# Critical care outreach: impacts of electronic observations and alerting technology

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#### ABSTRACT

Information technology is an increasingly pervasive aspect of the healthcare environment, but introduction of new technology into complex systems like healthcare can create new opportunities for failure. Whilst literature on the unintended consequences of technology is extensive, less is known about the impacts it has on clinical work and patient safety. This paper reports the findings of a case study conducted at a large National Health Service (NHS) Trust in England, where electronic observations and alerting technology was introduced to replace paper charts. Using a qualitative approach, the study aimed to explore the impacts of this technology on a critical care outreach team's performance and patient safety. Data from observation and ten semi-structured interviews with critical care outreach nurses were thematically analysed. The new technology has not only changed the way that patient observations data is recorded, displayed and viewed, it has also introduced a new mode of communication between groups of clinical staff: electronic alerts. Four main themes emerged that characterise the main changes brought about by the technology: communication, situation awareness, professional issues and workload. The relationship between aspects of these themes and patient safety was not perceived to be straightforward.

### **KEYWORDS**

Healthcare, information technology, electronic observations, communication, professional responsibility, critical care outreach teams

#### Introduction

IT is an increasingly pervasive aspect of the complex sociotechnical environment of healthcare; indeed, a recent report of the National Advisory Group on Health Information Technology in England states that "NHS Trusts should be largely digitised by 2023" and that "regulators should begin to deem trusts that have not reached a high level of digital maturity to be out of compliance on quality and safety grounds" (Wachter 2016, p.5).

Cook (1998), however, notes that introducing change creates new opportunities for potentially catastrophic failure, especially where technology is implemented in response to common and wellunderstood system frailties. Whilst literature on the unintended consequences of healthcare technology is extensive, sociotechnical assessment of the impacts of technology on clinical work practices and patient safety is lacking (Waterson & Catchpole 2015). This paper aims to start to address this latter point, with specific reference to the impact of electronic observation and alerting technology on a critical care outreach team (CCOT). The aims of this study project were twofold: i) to explore how the introduction of a new electronic recording and alerting system for patient observations has affected the work of a critical care outreach team; ii) to assess perceptions of how the technology might be affecting patient safety.

# Method

The setting was the critical care outreach team within a large NHS Acute Trust in England. The team has 24 nurses with a variety of clinical backgrounds including intensive care, general acute and emergency nursing. The team also comprises nurses with a varying range of experience levels. One of the main tasks the team carry out is to respond to deteriorating patients and life-threatening emergencies. The Trust adopted a mobile electronic observations chart in 2016 – known colloquially as E-obs – in response to concerns about the management of deteriorating patients from its regulator, the Care Quality Commission (CQC). The E-obs incorporates forcing functions for data entry, automatically calculates early warning system (EWS) scores and an electronic instant alerting feature for notifying other clinical staff including the CCOT.

The main researcher of this study was a nurse within the CCOT. Observation and semi-structured interview with ten participants was carried out. Sampling was primarily purposive (n=8), with potential participants meeting the following criteria: current member of the CCOT; previously worked with the CCOT before E-obs was introduced; used E-obs in their clinical work with the CCOT within the last three months.

As the study focused on exploring changes in the work system since the introduction of electronic observations, these criteria were selected to focus on those who had experience with both systems so as to maximise comparative experience between the two. However, a secondary convenience approach was employed due to time constraints, which extended the sample to include two nurses who did not meet initial inclusion criteria. Participant 6 was not in post when the bleep system was in use but was included because they had used a bleep system in their previous hospital. Participant 9 was relatively new to the team and had no experience as a bleep holder. All participants were experienced registered nurses (median  $\geq 10$  years qualified) and had spent between one and eight years with the CCOT (median 3.5 years).

Following two pilot interviews, interview questions were finalised covering the following four areas: i) differences between the old bleep system and the new electronic system; ii) impacts of the new system on their work; iii) perceived impacts on patient safety; iv) potential areas for improvement.

Interviews were audio recorded for analysis and to enable the researcher to focus on the content of conversation whilst taking only brief notes on points of interest. Verbatim transcription and qualitative thematic analysis was undertaken using Nvivo 11 software. Detailed, open coding was initially employed resulting in a substantial list of codes which were then iteratively refined using a combination of reflective memos, reports and text queries to identify patterns in the data.

### Results

Analysis revealed four main themes: communication, situation awareness, professional issues, and workload.

### Communication

Effective communication from ward staff about deteriorating patients was cited by CCOT staff as a major contributory factor in creating good outcomes for patients, regardless of what system is used. However, several changes appear to have occurred in the way that the team communicate and are communicated with, including format, communication roles and feedback.

