How is it best to deliver care in acute medical units? A systematic review.

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Main text

INTRODUCTION

Most patients presenting to hospital as a medical emergency in the United Kingdom (UK) are cared for in an acute medical unit (AMU)[1], defined as "a dedicated facility within a hospital that acts as the focus for acute medical care for patients who have presented as medical emergencies to hospital or who have developed an acute medical illness while in hospital"[2]. AMUs are also present in Ireland[3], other European countries[4,5], and Australasia[6,7]. Generally, AMUs receive patients presenting with acute medical complaints via the emergency department (ED) or by general practitioner (GP) referral. Following assessment, patients are either discharged from the AMU or transferred to other inpatient areas.

In 2007, a Royal College of Physicians (RCP) (UK) acute medicine task force produced a landmark series of recommendations for acute medical care: "The right person, in the right setting – first time"[2]. These recommendations, largely based on expert opinion, were generated by review of existing reports and evidence from key stakeholders involved in designing and delivering acute medical care. In 2012 the Society for Acute Medicine and the West Midlands Quality Review Service used the task force recommendations amongst others to produce a series of standards with the aim of improving UK AMU service quality[8]. NHS London also produced an abbreviated suite of minimum standards that patients utilising acute services should expect[9].

Despite these recommendations, care delivery differs across AMUs. Our recent review that examined the evidence for AMUs as "black box" interventions found that they were associated with reduced length of stay and, less convincingly, lower mortality[10]. This review also found variation in consultant work patterns, ward round frequency, policies on length of stay, admission criteria and AMU referral source[10]. This is consistent with survey evidence on the delivery of care in UK AMUs[11]. Therefore, it is unclear which components of AMU care are important to contributing to improved outcomes. As such, this systematic review aims to examine the available evidence relating to how best to deliver AMU care by studying the effect on outcome of specific interventions applied to acute medical patients within an AMU.

METHODS

Search strategy

Search terms

A scoping search was undertaken to identify how studies reporting on AMUs were described in the literature. Various terms used to describe AMUs (Supplementary Table 1) were used to build free text

searches. Searches using controlled vocabulary terms would have yielded many irrelevant results and therefore were not utilised.

Limits

Given the history of the development of acute medicine, the search was limited to 1990 onwards and was conducted on the 14th October 2014. Articles relating to paediatric medicine and non-research based articles were excluded.

Databases

Searches were conducted in six databases: MEDLINE, CINAHL, Health Management Information Consortium (HMIC), Web of Science including conference proceedings, Proquest for dissertations and theses and the Cochrane Controlled Trials Register. Supplementary Table 2 gives the Medline search strategy.

Other sources

Google scholar, Google with a 'gov.uk' limit and OpenGrey were also searched. The first 200 entries from Google scholar and the first 100 from Google with a gov.uk limit were screened. Further articles were identified through discussion with content experts, electronic searches for authors who had previously published in the field and through citation tracking and bibliography screening. Study authors were not contacted.

Screening and eligibility criteria

Two independent reviewers undertook abstract screening and full text review; any conflicts over eligibility were resolved through discussion. Interventions applied to undifferentiated acute medical patients within an AMU setting were included. No restriction was placed on intervention type, comparators/controls or outcomes. Only designs based on the evaluation of an exposure-outcome relationship were included.

Quality Assessment

Quality assessment was undertaken by two independent reviewers with any conflicts resolved through discussion. Observational studies were quality assessed using a template developed from the STrengthening the Reporting of OBservational studies in Epidemiology recommendations (STROBE)[12] and Preferred Reporting of Items for Systematic reviews and Meta-Analyses (PRISMA)[13] guidance (Supplementary Table 3). Quality improvement studies were quality assessed using a template developed from the SQUIRE 2.0 guidelines[14] (Supplementary Table 4). For each scoring system, a score equating to at least partial reporting of every component was the inclusion threshold: 13 out of 26 for observational studies and 14 out of 28 for quality improvement studies.

Data extraction

Two reviewers extracted data independently into pre-prepared tables and resolved any conflicts through discussion. Extracted data comprised: setting, study design, data sources, sample size, intervention, comparator and outcomes.

Data synthesis

As quantitative synthesis should not be undertaken on data obtained from diverse non-randomised studies[15], narrative synthesis was performed.

RESULTS

Figure 1 details the identification, screening and assessment for eligibility of articles. A total of 3,056 articles were identified. Following duplicate, title and abstract screening, 64 articles were full-text screened, of which 11 were deemed eligible. Two were excluded following quality assessment, leaving nine included studies.

Summary of included studies

The included studies are summarised in Table 1. Eight were conducted in the UK and one in Ireland. The unit of analysis varied between studies. In total, 1.3 million episodes, 3,617 patients and 49 staff members were evaluated. Studies were published from 1998 to 2014. Seven adopted an observational approach and two were quality improvement studies. In six, the intervention group was compared to a historical group cared for in the AMU[16-21]. In three studies the intervention group was compared to a concurrent non-intervention group cared for in the AMU[22-24]. No study designs included randomisation. There was one multicentre study[24]. Only one study attempted to adjust for confounding[24].

