Peripheral Activities during EMR Use in Emergency Care: A Case Study

Joanna Abraham BS, Thomas George Kannampallil BS, Madhu C. Reddy PhD
The Pennsylvania State University, University Park, PA 16802

Abstract
We report on how the use of electronic medical record (EMR) systems in an emergency department (ED) contributes to peripheral physician activities and in turn, how these peripheral activities can lead to challenges in the patient care process. Through a qualitative research study, we identify three prominent peripheral activities that affect the continuity of care: (1) transition between multiple artifacts, (2) movement between multiple locations and (3) transition of information between multiple care providers. We discuss how the peripheral activities can introduce new errors and create bottlenecks in patient flow, consequently affecting both clinical and organizational goals. We highlight the importance of integrating EMR applications with the model of practice in the ED.

INTRODUCTION
Electronic medical record systems play an important role in patient safety by ensuring higher quality of care and smoother workflow in a hospital. However, despite these benefits, EMR systems have drawn mixed reactions concerning their utility, effectiveness and value to patient care. Although EMR systems can reduce medical errors, and improve coordination of care, the physicians’ use of these systems during patient care pose challenges that affect the quality and effectiveness of care. These challenges are magnified in a dynamic, critical care setting such as the ED because of the rapid nature of work.

The ED is an information-intensive and collaborative environment that is challenging from a clinical and operational perspective because of the episodic nature of care. The emergent nature of ED work is characterized by the large volume of patient visits, uncertainty of patient conditions, and the frequent interruptions of physicians. This dynamic nature of the care process affects the quality of care and increases the possibility of errors. Health information technologies such as the EMR can help care providers in the ED organize their information, manage their activities, and support their collaboration with other care providers.

Through a qualitative research study, we investigate the challenges to the physicians’ use of an EMR system in an ED at a large academic hospital. We identify peripheral activities during EMR use and its effects on the physician’s workflow.

BACKGROUND
The role of the EMR has evolved from a data access and storage device to a more sophisticated system that supports implicit collaboration, coordination, and decision making in the hospital. Although it plays an important role in healthcare, an EMR system affects the workflow of the hospital. Researchers have examined various organizational processes and the role of EMR, specifically focusing on the impact of EMR systems on workflow and how it contributes to errors.

There are limited studies that have investigated the effects of EMR use on physicians’ work. These studies are centered on measures such as physician efficiency and satisfaction in using EMR systems. Lo et al. conducted a study in four hospital departments to examine the activities of physicians during pre-and post EMR implementation. They found that EMR use did not increase the time spent by the physician with patients. Other studies have highlighted the changes in communication patterns and increase in patient encounter time after the introduction of an EMR system.

EMR use has been studied in a variety of settings, but studies of EMR use in critical care settings have been limited. Our motivation for this work is based on (a) the limited research on physicians’ use of EMR and its effect on workflow; and (b) the limited number of prior studies that report on physicians’ EMR use in critical care settings. In this paper, we provide insights into activities that increase the time and effort of physicians for providing patient care in emergency care settings.

RESEARCH SITE AND METHODS
The study was conducted in the ED of a major suburban academic hospital in northeast United States. The ED has approximately 50,000 visits per year and was supported by 3 attending physicians, several residents, and 12 to 17 staff nurses managed by a charge nurse. The attending physician has an assigned centrally located computer. The hospital’s Institutional Review Board approved this study.

Data Collection
We employed qualitative methods commonly used in medical informatics studies to examine the peripheral activities surrounding EMR use. These methods help us in developing a detailed understanding of physician activities and use of the
EMR in the ED. Data was collected using general observation, physician shadowing and interviews.

We conducted 36 hours of observation of ED workflow activities over 9 shifts of approximately 4 hours each. Data on patient care activities and physician’s use of the EMR was collected. The observations were conducted during different times of the day over a one month period to ensure representativeness of the data.

