

Documenting Transitional Information in EMR

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ABSTRACT

An observational study was conducted to examine EMR-based documentation in an Emergency Department (ED), with an emphasis on computerized documentation activities in the complex flow of clinical processes. This study revealed a gap between the formal EMR documentation and the actual clinical workflow, which leads ED staff to rely on intermediate - transitional artifacts to facilitate their work. The analysis of these transitional artifacts in four different clinical workflows shows that the EMR system's inability to document procedural information, capture key information, and present information according to the actual clinical workflow are accountable for leading to the use of transitional artifacts. The findings of this study call for designing EMR system not only for keeping patients' formal records, but also for documenting transitional information in the chart-writing process.

Author Keywords

Medical Records, Clinical Documentation, EMR, Transitional Artifacts, Clinical Workflow

ACM Classification Keywords

H.0 [information systems], K.4.3 [organizational impacts]

General terms

Design

INTRODUCTION

According to the recent Healthcare IT Reform plan set forth by the US government, the majority of US hospitals will soon switch to EMR systems [18]. By definition, EMR is an information system that creates, gathers, manages and stores digital versions of patients' paper charts within one healthcare organization system [17]. EMR is publicly touted as a *silver bullet* for fixing a variety of current problems in healthcare, including the improvement of work efficiency, patient safety, accountability and billing [3, 11]. Surprisingly, recent studies show that healthcare IT systems, including EMR, are often coupled with certain

unintended consequences [1, 2], in particular, inefficiency and increased workloads.

Reports of these unintended consequences correspond with what has happened at the hospital where this study was carried out. Since the implementation of the EMR one year ago, many doctors complained that they had to spend 1-2 more hours on documentation-related activities each shift, which left them less time for actual patient care. At the beginning, these issues may have resulted from unfamiliarity with the new technology. However, the higher workload continued to exist till the time this study was carried out - one year after the EMR implementation. This work aimed to investigate why the documentation workload has increased after using the EMR system.

In particular, this study focuses on clinical workflow issues associated with the computerized documentation activities in an ED¹, a place known for its complicated disease types and urgent documentation needs. This study reveals a parallel documentation practice that records informal information facilitating the flow of clinical work. The informal documentation is considered as *Transitional Artifacts* that carry the information needed to facilitate EMR-based documentation². The use of these transitional artifacts is illustrated in four main ED roles' workflows. These four episodes were summarized from extensive field observation across multiple users who work in the same role. Although some of the transitional artifacts described in this paper, such as whiteboard used by room nurses and the paper notes used by case managers, were in place previously when the ED charting was a hybrid of paper-based and electronic charting, the continued use of these transitional artifacts shows the need to document such type of transitional information in EMR directly. Design implications are provided at the end of the paper to shed light on solutions for integrating transitional documentation into EMR design.

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¹ ED is also referred to as Emergency Room (ER).

² The observation and discussions in this paper are only based on the EMR system in one field site. Other systems may have different functionalities.

RELATED WORK

EMR is essentially a documentation tool that supports various clinical documentation activities. The most promising, yet challenging, task for the EMR system implementation is the transition from previously ambiguous hand-written paper records to organized and computerized documentations. Many times, the deployment of large Healthcare IT systems has resulted in the continued use of old paper records or workarounds [12, 19, 20]. One such study shows that most medical facilities experience a period of workaround when scanned paper records are uploaded in the EMR to substitute computerized documentation [12]. Paper has a unique advantage to support micro-mobility since it can be “handlable, manipulable, portable, dismantlable and can easily be reordered and reassembled [13].” These works all suggest that it is not an easy task to completely rule out paper usage in clinical practices.

Similarly, various CSCW studies show that clinicians, especially nurses, deploy “**working records** [6]”, “**provisional information** [8]” or “**scraps** [7]” to facilitate team collaboration in both paper [7] and electronic environments [6, 8]. These artifacts are essentially summaries of patients’ situations used during shift meetings or case discussions in order to facilitate key information sharing among team members. Information documented on these “working records” do not need to be transferred into patients’ permanent records again and are often discarded after knowledge sharing sessions.