Summary of evidence

A summary of the interventions, comparators and outcomes is presented in Table 2. Ten different interventions were evaluated.

Enhanced pharmacy care

Pickrell *et al* found enhanced pharmacy care, a combination of patient counselling and enhanced medicine reconciliation, to be associated with a reduction in unintentional drug discrepancies and an increase in patients' familiarity with drugs[22](Table 2).

Dedicated occupational therapy (OT) service

Sutton *et al* found the presence of a dedicated OT on the AMU compared to a non-dedicated service was associated with reduced time from referral to OT assessment and reduced mean length of stay

(LOS)[16]. The OT provided input for patients who were medically fit and anticipated to be discharged within 48 hours.

Consultant presence

Two studies evaluated consultant presence. McNeill *et al* compared the presence of a consultant on the AMU from 0900–1700 with no consultant presence until a post-take ward round at 1900 on weekdays in a single site[23]. The consultant role was described as "the use of one-to-one contact to ensure rapid and timely review of patients within AMU" and resulted in earlier requesting of required investigations and referrals to specialties and social care, and allowed the nurse coordinator to plan the disposition of patients sooner. It was unclear whether the consultant had clinical responsibilities outside the AMU.

Bell *et al* evaluated the effect of a consultant being immediately available for more than four hours at a time (excluding presence for a ward round or availability only on request) on unit level outcomes across 91 sites[24]. This was the only study which took account of potential confounders in the analysis, adjusting for age, comorbidity and deprivation and undertaking multiple regression analysis of the main outcomes.

Both of these studies reported mortality, readmission and LOS outcomes (Table 2). Consultant presence was associated with reduced mortality: McNeill found a non-significant 0.7% reduction in inpatient mortality and Bell *et al* found a statistically significant reduction in the adjusted case fatality rate (aCFR) in units where a consultant was present for more than four hours (magnitude of difference not given). However, McNeill also found a 0.5% increase in death within 48 hours of admission (significance not stated).

Bell *et al* reported a statistically significantly reduced proportion of patients readmitted after 28 days (magnitude of difference not given), whereas McNeill *et al* reported no significant change in 30-day readmission. This may simply reflect the contrasting sample sizes of the studies.

Bell *et al* found no significant difference in LOS between groups whereas McNeill *et al* report a mean 1.34 day reduction (95% CI 0.01 – 2.67). The lower confidence interval limit indicates that the effect on LOS could still be minimal.

McNeill *et al* also evaluated the proportion of patients discharged on day of admission, finding an increase of 9.2% (95% CI 5.7 – 12.6) when a consultant was present from 0900-1700.

Consultant work pattern

Bell *et al* also evaluated an "all-inclusive" consultant work pattern (Table 2)[24], reporting a statistically significant reduction in the excess hospital aCFR of weekdays versus weekend admissions (magnitude of difference not given).

Trainee staff levels

Bell *et al* also evaluated trainee staff levels, finding no association between the number of admissions per whole time equivalent medical trainee and aCFR, weekday/weekend aCFR ratio, LOS and 7 and 28 day readmission rate[24] (Table 2).

Rapid access medical clinic

One study evaluated the introduction of a rapid access medical clinic (RAMC) to the AMU[17]. The RAMC aimed to provide a safe alternative to hospital admission and facilitate safe discharge by formally following up discharged patients. It was led by a senior acute medicine trainee. General medical patients were selected on the basis of their care needs and there was no restriction on which presentation types were accepted. Eighty-nine per cent of RAMC patients were treated as outpatients. The clinic was associated with a statistically non-significant 4% decrease in readmissions; and a statistically significant 9% increase in the proportion of patients discharged on day of admission (Table 2).

Handover arrangements

Luther *et al* used quality improvement methodology to enhance the handover process from the AMU to specialty/general medical wards[18]. The development of the handover checklist was associated with improvement in all handover metrics (Table 2).

Interventions comprising multiple components

Three studies evaluated multiple component interventions. Each study measured its intervention effect using several outcome measures, with little overlap in outcomes across the three studies. All three studies first involved local work to identify areas for improvement within that specific setting.

Beckett et al[19]

The primary aim of the interventions in this study was to reduce the number of cardiac arrests on the AMU. The interventions were: early identification and rescue of deteriorating patients; improved learning from adverse events; improved end-of-life decision making; staffing changes such that most AMU medical staff only had responsibility for AMU patients; and routine twice daily consultant ward rounds were instigated. These changes were associated with a 71% reduction in cardiac arrest rate and reductions in AMU LOS and the 30-day mortality rate of AMU patients (Table 2).

Epstein et al[20]

Epstein *et al* identified key bottlenecks in the patient journey to AMU through the ED and developed multiple interventions to address these. Interventions changed staffing, diagnostic services, specialty input, pharmacy input and patient flow (Table 2).

