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Factors influencing the quality of vital signs data in electronic health records: a qualitative study

ABSTRACT

Aims and objectives: The purpose of this study was to investigate reasons for inadequate documentation of vital signs in an electronic health record.

Background: Monitoring vital signs is crucial to detecting and responding to patient deterioration. The ways in which vital signs are documented in electronic health records have received limited attention in the research literature. A previous study revealed that vital signs in an electronic health record were incomplete and inconsistent.

Design: Qualitative study.

Methods: Qualitative study. Data were collected by observing (68 hours) and interviewing nurses (n=11) and doctors (n=3), and analysed by thematic analysis to examine processes for measuring, documenting and retrieving vital signs in four clinical settings in a 353-bed hospital.

Results: We identified two central reasons for inadequate vital sign documentation. First, there was an absence of firm guidelines for observing patients' vital signs, resulting in inconsistencies in the ways vital signs were recorded. Second, there was a lack of adequate facilities in the electronic health record for recording vital signs. This led to poor presentation of vital signs in the electronic health record and to staff creating paper 'workarounds'.

Conclusions: This study demonstrated inadequate routines and poor facilities for vital sign documentation in an electronic health record, and makes an important contribution to knowledge by identifying problems and barriers that may occur. Further, it has demonstrated the need for improved facilities for electronic documentation of vital signs. Relevance to clinical practice: patient safety may have been compromised because of poor presentation of vital signs. Thus, our results emphasised the need for standardised routines for monitoring patients. In addition, designers should consult the clinical end-users in order to optimise facilities for electronic documentation of vital signs. This could have a positive impact on clinical practice and thus improve patient safety.

Keywords: vital signs, electronic health records, patient safety, qualitative study

'What does this paper contribute to the wider global clinical community?'

- Given the importance of recording vital signs, it is essential to understand problems and barriers to monitoring patient deterioration. Inadequate routines for measuring vital signs and poor facilities in electronic health records can have a negative impact on the quality of vital signs presentation.
- National guidelines on patient surveillance are warranted.
- The findings of this study can contribute to knowledge necessary for improving the design of electronic health records and thus improve patient safety.

INTRODUCTION

This article presents the second phase of a mixed methods investigation into documentation of vital signs in electronic health records (EHRs). In the first phase, a quantitative study was performed and found that vital signs were incomplete and inconsistently scattered throughout three sections of the EHR (Stevenson, Israelsson, Nilsson, Petersson, & Bath, 2016). The current paper presents a follow-up study, using a qualitative approach, the aim of which was to investigate in greater detail the reasons for inadequate documentation of vital signs in an EHR.

BACKGROUND

Abnormal vital signs are associated with adverse events such as cardiac arrest and unplanned admission to intensive care units (Goldhill, Worthington, Mulcahy, Tarling, & Sumner, 1999; Hillman et al., 2002; Kause et al., 2004). Monitoring vital signs is, therefore, crucial to recognising and responding to patient deterioration (DeVita et al., 2006; National Institute for Health and Clinical Experience, 2007; Smith, 2010; Smith et al., 2006). Several systems for detecting patient deterioration have been developed, e.g., early warning score (EWS) systems. A number of studies have shown that the way in which vital signs can be viewed in a clinical record can have a major effect on the ability of clinicians to detect deterioration in a patient's physiological state (Chatterjee, Moon, Murphy, & McCrea, 2005; Elliott, 2015; Horswill, Preece, Hill, & Watson, 2010; Preece, Hill, Horswill, & Watson, 2012). However, the way in which vital signs are presented in EHR systems has received minimal research attention. Since EHRs are increasingly used for all aspects of clinical documentation (Ayatollahi, Bath, & Goodacre, 2010), including vital signs, it is crucial that we understand the possible impact that this transition from paper to electronic systems might have. At the time of this research, the study hospital had been using an EHR for approximately eight years. Our previous work demonstrated inconsistencies in vital sign documentation indicating the need for further investigation into all aspects of vital signs monitoring: routines for measuring vital signs; and recording and viewing vital signs in the EHR.