Documentation consumes the most time in the clinical work, even more than direct patient care [10]. It is the basis not only for fulfilling clinical and legal requirements, but also for providing opportunities to improve the quality of healthcare delivery and serve as a basis for education and secondary use of clinical data [14, 16]. These benefits, however, have to be balanced with the consideration of work efficiency, especially for emergency medicine [4]. In an interview-based study [5], participants commented that computerized documentation creates new work processes that do not always coincide with the clinical workflows they are familiar with. The work processes brought in by clinical documentation systems can be rather complex and hard to understand. In fact, a systematic review [15] summarized major studies in the computerized documentation area and concluded that the goal of decreased documentation time is not likely to be realized through EMR systems.

Health and Luff [9] argued that though relevant categories of medical records are defined in the healthcare IT systems, “**the practices through which the document is written, read and used within consultation have been largely ignored.**” The issue surrounding how the medical records are written is closely related to how work is handled in the complex clinical workflow and how information can be documented in series of actions unobtrusively. These previous studies, as well as real cases happening in healthcare settings, have drawn attention to studying the

computerized clinical documentation in complex clinical environments, especially the issues of efficiency associated with the EMR usage.

METHODOLOGY

This observational study was conducted in an ED at a large regional hospital located in the west coast. There were two reasons for situating the study in an ED environment. First, work efficiency is the dominant concern in emergency care since ED represents the most urgent treatment needs in a hospital. During a short stay in an ED, patients experience the entire treatment process that one usually encounters in a longer hospitalization process. Second, because of the diverse disease types at various urgent levels, the frequent handoffs and the high time-constraint, ED workflow is notoriously complex. It affords a great opportunity to study documentation from different users and to see how the EMR system does or does not support the actual clinical workflow.

Participants

The ED being studied has a total of 57 clinical staff members, including 1 consulting physician, 11 attendings, 6 residents, 28 registered nurses, and 5 ED technicians. In addition, there are admitting staff members, case managers, discharge case planners, as well as social workers, working on the floor.

The general observation was able to cover the entire 57 ED staff during work, either briefly in the public area or through close shadowing. The author also followed 6 entire patients’ treatment processes, shadowed 5 ED doctors, 4 triage nurses, 5 room nurses and 2 case managers in order to obtain in-depth understanding about ED work and system usage patterns. In total, more than 100 patient cases were observed, either entire ED visits or partial processes such as triage process, diagnosis or discharge process.

Emergency Department

The ED has 4 major units: a pediatric ED, an urgent care unit, a trauma center, and the main ED.

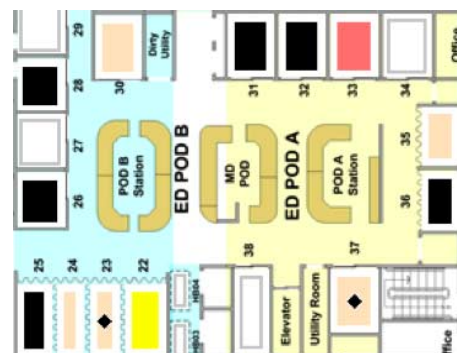


Figure 1. The map of the main ED area that is displayed in the EMR system

The main ED has 2 nursing stations and a MD station surrounded by 12 patient rooms (Figure 1). The nurses who

are in charge of these 12 rooms, the nursing manager, the case manager, and most of the attendings, all stay in this main ED area. The observation of this study was conducted in the main ED so that the researcher could easily observe the documentation activities and information flow among the various users of the EMR.

Data and Data collection

This study consisted of a field observation of the computerized clinical documentation in the ED. The IRB approvals were obtained from both the university that the researcher is affiliated with and the healthcare organization to which the field site belongs. The observation covered the clinical documentation process in patients' waiting rooms, triages, nursing stations, MD stations, patient rooms and other public areas in the ED. To protect patients' confidentiality, the researcher stayed outside the patient rooms during the observation. However, since the workstations are mounted at the corner of patient rooms facing outside, the author was able to observe various bedside documentation activities while the room curtains were closed.