The interventions were associated with reduced AMU LOS and mortality (Table 2). The number of weekend discharges increased substantially; the percentage of patients being admitted to the AMU rather than directly to specialty/general wards increased; and a greater percentage of patients exited the AMU within 48 hours. They also found reductions in two ED metrics: ED attendance duration and the number of breaches of assessment target times (Table 2).

Wald et al[21]

Wald *et al* developed interventions including changes to medical staffing, pharmacy services, support services and patient flow. These interventions were associated with a non-significant, slight increase in the proportion of patients readmitted after 28 days; an increase in the proportion discharged on day of admission; an increase in the percentage seen in the AMU rather than the ED; and a decrease in the percentage staying more than two days in the AMU (Table 2).

DISCUSSION

This review identified nine studies conducted in UK or Ireland encompassing 1.3 million episodes, 3,617 patients and 49 staff that evaluated seven single interventions and three multiple interventions.

The first principal finding is the evidence for the beneficial effects of increased consultant presence on the AMU, based upon two studies, one a large multicentre study in which the analysis controlled for confounding. Although the interventions were not identical between studies, both increased consultant presence for a sustained period, with beneficial effects on mortality, readmissions and same-day discharges.

This evidence for increased consultant presence has contributed to major policy change with regard to the provision of consultant delivered care, which is one of the recommendations resulting from the Keogh review[25]. However, it is unclear to what extent this has been implemented within individual AMUs. The most recent annual report of the quality of care delivered in AMUs showed that the Society for Acute Medicine recommendation of consultant review within 14 hours of arrival was only achieved for 68% of cases[26]. Furthermore, a study of care delivery in AMUs across Scotland also identified significant variation in consultant provision across sites[27]. In an otherwise limited evidence base, the findings of this review may serve to highlight the potential benefits for consultant presence in AMUs to practitioners and managers developing acute medical services at a local level. That being said, it is also important to note that the lack of evidence for other components of care within AMUs does not diminish their importance. Consultant presence is unlikely to be the only factor involved in optimising care delivery in AMUs, as highlighted by work that found no relationship between consultant intensity and weekday versus weekend mortality[28,29].

Our second main finding relates to the advantages of local service analysis and improvement work. Three studies evaluated multiple interventions that were developed following reviews identifying areas of service delivery requiring improvement[19-21]. Each provided evidence of benefit across the majority of outcomes. Given the variation in AMUs, such site-specific reviews are likely to be important in optimising care delivery. Although these are provided at a national level, for example by the Emergency Care Intensive Support Team in NHS England[25], there is also likely to be merit in developing capability and capacity for such work at a local level, to provide an infrastructure for continuous service development and quality improvement embedded in standard AMU operations. The resources for this may not be readily available locally given current demands on acute services: national support may be required to enable this. Such support may result from the recent introduction of the Getting It Right First Time (GIRFT) programme in England to acute medical pathways.

The third major finding is the lack of discernible evidence for the remainder of care delivery in AMUs. This is based upon the scope of the available evidence, covering only ten interventions; its quantity, which was limited to one study for nine of the interventions; and lastly, its quality. There were no randomised controlled trials found and only one study attempted to control for confounding[24]. As such, most findings reported in this review are likely to be affected by both known and unmeasured confounding. Furthermore, only one was multi-centred, on the whole sample sizes were small, most used a historical control and few studies reported inferential statistics. With regard to external validity, descriptions of interventions tended to be vague, with little adherence to reporting guidelines[30]. This makes comparison to other interventions, replication and critique difficult. As AMUs differ across settings, we should therefore be cautious in generalising these results given the likely relationship between context and effectiveness[31,32].

This review has shown that policy makers, managers and practitioners are having to plan, develop and deliver AMU services without a strong evidence base despite the fact that AMUs are uniformly present in acute hospitals in the UK and are increasingly relevant internationally. Given the prominence AMUs play in the unscheduled care pathway, there is a strong case for further empirical study of care delivery within them.

The planning and execution of such research will require careful consideration. Ideally studies would be multicentred and given that the interventions would be implemented at organisational level, a cluster design may be the most effective[33]. While randomised controlled trials are the gold standard method of determining the causal effect of an intervention on outcome, even in complex settings[34], an observational design may be more feasible from both a practical and cost perspective[31]. Given the complexity of AMUs, the Medical Research Council (MRC) framework for the development and evaluation of complex interventions[32] will be an important resource.

The outcomes measured in future research must be relevant to stakeholders in acute medical care. These include patients, clinical and managerial staff and policy makers. Outcomes should also be congruous to the national strategy that aims to deliver patient-centred, safe, efficient, effective, equal and timely care[35]. No restriction was placed on the outcomes in this review. As such, it comprehensively summarises the metrics used to evaluate AMU care quality thus far. Notably, neither patient nor staff satisfaction were measured in any study. This imbalance needs to be addressed in future evaluations. Although most outcomes measured were AMU-based, some studies also included metrics in the ED and downstream wards. This is encouraging since AMUs do not function autonomously but are embedded within the wider unscheduled care pathway involving multiple hospital departments and primary care. A whole system approach to selecting metrics in onward work will increase its relevance to stakeholders.

