

Tracking the take – Using patient flow data to improve AMU performance and safety

L Powter, T Brougham & C Gillett

Abstract

Aims: To create a system to co-ordinate the medical take, bed management and track patient flow.

To use the system to continuously audit against Society for Acute Medicine Quality Indicators.

To use the data to model patient flow and optimise working patterns to improve waiting times.

Method: An online whiteboard and underlying database system were designed, tested and implemented.

Data from this system were used to audit against SAM Quality Indicators and then analysed to optimise both trainee and consultant working patterns.

Results: The online whiteboard proved effective and popular as a working tool.

Data collection improved using the electronic system.

Optimising junior doctor working patterns to match demand led to a reduction of average waiting time to see a doctor from 190 minutes to 71 minutes ($p < 0.0001$), and a reduction in the proportion of patients waiting over 4 hours from 40% to 10% ($p < 0.0001$).

Optimising consultant working patterns did not produce significant changes in waiting times.

Conclusions: The online whiteboard improved day-to-day working and data collection, when compared to the previous paper-based system.

Better data facilitated analysis of working patterns leading to a significant improvement in patient waiting times.

Keywords

Admissions, whiteboard, patient flow.

Key Points

- An electronic whiteboard system enables more efficient tracking of patient flow.
- Optimised working patterns to match supply with demand can lead to significant improvements in patient waiting times.

Introduction

Attendances to Acute Medical Units (AMUs) are increasing rapidly.¹ Patients attending are more complex and have multiple co-morbidities.² AMUs concentrate admissions on one ward designed for rapid assessment, investigation and treatment, improving patient outcomes.³ With the rising caseload, the structure and processes of the AMU are under considerable strain.

Prolonged waits to be seen by a competent decision maker in the emergency department are associated with greater mortality and increased hospital admission.⁴ In many acute medical conditions prompt assessment and treatment improve outcomes, including sepsis,⁵ myocardial infarction⁶ and stroke.⁷ The Society for Acute Medicine (SAM) has published quality indicators, designed to ensure prompt assessment of patients (see Table 1).⁸ SAM recommends that consultants be solely dedicated to

covering the AMU with twice daily post-take ward rounds (PTWR). Increased consultant presence on AMU is associated with better outcomes and shorter length of stay.^{9,10}

Many units now use electronic systems to track patient admissions. These have limited evidence of benefit. Electronic tracking systems (ETS) can be used to analyse patient flow and optimise trainee rotas.¹¹ Here we demonstrate how data from an ETS can be used to optimise both trainee and consultant working patterns to improve compliance with SAM quality indicators.

Background

Frenchay hospital is part of North Bristol NHS Trust. During the week a mean of 43 patients per day are admitted on the medical take, 30 patients per day at the weekends. The on-call team comprises up to 7 juniors clerking. There were originally 3.6

L Powter

T Brougham

C Gillett

Correspondence:

L Powter

Department of Acute Medicine
Southmead Hospital
Southmead Way
Bristol
Avon
BS16 1LE
Email: louise.powter@nbt.nhs.uk

Tracking the take – Using patient flow data to improve AMU performance and safety

acute medical consultants who provided senior cover for the AMU Monday to Friday, with 2 allocated to AMU at a time. Weekend senior cover was by two general medicine consultants on-call. Over the course of this project the consultant working pattern changed and more acute medical consultants were employed, increasing from 3.6 to 5.6. The twice daily PTWR at 0800 and 1700 changed to a morning round at 0800 and a rolling PTWR throughout the afternoon and evening. Two consultants were on each round. Acute medicine specialists initially led the PTWR Monday to Friday, and more recently have provided all weekend cover. The number of consultants on each round remained the same. In May 2014 the AMU moved to a new 64-bed unit in a newly built hospital at Southmead.

Prior to the introduction of the ETS, medical admissions via North Bristol AMU were documented on a paper-based system. This had limited access and poor data display.

Method

A new electronic system was designed to improve the quality of data recorded and tackle the limitations of a paper-based system. This took the form of a web-based list developed within North Bristol's Clinical Information System Suite (CISS) (Figure 1), linked to the trust patient information system. The system was designed to be used by the medical team, bed managers and ward administrators.