A total of 120 hours of field observation were performed over a period of 8 weeks. Each observation session lasted for 4-5 hours, during which brief notes were jotted down and detailed notes were transcribed later after the observation session finished. The researcher observed general activities in the ED, shadowed individual ED staff³, asked questions, tracked critical incidents and followed various patient cases. The observation started with examining overall activities related to the ED patient flow with an emphasis on the documentation-related activities, the signoff activities for ED doctors and nurses, the ED admitting and discharging processes, as well as the shift-change meetings. The observation covered both day and night shifts. Approximately half of the observation hours were carried out during the ED peak times – weekends and Monday nights.

Data related to the ED documentation were extracted from the observational notes. The data were first listed according to various roles of the ED staff and the overall patient treatment process. These notes were then analyzed using an open coding technique to identify recurring patterns of documentation behaviors adopted by the ED staff. The findings were not drawn from one individual patient treatment flow, but based on a synthesis of the recurring behaviors demonstrated by multiple ED staff in the same work role and linked together according to the steps of a patient's ED visit procedures. The patterns revealed in the study were further verified with the ED staff to ensure their validities.

³ ED staff includes both clinical and non-clinical employees.

OVERVIEW OF ED DOCUMENTATION

The primary goal of emergency medicine is to quickly stabilize patients' situations and discharge patients out of an ED. The turnaround time for ED visits ranges from a couple of hours to a whole day, depending on the severity of an individual case. ED documentation captures all the detailed encounters between patients and ED staff, from the moment patients enter waiting room until they leave ED.

The EMR system being used in the field site went live in July 2008, since then, the old paper records system was no longer used in the ED. Paper charts were no longer kept permanently in the medical records storage; all patients' information was supposed to be directly written in the EMR system. To allow easy access to the EMR, workstations have been placed almost everywhere on the ED floor (Figure 2). Computers are available in most patient rooms, and inside and surrounding nursing stations and MD stations. There are also three computer-on-wheels (COW) available on the floor allowing mobile usage. The layout of the ED is designed to allow timely access to the EMR almost everywhere. Other than the EMR, another information system that was inherited from the previous paper record age, called *Tracker*, is also being used on the floor. *Tracker* was designed to track patients' flows and show where patients are on the ED floor.



Figure 2: Computers are everywhere on the ED floor (Photo taken from the MD station)

Patients' visits to the ED never follow one single path. They may walk into the waiting room or be transported in by ambulances from their home or other healthcare institutions. They may be discharged or admitted for hospitalization upon finishing their ED visits. This paper emphasizes one single path of patient treatment⁴ to illustrate the use of transitional artifacts – a patient walks into the ED and is later admitted for hospitalization.

⁴ This work did not count billing into the whole workflow since it is not conducted on the ED floor.