Until such primary evidence is produced, the available expert-level recommendations have an important role in guiding practitioners, managers and policy makers. Notably, a recent review reports gaps between current services and recommended standards of care in the UK[11]. It seems prudent that reasons for these gaps are explored, which may necessitate review of the standards themselves.

The strengths of this systematic review are its comprehensive search strategy, broad inclusion criteria and adherence to the PRISMA guidance[12]. The AMU setting was the main determinant for inclusion in this review. Although we could have broadened this to include other acute settings, which may have resulted in more studies per intervention plus the identification of other interventions, we judged this would be inconsistent with the AMU focus of the review and less externally valid. Our approach is consistent with the MRC's guidance for evaluating complex interventions, which underlines the importance of the context and environment in intervention effectiveness, including the potential for something that is effective in one setting being ineffective or indeed detrimental in another. We included quality improvement studies to enable a comprehensive review of all available evidence, maximising the utility of this work for those planning and delivering services. Furthermore, the included quality improvement studies satisfied the prospectively defined inclusion criteria of the review.

This review is limited by an established framework not being used for quality assessment. However, included studies were assessed using tools based upon existing accepted frameworks[12-14], tailored to the purposes of this review. It is possible that our quality assessment has excluded potentially useful evidence. That said, our quality threshold is in alignment with that expected of a systematic review conducted to rigorous standards and minimises the risk of introducing bias to our findings. A further limitation of this review is that a protocol was not prospectively registered.

CONCLUSIONS

Our findings apply to most patients presenting to hospital as a medical emergency in the UK and are also relevant internationally. We identified evidence that AMU care outcomes could be improved by increasing consultant presence on the AMU. This review also highlights the potential to improve outcomes through undertaking local service analysis that identifies areas for improvement. Lastly, this review demonstrates the clear gap in knowledge of how best to deliver AMU care and emphasises the need for further research to build the evidence base. These findings are especially important given the prominent role AMUs play in unscheduled care, the upward trajectory of demand on acute services and current challenges in the consistent delivery of high quality healthcare.

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Figure 1: Identification, screening and assessment for eligibility of articles.

Format adapted from the PRISMA guidance[12]. Cumulative Index to Nursing and Allied Health Literature (CINAHL), Health Management Information Consortium (HMIC).

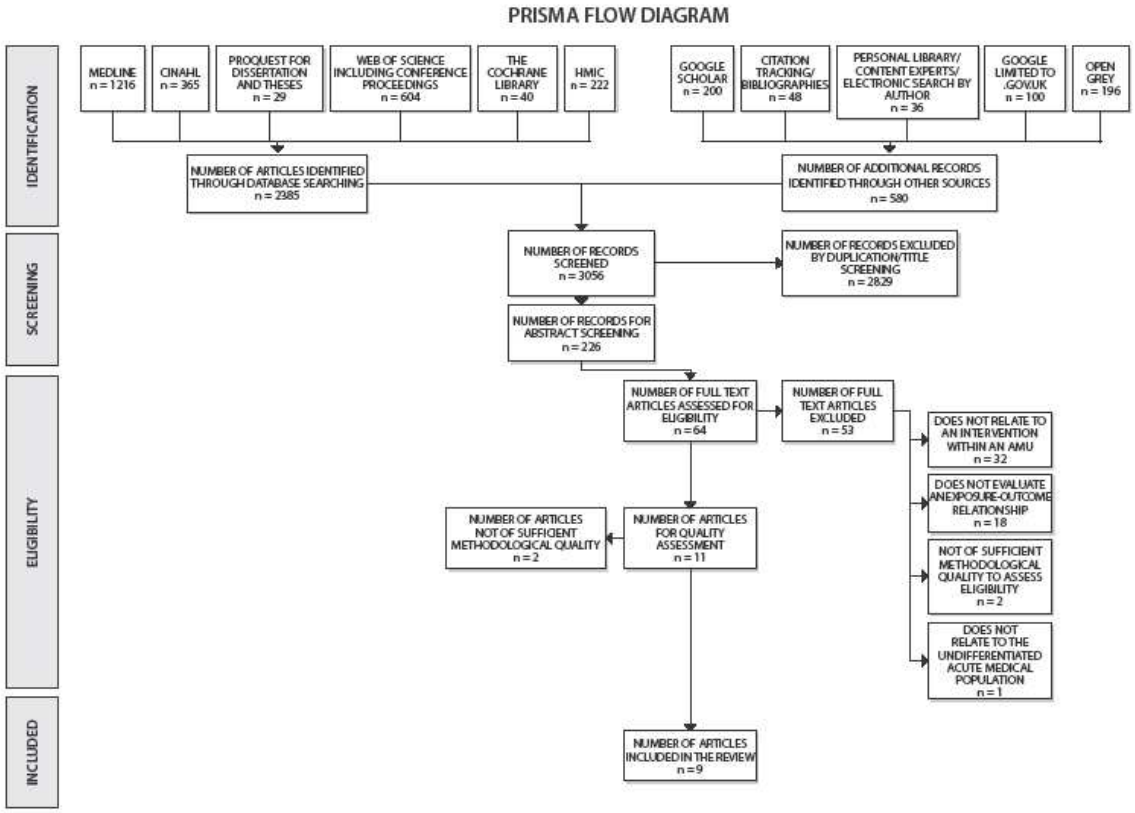


Table 1: Characteristics of included studies

CCU – Coronary care unit; ITU – Intensive Care unit; ED – Emergency department; MCU – Medium care unit; AHP – allied health professional; MDT – Multidisciplinary team.