We closely shadowed 6 ED attending physicians and detailed their work activities, specifically focusing on physical tasks and actions of the physician as he or she went through the patient care process. The physician shadowing was conducted over six sessions (approximately 4 hours per session). The first author used an activity log to capture the activities of the physician, the artifacts used, the location and amount of time spent on the task. The physician activities were captured at time increments of 1 minute. If two or more different activities occurred in the same minute, all of them were recorded. The shadowing activities were also conducted during different times of the day.

We conducted 8 individual semi-structured interviews with physicians and residents. The interview questions focused on two main themes: (a) their EMR usage behavior and (b) challenges physicians faced with the current ED workflow. Each interview lasted 25 to 45 minutes. Informal interviews were also conducted (during observation sessions) with physicians, consultants, residents, and charge nurses to get their perspective on physicians’ use and interaction with the EMR during ED patient care. A summary of the data collection methods, participants and time is provided in Table 1. The use of multiple data collection methods such as observations, shadowing and interviews helped us triangulate our findings.

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<thead>
<tr>
<th>Method</th>
<th>Participants</th>
<th>Time</th>
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<tr>
<td>Observation</td>
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<td>providers</td>
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<td>&amp; residents</td>
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<td>Shadowing</td>
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**Table 1. Data collection methods, participants and data collection time**

Data Analysis

The observation notes, interviews and shadowing notes were transcribed and then coded using Grounded Theory method\textsuperscript{11}. The coding was first performed manually and then by using Atlas.\textsuperscript{TM} (http://www.atlasti.com/) software. The main coding categories were basic physician activities such as patient care, documentation, administrative work, breaks, and interruptions. These coding categories can be considered as a taxonomy of physicians’ work activities in the ED. The shadowing transcripts were independently coded by the first two authors using these core categories. There was less than 10% disagreement on the coding. The disagreed codes were discussed and mutually agreeable codes were assigned.

RESULTS

Physicians use the EMR throughout the patient care process for documenting patient information, checking for result updates, reviewing the results and documenting disposition notes. Although physicians’ interaction with the EMR contributed to better documentation and management of patient care, it resulted in unanticipated modifications to normal work activities creating additional steps in the patient care process. These unanticipated modifications, or peripheral activities, were performed either to (1) incorporate patient information into the EMR, (2) to move between locations to use the EMR, or (3) to exchange information with care providers through the EMR.

These activities are considered to be peripheral since they did not contribute directly to the patient care process but were necessary add-on tasks to ensure the continuity of patient care thereby adding extra steps, time and effort for the physician. These activities thus increased the chances of new errors, created higher cognitive load on the physicians, and increased the time and effort required to coordinate patient care activities in the ED. Below, we detail three major peripheral activities around EMR use and identify some key issues that need to be considered when re-designing EMR systems for dynamic settings such as the ED.

Transition between Artifacts

Although the ED had a fully functional EMR system, healthcare providers relied on other artifacts such as paper records and phone recordings to coordinate their patient care activities. A paper record is prepared for all ED patients. Paper records are primarily used by physicians to record relevant medical information from the EMR such as triage notes, vitals, prior physician visit summaries, and medical history before visiting a patient. They also use it to capture information from patients such as current medications, and other health complaints as well as to enter possible diagnosis and temporary plan of care. After the patient evaluation, physicians
transfer the information written in the paper record to the EMR.

The transitioning between the EMR and the paper record creates several challenges. First, it increases the chances of information loss during the back and forth transitions. Physicians used the paper record primarily as a transitional medium, often using it to take preliminary notes. Most physicians did not always take meticulous notes on their paper records during their patient visits and relied on their memory for the information they gathered during their interactions with the patients. A physician emphasized that: “Paper records are not like it’s guaranteed to contain everything. Sometimes, it may contain nothing”. The reliance on memory for patient information increased the possibility of information loss and errors.

Second, the redundancy of information and effort leads to increases the time spent on each patient and to possible inconsistencies in the information. For example, some physicians wrote down every single bit of information obtained from patients on their paper record which increased the overhead of duplicating the information in the EMR. Third, the care process is reliant on the paper record, especially when the content of these records are not transferred to the EMR in a timely manner. For instance, during an observation session, a patient’s paper record was missing and the details of patient medications had not been transferred to the electronic record. This consequently resulted in a delay in administering drugs to the patient till the paper record was found.

