From Paper Forms to Electronic Flowsheets: Documenting Medical Resuscitations in a Time of Transition

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Abstract. Electronic Health Records (EHRs) have a critical role in supporting continuity of patient care and effective clinical decision-making. Although EHRs are widespread today, many emergency departments (EDs) have been slow in adopting them for documenting time-critical scenarios such as resuscitations. Introduction of an electronic flowsheet for documenting medical resuscitations at our research site provided a unique opportunity for studying the nuances of the transition from paper to electronic documentation. We observed 44 medical resuscitations and conducted post-event interviews with 24 nurse documenters to examine their interactions and behaviors with the newly implemented electronic flowsheet. While our findings showed many advantages of electronic documentation, such as improved access to patient records and auto-population of flowsheet sections, we also identified several challenges associated with the flowsheet navigation, technical issues, and lack of practice and use opportunities. We observed different workarounds used by nurse documenters to overcome these challenges, including the use of paper-based mechanisms, free-text fields, and simultaneous documentation by two nurses. Based on our findings, we provide design guidelines for improving the electronic flowsheet to support its use during resuscitations.

Keywords: Electronic Health Records · Emergency medicine · Nursing documentation · Workarounds · Information behavior · Observations · Interviews

1 Introduction

Electronic Health Records (EHRs) capture critical information to support clinical decision-making, effective patient care, and coordination among care providers. Although EHRs have been implemented in various medical settings, documentation during resuscitations within emergency departments (EDs) has not been completely digitized due to the time-critical and high-stress nature of these events. Resuscitation flowsheets have a key role in facilitating communication and coordination during resuscitation events, while also contributing to continuity of care and patient safety [1]. Documentation in these dynamic environments, however, is an overwhelming task. A nurse documenter is responsible for capturing the information from multiple team

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members and information sources, and producing a comprehensive record of all activities. The mental effort needed to gather patient information, record the diagnosis and treatment steps, and monitor the effects of clinical decisions is therefore high. These complexities in documentation have led some medical experts to dismiss the idea that electronic tools could ever replace paper flowsheets given the concerns about thoroughness, correctness, and timeliness of data recording [2]. For these reasons, many EDs have continued to use paper-based documentation during resuscitations.

Introduction of an electronic flowsheet associated with the EHR for documenting medical resuscitations at our research site in May 2017 provided an opportunity to study the nuances of the transition process from paper to electronic documentation in this high-risk medical setting. In this paper, we examine the nurse documenters' interactions with the newly implemented flowsheet, and discuss the advantages of electronic charting, challenges of use, and workarounds to overcome these challenges. We contribute to the existing literature by providing design recommendations for improving the use of the electronic flowsheet in dynamic medical settings.

2 Related Work

Prior HCI, CSCW, and health informatics studies have examined the implementation of electronic documentation in different medical settings, including intensive care units [3, 4], ED [5], and obstetrical units [6]. While some studies found the advantages of EHR implementation, such as the improved clinical workflow [3, 4], many studies identified misalignments between the EHR designs and clinicians' work practices [6–8]. We extend this body of work by discussing the challenges with the use of the EHR in a dynamic setting that requires the production of a complete and accurate record in real time, leading to the use of workarounds.

Specifically in resuscitation settings, some EDs have adopted electronic flowsheets despite the challenges of accurate and real-time data capture [1, 9–13]. These studies focused on different aspects of documentation, including completeness of the record [9, 10], the process of flowsheet design and implementation [1], evaluation of electronic documentation systems [11, 12], and efficiencies gained with electronic recording [13]. Most studies reported on a successful and seamless implementation of the electronic flowsheet, with only a few barriers (e.g., waiting for the appropriate technology to fit the needs of resuscitation settings) [1], finding an increase in completion rates on electronic flowsheets when compared to their paper-based predecessors. For example, Coffey et al. [10] compared the completions of electronic and paper flowsheets, focusing on 10 key fields related to patient care and safety. They found that more information was captured on the electronic versions, and key elements like vital signs, administered fluids and medications were all available in a single place in the EHR. Some studies also described different training strategies for the nurses before the EHR implementation [1, 13]. In sum, this prior research examined the effects of electronic charting and provided insights into the process of flowsheet implementation in emergency medical settings from a technological perspective. In contrast to this prior work, we examine the information behaviors of nurse documenters as they use the

flowsheet to understand the documentation practices during resuscitations. In doing so, we aim to provide recommendations for improving the current EHR designs to support the work of nurse documenters in these time-critical medical settings.