Author, Year, Reference	Setting – Country; Time period	Study design	Data source [s]	Total episodes/patients	Quality assessment score
Sutton, 1998, 16	UK; August 1995 – February 1996.	Observational.	Departmental data; patient administration system; case notes.	332 patients. (188 in control group and 144 in intervention group).	14/26
Wald, 2001, 21	UK; February 1998 – May 1999.	Observational.	Accident and emergency, AMU and medical directorate databases.	Not stated.	15/26
Pickrell, 2001, 22	UK; not stated.	Observational.	Patient notes, drug prescriptions; questionnaire.	32 patients. (17 in control group, 15 in intervention group).	15/26
Epstein, 2007, 20	UK; April 2005 and April 2006.	Observational.	Official ED and nursing records.	251 patients. (115 in control group and 136 in intervention group).	13/26
McNeill, 2009, 23	UK; January – August 2005.	Observational.	Data from hospital information department; case notes.	2928 patients. (864 in control group and 2064 in intervention group).	21/26
Jamdar, 2010, 17	UK; January - September 2008.	Observational.	Not stated.	74 patients in intervention group. Number in control group not stated.	13/26
Bell, 2013, 24	UK; April 2009 – March 2010.	Observational.	Administrative hospital inpatient data from Hospital episode statistics [HES]; questionnaire.	1.3 million adult emergency admissions across 91 hospitals. (27 control hospitals and 64 intervention hospitals for continuous consultant presence variable; 62 control hospitals and 29 intervention hospitals for "all-inclusive" variable; not stated for trainee variable).	22/26
Beckett, 2013, 16	UK, August 2010 – August 2012.	Quality improvement.	In-patient management system.	Not stated.	20/28
Luther, 2014, 18	UK; not stated.	Quality improvement.	Questionnaire.	29 responses in the control group and 20 in the intervention group.	14/28

Table 2: Summary of interventions, comparators and outcomes

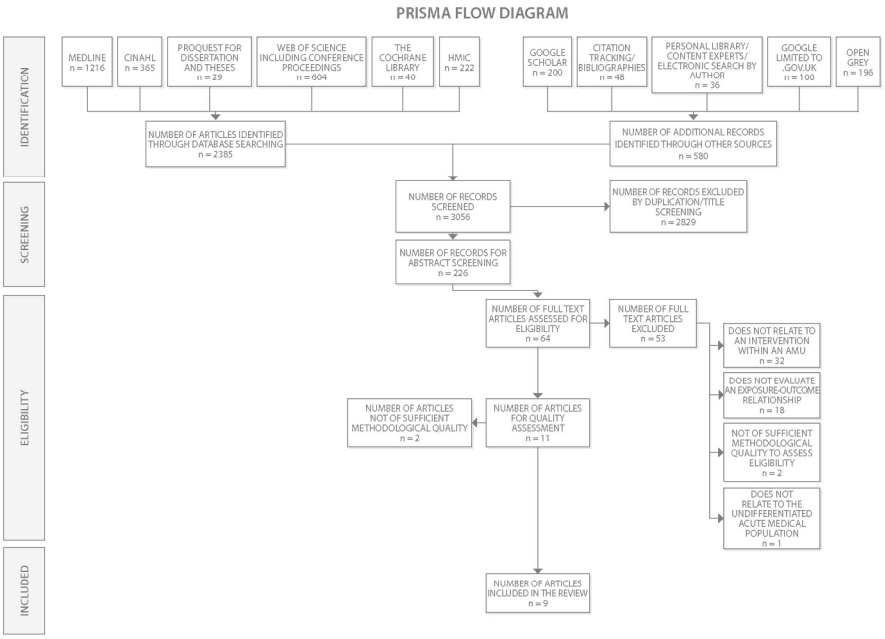
LOS – length of stay; MDT – multidisciplinary team; DNACPR – do not attempt cardiopulmonary resuscitation; ED – emergency department; CT – computerised tomography; MRI – magnetic resonance imaging; CI – confidence interval; EWS – early warning score; OT – Occupational therapy; NNT – number needed to treat; OPD – Outpatient department; EWS – early warning score; hr – hour; min – minute.

