: Costs: n/a ; Outcomes: n/a	Management [LIMM])	Outpatient visits	medication report - reduction in hospitalisation cost by 50% -hospitalisation cost 38% higher in intervention arm -admission part probability for hospitalisation in intervention arm increased to 100% -intervention cost (time) 50% higher -cost (time) for physicians and nurses administration reduced by 50% All SAs found the LIMM model to be dominant.
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Data sources

Health outcomes: Relative effectiveness estimates were based on linked clinical studies that were conducted to evaluate the intervention. **Quality-of-life weights:** EQ-5D UK tariff utility data were taken from the literature and supplemented by assumptions regarding QALY loss due to hospitalisation and outpatient visits. **Cost sources:** Costs were based on actual resource use reported in patient charts at Skane University Hospital in Lund, Sweden, in addition to data collected in a series of studies conducted at Swedish hospitals. Costs of hospital readmissions were based on hospital accounting data as well as the nurse, pharmacist and physician time unit cost.

Comments

Source of funding: Apoteket Farmaci AB (state owned pharmacy company with commercial interest in disseminating the LIMM model) **Applicability and limitations:** The standard care arm in the study is not clearly described. Some uncertainty regarding the applicability of resource use and costs from Sweden (2009) to current NHS context. Changes in quality of life are based on the literature and assumptions and not reported directly from patients. The model has a short time horizon and does not capture differences in downstream costs and outcomes between the comparators. The baseline and relative treatment effectiveness estimates are based on a series of non-randomised studies conducted to evaluate the LIMM model and source the input parameters for the model, hence by definition, does not reflect all evidence in the area. Local costs appear to have been used and it is not clear whether these costs reflect national costs. A potential conflict of interest might exist given that the study is funded by a pharmacy company with commercial interest in disseminating the LIMM model.

Overall applicability^(c): partially applicable **Overall quality^(d):** potentially serious limitations

Abbreviations: CUA: cost–utility analysis; 95% CI: 95% confidence interval; ED: emergency department; EQ-5D: Euroqol 5 dimensions (scale: 0.0 [death] to 1.0 [full health], negative values mean worse than death); ICER: incremental cost-effectiveness ratio; n/a: not applicable; NR: not reported; pa: probabilistic analysis; QALYs: quality-adjusted life years; SA: sensitivity analysis.

(a) For studies where the time horizon is longer than the treatment duration, an assumption needs to be made about the continuation of the study effect. For example, does a difference in utility between groups during treatment continue beyond the end of treatment and if so for how long?

(b) Converted using 2009 purchasing power parities⁵⁰.

(c) Directly applicable/Partially applicable/Not applicable.

(d) Minor limitations/Potentially serious limitations/Very serious limitations.

Study	Gillespie 2009 ²¹			
Study details	Population & interventions	Costs	Health outcomes	Cost effectiveness
<p>Economic analysis: CCA (health outcome: survival)</p> <p>Study design: Randomised controlled trial (RCT)</p> <p>Approach to analysis: Within-trial analysis of resource use and cost data. Logistic regression analysis of binary outcomes using odds ratios, COX proportional hazards model for survival analysis using relative risks, linear regression analysis for continuous outcomes and Poisson regression analysis for incidence. The cost of the intervention was calculated based on pharmacist time and its unit cost. Incremental cost was calculated as the difference between the cost of hospital and ED visits and the intervention cost.</p> <p>Perspective: Swedish healthcare</p> <p>Follow-up: 12 months</p> <p>Treatment effect duration^(a): 9 months</p> <p>Discounting: Costs: n/a ; Outcomes: n/a</p>	<p>Population: Elderly inpatients (80 years or older) admitted to 2 acute internal medicine wards at a University Hospital of Uppsala, Sweden.</p> <p>Cohort settings: (n=368) Mean age: Intervention 1: 87.1 years Intervention 2: 86.4 years</p> <p>Male: Intervention 1: 40.3% Intervention 2: 42.3%</p> <p>Intervention 1: (n=186) No pharmacist involvement in the healthcare team at the ward level.</p> <p>Intervention 2: (n=199) Pharmacist present on the ward. Duties included taking part in the ward rounds, documenting medication history, and discharge counselling and contacted patients 2 months after discharge for a follow-up. The intervention was delivered on weekdays between 8 am and 4 pm. Pharmacists had taken postgraduate courses in clinical pharmacy.</p>	<p>Total costs (mean per patient) including intervention cost Intervention 1: £6,630 Intervention 2: £6,508 Incremental (2-1): -£122 (95% CI: NR; p=NR)</p> <p>Currency & cost year: 2008 Swedish Kroners converted to US dollars (presented here as 2008 UK pounds^(b))</p> <p>Cost components incorporated: Pharmacist time Hospital readmissions and ED visits</p>	<p>Mortality: Intervention 1: 61/186 (32.3%) Intervention 2: 57/182 (31.3%) Incremental (2-1): -1% (95% CI: NR; p=0.82)</p>	<p>ICER (Intervention 2 versus Intervention 1): Clinical pharmacist intervention dominant</p> <p>Analysis of uncertainty: None reported</p>
Data sources				
<p>Health outcomes: Within-trial analysis of hospital readmissions and ED visits data from the hospital's patient administrative system over a period of 12 months follow-up. Quality-of-life weights: n/a. Cost sources: The main source of cost data was the hospital's patient administrative system, so likely to be local unit costs. No source is</p>				

given for the unit costs of pharmacist time.