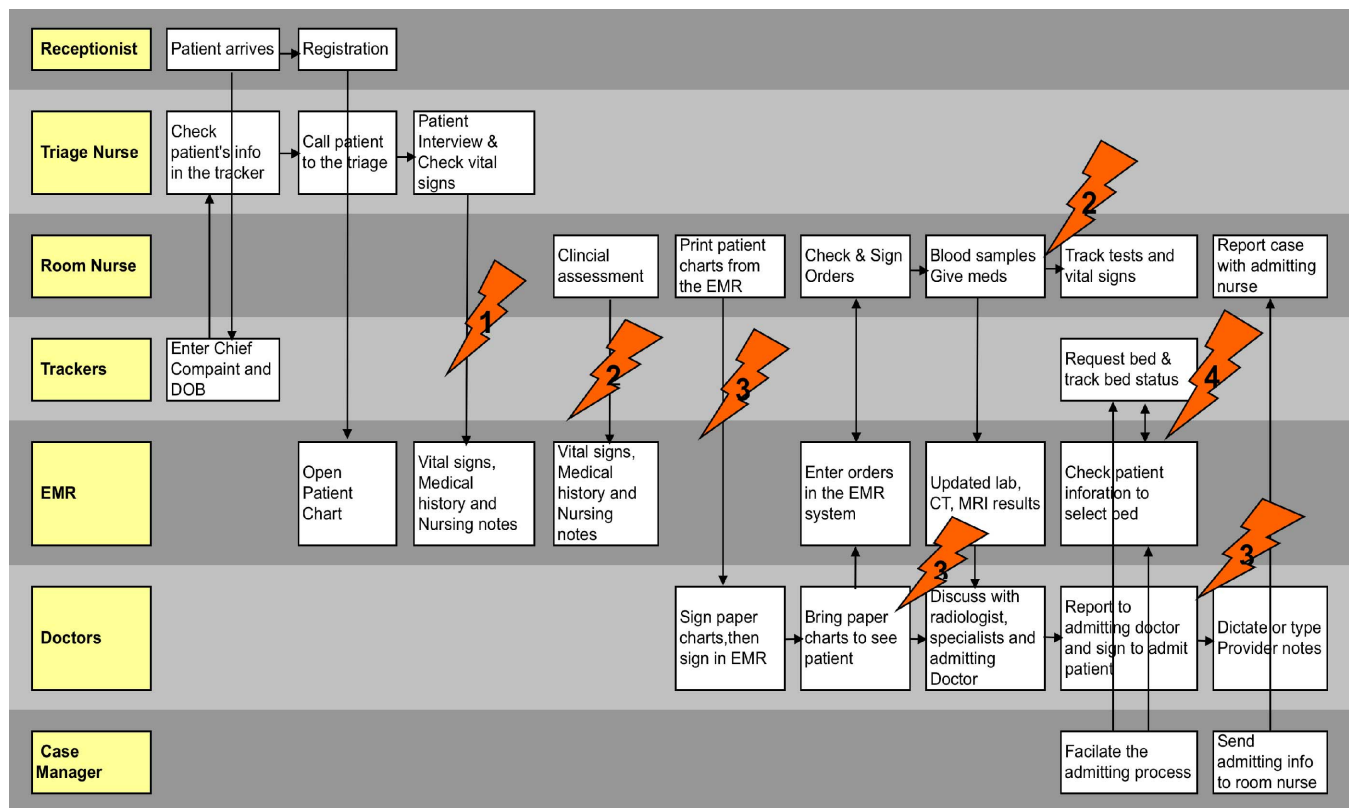


Figure 3: Simplified Swimming Lane diagram of the overall ED workflow

Figure 3 shows a brief view of a patient’s entire ED treatment process. The actual process may have many more varieties and it may involve other staff members such as social workers, ambulance drivers, etc. This work only describes the ED staff who actually document patient charts. As illustrated in Figure 3, the ED documentation is handled by four main roles and two information systems following patients’ treatment process. The red signs indicate where the transitional artifacts are heavily used across all the users being observed. Numbers correspond to episodes detailed below.

FOUR VIEWS ON TRANSITIONAL ARTIFACTS

Though the EMR system is accessible in almost every location, this convenience doesn’t guarantee paperless documentation in the ED. As observed, paper notes has been used to bridge information between the actual ED work and the EMR-based documentation. These intermediate notes are considered *Transitional Artifacts* that bridge the gap between the formal EMR documentation and the actual ED clinical workflows. Unlike the findings of previous studies that discovered that paper charts were used as a substitute for EMR documentation [12] or to facilitate information sharing in collaborative work practices [6, 8], transitional artifacts described in the current study are often printed from the EMR system first and then transcribed into the formal computerized documentation after usage. Transitional artifacts are discarded once the formal documentation finished. Hence, the use of transitional artifacts is more of a dual documentation

activity and documenting the same information twice would consume more of clinicians’ work time.

This section describes the use of transitional artifacts in four users’ views (triage nurses, room nurses, ED doctors and case managers, respectively) and explains why the transitional artifacts are an essential part of the ED documentation despite the ubiquitous presence of the EMR system. Findings are presented sequentially following the patient treatment process. Note that even though these episodes describe the clinical workflows of one patient, they are literally summarized from the observation of the entire study.