Author, Year, Reference	Intervention (s)	Comparator	Outcomes
Sutton, 1998, 16	The introduction of a dedicated occupational therapy [OT] service on the AMU.	Compared to a control group cared for in the AMU prior to the introduction of the intervention with a non-dedicated OT service.	1. Average LOS: control group 18 days and intervention group 16 days. 2. Average number of days between admission and assessment: control group 9.5 days, intervention group 6.4 days.
Pickrell, 2001, 22	Enhanced pharmacy care comprising: 1. Documented admission drug history compared with that obtained from the GP. 2. Patients counselled on their medication on admission and discharge. 3. Changes to medication summarised on discharge prescription to GP.	Compared to a concurrent control group which received standard pharmacy care.	1. Total unintentional drug discrepancies on discharge: control group 60.1%, intervention group 11.8% ($x^2 = 19.27$, $p < 0.001$, $df = 1$) 2. Unintentional drug discrepancies on discharge per patient: control group 3.7%, intervention group 0.86%. 3. Mean score for patient's familiarity with drugs: control group 0.36, intervention group 0.84.
Bell, 2013, 24	Medical staffing interventions comprising: 1. Continuous consultant presence for > 4 hrs a day 2. "All-inclusive" consultant working patterns, characterised as: • protected clinical time; • 2 or more consecutive days; • 2 or more ward rounds a day; • across 7 days of the week. 3. Number of admissions per each whole time equivalent medical trainee.	Compared with a concurrent control group cared for in AMUs without the intervention. Analysis adjusted for age, the Charlson comorbidity index and the Index of multiple deprivation.	<u>Continuous consultant presence for > 4 hrs a day</u> 1. aCFR: reduced in intervention group (effect size not given) ($p < 0.01$). 2. 28-day readmission rate: reduced in intervention group (effect size not given) ($p < 0.01$). 3. Mean LOS: no association. <u>"All-inclusive" working pattern</u> 1. Ratio of aCFR of those admitted at weekends compared to weekdays: reduced excess hospital aCFR of weekend vs. weekend admissions in intervention group (effect size not given) ($p < 0.05$). <u>Admissions per trainee</u> 1. No associations with aCFR, 7/28 day readmission rates and mean LOS.

McNeill, 2009, 23	The presence of a medical consultant on the AMU on weekdays between 0900 and 1700.	Compared to a concurrent control group where there was no routine weekday consultant presence until a post-take ward round at 1900.	1. Inpatient mortality: control group 10.1%, intervention group 9.4% ($p = 0.55$). 2. Percentage of patients that died within 48 hours of admission: control group 1.4%, intervention group 1.9%. 3. Percentage of patients readmitted within 30 days: control group 10.2%, intervention group 10.5%. 4. Percentage of patients readmitted within one week that had been discharged within 24 hours of admission: control group 2.1%, intervention group 2.4%. 5. Mean LOS: control group 9.06 days, intervention group 7.72 days. Difference: -1.34 days (95% CI 0.01 – 2.67, $p = 0.048$). 6. Proportion of patients discharged on day of admission: control group 23%, intervention group 32.2%. Difference: +9.2% (95% CI 5.7% – 12.6%, $p < 0.001$).
Jamdar, 2010, 17	A daily rapid access medical clinic [RAMC] for the review of selected general medical patients.	Compared to a control group cared for in the AMU prior to the introduction of the RAMC.	1. Readmission rate of patients discharged directly from the AMU: control group 8%, intervention group 4% ($p = 0.12$) (time interval of readmission not stated). 2. Proportion of patients discharged on day 0: control group 17%, intervention group 26% ($p < 0.001$).
Luther, 2014, 18	A handover sheet that was required to be completed prior to transfer from the AMU.	Compared to a control group cared for in the AMU prior to the introduction of the intervention.	1. Number of patients arriving from AMU to the downstream medical ward without a handover: control group 5, intervention group 2. 2. Percentage of patients handed over by a doctor not familiar with their care: control group 33%, intervention group 1%. 3. Percentage of doctors feeling rushed to handover: control group 50%, intervention group 1%. 4. Handovers after 1600: control group 33%, intervention group 50%.