Movement between Locations

Although patient rooms had workstations with similar capabilities, physicians preferred to use their centrally located computer to access the EMR. Most physicians attributed the use of the central workstation to the extra time involved in logging in and out of the machines in patient rooms, the lack of awareness of events happening in the ED when in patient’s room and the potential lack of visibility of the physician’s availability and status especially when needed by other care providers.

The centrally located computer was considered as the “information center” for the ED staff. One of the physicians described the advantage of using his centrally located workstation: “I like being in the front because I like to be aware of what’s going on in that ED broadly. I want to know what my staff is doing, I want to know which alarms are going off. I want to be very accessible to my staff, because they often have questions or information that will be helpful for the care of the patient”.

Although the use of the centrally located workstation afforded greater visibility, it required physicians to move frequently between multiple locations such as patient rooms, nurses’ station and their central workstation to meet their information and clinical needs. This constant mobility had several unanticipated consequences. First, it increased the physical effort on the physician requiring him to constantly move between patient rooms and the central workstation. The movement becomes critical especially when the ED is working at full or overflow capacity. The constant movement reduced the time spent with the patients in their rooms, affecting the patients’ perception on the quality of care.

Second, the constant movement also increased the mental effort (i.e., cognitive load) on the physicians. For example, the physicians experienced interruptions in hallways during the transitions between the patient room and the workstation. Physicians were interrupted either by residents seeking advice on a patient case or providing patient summary or by nurses requiring physician attestation on care flow sheets or verifying medication dosages. The hallway interruptions resulted in physicians diverting their attention to a new task which consequently led to higher information load and in turn affected their work activities.

Transition of Information between Care-Providers

The final peripheral activity caused by physicians’ EMR use was the transition of information between care providers using the EMR. Patient care responsibilities in the ED are shared between functionally diverse healthcare providers from within and outside the ED. The patient’s electronic record is often used as the basis for sharing information regarding plan of care or for administering medications. This process assumes that other care providers (such as nurses, residents) are able to find the specific information needed for the coordination of care in a timely manner.

The EMR used in the ED is highly comprehensive with a range of functionalities to support both administrative and clinical tasks. In order to support these tasks, the EMR has different views (organized into tabs) with specific functional support. Physicians can access both individual patient information and overall ED patient list on the EMR. There are also specific views for order entry, medication lists, and patient history. Although the tabbed interface of the EMR helps in organizing patient information, it increases the possibility of critical pieces of information being “hidden” within functionally “organized bins”. Furthermore, these individual views have a free-form structure for documentation (e.g., instructions, orders, diagnosis) entry. Physicians can enter their notes (and
This relative flexibility for physician documentation in each of the views creates challenges for physicians for information sharing with other care providers. For example, the detailed instructions for nurses or residents regarding some patient tests can become hidden within the multiple layers of structured information in the EMR. This is because the information may have been added in a view that may not be immediately visible to other care providers. Thus the shared information (instruction in this case) is not attended to in a timely fashion. At times, physicians had to take the extra effort and time to find the respective care providers to provide verbal instructions that was already included in the EMR. Thus extra work was added to the physicians’ tasks. The use of the EMR for information sharing to coordinate physicians’ activities with other care providers’ required them to provide more details of the information to the other care providers.

The functional organization of the EMR also creates a fragmentation of patient information. In order to develop an overall perspective on the status of a patient, the physician has to spend extra time and mental effort in integrating information from the various views. A physician stated that: “there are times when it takes 4 clicks. The system is not really customized to EM (Emergency Medicine)”.

To reduce the time spent on each patient record, especially when the ED is at its maximum capacity, physicians have to rely on other care providers to clarify information regarding new patients, thus creating additional information transitions. As a result, physicians are forced to constantly switch between EMR tasks and patient care activities in order to organize individual patient information and also manage the overall workflow of the ED.