METHODS

Design

Using a qualitative approach, we examined work processes of medical and nursing staff for measuring, documenting and retrieving vital signs. Data were collected through observations and semi-structured interviews between August 2014 and January 2015. The data were analysed using thematic analysis (Braun & Clarke, 2006). Data collected during interviews were used to corroborate the results of the observational data. In addition, an EWS system, Vitalpac Early Warning Scores (ViEWS), was used as a validated model for monitoring vital signs (Prytherch, Smith, Schmidt, & Featherstone, 2010). In ViEWS, six vital signs (temperature, pulse, respiratory rate, blood pressure, oxygen saturation and conscious level) are measured twice daily.

Setting

The setting was a 353-bed district general hospital in Sweden. Four independent clinical settings were included: an acute medical department (cardiology unit (CU), 40 beds); an acute surgical ward (SW) (28 beds); an infection ward (IW) (18 beds); and an emergency department (ED). The ED attended to approximately 35,000 patients annually. These clinical areas were selected as they provided a wide range of patients receiving acute clinical care who would require monitoring of vital signs. The hospital had no general guidelines for monitoring vital signs. An EHR had been implemented in 2007.

Participants

The sampling method was a purposive, convenience sample. Nursing and medical staff who used the EHR were invited to take part in the study. Several nurses volunteered immediately and, during observation sessions, further volunteers were recruited. The observational study included a total of 68 hours of observations in four clinical areas. In the interview study, interviews were conducted with eleven registered nurses (RNs) and three medical doctors (MDs).

Data collection and analysis

Within each clinical area, data collection was performed in two sequential stages: first, the observations were undertaken. These were followed by conducting the semi-structured interviews, providing the opportunity to probe issues raised during observations.

Observations

Observations aimed to explore all aspects of vital sign measurement, documentation and retrieval: which vital signs were measured, how often they were measured, why they were measured; where they were documented, how they were documented; how they were retrieved. Nurses were observed in their everyday duties, and particular attention was given to actions and activities that were associated with vital signs. Observed data were recorded in field notes by one of the researchers (JS).

Analysis of observational data

The observational data were analysed using an inductive approach (Elo & Kyngäs, 2008). The data were coded. How and why vital signs were documented in the EHR were explored. A matrix (Graneheim & Lundman, 2004) was used to ensure that meaning units were analysed systematically. Figure 1 displays an example of the matrix. Thus, the data from the observational study were organised into themes. Three main themes emerged: measuring vital signs, documenting vital signs and retrieving vital signs. These themes were then used to inform the questions for the semi-structured interviews.

Semi-structured interviews

An interview guide with semi-structured questions was designed based on the three main themes that had emerged from the analysis of the observational study. This allowed us to explore issues raised from the observations. An informal, flexible approach was taken. Each interview lasted approximately 19 minutes (+/- 9). Interviews were carried out by

JS in each of the clinical settings until data saturation was reached. Data were recorded using digital audio equipment.

Analysis of interview data
Because there were pre-determined themes, the data analysis was carried out using a deductive approach (Elo & Kyngäs, 2008). Data were coded and interview excerpts were identified to illustrate the themes.

Combined data analysis
Data sets from both the observational study and the interview study were combined to make one corpus and used to corroborate one another. Analysis of the measurement of vital signs was based on and compared to ViEWS. The accuracy of the results was validated by member checking within the same clinical areas, i.e., key participants agreed that the findings reflected their practice (Creswell & Plano Clark, 2007).

Ethical considerations
The Regional Ethical Review Board, Linköping, Sweden, approved the study (DNR 2014/351-52). The managers of the clinical areas consented to the study. Participants gave their informed consent, those being observed as well as those being interviewed.

RESULTS
The results are presented using the main themes that were identified: measuring vital signs; documenting vital signs; and retrieving vital signs.

Measuring vital signs
In the four clinical areas, there was noticeable variation regarding which, and how often, individual vital signs were measured. These were compared to ViEWS and are shown in Table 1.