Episode 1: Triage Nurses’ View

Triage is the first step of patient care in the ED. Upon the patient’s arrival, his/her main symptom – medically referred to as *chief complaint*-- is entered into the Tracker system at the registration desk. A triage nurse checks the Tracker and calls the patient in for clinical assessment. This assessment is then formally documented in the patient’s records through the EMR system.

The triage process generally takes 2-3 minutes. It may even be shortened to 1-2 minutes during the ED peak time. Nevertheless, a large amount of information has to be recorded during this very limited time period. The triage process normally starts with an inquiry about the patient’s symptoms, and then moves on to asking specific information like when, how and where these symptoms

appeared. Past medical history, present illnesses and home medications are also inquired and documented during this brief interview. The triage nurse would also check vital signs. However, during the peak time, another nurse would perform this assessment and the triage nurse would only be in charge of the documentation. The EMR system takes a standard template-based view that many clinical documentation systems are currently use. A nurse selects tabs on the main interface and enters information. Information such as social and family histories that don't fit anywhere else in the template is typed in *ED notes* – the only place where nurses could type freely in the EMR.

Even with direct access to the EMR system, triage nurses still apply a transitional artifact⁵ – personal notes – to facilitate the triage documentation process. They always prepare a stack of blank paper in advance and fold the A4 paper into smaller sizes so that they could put it between the keyboard and themselves. These personal notes are referred to as transitional artifacts since the information is jotted down on paper notes before it is entered into the EMR, especially for vital signs. Nurses adapted their own templates to take notes so that they could quickly capture information by jotting down a few numbers or keywords. For example, a note: “140/90, 75, 104, 6” represented a patient's blood pressure of 140/90, pulse of 75, body temperature of 104 F and pain scale of 6 out of 10. Nurses usually jot down these numbers at the same time the readings are reported. Since all the vital signs are in normal ranges, nurses could easily tell the meaning of each number. Medical history and home medications are usually entered directly into the EMR if the system is ready to chart at the time. After the patient left the triage room, it would take the triage nurses another 2-3 minutes to enter the vital signs and type in the ED notes. Sometimes, when patients present with acute illnesses, e.g. chest pain, they have to be called into the triage before their EMR charts are ready to be documented. In such an occasion, all the patient information has to be noted on the personal notes before they could be documented into the formal ED documentation.

Discussion

Using personal notes to transit a patient's information into the EMR system is a common practice in ED triages. In fact, it is so important that nurses all prepare a few blank papers along with their stethoscope and other tools before the shifts start. The transitional artifacts are used to bridge the gap between the regular triage workflow and the formal EMR documentation. The conflicts lay in the discrepancy between the structured EMR documentation and the non-sequential nature of the triage information flow. Triage information does not always follow the exact flow

presented in the EMR system, especially during the ED peak time or when patients with acute illness appear. For the sake of saving time, sometimes two nurses work together in the triage where one interviews the patient and family members, and the other measures vital signs. In this case, information is given to the nurse by the patient and family members in no particular order; and the nurse who takes notes may have to do so based on the patient's condition and state of mind. The whole process makes the triage information flow a non-sequential and unpredictable process, thus making it difficult for the nurses to formally enter it into the structured EMR documentation.

The EMR system is dedicated to the formal documentation only. Once data are entered into the EMR, they are available for view by all who have access to the system. Since this formal record bares both medical and legal consequences, nurses have to take sequential steps to fill in all the parameters needed for vital signs, and then proceed to the next page. It usually takes a couple of clicks to forward to the next page, and the triage documentation contains several pages in the EMR. The non-sequential, synchronous nature of information flow conflicts with the sequential structure of EMR documentation process. Nurses are unable to navigate back and forth among different tabs at the moment when vital signs or medical history are being reported.

It is notable that although the information flow is sporadic, the key information for the triage documentation is standard. Everyone can tell the meanings by the brief numbers or abbreviations that have been jotted down. The transitional artifacts are used to capture key information before it is lost in the conversation. Hence, for triage nurses, paper note is a tool to transit sporadic patient information to formal EMR records.