Information that would have been conveyed verbally using the bleep system is now sent electronically and displayed instantaneously as a digital alert, presenting data both numerically and

graphically. A perceived advantage of this format is that information is clearer and more accurate and many valued being able to easily check trends in the data.

"you're not relying on peoples' ambiguous handwriting and wobbly lines on the obs chart"

However, a strength of the bleep system was seen to have been the conversational dialogue about patients that occurred when nurses needed to refer a patient to the CCOT and was viewed as something to be preserved. This appears to be because, although information within the alert can be useful, it can be difficult to contextualise.

"it's just a set of numbers that actually you can't put into context."

However, there was agreement that since its introduction, E-obs had become the referral route preferred by ward nurses, demonstrated by a drop in the number of bleeps received. Several participants viewed this as suggestive of a reliance on the electronic system for communication with the CCOT.

"I just find now, that the bleep never goes and actually, it doesn't even need to be a bleep just a conversation that's not just reliant on an E-ob, I just feel like the communication about patients now is reliant on this text message alert system..."

Participants postulated that this was due to the ease with which ward nurses could now pass on information about deteriorating patients, an aspect that was generally viewed unfavourably.

"...it's so easy to press the button ... "

"...so then they would just press send..."

However, one participant alluded to the positive potential this may have in overcoming professional barriers to communication between ward and CCOT nurses.

"...sometimes if the nurse doesn't always know what's going on with the patient they probably feel a bit shy about having a conversation with outreach because we're probably seen as these super clever nurses and they don't really know what's going on with the patient and they just think if they can shove us some numbers we'll know what to do..."

A characteristic of the old bleep system of referral was that conversations about deteriorating patients were usually initiated by ward nurses, with the CCOT on standby to receive these referrals.

"...they had to make the decision of whether they needed someone or not and they had to pick up the phone and they had to alert us..."

Whilst the initial contact is still made by the ward nurses by sending the electronic alert, conversations are now more commonly initiated by CCOT nurses in response to the need to contextualise the information as previously described. As a result, CCOT nurses appear to have assumed a much more active role in seeking out deteriorating patients, rather than more passive receivers.

In fact, some participants perceived that there was now an expectation from some ward nurses that the CCOT would follow up on alerts by contacting them. However, seeking information through attempting to initiate conversations with ward nurses was often problematic, requiring multiple attempts by phoning or journeys to the ward.

The timing and nature of feedback within the referral process also appears to have changed since the introduction of the electronic system. The closed loop nature of communication with the bleep system was regarded as a positive aspect for all staff involved. Firstly, ward nurses knew when their attempts to contact the CCOT had failed, prompting them to continue to seek help elsewhere. Secondly, CCOT nurses could be confident that their advice had been received.

"...they would know that we had received the alert [bleep], by the fact that we rang them back" and "...phoning the ward would be my preferred method because you are physically speaking to somebody, you know the message has been relayed to them..."

"With the bleep it was like, well outreach aren't answering, ok, so outreach aren't answering so what are you gonna do next? Well, well I'll get the doctor, because, they can't just write 'outreach not responding', they've got to be seen to be escalating the patients, so when they send off that ob via [E-obs], they don't know, so it's... sometimes makes me feel a little bit uneasy."

With the new system however, this requirement for ward nurses to seek this confirmation is less clear and has potentially led to confusion about how to refer. For this reason, the CCOT continues to emphasise to ward staff the importance of 'backing up' alerts with a bleep, in order to reinstate this confirmatory feedback mechanism.

Compounding this issue, the urgency of response demanded by the two technologies appears to be perceived differently, with bleeps requiring an almost immediate response and alerts less so. Therefore, a reliance on the electronic system to summon urgent help was seen to be problematic and even dangerous, because alerts are not always responded to immediately.

CCOT nurses can use a button to decline an alert if they are busy with another patient but overall this function was not deemed useful because the alert is simply resent a few minutes later. Most reported accepting all alerts, with a minority claiming that they will decline an alert only if they are at an emergency, or to hand the alert over to a colleague. This can lead to multiple alerts being accepted and accumulated at once, with potential implications for how these are responded to.

"...you can get maybe ten, fifteen alerts and sometimes if it's bleeping all the time and you just accept accept accept and you don't always see all of the clinical details and if you're busy with another patient then you might not actually get to see that EWS of eleven... for half an hour or more, which is dangerous and yes now we have the... the thing to decline, busy with patient, but then what happens...what happens to the patients?"