In the ED, the routine for measuring vital signs was well-defined and was similar to routines demanded in ViEWS with all vital signs recorded on admission and subsequent vital signs recorded according to the seriousness of the patient's condition. The ED used the rapid emergency triage and treatment system (RETTS) (Widgren, 2013), which mandates that all vital signs (temperature, pulse, respiratory rate, blood pressure, oxygen saturation and conscious level) are taken and recorded in the system so that the triage priority can be estimated.

There were well-defined guidelines in the SW. Five of the ViEWS vital signs were recorded routinely once daily, thereby varying from ViEWS in frequency, and that conscious level was not included routinely. These vital signs were also recorded when a patient was admitted, when transferred from ICU or recovery room, and after surgical procedures. The guidelines also specified that patients who showed any signs of clinical deterioration needed to have vital signs checked. These guidelines provided a clear routine that seemed to be adhered to by nursing staff (Field note. 12).

There were some occasions in which isolated vital signs were taken in both the ED and the SW. This could be an extra blood pressure recording, for example, if a patient seemed unwell. These additional checks were considered 'extra' recordings to find out if a patient was alright. Nevertheless, universal guidelines recommend recording complete sets of vital signs (DeVita et al., 2010).

Findings in the CU and the IW were rather more complex. Neither RETTS nor written guidelines were used in these clinical areas. Within cardiology:

"The routine is to measure three times a day, morning, afternoon and evening". (Interview 2. Nurse CU)

Decisions on which vital signs should be taken at these routine times were made individually by nurses:

"It's blood pressure, pulse, saturation. It's always blood pressure and pulse as a routine, you could say." (Interview 2. Nurse CU)

Blood pressure and pulse were considered the most important vital signs in the CU. Clinical judgement drove decisions on whether additional vital signs were required:

"We would take vital signs if a patient became poorly. Then we measure temperature, pulse and blood pressure, and oxygen saturation - those four. Sometimes we measure respiratory rate if a patient is breathless." (Field note 1 CU)

In the IW, the standard process was to record vital signs on admission and at least twice daily. Only temperature was routinely included in these twice-daily recordings as it was considered the most important. The remaining vital signs were measured 'as required' (Interview 12. Nurse IW).

"With us, all patients have their temperature checked - that's what we're interested in." (Interview 12. Nurse IW)

This meant that nurses used their clinical judgement to decide if they would measure additional vital signs:

"If we notice that a patient's condition worsens, then we decide ourselves as nurses if we should take it more often." (Interview 11. Nurse IW)

These results show that there was clear variation within the clinical areas for which vital signs were measured and how often this occurred.

Documenting vital signs
The findings showed that documentation of vital signs was not only carried out in the EHR but also on paper. A summary of the findings is shown in Figure 2.

Electronic health records

In the EHR, vital signs were documented in three sections known as: the table; the journal; and the report sheet. Figure 3 shows a screen shot of the table, in which all vital signs were entered as numbers with no available graph. In all four clinical areas, the most frequently used section of the EHR was the 'table' (Figure 3).

Tables
Tables had to be generated in the EHR for each new patient:

". . . every time you get a new patient you have to create a new one [table]. (Interview 1. Nurse CU)

Nurses found the table awkward to use, and time-consuming:

". . . there are very many clicks before you can get anywhere. Masses of clicks . . . if there were less clicks it would be easier." (Interview 12. Nurse IW)

They also found that the table could not accommodate many vital signs, for example, if a patient was very sick and needed frequent recordings, because then, the table became too 'long':

"You don't write down every time you check . . . then we enter the first BP and the final BP [in the EHR] instead of filling in each pulse and blood pressure in the patient table." (Interview 1. Nurse CU)

These findings suggest that the table in the EHR did not support the recording of recurrent vital signs.

Journal
The journal section of the EHR was used in some instances. In the ED, the first set of vital signs was automatically transferred from RETTS to the journal. However, as this quotation illustrates . . . :

"It is only the first vital signs that we write in the RETTS triage module. After that we write vital signs in the table for vital signs in the EHR, as is done in the rest of the hospital." (Interview 9. Nurse ED)

Not having baseline recordings on the same page as subsequent recordings could make it difficult to follow a patient's progress or any changes from the time of admission.