Episode 2: Room Nurses' View

After the triage, patients are transferred to an available ED room. Accordingly, room nurses are responsible for recording patients' situation in the EMR. A room nurse generally manages 3-4 patient rooms simultaneously. Room nurses' major tasks are to administrate orders and to monitor patients' situations.

Right after a patient is settled in, the room nurse begins the first clinical assessment to obtain the most up-to-date vital signs and to interview the patient again. The interview is similar to what is conducted in the triage but more concrete. Unlike the triage nurses, the room nurses have sufficient time to streamline patient information and enter vital signs one after another. They could also physically face vital sign readings while documenting them into the EMR. Thus, they normally enter the patient information directly into the bedside EMR system located in the patient room. Only occasionally do they document vital signs at the nursing stations; even so the vital sign readings are displayed on monitors inside the nursing stations. Consequently, no

⁵ The triage view is not presented in picture due to the IRB regulation of the field site: no picture can be taken while patients are present.

transitional artifact is needed for the room nurses for clinical assessment.

Despite that documenting clinic information seems convenient, the EMR does not provide sufficient support for the room nurses. Room nurses have to oversee multiple patients at the same time, check vital signs every two hours and continuously follow orders given by the ED doctors. These orders include, but not limited to, medicine, IV, lab and radiology tests. Once doctors sign orders in the EMR, the orders are automatically shown as pending tasks on the room nurses' interfaces. Since orders may come in at anytime, nurses are required to frequently log into the EMR to check if they have any pending orders to perform. As a result, they have adapted a transitional artifact – a white board hung outside each patient's room – to manage information across multiple patients.

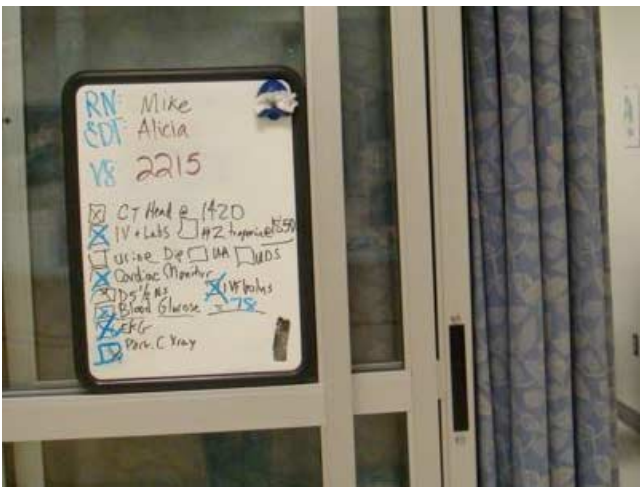


Figure 4. Whiteboard outside a patient's room

Whiteboards are often filled with various signs written down by room nurses (Figure 4). The top section of the whiteboard lists the nurse and the ED technician⁶ who are in charge of this room, followed by vital signs checking time. For example, in Figure 4, *VS 2215* indicated that the next 2-hour vital signs check-up time would be at 22:15. The nurse also noted on the board the status of the various orders, such as *IV*, *CT*, *lab*, *MRI* with hand-drawn check boxes in front of each order. For instance, in Figure 4, *CT head @1420*, *lab* and *IV* were checked, but the urine sample still needed to be collected. Mike, the nurse who managed this patient said, “*I like to write everything on the whiteboard, it's a visual reminder for me. I just recently learned to add time beside each order since some tests need to be performed multiple times* [he referred to the *CT head @1420*]. *It also tells me what have been done, and what haven't.*” By listing to-dos on the patients' room doors, the nurse could visually see their tasks across all their patients and plan the flow to complete their tasks.

⁶ ED technicians facilitate room nurses to perform basic vital signs checking.

The whiteboard thus serves as another transitional artifact connects the information residing in the EMR with the workflow of the room nurses. These transitional artifacts help the room nurses track their tasks. Nurses are so reliant on the whiteboards that they always update them immediately after EMR charting. Many of them applied different colors to represent different order status.

