Implementing an electronic patient handover system

ABSTRACT

Background: Clear communication among health-care teams is paramount for safe patient care and effective handover. Advances in information technology have led to an increased use of electronic systems within modern health care. This quality improvement project introduced an electronic patient handover system that was intended to improve the accuracy of patient handover lists and be readily available to all members of the health-care team.

Methods: A quality improvement project was undertaken to assess the effect of introducing an electronic patient handover system on maintenance workload and list accuracy.

Results: List errors were common before the introduction of the electronic patient handover system, commonly patient location or a patient being incorrectly omitted from the list. These errors decreased significantly after the introduction of the electronic system ($P<0.005$ and 0.04 respectively). The workload associated with its maintenance also decreased ($P<0.005$) because many data fields were pre-populated by the software. This resulted in fewer instances of patients being missed on ward rounds ($P<0.04$).

Conclusions: Through modifying existing information technology infrastructure, a centrally maintained, widely accessible electronic handover system was introduced. This reduced the workload associated with maintaining handover lists and the rate of errors.

Clear communication among health-care teams is paramount for safe, effective patient care. This is particularly important during periods of handover, where responsibilities for a patient are transferred from one team to another (Solet et al, 2005). To facilitate this a 'patient list' is maintained to track patients under a team's care and record any outstanding or completed tasks. These lists are normally maintained using either word processing software or an Excel spreadsheet. Although both pieces of software have been used successfully and been shown be effective (Vithlani, 2015), maintaining a handover list is a laborious process, prone to human error and breaches in confidentiality. Furthermore these lists are often not always easily accessible by all those involved in the patient's care.

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Nottingham University Hospitals NHS Trust is a major trauma centre with a busy trauma and orthopaedics department. Rapid patient turnover across three trauma wards plus those on outlying wards frequently results in difficulty keeping track of a patient's location. The organization of health-care staff is also complex, with ward-based staff such as foundation doctors and other health-care staff working alongside firm-based staff such as core trainees or registrars who work for a team of three consultants.

Nursing staff, physiotherapists, occupational therapists, ward-based doctors and firm-based doctors all maintain their own lists independently of one another, using word processing software. A single patient will appear across multiple lists, hence a single change in a patient's details would have to be replicated multiple times. Not only is this inefficient, but it is also a potential hindrance to communication between teams as each list is being maintained in isolation.

Information technology (IT) is increasingly being used in everyday modern health care, and electronic patient handover systems have been successfully introduced in other settings and resulted in an improved handover (Graham et al, 2013; Starmer et al, 2013; Dubosh et al, 2014). When used in a multidisciplinary team setting, an electronic patient handover system has helped multidisciplinary team communication through collectively pooling information into a single record (Naik and Singh, 2010; Schuster et al, 2014). Furthermore, its introduction has led to a reduced workload for the medical staff who are responsible for its upkeep, plus fewer patients being missed on rounds as a result of inaccuracy of the list (Pucher et al, 2015).

This quality improvement project introduced an electronic patient handover system that was intended to improve the accuracy of patient handover lists, reduce the workload associated with maintaining them and be easily accessible to all members of the health-care team.

Methods

This quality improvement project involved inpatient handover lists in a busy trauma and orthopaedics department spanning three trauma wards plus outliers (outlying patients in other wards). The SQUIRE guidelines for quality improvement reporting have been adhered to whenever possible (Ogrinc et al, 2015).

Intervention

The Nervecentre app produced by Nervecentre Software Ltd (www.nervecentresoftware.com) was already in use throughout the department for electronic recording of patient observations. Data were entered either via desktop application or through a portable device issued to members of staff. The Nervecentre app draws patient information from the electronic bed state system (Medway, System C Healthcare Ltd. www.systemc.com), including patient demographics, location including bed number and the consultant under whose care the patient is admitted. This is updated in real time as changes occur, such as changes in patient location (*Figure 1*).

The primary use for Nervecentre within the department was for electronic recording of patient observations. The software also contained, for each patient, headed data fields such as diagnosis, background, management plan and outstanding jobs. However, these fields were not currently used or kept updated.