Comments

Source of funding: Institutional and governmental funding. **Applicability and limitations:** QALYs were not used as an outcome measure. Some uncertainty regarding the applicability of resource use and costs from Sweden (2008) to current NHS context. The intervention is delivered by pharmacists with postgraduate training in clinical pharmacy but no specialist status which may not reflect the situation in UK hospitals. Relative effectiveness evidence is based on a single RCT, so by definition does not reflect all evidence in the area. Follow-up for 12 months which may not capture all relevant costs and outcomes. Primary care visits, medication costs and cost of other staff time were not included in the analysis. No sensitivity analysis is reported.

Overall applicability^(c): partially applicable **Overall quality^(d):** potentially serious limitations

Abbreviations: CCA: cost–consequence analysis; 95% CI: 95% confidence interval; ED: emergency department; ICER: incremental cost-effectiveness ratio; n/a: not applicable; NR: not reported; pa: probabilistic analysis; QALYs: quality-adjusted life years.

(a) For studies where the time horizon is longer than the treatment duration, an assumption needs to be made about the continuation of the study effect. For example, does a difference in utility between groups during treatment continue beyond the end of treatment and if so for how long?

(b) Converted using 2008 purchasing power parities⁵⁰.

(c) Directly applicable/Partially applicable/Not applicable.

(d) Minor limitations/Potentially serious limitations/Very serious limitations.

Study	Karnon 2008 ^{16,29}			
Study details	Population & interventions	Costs	Health outcomes	Cost effectiveness
<p>Economic analysis: CUA (health outcome: QALYs)</p> <p>Study design: Decision tree model</p> <p>Approach to analysis: A decision tree model developed to describe series of error points and subsequent error detection points in pathways through the medication process in a generic secondary care setting. Errors were</p>	<p>Population: Inpatients at 400 beds acute hospital (average hospital size) with around 14 wards and approximately 162,000 prescriptions per year.</p> <p>Cohort settings: Start age: NR Male: NR</p> <p>Intervention 1: No ward based pharmacist (a pharmacist covers 2 wards of about 30 patients</p>	<p>Total costs (per hospital over 5 years): Intervention 1: £0.6 million Intervention 2: £0.42 million Incremental (2–1): £0.18 million (95% CI: NR; p=NR)</p> <p>Currency & cost year: 2006 UK pounds</p> <p>Cost components incorporated: Monetary values were assigned to interventions,</p>	<p>QALYs (per hospital over 5 years): Intervention 1: NR Intervention 2: NR Incremental (2–1): 285 (95% CI: NR; p=NR)</p>	<p>ICER (Intervention 2 versus Intervention 1): £631.57 per QALY gained^(b) 95% CI: NR Probability Intervention 2 cost-effective (£20K/30K threshold): NR</p> <p>Net monetary benefit over 5 years: Minimum intervention cost scenario: £27.256 million (pa) (95% CI: £5.673 to £69.520 million; p=NR) Maximum intervention cost scenario: £26.509 million (pa) (95% CI: £4.925 to £68.772 million; p=NR)</p>

<p>classified as significant, serious, life-threatening or fatal. The effectiveness of potential interventions was estimated by describing their impact on error incidence and detection rates which alters the estimated frequency of errors and preventable adverse events (pADEs) and consequently their associated costs and health effects.</p> <p>Perspective: UK NHS Time horizon: 5 years Treatment effect duration^{(a)(a)}: 5 years Discounting: Costs: NR ; Outcomes: NR</p>	<p>over a morning to provide basic level of pharmaceutical care and in the afternoons they have departmental commitments)</p> <p>Intervention 2: Ward based senior pharmacist (grade 7/8a) attends rounds with residents, nurses, attending staff each morning, is present in the ward for consultation and assistance to nursing staff during the rest of the morning and is available on call as necessary during the rest of the day.</p>	<p>efficiency savings, treatment and health effects of pADEs. Costs included: pharmacist time, length of stay, litigation costs</p>		<p>Analysis of uncertainty: The analysis was run using the lower and upper estimates of the intervention cost, which were calculated assuming an average of 2.5 and 1.5 wards per morning per pharmacist in the intervention 1 scenario.</p> <p>The authors presented another analysis including the cost of treating pADEs only but not the monetary valuation of the health outcomes (QALYs), which showed that the ward-based pharmacist intervention had small expected negative NMB for both the minimum and maximum intervention cost scenario.</p>
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Data sources

Health outcomes: Baseline event data were subjectively defined by the authors based on evidence from the literature and qualitative findings from an expert elicitation workshop. Effectiveness data are based on a review of the literature; however, this hasn't been described in the current paper in detail but in a separate project report.³⁰ **Quality-of-life weights:** estimates of utility decrements were based on discussions within the research team. **Cost sources:** Cost of pharmacist time was taken from national sources, while estimates of other resource use and costs were based on published literature. NHS litigation costs were also included and based on estimates from the NHS litigation authority database.