A nurse explained that she sometimes wrote vital signs in the journal notes so that she could give a better account of the patient.

"They [vital signs] are always written in the table but it can be that a summary is written in the journal notes." (Interview 12. Nurse IW)

Report sheet
Nurses also said that they sometimes preferred using the report sheet to the table. One reason was that it was quicker:

"I use the report sheet, because it is faster, if I don't have time to create a column [in the table], then I quickly write it in the report sheet." (Interview 3. Nurse CU)

A further reason for writing in the report sheet was to alert nurses to any abnormalities or potential problems:

"In the report sheet . . . I write if a patient is deteriorating." (Interview 1. Nurse CU)

"I can tell the whole story there . . . if the patient becomes poorly, I think the next nurse needs to be able to read what has happened." (Interview 3. Nurse CU)

Nurses felt the report sheet was suitable if they wanted to write additional details about the patient's care.

Paper charts

Paper charts were used extensively alongside the EHR, so-called 'workarounds', which have been reported previously (Tucker, 2009). One reason was if a patient required frequent vital signs to be measured, e.g., if a patient was very ill, unstable, had had surgery or commenced a new treatment. In cardiology:

"You have an acutely sick patient and you don't have time to document all this [in the EHR]. Then it is paper charts that are suitable. That's because we might be taking the vital signs every 5 minutes, so we don't put all of those in the EHR." (Interview 4. Nurse CU)

"On the paper, it is certainly easier to see. Then you don't need to click in the EHR, you don't always have the page with the table open in the EHR, so if you have it there on paper, then you can see it quickly." (Interview 3. Nurse CU)

In the ED:
"We write the vital signs on a paper first when we admit a patient . . .This is just so that we can have it for ourselves, to simplify, to be able to quickly hand over to the doctor so they don't have to go to the EHR." (Interview 10. Nurse ED)

The doctor collected this paper when going to see a new patient (Field note ED).

In the infection ward:

"If we have a sepsis patient who is unstable in the ward, then there is a paper chart which is left in the room with the patient. You don't need to run back and forth between the computer and the patient . . ., instead you have a paper that is there all the time." (Interview 13. Doctor IW)

When patients were discharged, these paper charts were electronically scanned and stored in a separate part of the EHR.

For routine vital signs, paper lists with room numbers were used to document at the bedside:

"We have the [paper] list so that we have it when we go round [the patients]. You don't always have time to stand at the computer. We write it in later. . . . We have a routine that it is written in the EHR before we go home." (Interview 12. Nurse IW)

The SW had one pre-printed paper chart for the 'once daily' routine recordings, with the room numbers in the left vertical column and the vital signs in a horizontal line along the top.

"We take one of those lists so that we see that it is done on everyone [vital signs]. Then we see if one is not done then we go in and take them. The paper is like a checklist. We write it into the EHR later." (Interview 14. Nurse SW)

Thus, paper charts were adopted because the EHR did not fit in with the workflow. Staff felt that they could obtain a more complete overview of vital signs on a paper chart. Moreover, it was simpler and quicker and paper charts could be kept at the bedside, allowing documentation at the point of care.

Paper notes
In addition to pre-printed paper charts, many paper notes were used as and when they were required on whatever paper happened to be available, e.g., note pads, 'post-its' and, occasionally, paper towels, were used for taking quick notes of vital signs. In Cardiology:

"Most often you have a paper in your pocket or a paper towel, (laughs) whatever, so that you have something to write on and make it easy. That's the way it is . . . so that I remember it until I get to a computer." (Interview 4. Nurse CU)

"And sometimes that may be towards the end of my shift, as it can be very busy." (Interview 3. Nurse CU)

In the ED, it was observed that when vital signs were checked in locations that were some distance from the nearest computer, paper notes were used and afterwards the information was transcribed to the EHR. These excerpts indicate the need for paper notes to ensure 'point of care' documentation when nurses were busy or were not close to a computer.