For each referral the co-ordinating nurse on AMU would enter the source of the referral, patient's demographics, reason for referral and time. If the referral was coming from ED an Early Warning Score (EWS) would be calculated (a physiological "track-and-trigger" score based on the patient's observations). A "Start Time" was entered referring to the time from which the patient could be clerked by the medical team – for patients referred from the community this was the time they arrived

in hospital, for patients referred from ED it was the time of referral. This "Start Time" was used to calculate waiting times to be clerked and to review by a consultant. Once the patient was in the hospital location and EWS score would be entered.

For the medical team the system would display patients referred but not yet here, those waiting to be clerked by a trainee and those awaiting consultant review. Junior doctors would assign themselves to patients when they went to clerk and this time would be logged. Similarly when consultants assigned themselves to the patient for the Post-Take Ward Round (PTWR) a time would be logged. It used these times to indicate how long patients had been waiting to be seen. It also recorded which junior and which consultant saw each patient.

The system recorded the patient's current location and expected destination (either discharge or a specified ward bed), to enable bed management. These locations were updated by the co-ordinating nurse. Finally administrative tasks were logged once completed – note ordering, placing the patient on the hospital electronic bed board and creating an admission pack for them. (See Figure 1)

It was accessible from any hospital computer by multiple users simultaneously. All information for the current day was displayed in a single screen "whiteboard" format. Patients did not disappear from the screen until all medical, logistical and administrative tasks had been completed. Data were archived for audit and analysis.

There were a total of 4 rounds of data collection, each lasting 7 days:

- **6th–13th December 2012** – retrospective audit of the paper-based system for all admissions in seven days of December 2012. The main focus was on time to review by a competent decision maker and the duty consultant as recorded on

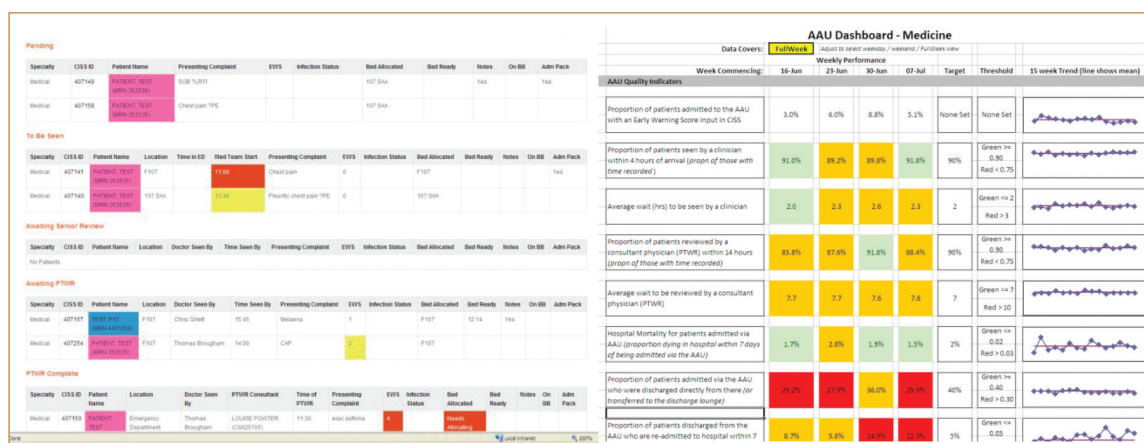


Figure 1. Examples of the system in use – Left - The admissions tracking system groups patients by their stage in the clerking process. Right - Weekly dashboard produced to analyse compliance with quality indicators.

Tracking the take – Using patient flow data to improve AMU performance and safety

Table 1. SAM Quality Indicators.

1. All patients admitted to the AMU should have an early warning score measured upon arrival on the AMU.
2. All patients should be seen by a competent clinical decision maker within 4 hours of arrival on the AMU who will perform a full assessment and instigate an appropriate management plan.
3. All patients should be reviewed by the admitting consultant physician or an appropriate speciality consultant physician within 14 hours of arrival on the AMU.
4. All acute medical units should collect the following data: • Hospital mortality rates for all patients admitted via the AMU • Proportion of admitted patients who are discharged directly from the AMU • Proportion of patients discharged from the AMU who are readmitted to hospital within 7 days of discharge

the paper tracking sheet (Table 1 – guidelines 2 and 3).