Comments

Source of funding: governmental funding (Department of Health). **Applicability and limitations:** Some uncertainty regarding the applicability of resource use and costs from the literature, which were converted to 2006 UK pounds and adjusted for inflation. No discounting was applied despite using a 5-year time horizon. Utility decrements due to medication errors are based on estimates reached at through discussion within the research team and not based on data collected from patients. The model has a relatively short time horizon and may not capture all the relevant costs and outcomes, given the potential for preventing fatal medication errors. The health outcomes assessed included only QALY gains from prevention of medication errors. The authors reported that the estimates of baseline and relative

effectiveness are "subjectively defined by the authors based on evidence from the literature and qualitative findings from an expert elicitation workshop involving mixture of human factors experts and health professionals to estimate individual error incidence and detection rates", however no detail is given regarding how the evidence has been identified or reviewed. Costs relating to the time of other health care professionals, which might be affected by more pharmacist involvement, have not been included.

Overall applicability^(c): partially applicable **Overall quality^(d):** potentially serious limitations

Abbreviations: 95% CI: 95% confidence interval; CUA: cost–utility analysis; ICER: incremental cost-effectiveness ratio; n/a: not applicable; NR: not reported; pa: probabilistic analysis; QALYs: quality-adjusted life years

(a) For studies where the time horizon is longer than the treatment duration, an assumption needs to be made about the continuation of the study effect. For example, does a difference in utility between groups during treatment continue beyond the end of treatment and if so for how long.

(b) Calculated by NGC

(c) Directly applicable/Partially applicable/Not applicable

(d) Minor limitations/Potentially serious limitations/Very serious limitations

Study	Klopowska 2010 ³²			
Study details	Population & interventions	Costs	Health outcomes	Cost effectiveness
<p>Economic analysis: CCA (health outcome: prescribing errors, patient harm)</p> <p>Study design: before and after comparative interventional study</p> <p>Approach to analysis: Data were collected during a baseline period, with no ICU hospital pharmacist intervention, on the incidence of prescribing errors, rate of consensus, number of preventable adverse drug events (pADEs); defined as prescribing errors that</p>	<p>Population: Patients in an adult surgical and medical 28-bed ICU of the academic Medical Centre, a 1,002-bed (tertiary care) academic hospital in Amsterdam, the Netherlands.</p> <p>Cohort settings: (n=1,173) Mean age: Intervention 1: 63.2 years Intervention 2: 61.3 years</p> <p>Male: Intervention 1: 36.5% Intervention 2: 35.5%</p>	<p>Total costs (mean per patient)^(a): Intervention 1: assumed zero Intervention 2: -£108 Incremental (2–1): -£108 (95% CI: NR; p=NR)</p> <p>Currency & cost year: 2007 euros (presented here as 2007 UK pounds ^(b))</p> <p>Cost components incorporated: Pharmacists' time Physicians' time pADEs</p>	<p>Incidence of prescribing errors (mean per patient) Intervention 1: 0.57 Intervention 2: 0.19 Incremental (2–1): -0.38 (95% CI: -0.27 to -0.5; p<0.001)</p> <p>Incidence of prescribing errors that resulted in patient harm^(c) (pADEs) (mean per patient) Intervention 1: 0.012 Intervention 2: 0.003 Incremental (2–1): -0.009 (95% CI: NR; p=0.25)</p> <p>Incidence of potentially</p>	<p>ICER (Intervention 2 versus Intervention 1): n/a</p> <p>Analysis of uncertainty: No sensitivity analysis reported A subgroup analysis was conducted to compare the results during the first half of the intervention period (4 months) with the second half, to account for the learning curve. The analysis showed significant difference in outcomes between the 2 periods, with the second period showing better outcomes</p>

<p>resulted in patient harm. These baseline data were collected for 3 weeks. The same data were collected during the intervention period. Cost of delivering the intervention was calculated as the cost of the pharmacist time. The cost of doctors' time was also calculated. Unpaired student t-test was used to compare costs.</p> <p>Perspective: Dutch healthcare</p> <p>Follow-up: ICU stay.</p> <p>Treatment effect duration: same as follow-up.</p> <p>Discounting: Not discounted.</p>	<p>Intervention 1: (n=115) Standard pharmacy services provided by the hospital pharmacy department including on-call availability of a hospital pharmacist or hospital pharmacy resident for consultations and therapeutic drug monitoring. Pharmacy technicians prepared ready-to-use parenteral medication at an ICU based satellite pharmacy. The prepared medications were reviewed twice a day by a hospital pharmacist at the central pharmacy department.</p> <p>Intervention 2: (n=1,058) Two hospital pharmacists with more than 10 years hospital practice experience trained in the ICU for 4 weeks prior to starting were present on the ICU daily for 8 months, reviewing medication orders and recording prescribing issues. These issues were then discussed with ICU physician during the multidisciplinary patient review meeting.</p>		<p>harmful pADEs (mean per patient): Intervention 1: 0.16 Intervention 2: 0.048 Incremental (2-1): -0.552 (95% CI: -0.051 to -0.174; p<0.001)</p> <p>Incidence of prescribing errors that did not result in harm (mean per patient): Intervention 1: 0.399 Intervention 2: 0.136 Incremental (2-1): -0.263 (95% CI: -0.166 to -0.359; p<0.001)</p>	
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Data sources