Retrieval of vital signs
The methods by which vital signs were retrieved varied. In cardiology, most nurses looked in the journal first and then the report sheet. For example:

"I usually read the journal and a little in the report sheet. I do not go in so often on the table for vital signs." (Interview 1. Nurse CU).

Doctors vented most concern about viewing vital signs. A doctor from CU indicated that it was problematic to see a patient's vital signs at a glance and also said that an excessive number of clicks was required before you could view whatever you were looking for in the EHR:

"It is very hard to get to this information in [the computer]. I must make many clicks to see those vital signs . . . They are not easily accessible." (Interview 8. Consultant CU)

This cardiology consultant emphasised how important it is to know the vital signs of acutely sick patients immediately.

"It's quicker to ask the nurses what the vital signs are than it is to find them in the EHR." (Interview 7. Doctor CU)

". . . I get the report from the night nurse. Most often they tell me the blood pressure, if it has been fine, or if it is high or low." (Interview 6. Nurse CU).

In the ED, a nurse reported that:

"Our triage vital signs can be seen in the journal part of the EHR . . . you must go in to the table to see what subsequent vital signs the patient has had". (Interview 9. Nurse ED)

Thus, comparing admission vital signs to subsequent values required users to view two independent locations in the EHR.

In the IW, nurses often used the paper 'list' to view vital signs. This list was kept on the trolley at all times so that nurses could easily access the most recent vital signs:

"We have the list so that we have it when we go round. You don't always have time to stand at the computer." (Interview 12. Nurse IW)

These paper 'lists' ensured that vital information was easily available. A doctor reported that:

"First I ask the nurse for the latest vital signs. They can often be given verbally." (Interview 13. Doctor IW).

In the SW, it was routine to retrieve vital signs from the table:

"We are so used to it. You have a row with all the vital signs and you can look in the history. And if there is anything, then they are there." (Interview 14. Nurse SW)

Clearly, various practices for documenting and retrieving vital signs among the four clinical areas existed.

Summary of results
There were two central factors influencing the quality of vital signs data in the EHR. The first was associated with *practices and routines for measuring vital signs* and the second concerned *facilities and functions in the EHR* (Table 2).

DISCUSSION

The aim of our study was to develop a better understanding of why documentation of vital signs in an EHR may be incomplete and inconsistent (Stevenson et al., 2016). We identified two central reasons that may help to explain this. The first is that the absence of firm guidelines, practices and routines for observing patient's vital signs can result in many vital signs not being measured routinely. The second is that the lack of adequate facilities and functions for documenting vital signs in an EHR, can make it difficult both to enter and to locate and retrieve the data. Given the importance of recording vital signs (DeVita et al., 2010; Smith, 2010), it is essential to understand problems and barriers to recording and monitoring patient deterioration. This is particularly important with the development of EHR systems, and the transition from traditional paper-based systems. These results can help developers to design systems that fit into the work practices of health care professionals.

Practices and routines for measuring vital signs
The benefits of early warning score (EWS) systems are widely accepted and have been adopted internationally for early detection of deteriorating patients (Hammond et al., 2013; Ludikhuize, Smorenburg, de Rooij, & de Jonge, 2012; Monsieurs et al., 2015). They are associated with the reduction of cardiac arrest, unplanned admissions to ICU, and death (DeVita et al., 2010; Smith, 2010). Where a hospital, or health care provider does not have a policy for vital sign recordings, patient surveillance and monitoring can vary extensively depending on the clinical area. Three of the four areas in our study showed considerable disparity to ViEWS.