**DISCUSSION**

The three peripheral activities add extra steps in the patient care process. The additional steps created by the peripheral activities affect the care process by increasing the chances of errors and creating bottlenecks in patient flow. These disruptions in turn can have a detrimental effect on patient safety, quality and the overall hospital management and efficiency. Below we highlight the two challenges that are caused by the peripheral activities: possibility of new errors and bottlenecks in patient flow.

**Possibility of New Errors**

Medical errors cause approximately 98,000 deaths in the US every year². A hospital’s main focus is on avoiding errors and improving patient safety. The peripheral activities around EMR use increase the possibility of errors. The physicians used the EMR system as an effective “information repository” to store information as well as track the status of patient care activities performed by other care providers. However, their use could lead to possible errors.

First, physicians transferred the information to the paper record during the patient care process. As described earlier, the transition between the paper and electronic record increases the chances of information loss due to redundancy of information and reliance on physician memory for patient diagnosis information. Second, physicians were often interrupted in the hallways requiring the physician to divert his attention to new information. The hallway interruptions increase the cognitive load on the physician increasing the possibility of the physician losing details of the patient encounter which was not captured in his/her notes.

**Bottlenecks in Patient Flow**

Timely transfer of patients to appropriate clinical departments is critical in ensuring an effective patient flow in a hospital. The delays in moving patients out of the ED in a timely manner created bottlenecks in the patient flow. To maintain the ED workflow, physicians had to coordinate their normal care activities with the peripheral activities effectively, which consequently required extra effort and time of physicians.

The additional time spent on activities surrounding EMR use increased the overall patient care time. For instance, updating and replicating information on paper and the electronic system led to delays in not only patient care but also in patient discharges and transfers. This increased length of patient stay resulted in the departmental resources such as beds and medical equipment not being optimally used, consequently increasing the wait times for incoming patients. For example, a patient with a fracture on his index finger was held in an ED hallway bed for a couple of hours even after his evaluation and treatment had been completed. Before he could be discharged, the physician had to enter discharge orders, and transfer written notes to patient’s EMR. With the ED as a gateway to the hospital, timely and efficient disposition of patients is critical for the smooth functioning of the entire hospital.

**SUPPORTING WORKFLOW IN ED**

The peripheral activities that arise out of EMR use result in additional steps that can potentially contribute to a problems in care. We believe that a more detailed understanding of the ED model of care
is required before such technology solutions can be seamlessly incorporated into the workflow. In order to develop EMR systems that support the ED model of care, system designers must pay attention to the following aspects: complex and contextual nature of the work activities, and the organizational influences on and structural aspects of the EMR.

First, researchers have argued that the ED exhibits the typical behavior of any complex system based on its unique features such as the non-linear cause and effect relationships, extreme volatility, innumerable feedback loops in addition to other kinds of uncertainties. Designers of EMR systems have to account for the complex interactions in the ED along with the various transitions that occur during the care process.

The second aspect is the organizational considerations such as physical layout of the department, locations of the various workstations, and work policies. Specifically with respect to EMR use, the distance between the workstation and the patient rooms affected the way in which EMR was used. Although there were no organizational stipulations as to where the physicians should use the EMR, the location and orientation of the physicians’ workstation was based on organizational policies.

The third aspect that had a significant effect on the transitions of information between multiple care providers is related to the structural aspects of EMR. As described earlier, a structured functional view of the EMR can introduce rigidity to the patient care process. Consequently, the EMR may be used for functions that it cannot adequately support. For example, instructions on the EMR become hidden because of the view-based structure. The EMR did not have functionality to support notifications and alerts. To support the dynamic workflow in the ED, the EMR has to support a shared model of patient care by providing shared representations of information and explicit communication channels between care providers to effectively continue the process of care.

The design of an ED EMR system has to take into account these three aspects. It is important that the design of EMR should appropriately fit with the ED model of care in order to be used effectively. A “one-size-fits-all” model of EMR system that is designed for the entire hospital can result in physicians and care providers adopting new and peripheral activities to support their unique work requirements. These new activities, in addition to increasing the patient care time and effort for the physician, have a negative effect on patient care and workflow.

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REFERENCES