Health outcomes: data on prescribing errors and patient harm (pADEs) were collected during the baseline observation period and the intervention period and

compared. Cost of pharmacist and physicians' time were calculated well as the cost of the recorded pADEs. **Quality-of-life weights:** n/a. **Cost sources:** ICU pharmacists' and physicians' time costs were based on national unit costs. Potential savings from the pADEs were calculated using estimates from Bates 1997⁶ in 1997 US dollars converted to 2007 euros.

Comments

Source of funding: the Netherlands Organization for Health Research and Development (ZonMW), The Hague. **Applicability and limitations:** QALYs were not used as an outcome measure and only costs and cost savings were included as outcomes. Some uncertainty regarding the applicability of resource use and costs from the Netherlands (2007) to current NHS context. The intervention is delivered by senior clinical pharmacists but with limited ICU experience, which may not be the same as in NHS hospitals. The study is a cost-consequences analysis with only patient harm as a health outcome. The costs included were limited to staff time and potential saving from pADEs, while the cost of hospital stay and medication were not included. The study follow-up is short (ICU stay) and may not capture all relevant costs and outcomes. No sensitivity analysis is reported.

Overall applicability^(c): partially applicable **Overall quality^(d):** potentially serious limitations

Abbreviations: CCA: cost–consequence analysis; 95% CI: 95% confidence interval; ICER: incremental cost-effectiveness ratio; ICU: intensive care unit; n/a: not applicable; NR: not reported; pa: probabilistic analysis; QALYs: quality-adjusted life years

(a) Calculated by NGC

(b) Converted using 2007 purchasing power parities⁵⁰

(c) Defined as temporary or permanent impairment of the physical, emotional or psychological function or structure of the body and/or pain requiring intervention resulting from this impairment.

(d) Directly applicable / Partially applicable / Not applicable

(e) Minor limitations / Potentially serious limitations / Very serious limitations

E.2 Pharmacist at admission

Study	Fertleman 2005 ¹⁹			
Study details	Population & interventions	Costs	Health outcomes	Cost effectiveness
<p>Economic analysis: CC (health outcome: n/a)</p> <p>Study design: before-and-after observational study</p> <p>Approach to analysis: Retrospective audit of the pre-intervention period where patient notes were reviewed and data extracted for 3 post-take ward rounds (PTWRs). This was compared with data prospectively collected using intervention form in the intervention. Identified medication changes were assigned a clinical risk score using NPSA guidelines and a cost assigned to each.</p> <p>Perspective: UK NHS</p> <p>Follow-up: 3 days</p> <p>Treatment effect duration^(a): extrapolated over a year</p> <p>Discounting: Costs: n/a ; Outcomes: n/a</p>	<p>Population: Medical patients admitted within the preceding 24 hours to a general medical ward at a district general hospital (Northwick Park hospital in north-west London) with 800 acute beds; providing acute medical services to a population of 300,000.</p> <p>Cohort settings: Start age: NR Male: NR</p> <p>Intervention 1: (n=50) Ward-based pharmacist provide pharmaceutical care for 1-2 hours at some time during the day, examining prescriptions and performing rounds at a different time to the clinical team; identifying clinical interventions after the prescribing decision has been made.</p> <p>Intervention 2: (n=53) Senior pharmacist present on post-admission (post-take) ward rounds (PTWR) in addition to the pharmaceutical care provided by the ward-based junior clinical pharmacists. The pharmacist obtained drug history in addition to the doctor's admission drug history and contributed to prescribing decisions.</p>	<p>Net drug cost per annum (mean per patient): Intervention 1: £175.48 Intervention 2: £33.40 Incremental (2-1): -£142.08^(b) (95% CI: NR; p=NR)</p> <p>Currency & cost year: 2003 UK pounds</p> <p>Cost components incorporated: Cost of drugs on admission Cost of drugs on discharge Saving from avoided clinical risk Pharmacist time</p>	n/a	<p>ICER (Intervention 2 versus Intervention 1): n/a</p> <p>Clinical pharmacist intervention cost saving</p> <p>Analysis of uncertainty: None reported. No statistical analysis was undertaken.</p>
Data sources				

Health outcomes: Only process outcomes were considered where patient notes were analysed and data collected on accuracy of drug history, number of admission drugs stopped before discharge and pharmacist recommendations. Retrospective review of risk using NPSA guideline was undertaken to assign a clinical risk score for each pharmacist-initiated medication change intervention. **Quality-of-life weights:** n/a. **Cost sources:** National unit costs for medications were taken from the British National Formulary (BNF).