3 Methods

We conducted our study in an ED of a pediatric teaching hospital in the U.S. Mid-Atlantic region serving over 90,000 patients per year, including those with time-critical, acute medical illnesses such as seizures, respiratory distress, cardiac arrest and altered mental status. Medical resuscitations take place in a dedicated room called the resuscitation bay. The room has three bed spaces, each equipped with the necessary equipment for rapid evaluation and treatment of patients. The resuscitation teams are multidisciplinary, consisting of seven to 15 members, each having a specific role and pre-determined yet flexible responsibilities. A typical resuscitation team consists of an attending physician (team leader), a fellow or a senior resident, a physician surveyor, a nurse documenter, a medication nurse, two or three bedside nurses, and a respiratory therapist. Other specialists may be called, if needed.

Our fieldwork spanned 11 months (April 2017–February 2018) and involved 616 h of in-situ observation in four- to eight-hour shifts. We observed the documentation practices by shadowing nurse documenters during resuscitation events in the resuscitation bay and in common ED areas. During observations, we took notes of nurse documenters' attitudes towards the electronic flowsheet and their information and communication behaviors. Medical resuscitations that occurred outside of researcher work shifts were observed using video review of recorded resuscitations available at the time. Videos are recorded for quality improvement and research purposes and deleted within 30 days of the event date based on the hospital's Institutional Review Board policy. The length of observed resuscitations ranged from 7 to 98 min (average = 33, SD = 23). We also conducted post-event, semi-structured interviews with the documenters, asking about nurse documenters' experience levels, their views of electronic flowsheet, including preferences, barriers, and workarounds to overcome the challenges. The interviewed nurses had, on average, four years of experience as a nurse in the emergency department. In this paper, we report the results from analyzing 14 in-situ observations and 30 video recordings of medical resuscitations, and 24 interviews. Field notes from observations and video review were transferred to an observation log, and interviews were audio-recorded and transcribed. We used thematic analysis [14] to identify various aspects of documentation on the electronic flowsheet including advantages, challenges, and the use of workarounds.

4 Results

We identified three advantages of electronic documentation during medical resuscitations. First, the documenters reported that the electronic flowsheet facilitated better patient handoff by providing *improved access to the patient record* from anywhere in the

hospital, eliminating the need to carry around paper flowsheets. Second, the electronic flowsheet provided a *timeline of events* that occurred in the resuscitation bay in an overview screen, which was valuable for formulating a care plan, reviewing data, and improving handoff efficiency. On paper flowsheets, the documenters time-stamped events in different sections that were spread across the flowsheet, making it difficult to visualize a summary of events. Third, the electronic flowsheet allowed for *auto-populating* patient data from sources such as vital signs monitor, medication orders, blood gas and laboratory tests, reducing the time required to manually document these values. Even so, our results showed several challenges that the documenters faced and workarounds for overcoming those challenges, as described next.

4.1 Electronic Flowsheet Navigation

We identified three major navigational issues with the electronic flowsheet. First, the documenters reported that they spent more time locating flowsheet sections on the electronic version. They found it difficult to keep up with the information from different sources while they searched for specific sections. We observed how documenters were sometimes distracted while searching, which led to skipping information on the flowsheet. Second, unlike the paper flowsheet, the electronic version does not support at-a-glance overview for viewing multiple sections at once. It also does not allow concurrent multiple windows opened for the same patient. Because the documenters were required to complete and close the current window before moving on to the next, they found it difficult to follow and capture the reports from multiple information sources. They also spent time switching between multiple sections to communicate last entry with the team (e.g., vitals). Finally, some assessment sections contain many fields. The documenters simply skipped those sections because they could not complete them in real time. Although "Vitals" is one of the most frequently documented sections, the nurses stated that it was not easily accessible on the main screen, requiring additional time to navigate to the section and record every three minutes.

To work around these navigational issues, the documenters relied on additional mechanisms such as scrap paper, paper towel, and paper flowsheet to quickly jot down information along with timestamps. Our observations showed that 34 (out of 44, 77.27%) documenters used scrap paper with the electronic flowsheet; five (11.36%) used scrap paper only; four (9.09%) documented on the electronic flowsheet only; and one (2.27%) used a paper flowsheet with the electronic flowsheet. The documenters also extensively used the free-text field on the electronic flowsheet. To build a complete narrative of the resuscitation, they first entered the information on paper or free-text fields on the flowsheet, and then transcribed it into appropriate sections by modifying timestamps accordingly. This process of retrospective documentation is commonly known as "backcharting." For example, a documenter typed, "*22 left A.C. IV placed at this time*" in the free-text field and backcharted the size and location of the IV in the "Peripheral IV" section with the timestamp on the free-text field.