In this study, clear guidelines such as the RETTS tool used in the ED and the guidelines used in the SW had observable benefits; vital signs were recorded routinely and not only when there was a clinical indication. Precise guidelines did not exist in the CU or the IW. The association between clear procedures for recording specific vital signs have been demonstrated, with EWS systems having been shown to enhance the frequency of recordings, particularly of respiratory rate (Bunkenborg, Samuelsson, Poulsen, Ladelund, & Åkeson, 2013; Cahill et al., 2011; McBride, Knight, Piper, & Smith, 2005; McCormick, 2005; Odell et al., 2007; Sharpley & Holden, 2004). A previous study showed low frequency in the documentation of respiratory rate (Stevenson et al., 2016). The current study found that decisions for measuring vital signs were made at departmental or ward level, or left to individual nurse's clinical judgement. A number of studies have shown that clinical judgement can be subjective and should not replace the systematic recording of vital signs (Cuthbertson & Smith, 2007; Fullerton, Price, Silvey, Brace, & Perkins, 2012; Preece et al., 2012; Zarabzadeh et al., 2013).

Given the advantages of evidence-based patient surveillance systems such as EWS, this study underlines the importance of a hospital wide policy for detecting patient deterioration (Smith et al., 2006). Although many health authorities in Sweden have now adopted EWS systems, there is not, to date, a national policy. Such a policy could have the potential to improve patient safety and promote equality in care across Sweden.

Facilities and functions for documenting and retrieving vital signs in the EHR

Recording vital signs in EHRs has received minimal attention in previous research; however, the results of this study elucidated several problems when considered alongside key requirements of electronic record systems. In health care settings, interfaces need be streamlined to work processes and meet specified goals to be safe, efficient and effective (Kushniruk & Patel, 2004; Peute, Spithoven, Bakker, & Jaspers, 2008), and an EHR should facilitate clinical work and take account of work routines (Ovretveit, Scott, Rundall, Shortell, & Brommels, 2007). Clearly, the EHR in this study did not meet these demands for recording vital signs. In another Swedish study, five out of nine hospitals used paper charting alongside the EHR to support the documentation of vital signs, indicating that these hospitals also experienced difficulties in vital signs documentation (Skyttberg et al., 2016).

In our study, there were three main concerns when documenting and retrieving vital signs in the EHR: consistency, correctness and currency (Russ et al., 2010). First, there was a lack of consistency as vital signs could be documented in three locations. The variation in the location of vital signs could lead to difficulties in viewing consecutively recorded vital signs, and thus, immediate changes in a patient's condition, or trends, might easily be missed. For example, in the ED, vital signs from RETTS were automatically charted in the journal with subsequent vital signs manually recorded in the table section of the EHR. This could hinder appropriate clinical decision making and could compromise patient safety.

Second, vital signs were not adequately presented. Previous research has shown that the way in which vital signs are presented visually has a profound impact on the ability of clinicians to identify patient deterioration and emphasises the need for coloured charts and plotted graphs; the possibility to easily identify trends enhances the processing of information, enables rapid detection of changes and facilitates informed decision making (Chatterjee, Moon, Murphy, & McCrea, 2005; Preece et al., 2012). Viewing vital signs in a table, such as that used by health care professionals in our study, meant that changes and trends could not be recognised easily or quickly (Figure 3). Previous studies have shown that vital signs should be presented on plotted graphs which are colour coded to ensure clinicians are able to identify patient deterioration at a glance (Chatterjee et al., 2005; Horswill et al., 2010; Preece, Horswill, Hill, & Watson, 2010).

Third, the vital signs recorded in the EHR were not current. Entering and accessing vital signs was time consuming and cumbersome resulting in the staff delaying entry of vital signs into the EHR; the delay could be from a few minutes after measurement, to several hours, or could be delayed until the end of a shift. If frequent vital signs were required, paper observation charts were used instead so these would not be added to the EHR until they were scanned in when a patient was discharged. Thus, vital signs in the EHR were often not current and the latest vital signs were not available for clinical assessment.

"Workarounds are non-standard methods for accomplishing work blocked by dysfunctional processes" (Tucker, 2009). The 'workarounds' mentioned above were initiated to fill functional gaps. The staff in this hospital used paper notes and checklists,

because it was quicker and more convenient; they carried out the 'official' documentation in the EHR at a later time. When frequent vital sign recordings were necessary, workarounds in the form of paper observation charts were used; it was quicker and easier and it meant that vital signs could be entered at the point-of-care and were available for viewing beside the patient. It is important, therefore, that EHR systems are designed to facilitate easy recording of vital signs, as well as other clinical measurements, in order to avoid the need for workarounds.