Comments

Source of funding: NR. **Applicability and limitations:** QALYs were not used as an outcome measure. Some uncertainty regarding the applicability of resource use and costs from 2003 to current NHS context. Observational study with no adjustment for confounders, so by definition not reflecting all evidence in this area. The study has a very short follow-up time for both the pre- and post-intervention phases (3 ward rounds each) and the calculated cost-saving was extrapolated over a year. Long-term impact on costs and outcomes has not been assessed. Additionally, limited costs were included in the analysis (medication costs and pharmacist time). No sensitivity analysis is reported.

Overall applicability^(c): Partially applicable **Overall quality^(c):** Potentially serious limitations

Abbreviations: CC: comparative cost analysis; 95% CI: 95% confidence interval; ICER: incremental cost-effectiveness ratio; n/a: not applicable; NR: not reported; QALYs: quality-adjusted life years.

(a) For studies where the time horizon is longer than the treatment duration, an assumption needs to be made about the continuation of the study effect. For example, does a difference in utility between groups during treatment continue beyond the end of treatment and if so for how long?

(b) Calculated by NGC.

(c) Directly applicable/Partially applicable/Not applicable.

(d) Minor limitations/Potentially serious limitations/Very serious limitations.

E.3 Pharmacist at discharge

Study	Wallerstedt 2012 ⁶⁶			
Study details	Population & interventions	Costs	Health outcomes	Cost effectiveness
<p>Economic analysis: CUA (outcome: QALYs)</p> <p>Study design: Randomised controlled trial (RCT) (linked RCT Bladh 2011⁸)</p> <p>Approach to analysis: Within-trial analysis of cost and EQ-5D data collected at baseline and after 6 months follow-up.</p> <p>Perspective: Swedish healthcare</p> <p>Follow-up: 6 months</p> <p>Treatment effect duration^(a): 6 months</p> <p>Discounting: Costs :n/a ; Outcomes: n/a</p>	<p>Population: Elderly inpatients on 2 internal medicine wards at Sahlgrenska University Hospital, Sweden.</p> <p>Cohort settings: (n=345) Median age: 82 years Male: 39%</p> <p>Intervention 1: (n=181, EQ-5D data available for 124 patients) Usual care, which was received from the same group of physicians and nurses. No other details given</p> <p>Intervention 2: (n=164, EQ-5D data available for 116 patients) Clinical pharmacists delivering a composite intervention consisting of medication review including feedback to physicians on prescribing, drug treatment discussion with the patient at discharge, medication</p>	<p>Total costs (mean per patient)-complete case analysis: Intervention 1: £6,564 Intervention 2: £7,613 Incremental (2-1): £1,050 (95% CI: NR; p=NR)</p> <p>Total costs (mean per patient)-all patients' analysis: Intervention 1: £7,308 Intervention 2: £7,500 Incremental (2-1): £191 (95% CI: NR; p=0.79)</p> <p>Currency & cost year: Swedish Kroners converted to 2011 Euros (presented here as 2011 UK pounds^(b))</p> <p>Cost components incorporated: Inpatient and outpatient consultations Hospital admissions Intervention cost (pharmacists' time) Medication costs</p>	<p>QALYs (mean per patient)-adjusted for baseline EQ-5D score: Intervention 1: NR Intervention 2: NR Incremental (2-1): 0.0035 (95% CI: NR; p=NR)</p> <p>QALYs (mean per patient)-unadjusted for baseline EQ-5D score: Intervention 1: NR Intervention 2: NR Incremental (2-1): 0.0051 (95% CI: NR; p=NR)</p>	<p>ICER (Intervention 2 versus Intervention 1): £327,378 per adjusted QALY gained and £223,430 (pa) 95% CI: NR Probability Intervention 2 cost-effective (£20K/30K threshold): NR/NR</p> <p>Probability Intervention 2 cost-effective (£35,326 (50,000 Euro) threshold): 20%</p> <p>Analysis of uncertainty: Two sensitivity analyses were reported: -Subgroup of deceased (terminally ill) and alive patients: ICER for deceased (terminally ill) patients-baseline-adjusted analysis: dominant (£56,946 saved per QALY gained) 95% CI: NR</p> <p>ICER for deceased (terminally ill) patients-unadjusted analysis: NR 95% CI: NR</p> <p>ICER for alive patients-baseline-adjusted analysis: £125,856 per QALY gained 95% CI: NR</p> <p>ICER for alive patients- unadjusted analysis:</p>

	report including summary of drug treatment changes to be sent to the GP			<p>£179,748 per QALY gained 95% CI: NR</p> <p>-Imputed dataset: Where missing data for EQ-5D were imputed using a regression model (multiple imputation)</p> <p>ICER – using baseline-adjusted analysis: £81,377 per QALY gained. 95% CI: NR</p> <p>ICER – unadjusted analysis: £117,681 per QALY gained. 95% CI: NR</p>
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Data sources