Therefore, although an alert may have been accepted by the CCOT, the ward nurse sending the alert may not know if it has been reviewed and when to expect a response from the CCOT. Responding to an alert might involve simply adding a comment and closing it, phoning the ward, or attending the ward in person. Nearly all participants mentioned adding comments to alerts by way of responding. However, many were unsure about whether ward nurses could view these notes, bringing into question the purpose of adding this information. Rather than being a communicative task, intended to relay information back to ward nurses as might have been done when responding via the bleep system, it was in fact described as a documentary activity, for the purposes of audit and investigation.

### Situation awareness

Whilst recognising issues with E-obs, most participants remarked that they would not elect to return to the bleep system if given the choice. A significant limitation of the paper chart and bleep system was that hospital-wide oversight was impossible because of the lack of remote monitoring capability and a heavy reliance on ward nurses to inform and update the CCOT about patients' progress. Referring to how they would become aware of deteriorating patients previously, two participants described how they would accidentally discover patients whom they had not been contacted about.

"...or if you're doing a walk round the wards, discovering... patients [laughs]"

"...or, if I went to the ward and accidentally come across that patient...[laughs]"

When the CCOT were not informed in a timely manner or there was not the fortune of 'discovery', this had potentially serious consequences for patients. Whilst there is still an expectation that it is ward nurses' responsibility to inform the CCOT of a deteriorating patient, now however, they are also able to actively monitor for deteriorating patients through the CCOT virtual ward and can remotely track multiple patients.

"...you might only know about patients if you were contacted about them previously, whereas now you can keep track of them the whole...the whole way through"

"...it's a big hospital to walk round just to look at the obs on paper... from a watching point of view, it's great."

### **Professional issues**

The three related concepts of responsibility, ownership and autonomy emerged strongly from data from all participants and related to perceptions of their own work and that of the ward staff. Participants voiced concerns about how this might be affecting patients, with many describing how a lack of ownership and responsibility can lead to delays in treatment.

"...when they press that submit button and it goes into the ether...I've done something about that because it's gone so...I've sent my...I've sent my alert, I'm just gonna carry on doing what I'm doing because they now need to respond to what I've sent, do you see what I mean?"

Although improved awareness for CCOT nurses was generally felt to be a positive effect of increased availability of data, this was perceived to have come at a cost, contributing to a diminished sense of responsibility amongst ward nurses. Another described how the expectation that the CCOT would "know already" and attend by default, has eroded autonomy. Loss of control over one's work – rather than responsibility – was a nuance within this narrative offered by one participant when referring to the bleep system.

"I don't know whether they had greater responsibility, but I think they felt personally more in charge..."

Specifically, many interviewees mentioned the ease with which information could now be communicated – and the lack of thought required in this process – as a factor contributing to an erosion of these aspects of professional identity. Some also attributed it to a fear of litigation and pressures to follow standard policy exerted by the system itself.

"...it's a machine, it's telling you how you need to do stuff so people do it. There's no thought process in using this at all. I just don't...I think we've taken all that away from people."

"...but it just feels... sometimes it's just to cover the system um..."

Interestingly, CCOT nurses used conversations as a way of returning some of the responsibility felt to have been carelessly shared with them.

"...it's kind of sharing that responsibility of that patient back again because you get it all dumped onto you when you get that E-ob alert...and making them think, right, could I do something more than what I've done?"

In contrast to this perception of diminished responsibility in ward nurses, and perhaps because of this, CCOT nurses reported a strong feeling of responsibility within themselves towards dealing with alerts.

"...you can't leave it once you've got it, you have to at least check that they're ok with things..."

Some however, linked this with a sense of anxiety. This may be due to a characteristic of the bleep system, which is that there is no reliable way of recording if bleeps were received, by whom and what action – if any – was taken. In contrast, the electronic system can record the recipient of the alert, time of sending and completion and any comments added. As with perceptions of ward nurses, some CCOT nurses also reported feeling pressurised to respond in a certain way due to the fear of being reprimanded if something went wrong.

"...I'm very aware of protecting myself so writing 'I've discussed this with the ward staff' and I'll name if I know the names and what we've actually discussed and what the plan is so that if anything happens, they can come back and say that well actually yeah [name] did... [name] was present and she did..."

### Workload

Although the scoring component of the early warning system has remained the same between the bleep and electronic system, workload was generally perceived to have increased with the new system, requiring CCOT nurses to continually triage and prioritise alerts. Real-time alerting is cited as a major advantage of the system but if nurses are busy with other tasks, this can be disruptive.

"At the beginning I found it quite distractive and quite... unhuman..."

Surprisingly, this increase in workload was not necessarily viewed as a negative thing, with one participant (Participant 3) suggesting that any issues associated with a heavier workload were potentially offset by an increase in awareness. However, three participants described what appears to be alert fatigue, with potential impacts on how alerts are responded to and prioritised.

"You get, fifty-six of these in a day, I've probably taken in four of them..."