Discussion

A few reasons account for the use of transitional artifacts by room nurses. First, the EMR could not track task status. Nurses are able to acknowledge and sign orders in the EMR, but they are unable to track the status or update the progress of an order, if the order takes more than one steps. For instance, room nurses could sign an order of a urine test from the EMR, indicating they are going to collect samples. However, the urine sample may not be available at the moment. But since the order was already signed, it was marked as done in the EMR. The process of intending to obtain a urine sample until it is collected could not be displayed on the EMR. Similarly, orders such as X-Ray or CT relied on the technicians in the radiology department. In this case, even though the order has been placed and signed in the EMR, the actual tests may not have yet been performed. It is true that in the formal records, the process of taking urine test does not need to be kept in patients' formal records, but in the actual clinical work, this procedural information is essential for tracking work progress.

In reality, room nurses manage more than one patient at the same time. They have to oversee all their patients' situations simultaneously; in the EMR, nurses could open each chart to look into a patient's information, but it is not easy for them to track all their tasks for multiple patients, such as displaying scheduled vital signs assessment times together. By contrast, whiteboards could display all the scheduled assessment times publicly on the patients' doors that surrounded the nursing station. The transitional artifacts, in this case, support the viewing of key information across multiple patient cases that follow the natural clinical workflow.

In the room nurses' view, the transitional artifact is a tool to integrate individual patient orders into their clinical workflows and to capture procedural information that otherwise would be lost in the formal EMR documentation. This transitional information is extracted from the EMR and erased when the patient cases are complete.

Episode 3: ED Doctors' View

By policy, doctors should sign in new patients and check the new patients' information from the *My Patient* view in the EMR. In reality, ED doctors accept new patients by taking so-called *paper charts* that room nurses prepared for them. The paper chart is a print version of the *First Look* pages in the EMR. The First Look pages compile ED documentation that have been entered by the triage nurse

and the room nurse, including chief complaint, contact information, medical history, vital signs and ED notes. The First Look is printed when the initial assessment is done in the patient room and when the patient is ready to be seen by an ED doctor. ED staff normally call this printed first page as *Paper Charts* on the floor. Nevertheless, these so-called paper charts differ fundamentally from the previous handwritten paper records.

ED doctors always bring the paper charts to patients' rooms, then come back to document patients' information into the EMR located in the MD station. Paper chart provides overviews of patients' situation and help the ED doctors to capture information that they gathered during medical consultations (Figure 5). The ED doctors use paper chart to note down information that has not yet been recorded on the current paper charts, such as patient's social history, more detailed medical history and physical examinations, etc. The ED doctors first order various tests and medications from the EMR. Meanwhile, they have to wait until patient's situation is stabilized, all the lab/image results are received and the case is discussed with other specialists before they could discharge the patient.



Figure 5: paper charts with notes piled on ED doctors' desk before dictation

The final procedure for the ED doctors was to dictate or type the detailed encounter with the patient into an EMR accepted scenario – the *Provider Notes*. The Provider Notes contain detailed information regarding a patient's entire visit, including factual information and rationales behind the medical decision-making. The ED doctors often use the keywords that they jotted down on the paper charts to integrate the interview information into meaningful clinical scenarios, even if the interview was done hours ago. In fact, many ED doctors even adapted *T-Sheet* - an old ED documentation tool to facilitate their patient interviews and EMR documentations. Each T-Sheet specifies one ED complaint whereas a detailed scenario about the complaint is provided to capture key information during the patient interview. The ED doctors could quickly fill in their notes in the blank areas of the T-Sheet while talking with

patients. This way, the non-sequential nature of the patient-doctor interaction manifests itself in a meaningful way on the paper charts. After provider notes are completed the paper charts are discarded immediately and recycled by an ED staff.