Health outcomes: Within-trial analysis of costs and QALY data collected at baseline and at 6 months follow-up. The clinical effectiveness results were reported in a separate paper included in the clinical review (Baldh 2011⁸). **Quality-of-life weights:** estimated using EQ-5D, with data collected at baseline and 6 months follow-up. **Cost sources:** National unit costs were used for example Swedish Prescribed Drugs Register and other public sources (not specified) for healthcare resources used during inpatient and outpatient care. Resource use data were obtained from a national database that includes all health care consultations (both inpatient and outpatient)

Comments

Source of funding: National Board of Health and Welfare. **Applicability and limitations:** Some uncertainty regarding the applicability of resource use (2007-2008) and costs (2011) from Sweden to the current NHS context. It is not clear which EQ-5D tariff was used for calculating utilities. The intervention is delivered by junior pharmacists, which may not be the same to clinical pharmacist services delivered at UK hospitals. Relative effectiveness evidence is based on a single RCT, so by definition does not reflect all evidence in the area. Short follow-up, 6 months, so may not capture all relevant costs and outcomes.

Overall applicability^(c): partially applicable **Overall quality^(c):** minor limitations

Abbreviations: 95% CI: 95% confidence interval; CUA: cost–utility analysis; da: deterministic analysis; EQ-5D: Euroqol 5 dimensions (scale: 0.0 [death] to 1.0 [full health], negative values mean worse than death); ICER: incremental cost-effectiveness ratio; n/a: not applicable; NR: not reported; pa: probabilistic analysis; QALYs: quality-adjusted life years.

- (a) For studies where the time horizon is longer than the treatment duration, an assumption needs to be made about the continuation of the study effect. For example, does a difference in utility between groups during treatment continue beyond the end of treatment and if so for how long.*
- (b) Converted using 2011 purchasing power parities⁵⁰*
- (c) Directly applicable / Partially applicable / Not applicable*
- (d) Minor limitations / Potentially serious limitations / Very serious limitations*

Appendix F: GRADE tables

Table 12: Clinical evidence profile: Regular in-hospital pharmacy support versus no ward-based pharmacist

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Regular in-hospital pharmacist support	No ward-based pharmacist	Relative (95% CI)	Absolute		
Mortality (follow-up median 1 years)												
3	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	105/534 (19.7%)	19.8%	RR 0.92 (0.72 to 1.16)	16 fewer per 1000 (from 55 fewer to 32 more)	⊕○○○ VERY LOW	CRITICAL
Survival (follow-up 1 years)												
1	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	very serious ²	none	0/182 (0%)	0%	HR 0.94 (0.65 to 1.36)	-	⊕○○○ VERY LOW	CRITICAL
Admissions to hospital (over 30 days) (follow-up median 1 years)												
4	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	no serious imprecision	none	327/942 (34.7%)	38.4%	RR 0.93 (0.83 to 1.04)	27 fewer per 1000 (from 65 fewer to 15 more)	⊕⊕○○ MODERATE	IMPORTANT
Readmission (follow-up 30 days)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	very serious ²	none	40/298 (13.4%)	14.6%	RR 0.92 (0.62 to 1.37)	12 fewer per 1000 (from 55 fewer to 54 more)	⊕○○○ VERY LOW	IMPORTANT
Prescribing errors (follow-up at discharge; measured with: medication appropriateness index; Better indicated by lower values)												
2	randomised trials	serious ¹	serious inconsistency ³	no serious indirectness	no serious imprecision	none	408	403	-	MD 0.02 lower (0.12 lower to 1.08 higher)	⊕⊕○○ LOW	CRITICAL

Prescribing errors (follow-up 30 days; measured with: medication appropriateness index; Better indicated by lower values)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	no serious imprecision	none	304	309	-	MD 2.1 higher (0.45 to 3.75 higher)	⊕⊕⊕O MODERATE	CRITICAL
Preventable adverse drug events (follow-up until discharge)												
2	randomised trials	very serious ¹	serious ³	no serious indirectness	very serious ²	none	5/391 (1.3%)	5.4%	RR 0.74 (0.06 to 8.57)	14 fewer per 1000 (from 51 fewer to 409 more)	⊕OOO VERY LOW	CRITICAL
Preventable adverse drug events (follow-up 90 days)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	very serious ²	none	7/295 (2.4%)	3.1%	RR 0.77 (0.29 to 2.05)	7 fewer per 1000 (from 22 fewer to 33 more)	⊕OOO VERY LOW	CRITICAL
Adverse drug reactions (follow-up 6 months)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	very serious ²	none	3/43 (7%)	4.8%	RR 1.47 (0.26 to 8.33)	23 more per 1000 (from 36 fewer to 352 more)	⊕OOO VERY LOW	CRITICAL
Length of stay (days) (follow-up in-hospital; Better indicated by lower values)												
2	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	no serious imprecision	none	547	569	-	MD 1.74 lower (2.76 to 0.72 lower)	⊕⊕⊕O MODERATE	CRITICAL
Patient and/or carer satisfaction (follow-up 1 months)												
1	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	no serious imprecision	none	71/89 (79.8%)	44.6%	RR 1.79 (1.38 to 2.32)	352 more per 1000 (from 169 more to 589 more)	⊕⊕OO LOW	CRITICAL
Patient and/or carer satisfaction (at discharge)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	35/43 (81.4%)	54.8%	RR 1.49 (1.09 to 2.03)	269 more per 1000 (from 49 more to 564 more)	⊕⊕OO LOW	CRITICAL

¹ Downgraded by 1 increment if the majority of the evidence was at high risk of bias, and downgraded by 2 increments if the majority of the evidence was at very high risk of bias

² Downgraded by 1 increment if the confidence interval crossed 1 MID or by 2 increments if the confidence interval crossed both MIDs.