Using pre-existing infrastructure was identified as a cost-effective, simple and sustainable intervention. The currently available software already had the capacity to be used as a handover list. However, there were limitations – the software could only generate patient lists by ward rather than by consultant or orthopaedic team. As the department operated a firm-based structure alongside a ward-based structure the software required modification to accommodate the needs of the department.

These requirements were discussed with IT services, who were able to modify the software appropriately to come to a solution. This was achieved by creating custom lists for the department. Nervecentre filters patients (as listed on the bed state) according to set criteria such as location or consultant code. It then presents these patients as a list which, when selected, only shows patients relevant to that user. IT services were able to modify the software so that it could filter patients admitted under any one of the three consultants who made up an orthopaedic firm. As a result, a patient list could be created for each orthopaedic firm. Once fully functional, the Nervecentre app was used as a handover list instead of using word-processing software.

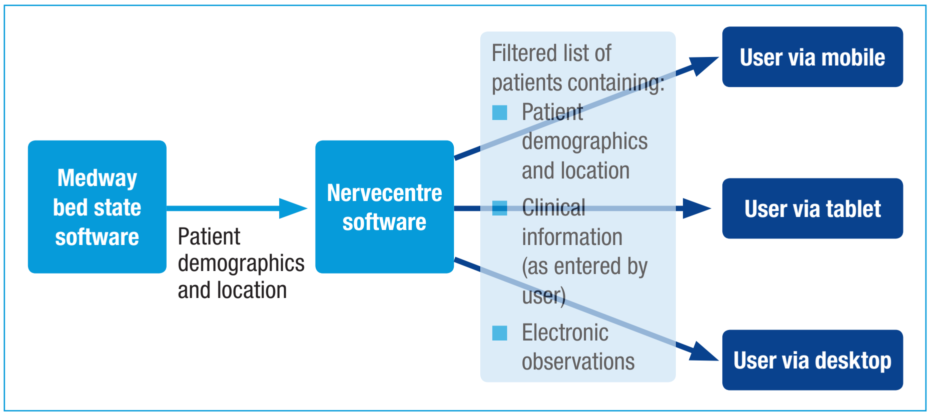

Figure 1. Representation of software setup.

Table 1. Comparison of handover list errors before and after the introduction of an electronic system

	Word-processed list	Electronic list via Nervecentre	
Location incorrect	24	0	$P<0.005$
Patient discharged	26	0	$P<0.005$
Patient details incorrect	1	0	$P=0.303$
Wrong consultant	6	12	$P=0.619$
Patient missed	16	1	$P=0.04$

Measurements

A baseline audit of the current list system was performed during the daily ward round over a period of 3 weeks, including a weekend on call, resulting in 17 days' worth of data. The time spent updating the list and any inaccuracies were recorded. This was self-reported using the results of a single orthopaedic team's patient list.

Once the electronic system had been implemented the audit was repeated, using the same orthopaedic firm over the same time period and on-call commitments in order to minimize potential variation in workload.

Statistical analysis

All statistical analysis was performed using IBM SPSS Statistics version 23. Each variable was analysed to determine its normality. Non-parametric, ordinal data were compared using a Mann–Whitney U-test. Parametric data were compared using independent samples *t*-test. A *P* value of less than 0.05 was considered significant.

Ethical considerations

The project was registered and accepted with the local audit department and deemed exempt from ethics review in accordance with local guidelines.

Results

The baseline audit revealed that there was at least one list error daily, most commonly bed location because of the high patient turnover on the unit. More alarmingly, patients were often omitted from the list in error. On average 12.5 minutes was spent daily updating the list, this varied with patient turnover (interquartile range 10–15 minutes) (*Table 1*).

The introduction of the electronic list system eliminated patient location errors because of the automated pre-population of patient location and demographic fields. This, combined with being able to enter data via a mobile device, also reduced the workload associated with the maintenance of the list. An average of 3 minutes (interquartile range 2–5 minutes) was spent daily updating the list using the electronic system (*Table 1*).

However, some patients had the wrong consultant code recorded at time of admission on the bed state software (Medway), and as the Nervecentre application draws patient data directly from this software, this error was reproduced. As a result some patients did not appear on the correct list when filtering by consultant (*Table 1*).