The paper observation charts created by staff were not optimal as they were all in the form of tables, thereby not meeting the recommendations of evidence-based observation charts that have coloured bands and plotted graphs, which have the possibility to detect changes quickly and facilitate informed decision making (Chatterjee et al., 2005; Horswill et al., 2010; Preece et al., 2012). Therefore, if paper charts are employed, we recommend that a standardised evidence-based chart is adopted to ensure timely detection of patient deterioration.

EHRs are used in all hospitals in Sweden and there are several providers. There is a dearth of research into the way in which vital signs are presented in EHRs: this study helps to develop a better understanding of the problems associated with recording important information in EHRs. Clearly, the way in which vital signs were recorded in this EHR did not concur with evidence-based guidelines for paper observation charts, and this suggests that developers and providers of EHRs need a better understanding of how to accommodate vital signs, and of their importance.

This study adds to the evidence base on vital signs in EHRs. It demonstrates shortfalls in this EHR, one widely used in Sweden (Nilsson, 2013), when it comes to documenting and retrieving vital signs. In light of our study, it could be time for a standardised policy for documentation of vital signs in EHRs to promote patient safety and enhance equality of care. This would mean that those who procure systems for use in acute care could insist on basic evidence-based characteristics in EHRs and require developers to involve health care professionals in the design, development and testing of systems. However, the degree to which managers involve research-based evidence in decision making is unclear (Walshe & Rundall, 2001). Furthermore, there is a need of consensus among stakeholders when introducing interventions such as electronic documentation (Ericson, Hammar, Schönström, & Petersson, 2017).

Strengths and weaknesses
A limitation of the study was that it just examined the use of a single EHR system. This could mean that the findings may not be generalisable to all EHRs. However, the general issues that were raised in relation to this particular EHR system are likely to be transferable to similar systems in which there are problems with documentation of vital signs. A strength of this study was that it complemented previous quantitative research on vital sign documentation in an EHR (Stevenson et al., 2016). It elucidated reasons for incomplete documentation identified in the quantitative study by examining these issues more deeply, and thus, completed the second phase of a mixed methods investigation

(Creswell, 2013). An additional strength of our study was that it was carried out in different areas and examined a broad selection of data on vital sign monitoring within one hospital. A limitation of qualitative methods based on observations is that staff may behave differently when they know that they are being observed (Kumar, 2011). On the other hand, two qualitative approaches - observations and interviews - provided triangulation of data sources and ensured consistency of the results in this qualitative study (Johnson, Onwuegbuzie, & Turner, 2007).

CONCLUSIONS

Monitoring patients' vital signs is essential to safe patient care. This study makes an important contribution to knowledge about the documentation of vital signs in an EHR, by identifying problems and barriers that may occur. It has demonstrated the need for improved facilities for electronic documentation of vital signs. Moreover, it has confirmed the need for standardised routines for measuring vital signs. Complete and current documentation may be possible in EHRs when issues of safety and user-friendliness are addressed and iteratively evaluated. Until then, parallel paper systems are likely to persist. Previous studies have shown that nursing documentation in the EHR system can be difficult and inefficient (Stevenson & Nilsson, 2012); however, this research has demonstrated that inadequate facilities for documenting vital signs could have an adverse impact on patient safety.

RELEVANCE TO CLINICAL PRACTICE

Inconsistencies in recording vital signs may delay recognition of patient deterioration and lead to adverse outcomes. Patient safety may have been compromised because of poor presentation of vital signs. Thus, our results emphasised the need for local and national guidelines on patient monitoring to improve clinical practice. Moreover, designers of electronic health records need to consult with clinical end-users in order to optimise facilities for electronic documentation of vital signs. Applying these suggestions could have a positive impact on patient safety.