³ Downgraded by 1 because: The point estimate varies widely across studies

Table 13: Clinical evidence profile: Pharmacist at admission versus no ward-based pharmacist

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Pharmacist at admission	No ward-based pharmacist	Relative (95% CI)	Absolute		
Medication reconciliation (measured with: errors identified at admission; Better indicated by lower values)												
2	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	149	144	-	MD 0.36 higher (0.07 to 0.65 higher)	⊕⊕○○ LOW	CRITICAL
Quality of life (follow-up 3 months; measured with: EQ-VAS index; Better indicated by higher values)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	33	30	-	MD 6.2 higher (5.7 lower to 18.1 higher)	⊕⊕○○ LOW	CRITICAL
Length of stay (follow-up in-hospital; Better indicated by lower values)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	no serious imprecision	none	50	49	-	MD 1.3 higher (108.96 lower to 111.56 higher)	⊕⊕⊕○ MODERATE	CRITICAL
Admission (follow-up 3 months; Better indicated by lower values)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	50	49	-	MD 0.1 lower (0.38 lower to 0.18 higher)	⊕⊕○○ LOW	IMPORTANT
Mortality (follow-up 3 months)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	very serious ²	none	8/50 (16%)	10.2%	RR 1.57 (0.55 to 4.46)	58 more per 1000 (from 46 fewer to 353 more)	⊕○○○ VERY LOW	CRITICAL
Staff satisfaction (follow-up at admission; assessed with: Physician agreement)												
1	randomised	serious ¹	no serious	serious ³	serious ²	none	139/235	43.7%	RR 1.35	153 more per 1000	⊕○○○	IMPORTANT

	trials		inconsistency				(59.1%)		(1.13 to 1.63)	(from 57 more to 275 more)	VERY LOW	T
Length of stay in AAU (minutes) (Better indicated by lower values)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	no serious imprecision	none	216	232	-	3.2 higher (26.49 lower to 32.89 higher)	⊕⊕⊕O MODERATE	CRITICAL
Total medication errors within 24 hours of admission (Better indicated by lower values)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	no serious imprecision	none	15/408 (3.7%)	0%	RR 0.05 (0.03 to 0.08)	748 fewer per 1000 (from 772 fewer to 763 fewer)	⊕⊕⊕O MODERATE	CRITICAL

¹ Downgraded by 1 increment if the majority of the evidence was at high risk of bias, and downgraded by 2 increments if the majority of the evidence was at very high risk of bias

² Downgraded by 1 increment if the confidence interval crossed 1 MID or by 2 increments if the confidence interval crossed both MIDs.

³ The majority of the evidence had indirect outcomes.

Table 14: Clinical evidence profile: Pharmacist at discharge versus no ward-based pharmacist

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Pharmacist at discharge	No ward-based pharmacist	Relative (95% CI)	Absolute		
Prescription errors (follow-up 6 weeks; assessed with: identification at outpatient follow-up)												
1	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	16/41 (39%)	68.2%	RR 0.57 (0.37 to 0.88)	293 fewer per 1000 (from 82 fewer to 430 fewer)	⊕○○○ VERY LOW	CRITICAL
Quality of life (follow-up 6 months; measured with: Global health index; Better indicated by higher values)												
1	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	95	109	-	MD 0.23 higher (0.02 lower to 0.48 higher)	⊕○○○ VERY LOW	CRITICAL
Quality of life (follow-up 6 months; measured with: Summated EQ-5D index; Better indicated by higher values)												

1	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	no serious imprecision	none	95	109	-	MD 0.05 higher (0.05 lower to 0.15 higher)	⊕⊕⊕⊕ LOW	CRITICAL
Quality of life (follow-up 6 months; measured with: EQ-VAS index; range of scores: 0-100; Better indicated by higher values)												
1	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	no serious imprecision	none	95	109	-	MD 2.8 higher (1.83 lower to 7.43 higher)	⊕⊕⊕⊕ LOW	CRITICAL
Readmission (follow-up 15-22 days)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	5/43 (11.6%)	32.5%	RR 0.36 (0.14 to 0.91)	208 fewer per 1000 (from 29 fewer to 279 fewer)	⊕⊕⊕⊕ LOW	IMPORTANT
Prescriber errors (Drug therapy inconsistencies and omissions) (follow-up at discharge)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	no serious imprecision	none	1/28 (3.6%)	56.3%	RR 0.06 (0.01 to 0.44)	529 fewer per 1000 (from 315 fewer to 557 fewer)	⊕⊕⊕⊕ MODERATE	CRITICAL

¹ Downgraded by 1 increment if the majority of the evidence was at high risk of bias, and downgraded by 2 increments if the majority of the evidence was at very high risk of bias

² Downgraded by 1 increment if the confidence interval crossed 1 MID or by 2 increments if the confidence interval crossed both MIDs.