Discussion

Implementing an electronic patient handover system significantly reduced the workload associated with the maintenance of handover lists, reduced list errors and hence avoided patients being missed on ward rounds. Working with IT services to modify existing software and making the most of the existing IT infrastructure provided a low-cost solution by avoiding large setup costs.

Introduced in 2011, the Nervecentre application was already used in other departments in conjunction with a specialist nurse, to coordinate the assignment of tasks electronically when providing out of hours care (Blakey et al, 2012). However, the software is available trust-wide to allow electronic monitoring of patients'

KEY POINTS

- Implementing an electronic patient handover significantly reduced the workload associated with the maintenance of handover lists.
- Implementing an electronic patient handover significantly reduced the rates of handover list errors.
- Large setup costs can be avoided by modifying existing software.
- Central pooling of easily accessible data facilitated collaboration and communication among staff.

observations. The cost of introducing a capable wireless network, and purchasing mobile devices and the software at the time of introduction was approximately £124 000 (Blakey et al, 2012). However, such costs were avoided when introducing the handover system in the authors' department as the infrastructure was already in place.

As described in other studies (Till et al, 2014), working closely with IT services was also key to the success of this project. This required regular meetings not only to allow the needs of the department to be explained to the IT service, but for IT technicians to demonstrate the potential applications of the software and explain its limitations.

The reduction in workload and errors associated with the use of electronic systems is in keeping with findings from previous studies (Starmer et al, 2013; Till et al, 2014; Pucher et al, 2015). Any data entered into the Nervecentre application are stored centrally and can be accessed or edited from any enabled device. This facilitated collaboration and communication among all members of the health-care staff. Despite using different patient lists within the app, health-care staff access and edit the same data, updating it collectively (*Figure 1*). This was particularly useful in its application to trauma patients whose care involves a large multidisciplinary team. In comparison, other electronic solutions such as a printed Excel spreadsheet are not as easily accessible. The potential confidentiality breaches associated with paper lists were avoided when using the new system. Each device was passcode protected and fitted with time-out systems preventing unauthorised access.

The user interface has previously been a barrier to successful implementation of electronic systems (Walsh, 2004). However, this system gave users a choice of entering data via mobile devices, allowing data entry while on the ward round, or via desktop computer. Advances in technology have made also implementation easier – touch screen devices are intuitive to use and easy to understand. Surveys of health-care staff have demonstrated that the majority welcome electronic systems to aid their practice (Mehra and Henein, 2014; Vithlani, 2015). Furthermore, using electronic systems has resulted in better user satisfaction compared to traditional methods (Graham et al, 2013).

The Nervecentre software drew patient demographics, location and admitting consultant from the Medway system and automatically pre-populated the relevant data fields in the Nervecentre application, reducing the workload associated with its maintenance. It had the added advantage of being updated in real time – as patients were admitted, moved, discharged, or had their care transferred from one consultant to another, the relevant data fields were updated as appropriate. For a unit with a high turnover and patient movement, this was a significant benefit, particularly when patients were moved to other outlying wards as a result of bed pressures.

There were, however, limitations of this system – automatically pre-populating data fields with data from the bed state software meant that any errors contained within the bed state software were reproduced. Although patient details and location were usually correct, admissions staff often admitted patients under the wrong consultant. Although this would not affect patient lists that were generated on the basis of location, such as those used by ward-based doctors, it would result in the patient appearing on the wrong orthopaedic firm's list. Once identified, the error can be easily rectified but care had to be taken by the admitting doctor at the time of admission to check that the consultant listed was correct.

These errors were likely to have existed before the introduction of the electronic system. The Medway bed state software was already was in use with the consultant code being entered manually into Medway by admissions staff. Nervecentre's introduction would not have influenced the data on Medway as Nervecentre is only able to draw information from Medway rather than edit it. The incorrect consultant being recorded on Medway would have gone unnoticed before Nervecentre's introduction as handover lists were based on Excel spreadsheets. The handover data was manually entered into these spreadsheets by the admitting senior house officer, who would be more likely to know the correct consultant, rather than automatically drawing information from the Medway bed state software. Hence automating the process is likely to have highlighted rather than caused this error.