"I don't know about anybody else but you can sometimes become a bit desensitised to it when it's going off all the time..."

"...so you also fall into a sense of false security because if you have sometimes twenty E-obs, maybe nineteen isn't appropriate so you're thinking...ah it's probably not going to be anything..."

Potential reasons cited for this increased workload were easier and faster communication, and high volumes of 'false' or 'inappropriate' alerts. False scores occur where the EWS score does not represent a true picture of the patient's overall condition, for example, patients in whom high scores are due to a stable chronic condition, or terminal illness. Equally, a low score can also be misleading.

"...a score wouldn't tell you... a score... somebody scoring three could be sicker than somebody scoring eight or nine for example."

"...the hardest part is when you have to decide which ones are relevant and which ones aren't..."

Consequently, this difficulty in interpreting scores alongside high volumes of alerts can make prioritising work mentally demanding, time consuming and sometimes stressful, with participants using words like "daunting" and "overwhelming". To deal with this, participants reported processes of 'sorting and sifting' when dealing with multiple alerts. However, a common strategy of working from the top of the list down was recognised to be problematic because alerts were typically displayed in time order with most recent first, resulting in a delayed response to the oldest alert. Additionally, all alerts are categorised as high priority and the score for each patient is not displayed on the list view, making comparison of scores between patients difficult.

The time required to respond to alerts was seen to be important – in particular, time diverted towards dealing with false alerts can potentially increase the risk of delays in responding to deteriorating patients.

"...sometimes, say, again, it comes down to um...inappropriate escalation, so that would disrupt my workflow, having to taking time that time out to go to that ward when I could be elsewhere seeing another patient."

# Discussion

A significant perceived benefit of the E-obs was the clarity delivered by the digitally displayed chart which eliminated any ambiguity caused by handwritten charts. However, contextualising information within the alert was reported to be problematic, a finding also reported by Reddy et al. (2005). In their study of wireless pagers in a surgical intensive care unit, they found: an ongoing need for doctors to contact nurses for more information so as to contextualise and prioritise alerts; that high volumes of alerts without prioritisation can create information overload; that conversations were viewed as a positive aspect of the bleep system to be preserved. In another study the importance of feedback mechanisms in technology-mediated communication between clinicians has already been noted (Reddy et al. 2003). Unfortunately, the study also confirms that this continues to be an issue despite 14 years of technological advancement.

Professional culture between nurses and anxiety about communication has been recognised as a barrier to calling for assistance from response teams like the CCOT (Astroth et al. 2013). One of the perceived patient safety benefits of this technology is its potential to overcome this barrier through alerts, which removes the need for ward nurses to verbally communicate a referral in the first instance. However, (Reddy et al. 2005, p.234) report a loss of hierarchal context whereby junior doctors, who acted as gatekeepers for information, were bypassed by the technology, resulting in a loss of control of information flow to senior doctors: "the importance derived from a notification moving up the hierarchy is lost".

Increased interruptions was found to be significant in one study by Quan et al. (2013), as a result of the removal of traditional barriers to bleeping e.g. having to wait for a response. A culture of accountability was also found to be a contributory factor, underpinning decisions to send information and resulting in a higher burden of alerts. Interestingly, as with this study, a tension was identified between groups of staff (doctors and nurses) on the use of technology to either carry out or absolve oneself of professional responsibility (Quan et al. 2013). From a patient safety point of view, the implications of this are potentially serious, and warrant further exploration.

Through focusing on the CCOT, this study was able to gain an in-depth insight into the perceptions of a single group of staff. However, a similar study exploring the perceptions of ward nurses would be desirable to balance and (to some extent) validate the findings reported here. Whilst studies that recognise the value of clinician experience and expertise such as this are important, research that assesses actual rather than perceived patient safety impacts of information technology is required (Nguyen et al. 2015). This should include more prospective longitudinal designs that capture the emergent and evolutionary nature of healthcare information technology (Waterson 2014). Finally, we need to consider how we can enable busy clinicians to effectively participate in the initial and continuing design of their working systems (Carayon 2006).

Information technology promises to significantly improve clinician communication and improve patient safety; but in their systematic literature review of clinician-clinician communication, Nguyen et al. (2015) conclude that technology alone cannot be used as a solution to problems with

urgent communication between clinicians. Based on their findings, they argue that whilst technology increases communication, improvements in quality are not guaranteed. This is echoed in a national safety alert that, whilst recognising its increasing use, states that technology must be situated within a "whole safe system of care" if patients are to benefit from its use (NHS Improvement 2016, p.1). The corollary of this is that these systems need to recognise the complex sociotechnical nature of healthcare, if technology is to be successfully integrated.

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