- **5th-11th August 2013** – Re-audit after introduction of the electronic tracking system and change to the junior doctors' rota to increase the number of juniors clerking from 5 doctors to 7 during peak time of patient arrival.
- **1st-7th December 2013** – Re-audit after changing the consultant working pattern from twice daily PTWRs at 0800 and 1700 to a morning PTWR and rolling PTWR throughout the afternoon. Acute medical consultant numbers increased from 3.6 to 5.6. No change to junior rota from August 2013.
- **1st-7th June 2014** – Re-audit after moving to a new AMU in a new build hospital. No change to junior or consultant working patterns from December 2013.

After the introduction of the ETS, an online survey was conducted asking doctors to rate key aspects of the new system relative to the previous paper-based method.

All data was collected within Microsoft Excel, and exported to GraphPad Prism where more complex analysis was required. Histograms and the D'Agostino-Pearson test confirmed that the data was not normally distributed. The Mann-Whitney test was used to assess for significance of patient waiting times, and Fisher's exact test to compare proportions.

Results

Data collection

The audit of the paper-based system identified 288 patients. Full patient details (name, date of birth and hospital number) were recorded for 191 patients (66%). Start Time was documented for 273 patients (95%). 167 patients (58%) had a clerking time documented on the paper tracking sheet. 153 (53%) patients had both time of arrival and clerking time documented, allowing calculation of a "waiting time to be clerked". None of the 288 patients had time documented for consultant review so no waiting times for consultant review could be calculated.

Following introduction of the electronic tracking system data collection improved (Table 2). In the August 2013 audit, 262 patients were admitted

Table 2. Improvements in data recording after the introduction of the electronic system

		n	Details Recorded (%)		Times Completed (%)			SAM QI 2&3 calculable
			Hospital Number	Age/DOB	Start Time	Clerking	Post Take Ward Round	
PAPER	Dec 2012	288	204 (71%)	272 (94%)	273 (95%)	167 (58%)	0 (0%)	0 (0%)
	Aug 2013	262	262 (100%)	262 (100%)	237 (90%)	227 (87%)	260 (99%)	225 (86%)
	Dec 2013	316	316 (100%)	316 (100%)	291 (92%)	277 (88%)	310 (98%)	256 (81%)
	Jun 2014	339	339 (100%)	339 (100%)	324 (96%)	303 (89%)	332 (98%)	278 (82%)

Tracking the take – Using patient flow data to improve AMU performance and safety