4.2 Electronic Flowsheet Auto-Population

The electronic flowsheet has an advantage of auto-populating information from several sources such as vital signs monitor and laboratory tests. Despite the advantage of auto-populating vitals, only 14 of the 24 interviewed documenters were aware of this feature. Among the 14, six documenters (42.85%) reported that the patient was not appropriately setup on the monitor to allow for data feed to other systems, either because the team did not prioritize this task or the resuscitation was short; five (35.71%) stated that they forgot how to use the feature; two (14.28%) indicated that the vitals did not auto-populate due to technical issues; and, one (7.14%) reported that they did not use the feature because they were worried about missing the data in case auto-population failed. In addition, our observations showed a significant delay (>10 min) in the auto-population of values from other sources such as blood gas tests, posing a challenge for communicating these values to the team. For these reasons, the nurses mainly relied on paper-based mechanisms to quickly note down information along with the timestamps or manually enter the values in the flowsheet sections.

4.3 Use Opportunities and Unfamiliarity with the Interface

We observed that the ordering of sections on the electronic flowsheet does not reflect the ordering on the paper flowsheet. In addition, the documenter role is not always assigned to the same nurse, leading to infrequent use of the electronic flowsheet across nurses and resulting in unfamiliarity with the interface. In 20% of the resuscitations, two nurses assumed the role of the documenters per resuscitation, where one recorded on scrap paper and the other on the electronic flowsheet. Documenters described that double documentation was helpful because they had assistance with keeping track of information when one documenter was unfamiliar with the interface.

5 Discussion and Conclusion

Technology implementation in emergency medical scenarios is a complex task, given their safety-critical and high-risk nature. In this study, we sought to understand the information behaviors of nurse documenters and their attitudes towards the use of a newly implemented electronic flowsheet during medical resuscitations. Our findings about the challenges of flowsheet use and workarounds to overcome those challenges led to four design recommendations for improving the flowsheet design.

First, our findings showed that the documenters were either not aware of the auto-population of vitals or could not recall how to use the feature. An *auto-population notification* in the corner of the screen indicating that the data is ready to be validated could encourage the documenters to use the feature, thereby greatly reducing the time spent on manually entering those sections. Second, although providing an at-a-glance view of the entire electronic flowsheet is challenging, an on-screen *timer* indicating the time elapsed since the last entry could alleviate its absence, mainly for repeatedly filled out sections (e.g., Vitals, Medications). The timer feature could reduce the documenter's time spent on switching sections and support their current time-keeping

practices to communicate different information to the team. Third, because the documenters extensively used free-text fields on the electronic flowsheet, providing *auto-complete suggestions* similar to those found when searching online with a search engine could reduce their typing time. For example, when a documenter starts typing "Peripheral IV on…," suggestions such as "Peripheral IV on left AC" could assist the documenters to quickly complete the typing task. Also, a prompt that would allow documenters to transfer their documentation to the actual flowsheet section simultaneously as they type in the free-text fields could reduce the time spent on backcharting. For example, typing in "Peripheral IV" in the free-text field could prompt the nurse to transfer this note to the "Peripheral IV" section. Finally, our findings showed that the documenters increasingly spent time searching for different flowsheet sections. Presence of a *find bar*, with a function similar to "control + find" or "command + find" that searches through all the sections, including the collapsed ones, could allow the documenters to quickly locate the appropriate sections.

With this study, we found that electronic documentation in complex medical settings has advantages with supporting continuity of patient care. However, the issues related to flowsheet navigation, auto-population, and use and practice opportunities created barriers to achieving real-time documentation during resuscitations. Recording all activities *during* these events is critical for supporting team communication and coordination, as well as for maintaining team members' situational awareness. Our findings on technical issues of auto-population resonated with Bilyeu and Eastes [9], where they reported a decline in the completion rate of vital signs on electronic flowsheet due to similar challenges. Wurster et al. [1] also described the navigational barriers with documenting multiple flowsheet sections at once as time-consuming. Although we found that the nurses managed to work around these issues by relying on paper-based documentation mechanisms, these workarounds increased their workload because they had to transcribe (or "backchart") all the information into the flowsheet fields at a later point of time. Park et al. [8] similarly found that the flexibility provided by the electronic flowsheet to edit and save at any time contributed to piling up of incomplete patient records, which potentially required more time to complete. If the documenters missed noting down timestamps on the paper, they had to estimate the timestamps in the electronic flowsheet based on their memory, which often led to inaccuracies in patient records. In addition, the ability to modify the timestamps could potentially lead to falsifying information after a bad patient outcome [15].

Through continued research, we next aim to investigate different facets of documentation on electronic flowsheet including its impact on team communication, completion and error rates, as well as timeliness of data entry and its effects on patient outcomes. Understanding the social and organizational aspects of medical work affecting documentation practices on electronic flowsheet is also critical, because it will lead to further improvement of EHR designs.

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