This study design also has limitations. List error data were collected by a single user and hence are vulnerable to observer bias, although the same data collection method was used for both audit cycles in order to minimize this. The sample size used was relatively small; although steps were taken to ensure patient turnover and workload were similar over the two periods the fluctuating workload associated with trauma prevented this from being standardized.

Finally, a similar electronic handover system could be implemented successfully in any inpatient setting. It particularly benefits departments with a high patient turnover and a large multidisciplinary team. Without the existing IT infrastructure, there would be significant costs to implement such a system, which may limit its viability.

Conclusions

Through modifying existing IT infrastructure, a centrally maintained, widely accessible electronic handover system was introduced. This reduced the workload associated with maintaining handover lists and the rate of errors. **BJHM**

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Blakey JD, Guy D, Simpson C, Fearn A, Cannaby S, Wilson P, Shaw D (2012) Multimodal observational assessment of quality and productivity benefits from the implementation of wireless technology for out of hours working. *BMJ Open* **2**: e000701. https://doi.org/10.1136/bmjopen-2011-000701

Dubosh NM, Carney D, Fisher J, Tibbles CD (2014) Implementation of an emergency department sign-out checklist improves transfer of information at shift change. *J Emerg Med* **47**: 580–585. https://doi.org/10.1016/j.jemermed.2014.06.017

Graham KL, Marcantonio ER, Huang GC, Yang J, Davis RB, Smith CC (2013) Effect of a systems intervention on the quality and safety of patient handoffs in an internal medicine residency program. *J Gen Intern Med* **28**: 986–993. https://doi.org/10.1007/s11606-013-2391-7

Mehra A, Henein C (2014) Improving hospital weekend handover: a user-centered, standardised approach. *BMJ Qual Improv Rep* **2**: u202861.w1655. https://doi.org/10.1136/bmjquality.u202861.w1655

Naik AD, Singh H (2010) Electronic health records to coordinate decision making for complex patients: what can we learn from wiki? *Med Decis Making* **30**: 722–731. https://doi.org/10.1177/0272989X10385846

Ogrinc G, Davies L, Goodman D, Batalden P, Davidoff F, Stevens D (2015) SQUIRE 2.0 (Standards for QUality Improvement Reporting Excellence): revised publication guidelines from a detailed consensus process. *BMJ Qual Saf* **25**: 986–992. https://doi.org/10.1136/bmjqs-2015-004411

Pucher PH, Johnston MJ, Aggarwal R, Arora S, Darzi A (2015) Effectiveness of interventions to improve patient handover in surgery: A systematic review. *Surgery* **158**: 85–95. https://doi.org/10.1016/j.surg.2015.02.017

Schuster KM, Jenq GY, Thung SF, Hersh DC, Nunes J, Silverman DG, Horwitz LI (2014) Electronic handoff instruments: a truly multidisciplinary tool? J *Am Med Inform Assoc* **21**: e352–e357. https://doi.org/10.1136/amiajnl-2013-002361

Solet DJ, Norvell JM, Rutan GH, Frankel RM (2005) Lost in translation: challenges and opportunities in physician-to-physician communication during patient handoffs. *Acad Med* **80**: 1094–1099. https://doi.org/10.1097/00001888-200512000-00005

Starmer AJ, Sectish TC, Simon DW et al (2013) Rates of medical errors and preventable adverse events among hospitalized children following implementation of a resident handoff bundle. *JAMA* **310**: 2262–2270. https://doi.org/10.1001/jama.2013.281961

Till A, Sall H, Wilkinson J (2014) Safe handover : safe patients - the electronic handover system. *BMJ Qual Improv Rep* **2**: u202926.w1359. https://doi.org/10.1136/bmjquality.u202926.w1359

Vithlani R (2015) Introduction of a new electronic medical weekend handover at Tunbridge Wells Hospital. *BMJ Qual Improv Rep* **4**: 1 u204755.w2342 https://doi.org/10.1136/bmjquality.u204755.w2342

Walsh SH (2004) The clinician's perspective on electronic health records and how they can affect patient care. *BMJ* **328**: 1184–1187. https://doi.org/10.1136/bmj.328.7449.1184