

Electronic Health Records in Emergency Medical Care

Aleksandra Sarcevic

College of Computing and Informatics
Drexel University
Philadelphia, Pennsylvania, USA
aleksarc@drexel.edu

Over the past decade, our multidisciplinary research group has been focusing on teamwork and work practices during *trauma* and *emergency medical resuscitations*—complex, time-critical processes of treating severely injured or ill patients, where information awareness is critical to patient management. Documentation is an important component of these processes because it provides a detailed account of evaluation and treatment steps for each patient. The resuscitation events are currently documented in the medical record using contemporaneous recording by a dedicated nurse observer and retrospective summaries by physicians. The accuracy of these records is limited by several factors, including the need to observe simultaneous tasks by individuals or small groups in a confined space, a reliance on manual data entry for recording and time-stamping events, and a reliance on nurses' and physicians' retrospective recall. This manual documentation and delayed physician summaries make the system inefficient and limit accessibility. Developing more accurate medical records and more effective documentation methods are essential aspects of modernizing these life-saving, emergency procedures.

Despite the use of electronic health records (EHR) in most hospital settings, the complex nature of resuscitation and perceived difficulty in accurate and timely data entry have led to provider reluctance in adopting EHR in this environment [2, 6]. The situation is changing, however. Efforts to digitize work processes that have traditionally relied on paper records during emergency medical scenarios are already underway [5, 10, 11]. Initial attempts to digitize paper records in trauma resuscitation, for example, started two decades ago, but only a few U.S. emergency departments have successfully implemented electronic flowsheets [3, 4, 9]. Studies related to EHR use in the resuscitation rooms are also scarce and mostly come from the medical sciences. A few have reported on transition to electronic documentation [2, 12], focusing on system requirements (e.g., visualization of care flow, direct feed of vitals into the record, resemblance to paper flowsheets, and report generation for post-event use). Another study compared paper to electronic documentation, showing advantages in electronic data capture for some data elements, such as team activation time, primary survey information, and amount of intravenous fluid received since patient arrival [1]. Recording of vital signs, pre-hospital treatments, mechanism of injury, and patient arrival time showed no statistically significant difference between the two methods.

To date, we have conducted several studies at local and regional emergency departments and trauma centers to understand both paper-based and electronic documentation practices during trauma and medical resuscitations, with the goal of informing the design of electronic documentation solutions for supporting these safety-critical medical processes [7-9]. Our research sites included emergency departments at Robert Wood Johnson University Hospital in New Brunswick, New Jersey (focus on paper-based documentation); Children's Hospital of Philadelphia (CHOP) in Philadelphia, Pennsylvania (focus on paper-based documentation and on transition to EPIC-based electronic records), and Hospital of the University of Pennsylvania

(HUP) in Philadelphia, Pennsylvania (focus on electronic documentation). We mostly used qualitative approaches to studying documentation practices, including in situ observations, shadowing of nurse documenters, interviews and video review. Our most recent study at CHOP has also involved the comparison of times when actual tasks were performed or completed (obtained from video review) to those of actual data entry into the record (obtained from the EHR log data) to assess the timeliness and accuracy of the documentation.

Although each study shed new light on different aspects of the documentation process in this medical setting, three major themes have emerged over time and remained persistent. First, it was important to understand the nature of data and how transitions from paper to electronic forms of documentation may be affected by the data (i.e., static vs. dynamics, permanent vs. transient data). We found that data about patient status and the work of the medical teams become available through several streams, including auditory (speech), visual (observations of patient status and team tasks) and electronic sources (vital sign monitors and data from hospital-based information systems). Data streams may be classified as continuous (e.g., from vital sign monitors) or transient (e.g., verbal reports or descriptions of the physical examination). Data streams can also be synchronous (e.g., from vital sign monitors) or asynchronous (e.g., verbally reported examinations) with respect to the occurrence of key events. Data streams may flow either in series (ordered within the standard evaluation format) or in parallel (simultaneous ordered data streams). Second, our findings showed that current approaches to recording clinical data in the emergency department are time-consuming and yield data of variable accuracy. In the settings where EHRs already have replaced paper flowsheets, documentation is still slow. Nurse documenters are finding it challenging to navigate the records due to multiple switching between tabs and pages, or many drop down menus and options. This challenge in turn prevents real-time documentation and requires post-event recording. Finally, the use of paper persists even when an electronic flowsheet is available, which is not surprising, as prior studies of EHR in other clinical and outpatient settings have also shown.

Using the results of our studies, we have been deriving the guidelines for improving the design of EHR for medical emergencies, including the following:

- First, future designs of electronic medical records for fast-paced medical settings will require some partitioning of information into different screens. Because design is limited by screen size, tab switching is unavoidable. Our analysis of the nature of the incoming information suggested designs that could minimize tab switching and increase the amount of information recorded in real time. We expect that the time required to record resuscitation events in real-time will be reduced if the organization of the electronic flowsheet matches the structure of the incoming information. We could consider the work process as two-tiered. First, there are baseline activities performed in all resuscitations such as monitoring vitals, setting up IV access, administering fluids or pain medications, and lab tests. Second, there are tasks specific to major injuries that are performed only when needed (e.g., endotracheal intubation, chest tube insertion). The medical record could therefore be organized using baseline vs. major tasks.
- Second, information items related to administrative (e.g., admission date, patient number) and patient demographic or historical aspects of care (e.g., prehospital information, patient weight or allergies) could be pre-populated on patient arrival when available. Pre-populating data may save valuable time once the patient arrives and the documenter could focus on the items that need to be documented in real time. While some EHRs we have

observed are attempting to implement this functionality, their success has been low given the challenges in obtaining this information timely and accurately.

- Third, real-time status of the EHR completion (as another valuable affordance of a paper form) could be displayed to the documenters either by indicating missing fields or through a status bar. This design modification would allow documenters to quickly identify the missing information and focus on those items.
- Fourth, our observations showed that team members were constantly involved in verbal exchanges with the nurse documenters—providing updates on patient status, requesting information, or relaying information that they heard. An overview tab showing the currently completed items that is always visible on the screen would allow the documenter to provide appropriate information about medications or vitals when that information is requested.
- Fifth, a free-text field to enter notes could also be helpful. This text field could be particularly useful for quickly jotting down notes when the documenter is not able to immediately locate an item on the electronic flowsheet. However, the notes recorded in free-text field would still need to be transferred to the appropriate flowsheet sections, but the transcription from paper to electronic flowsheet could be prevented.

In summary, the information captured in medical records is important for clinical decision-making, the coordination of care among providers, and as a source of research data, yet these functions are limited by current systems that use handwritten records or rely on manual entry into electronic records. The absence of an effective method for information capture in the domain of emergency medical care remains a barrier to the development of effective electronic documentation systems. Our research group has been working with the regional emergency departments and trauma centers to change this status quo by providing in-depth understanding of both paper-based and electronic documentation practices, and by informing the design of the next generation documentation tools.

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