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Meaning unit	Condensed meaning unit and description close to the text	Condensed meaning unit and interpretation of underlying meaning	Sub-theme	Theme
Nurse takes the VS: T,P, BP and SaO2 of the second patient in this room	Takes vital signs- T, P, BP and SaO2	Selecting which vital signs taken according to individual patient needs	Clinical judgement	Measurement
Nurse writes VS in her notebook after checking each patient	Writes VS in notebook	Using paper instead of the EHR	Documentation on paper in notebook	Documentation

Note: VS=vital signs; T=temperature; P=pulse; BP=blood pressure; SaO2=oxygen saturation

Figure 1. Examples of meaning units, condensed meaning units and themes

Table 1. Frequency of vital signs recorded routinely

	ViEWS	Emergency Department	Surgical ward	Cardiology unit	Infection ward
Times per day	2	Admission + as per protocol	1	3	2
Temperature	Yes	Yes	Yes	As required	Yes
Pulse	Yes	Yes	Yes	Yes	As required
Respiratory rate	Yes	Yes	Yes	As required	As required
Blood pressure	Yes	Yes	Yes	Yes	As required
SaO$_2$	Yes	Yes	Yes	As required	As required
Conscious level	Yes	Yes	As required	As required	As required
Total	6	6	5	2	1

Note: ViEWS=Vitalpac Early Warning Scores, SaO2=saturation of oxygen
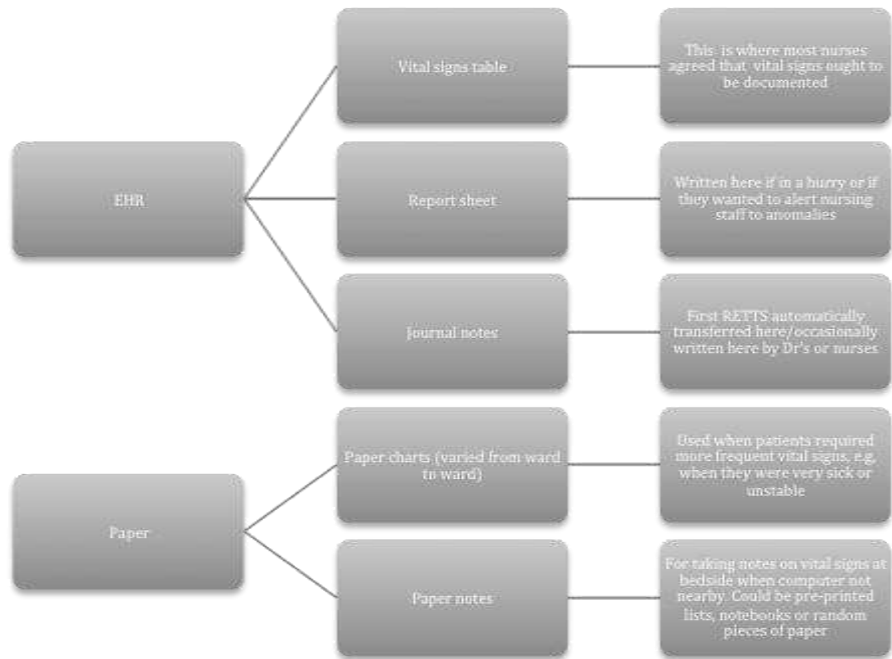
Figure 2. Documentation of vital signs within the EHR and the paper-based system.

Figure 3. Screen shot of the table used for vital signs in the EHR. N.B. this is an example for illustration purposes, not an authentic copy.

Table 2. Summary of results

Practice and routines for measuring vital signs	Facilities and functions in EHR
No clear policy on which vital signs to measure	Usability issues - excessive clicking
Varied practice and routines from ward to ward	Not suitable for frequent vital signs
Variability in which vital signs were measured	Quicker and easier to document on paper (workarounds)
Decisions on routines for measurement of vital signs made at ward level or left to clinical decisions of individual nurses	Quicker and easier to write in one section than another
	In RETTS - first set of vital signs in journal. Subsequent vital signs in table