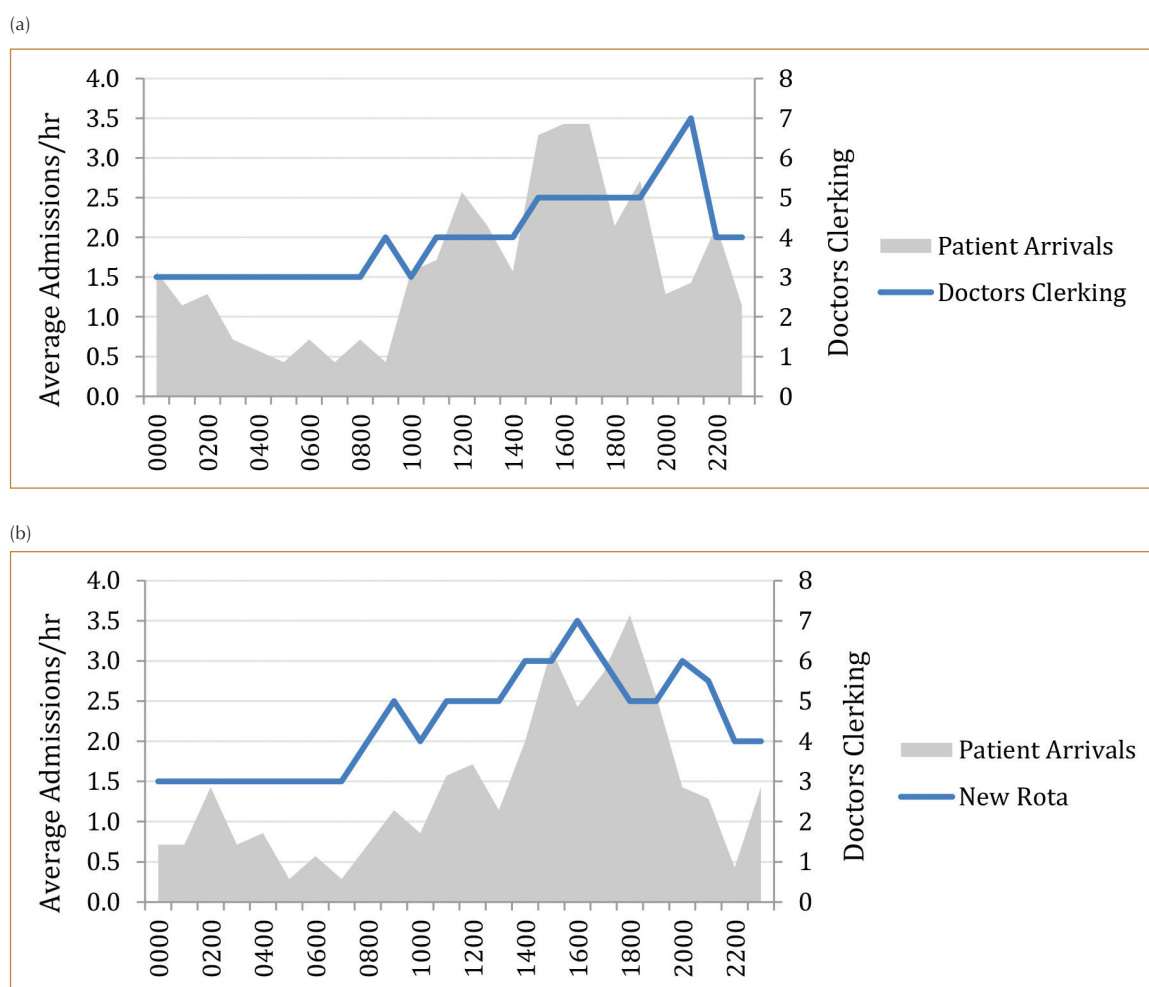


Figure 2. Modification of the junior rota resulted in more doctors clerking at peak times a) Doctors Clerking per Patient Arriving on the AMU (Dec 2012). b) Doctors Clerking per Patient Arriving on the AMU (Aug 2013 – following rota change)

during the study period. All patients had full details entered into the electronic tracking system (ETS). 237 patients had their Start Time documented (90%). 228 patients had clerking time documented (87%). 227 patients (87%) had both Start Time and clerking time documented. 215 patients remained under the medical team to require consultant review. 212 (99%) had both Start Time and the time of this review documented,

Overall the number of patients for whom SAM Quality indicators 2 and 3 could be calculated significantly improved from 0 of 288 to 226 of 262 (86%, $p < 0.0001$).

The further rounds of audit in December 2013 and June 2014 showed similar improvements to documentation as see in Table 2.

Analysing patient flow and trainee working patterns

The December 2012 audit found a consistent peak of patient arrival between 1400 and 2000, as did all rounds of data collection. Numbers of trainees clerking did not match this peak, with a maximum of 5 trainees

clerking during the busiest period (See Figure 2). The median waiting time to be clerked was 190 minutes (interquartile range 70–320 minutes). Of the 153 patients for whom waiting times could be calculated, 61 patients (40%) waited longer than 240 minutes to be clerked. Using these data, we reconfigured the junior doctor working pattern to increase the maximum number of trainees to 7 during the peak period.

After implementation of the new rota and the electronic tracking system the number of trainees clerking more closely matched patient arrival. (See Figure 2). Following this change the August 2013 audit showed that the median waiting time to be clerked fell significantly to 71 minutes (interquartile range 29–151 minutes, $p < 0.0001$). Where waiting time could be calculated, the proportion of patients waiting more than 240 minutes to be clerked also fell significantly to 10% (22 patients, $p < 0.0001$).