Beckett, 2013, 19	Multiple interventions comprising: 1. Introduction of EWS charts to the ED. 2. EWS routine part of nursing handover. 3. Staff training on EWS. 4. Introduction of recognition and response stickers. 5. Weekly MDT safety meetings. 6. Safety data displayed on information screens. 7. Formalised monthly acute medicine morbidity and mortality meetings. 8. A new method for referral to palliative care. 9. New DNACPR policy. 10. Change in staffing model from team based structure to ward based structure. 11. Structured twice daily ward rounds.	Compared to a control group cared for in the AMU prior to the introduction of the interventions.	1. Percentage accuracy of EWS recording: control group 65%, intervention group 100%. 2. AMU LOS: control group 1.2 days, intervention group 0.6 days. 3. 30-day mortality of patients admitted to the AMU: control group 6.3%, intervention group: 4.8% (relative risk reduction 24%). 4. Cardiac arrest rate (number of cardiac arrest in 1000 patients admitted): control group 2.8, intervention group 0.8 (71% reduction). 5. Number of emergency calls in AMU per 1000 patients admitted: control group 4.9, intervention group 1.3 (73% reduction).
Epstein, 2007, 20	Multiple interventions comprising: 1. Clinical staff and bed managers encouraged to expedite discharges from medical wards. 2. Acute weekend team made aware of importance of actively managing weekend discharges. 3. Consultant of the week model instigated. 4. Improved weekday access to diagnostic services including X-ray, CT, MRI, ultrasound, endoscopy, echocardiography and exercise tolerance tests. 5. Improved access to specialist opinions such that most referrals were reviewed on the day of the request. 6. Satellite pharmacy and dedicated pharmacist incorporated into the AMU.	Compared to a control group cared for in the AMU prior to the introduction of the interventions.	1. Percentage of ED-referrals admitted directly to the AMU: control group 44%, intervention group 80%. 2. Percentage of patients reviewed by a consultant within 12 hours: control group 100%, intervention group 100%. 3. Percentage of patients leaving the AMU within 48 hrs: control group 45%, intervention group 90%. 4. Number of avoidable delays in the AMU: control group 14, intervention group 5. 5. Number of weekend AMU discharges: control group 2, intervention group 27. 6. Percentage of patients discharged home from the AMU: control group 50%, intervention group 53%. 7. Mean ED attendance time: control 4 hr. 31 min., intervention 3 hr. 57 min. 8. Percentage of patients breaching the 4 hr. ED target: control 19%, intervention 14%. 9. AMU LOS: control group 2.9, intervention group 1.8 days. 10. AMU mortality: control group 4.4%, intervention group 2.7% (time interval not stated).

Wald, 2001, 21	Multiple interventions comprising: 1. The appointment of a resident senior acute medicine trainee. 2. Relocation of the bed manager to the AMU. 3. All GP referrals sent directly to AMU and bypassed the ED. 4. Daily consultant post-take ward rounds completed by 1000. 5. Senior trainee ward round at 1600. 6. Daily MDT meetings. 7. Onsite pharmacy with 24-hour access to commonly prescribed medications installed. 8. Support services encouraged to give MAU priority.	Compared to a control group cared for in the AMU prior to the introduction of the interventions.	1. Proportion of GP-referred patients seen in the ED: control group 54%, intervention group 20%. 2. Percentage of GP-referred patients seen in the AMU: control 46%, intervention group 80%. 3. Percentage of patients who were ultimately discharged from AMU that stayed more than 2 days: control 55%, intervention group 27%. 4. Percentage of patients who were ultimately transferred to a ward from the AMU that stayed more than 2 days: control group 79%, intervention group 37%. 5. 28-day readmission rate of patients discharged from the AMU: control group 6.1%, intervention group 6.8% (not significant). 6. Same day discharge rate: control group 11%, intervention group 21%. Difference +10% (CI 8 – 11%, $p < 0.001$).



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Supplementary Table 1: Synonyms for Acute Medical Unit

Acute Medical Assessment Unit
Acute Medical Admissions Unit
Acute Assessment Unit
Acute Admissions Unit
Acute Planning Unit
Acute Medical Ward
Acute Medical Receiving Ward
Acute Medical Care
Combined Admissions Unit
Combined Assessment Unit
Clinical Decisions Unit
Early Assessment Medical Unit
Emergency Admissions Unit
Immediate Care Unit
Medical Assessment Unit
Medical Admissions Unit
Medical Assessment Planning Unit
Medical Emergency Departments
Rapid Intensive Observation
Rapid Assessment Medical Unit
Urgency Medicine

Supplementary Table 2: Medline search strategy

1.	(acute adj2 medical adj2 unit).ti,ab
2.	(acute adj2 medical adj2 assessment adj2 unit*).ti,ab.
3.	(medical adj2 assessment adj2 planning adj2 unit*).ti,ab.
4.	(acute adj2 assessment adj2 unit*).ti,ab.
5.	(acute adj2 medical adj2 ward*).ti,ab.
6.	(acute adj2 planning adj2 unit*).ti,ab.
7.	(rapid adj2 assessment adj2 medical adj2 unit*).ti,ab.
8.	(early adj2 assessment adj2 medical adj2 unit*).ti,ab.
9.	(acute adj2 admission* adj2 unit*).ti,ab.
10.	(acute adj2 medical adj2 admission* adj2 unit*).ti,ab.
11.	(medical adj2 assess* adj2 unit*).ti,ab.
12.	(acute adj2 medical adj2 care).ti,ab.
13.	(immediate adj2 care adj2 unit*).ti,ab.
14.	(urgency adj2 medicine).ti,ab.
15.	(rapid adj2 intensive adj2 observation).ti,ab.
16.	(medical adj2 admission* adj2 unit*).ti,ab.
17.	(clinical adj2 decision adj2 unit*).ti,ab.
18.	(decision adj2 unit*).ti,ab.
19.	(emergency adj2 admission* adj2 unit*).ti,ab.
20.	(medical adj2 emergency adj2 department*).ti,ab.
21.	"medical emergency department".ti,ab.
22.	(combined adj2 admission* adj2 unit*).ti,ab.
23.	(combined adj2 assessment adj2 unit*).ti,ab.
24.	(acute adj2 medicine adj2 unit*).ti,ab.
25.	(acute adj2 medical adj2 receiving adj2 ward*).ti,ab
26.	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25
27.	(infant or pediatr$ or paediatr$ or childr$ or childh$ or neonat$).ti,ab.
28.	26 not 27