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Appendix G: Excluded clinical studies

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Table 15: Studies excluded from the clinical review

Study	Exclusion reason
Abu-oliem 2013 ²	Inappropriate comparison (ward-based pharmacist)
Alassaad 2014 ⁴	Incorrect comparison. Post-hoc subgroup analysis for no of prescribed drugs from included study (Gillespie 2009 ²¹)
Basger 2015 ⁵	Incorrect population (patients admitted for treatment of chronic disease in addition to rehab after joint replacement surgery)
Bessen 2015 ⁷	Inappropriate study design (comparison of 2 hospitals)
Bolas 2004 ⁹	No extractable outcomes
Burnett 2009 ¹⁰	Inappropriate comparison (normal care involved chart reviews, counselling etc. by pharmacists)
Cani 2015 ¹¹	Not review population (chronic disease management)
Chen 2016 ¹²	Incorrect population (patients with chronic condition, not admitted to hospital); incorrect intervention (pharmacists were not ward-based)
De boer 2011 ¹⁴	Protocol only
Ghatnekar 2013A ²⁰	Inappropriate study design (health economic model); no relevant outcomes
Graabaek 2013 ²²	Systematic review: study designs inappropriate (non-randomised studies, non-ward based interventions, ward-based comparators)
Heselmans 2015 ²³	Incorrect intervention (drug therapy changes communicated to the physician; pharmacist was not ward-based)
Hodgkinson 2006 ²⁴	Systematic review: study designs inappropriate (non-randomised studies, non-ward based interventions, ward-based comparators)
Horn 2006 ²⁵	No intervention (literature review)
Israel 2013 ²⁶	No relevant outcomes (underutilization of cardiovascular medications)
Jarab 2012 ²⁷	Study to be considered in the comm pharm review
Kaboli 2006 ²⁸	Systematic review: study designs inappropriate (non-randomised studies, non-ward based interventions, ward-based comparators)
Koehler 2009A ³³	Inappropriate comparison- care bundle including clinical pharmacist for elderly high risk patients compared to usual care group including staff pharmacist
Klopotowska 2010 ³²	Incorrect study design (before and after)
Kucukarslan 2013 ³⁴	Incorrect study design (before and after)
Leape 1999 ³⁶	Incorrect study design (observational)
Lipton 1992 ³⁸	Incorrect interventions (post-discharge care)
Maclaren 2009 ⁴⁰	Incorrect study design (retrospective cohort)
Makowsky 2009 ⁴¹	Inappropriate comparison (ward-based pharmacist)
Malone 2001 ⁴²	Not review population (ambulatory care)
Mousavi 2013 ⁴³	Not review population (nutritional support service)
Neto 2011 ⁴⁵	Incorrect interventions (not ward-based)
O'dell 2005 ⁴⁷	Incorrect study design (non-randomised, observational)
Okumura 2014 ⁴⁹	Systematic review has unclear PICO (no breakdown of studies, most took place in ambulatory care)
O'Sullivan 2016 ⁴⁸	Inappropriate comparison (pharmacist review vs. clinical decision support software supported pharmacist review)
Penm 2014 ⁵¹	Systematic review (studies based in China only; references screened)

Study	Exclusion reason
Phatak 2016 ⁵²	Inappropriate comparison (normal care involved daily pharmacist assessment)
Renaudin 2016 ⁵³	Systematic review and meta-analysis- ordered relevant references
Roblek 2016 ⁵⁴	Incorrect intervention (advice about drug-drug interactions given to physicians; pharmacist was not ward-based)
Sadik 2005 ⁵⁵	Study to be considered in the comm pharm review
Schnipper 2006 ⁵⁶	Study to be considered in the comm pharm review
Stowasser 2002 ⁶⁰	Incorrect interventions (not ward-based)
Suhaj 2016 ⁶¹	Incorrect population (patients with chronic condition, not admitted to hospital); incorrect intervention (pharmacists were not ward-based)
Upadhyay 2015 ⁶⁴	Incorrect population (patients with chronic condition, not admitted to hospital); incorrect intervention (pharmacists were not ward-based)
Upadhyay 2016 ⁶³	Incorrect population (patients with chronic condition, not admitted to hospital); incorrect intervention (pharmacists were not ward-based); no relevant outcomes
Viswanathan 2015 ⁶⁵	Systematic review is not relevant (outpatient settings only)
Wang 2015A ⁶⁷	Incorrect population (patients with cancer, not admitted to hospital); incorrect intervention (pharmacists were not ward-based)
Zhao 2015E ⁶⁸	Article not in English

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1 **Appendix H: Excluded economic studies**

2 No studies were excluded.

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