The December 2013 audit allowed direct comparison with December 2012, eliminating seasonal bias. Consultant working patterns had

Tracking the take – Using patient flow data to improve AMU performance and safety

Table 3. Improvements in time to be clerked following introduction of ETS, with reduction in SAM Quality Indicators 2 and 3, where these times were calculable

		Time to Clerking			Time to PTWR		
		Median Wait	Waiting >240 mins		Median Wait	Waiting >840 mins	
		mins	n	%	mins	n	%
PAPER	Initial Audit Dec 2012	190 (IQR 250)	61	40%	Unknown		
ELECTRONIC	Junior Rota Aug 2013	71 (IQR 122)	22	10%	382 (IQR 519)	31	15%
	Consultant Rota Dec 2013	73 (IQR 109)	14	5%	369 (IQR 442)	29	11%
	Post Move Jun 2014	110 (IQR 137)	49	16%	330 (IQR 422)	32	11%

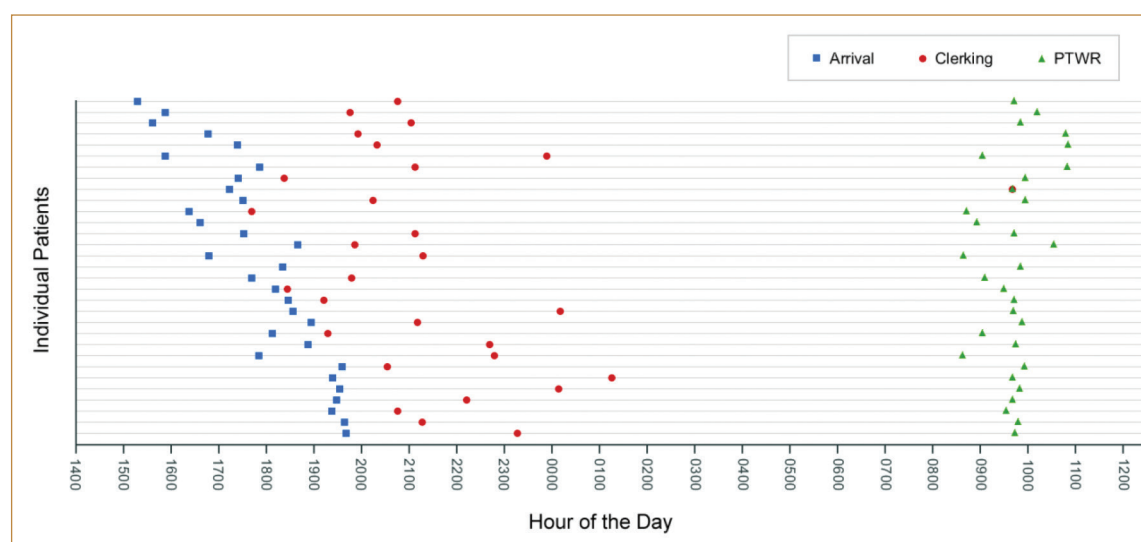


Figure 3. Patient 'timelines' created to analyse the journey of patients waiting over 14 hours for the PTWR reveal that arrivals late in the day, coupled with a longer than average wait to be clerked, result in missing that evening's ward round.

been changed in November 2013 to a rolling post-take ward round throughout the afternoon and evening. The trainee rota and electronic tracking systems remained the same. A total of 316 patients were referred. The median time to be clerked was significantly less than in the December 2012 audit (median 73 minutes Dec 2013 versus 190 minutes in Dec 2012, $p < 0.0001$). Where waiting time could be calculated, number of patients waiting more than 240 minutes to be clerked also fell significantly (14 patients, 5% Dec 2013 versus 40% Dec 2012).

Analysing patient flow and consultant working patterns

The August 2013 data showed that patients arriving in the peak period of 1400-2000 waited longer to

© 2016 Rila Publications Ltd.

be clerked despite the changes to the trainee rota (median time 65 minutes off peak, 74 minutes during peak time, $p = 0.46$). The data also showed that patients who were clerked later in the evening often missed the post-take ward round (PTWR), missing the 14 hour SAM target (See Figure 3).