29.	Limit 28 to English language
30.	limit 29 to yr="1995 -Current"
31.	limit 30 to (comment or editorial or letter or interview or news or newspaper article)
32.	30 not 31

Supplementary Table 3: Criteria used for quality assessment of observational studies

	Component	Stratification
Methods	Study design	2 = Presents key elements of study design early in the paper 1 = Does so partially 0 = Does not
	Setting	2 = Describes the setting, location, dates, exposure, follow up and data collection 1 = Does so partially 0 = Does not
	Participants	2 = Gives the eligibility criteria, the sources and methods of selection of participants 1 = Does so partially 0 = Does not
	Variables	2 = Clearly defines all outcomes, exposures, predictors, potential confounders, and effect modifiers 1 = Does so partially 0 = Does not
	Data sources/ measurement	2 = For each variable of interest, gives sources of data and details methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. 1 = Does so partially 0 = Does not
	Bias	2 = Describes any efforts to address potential sources of bias

		1 = Does so partially 0 = Does not
	Study size	2 = Explains how the study size was arrived at 1 = Does so partially 0 = Does not
	Statistical methods	2 = Describes all statistical methods including those used to control for confounding; describes methods used to examine for subgroups and interactions; explains how missing data were was addressed; describes any sensitivity analyses 1 = Does so partially 0 = Does not
Results	Participants	2 = Reports numbers of individuals at each stage of study and gives reasons for non-participation at each stage 1 = Does so partially 0 = Does not
	Descriptive data	2 = Give characteristics of study participants and information on exposures and potential confounders and indicates number of participants with missing data for each variable of interest. 1 = Does so partially 0 = Does not
	Outcome data	2 = Report number of outcome events or summary measures 1 = Does so partially 0 = Does not
	Main results	2 = Gives unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision, making clear which confounders are adjusted for why they were included; report category boundaries when continuous variables have been categorized; if relevant consider translating estimates of relative risk into absolute risk for a meaningful time period

		1 = Does so partially 0 = Does not
Discussion	Limitations	2 = Discusses limitations to the study, taking into account sources of potential bias or imprecision 1 = Does so partially 0 = Does not

Supplementary Table 4: Criteria used for quality assessment of quality improvement studies

	Component	Stratification
Introduction	Problem description	2 = Describes nature and extent of local problem. 1 = Does so partially. 0 = Does not.
	Available knowledge	2 = Summarises what is currently known. 1 = Does so partially. 0 = Does not.
	Rationale	2 = Explains the problem using formal/informal frameworks, models, concepts and/or theories; explains assumptions about the intervention and reasons why it is expected to work. 1 = Does so partially. 0 = Does not.
	Specific aims	2 = States the purpose of the project and the report. 1 = Does so partially. 0 = Does not.
Method	Context	2 = Contextual elements considered important when introducing intervention. 1 = Does so partially. 0 = Does not.
	Intervention	2 = Describes the intervention with sufficient detail that it could be reproduced; describes the team involved in the work. 1 = Does so partially. 0 = Does not.

	Study of intervention	2 = Describes the approached used to assess the impact of the intervention and that used to establish that the observed outcomes were due to the interventions. 1 = Does so partially. 0 = Does not.
	Measures	2 = Describes process and outcome measures, including rationale for choosing them, operational definitions, validity and reliability; describes the approach to the ongoing assessment of contextual elements; describes methods for assessing completeness and accuracy of data. 1 = Does so partially. 0 = Does not.
	Analysis	2 = Describes qualitative and quantitative methods used to draw inferences; describes methods used for understanding the variation within the data including the effects of time. 1 = Does so partially. 0 = Does not.
	Ethical considerations	2 = Describes ethical aspects of implementing and studying the intervention. 1 = Does so partially. 0 = Does not.
Results	Results	2 = Describes the initial steps of the intervention and their evolution over time; details the process measures and outcomes; describes contextual elements that interacted with the intervention; observed associations between outcomes, interventions and relevant contextual elements; describes unintended consequences; and details missing data. 1 = Does so partially. 0 = Does not.
Discussion	Summary	2 = Presents key findings with relevance to rationale and specific aims; describes the strengths of the project. 1 = Does so partially.

		0 = Does not.
	Interpretation	2 = Describes the nature of the association between the intervention and outcomes, compares the results with other publications, discusses the impact of the project on people and systems, provides reasons for any differences between observed and anticipated outcomes; and discusses cost/strategic trade-offs. 1 = Does so partially. 0 = Does not.
	Limitations	2 = Discusses limitations to the study, including limits to generalisability and internal validity, and the efforts made to minimise these. 1 = Does so partially. 0 = Does not.
	Conclusions	2 = Describes usefulness of work, sustainability, potential for spread, implications and suggested next steps. 1 = Does so partially. 0 = Does not.