Despite the changes to consultant working patterns and increased numbers of acute medicine consultants, the December 2013 audit showed no improvement in median time to consultant review compared to August 2013 (369 minutes Dec 2013 versus 382 minutes August 2013, $p = 0.49$). There was also no change in median waiting time to be clerked by a trainee (Median 71 minutes August 2013 versus 73 minutes December 2013, $p = 0.49$). It had been hoped that the new consultant working

Tracking the take – Using patient flow data to improve AMU performance and safety

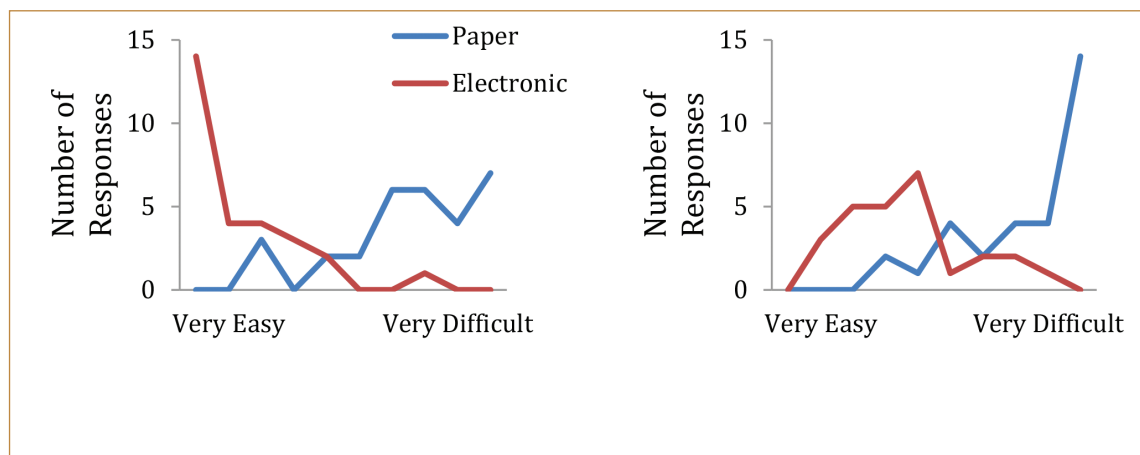


Figure 4. Doctors (n = 30) were asked to rate key aspects of the system on a 0-10 rating scale a) How easy is it to identify the next patient to be seen? b) How easy is it to identify the next patient to be seen?

pattern would free up more trainees to clerk at peak time.

User satisfaction

A survey among junior doctors and consultants showed that users felt that using the ETS it was easier to identify the next patient to be seen and easier to identify potentially unwell patients to (Figure 4).

Discussion

Electronic tracking systems (ETS) provide a wealth of data for audit and service improvement. Here we have used the data for optimising staffing rotas, validating changes against improvements in SAM quality indicators.

The ETS greatly improved documentation of patient details and timings of arrival, clerking and post-take ward round. Patients with sufficient data to measure SAM Quality Indicators improved from 0% in December 2012 to 86% in August 2013 (See Table 2).

Attendances to AMU followed a predictable pattern with a peak between 1400 and 2000 hours. Reorganising trainee rotas increased the number of trainees clerking during this peak period from 5 doctors to 7, leading to a significant fall in median waiting time to be clerked (190 minutes to 71 minutes, $p < 0.0001$). This improvement persisted despite seasonal variation in workload. The changes in trainee rota were cost neutral.

Consultant working patterns were changed to a rolling post-take ward round in the afternoon and evening. This change had no significant effect on either waiting time for consultant review or waiting time to be clerked.

The study had significant limitations. The audit of the paper-based system found incomplete data. The ETS improved this but may still have

missed patients, especially those discharged prior to admission and those under joint care with other specialities. Complexity and acuity of caseload and grade of trainees clerking was not taken into account. No outcome measures were used to assess the quality of care. The “time to first set of vital signs”, another of the SAM Quality Indicators, was not audited. Finally this was a series of limited snapshot audits from a single centre.

SAMBA (Society for Acute Medicine Benchmarking Audit) 2013 highlighted a similar pattern of attendance to that shown here, with a peak in the early evening. They found that 94.5% of patients were seen by a medic within 4 hours and 79.4% were seen by a consultant within 14 hours.¹² Even with the improvements made, our results are still worse than average despite the ETS and optimisation of junior rota.

Secondary analysis of SAMBA '13 found no relationship between unit performance relative to SAM Quality Indicators and medical staffing levels or experience.¹³

SAMBA 2014 showed similar average performance to ours. The average numbers of trainees clerking at different times of day were similar to ours before the change in the trainee rota. Again, they found no relationship between AMU characteristics, staffing and performance.¹⁴

Sabin et al reviewed physician working patterns finding limited published evidence. They highlight the difficulties of quantifying workload accounting for numbers, complexity and acuity.¹⁵

Further research is needed to work towards an optimum staffing level, both in terms of numbers and experience. Better data collection, through systems like our ETS, allows analysis of patient and logistical factors, and modelling of the ideal number of staff. Assessment of patient outcomes

Tracking the take – Using patient flow data to improve AMU performance and safety

is needed to establish if higher staffing ratios and shorter waiting times actually lead to improvement in patient outcomes such as 30 day mortality and discharge rates.

In conclusion, we have implemented an electronic tracking system, improving day-to-day working and allowing robust data collection regarding patient

flow through our AMU. We have then used this data to optimise trainee and consultant working patterns, validating these changes by demonstrating improvements in SAM quality indicators.

Conflict of interest

Nothing to declare.

References

1. Capewell S. The continuing rise in emergency admissions. *BMJ* 1996; **312**: 991–2.
2. Kendrick S, Conway M. Increasing Emergency Hospital Admissions among Older People in Scotland: A Whole System Account. Edinburgh: Information and Statistics Division, 2003.
3. Acute medical units: review of evidence. *Eur J Intern Med*. 2011 Aug; **22(4)**: 344–7.
4. Guttman *et al*. Association between waiting times and short term mortality and hospital admission after departure from emergency department: population based cohort study from Ontario, Canada. *BMJ* 2011; **342**: d2983.
5. Rivers E, Nguyen B, Havstad S, *et al*. Early goal directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med* 2001; **345**: 1368–77.
6. National Institute for Health and Clinical Excellence. *Chest pain of recent onset. Assessment and diagnosis of recent onset chest pain or discomfort of suspected cardiac origin*. London: NICE, 2010.
7. Wardlaw JM, Murray V, Berge E, *et al*. Thrombolysis in ischaemic stroke. *Stroke* 2004; **35**: 2914–5.
8. Society for Acute Medicine. Clinical Quality Indicators for Acute Medical Units (AMUs). June 2012.
9. Bell D, Lambourne A, Percival F, *et al*. Ward DK (2013) Consultant Input in Acute Medical Admissions and Patient Outcomes in Hospitals in England: A Multivariate Analysis. *PLoS ONE* **8(4)**: e61476. doi:10.1371/journal.pone.0061476
10. Royal College of Physicians. *An evaluation of consultant input into acute medical admissions management in England*. Report of hospital service patterns versus clinical outcomes in England. London: RCP, 2012.
11. Safety in numbers: lack of evidence to indicate the number of physicians needed to provide safe acute medical care *Clin Med* October 1, 2014; **14**: 462–46.
12. Le Jeune I, Masterton-Smith C, Subbe CP, *et al*. State of the Nation – The Society for Acute Medicine's Benchmarking Audit 2013 (SAMBA '13). *Acute Medicine* 2013; **12**: 214–219.
13. Subbe CP, Burford C, Le Jeune I *et al*. *Clin Med* 2015; **15**: 15–19.
14. Subbe CP, Le Jeune I, Burford C, *et al*. The Team at Work – The Society for Acute Medicine's Benchmarking Audit 2014 (SAMBA '14). *Acute Medicine* 2014; **14**: 99–103.
15. Sabin J, Subbe CP, Vaughan L, *et al*. *Clin Med* 2015; **14**: 462–467.