It takes hours from when the ED doctors first meet the patients to the time they complete their provider notes. Without the paper charts, most transitional information would have been lost before the formal documentation is carried out. As shown in Figure 5, after seeing patients, the doctor noted key information on the paper charts. These notes, although never taken in complete sentences, act as important hints for ED doctors to describe the sequences of the patients' encounters in the ED. *“These are the visual aids for me to remember things”* stated by a doctor being shadowed, as he pointed at the piles of paper charts to be dictated on his workstation. *“I sometimes put post-its or notes here to remind me what is left to do, such as these 3 patients were discharged earlier and I have to dictate [Marked with D/C on the charts], these 2 are waiting for MRI and lab results [on the left of his workstation] and this one I am waiting for the admitting doctor to call me back.”* This quote indicated that ED doctors either do not have sufficient time to dictate the patients' cases because of high ED patient volume or patients' information is not ready to be dictated as the formal records in the EMR. Hence, the paper chart serves as the transitional artifacts to help them retain informal and sequential information that is not yet ready to be documented into the EMR.

Even though the ED doctors regard documenting on the paper charts as a reluctant practice, most showed strong attachment to them. For them, taking a paper chart meant accepting a new patient and accepting the responsibility of that patient. They may sign orders from the EMR but leave the paper charts on the MD pod if they are not going to accept the patient. *“I left the chart there [on MD pod] since I am leaving soon. Whoever takes the paper chart will be responsible for him [the patient]. And I am just giving him 10 units of morphine before his doctor comes.”* An ED doctor explained why he did not take the chart from the MD pod. Likewise, the ED doctors are released from care of the patients the moment they throw the paper charts into the trash bins. They are no longer bound to the care of the patients once the paper charts are discarded, even though the patients may still be waiting for in-patient beds and still show up in the EMR.

Discussion

Similar to the triage nurses, for ED doctors, the paper charts are transitional artifacts retaining information that is not yet ready to be formally written in the EMR. The consultation is also a sporadic and non-sequential process during which patients may report everything that is socially, medically, physically and emotionally relevant to their chief complaints. Yet, most of the notes could only be recorded as contextual information in the provider notes to justify the

doctor's decision-making process. That is, the decision reasoning process could not be dictated before the actual decision is made, which relies on the return of the test reports and discussions with specialists in other departments or even other hospitals. The transitional notes that are jotted down on the patients' paper charts help the doctors to remember and reconstruct the patient scenarios later when they are ready to be dictated.

Secondly, the physical layout of the patients' rooms restricts doctors from directly documenting into the EMR at bedside. The doctor-patient interaction is far more complex than the routine nursing assessment described in the earlier section. Most patients are new to the ED and usually have no previous ED records available. In order to quickly obtain patients' information for diagnoses, the ED doctors have to inquire about a large amount of information in a short period of time. These conversations, along with the physical examinations, require the doctors to stay closely with the patients being examined. The workstations located near the doors (Figure 4) of the patients' rooms separated the doctors from the patients lying on the beds. The nature of the physical examinations, along with the non-sequential and sporadic information flow presented during the patient interview, determined that the bedside EMR is not convenient for the ED doctors at most times.

Paper charts, in the ED doctors' workflow, facilitate the process of transiting informal and procedural instances that are not yet to be documented into the EMR. They also help the ED doctors capture key information and remain intimately involved with their patients.

Episode 4: Case Managers' View

Once an ED doctor signs to admit a patient, the patient has to stay in the ED until he/she has a bed ready in the in-patient unit. A case manager's role is to make sure that the patient receives a bed in the corresponding in-patient unit and moves out of the ED quickly. This process guarantees the ED patient flow and the optimal use of the ED resources.

Although patients are assigned to a case manager in the EMR system, the case manager could not request beds through the EMR. The case manager has to transit a patient's clinical information from the EMR to the Tracker system for the purpose of requesting in-patient beds. Then, the bed status has to be monitored in the Tracker system – whether it is available (shown as BA in the Tracker system) or ready to be used (BR); when bed is assigned to the patient, the case manager has to transit the bed information from the Tracker back to the EMR.

Figure 6 shows the view of a case manager's workstation – the only place in the whole ED with dual monitors. Nevertheless, displaying both the EMR and the Tracker simultaneously does not ensure a smooth transition between the two systems. The case manager has to rely on paper charts as a transitional artifact to carry information. The transitional artifact is called a *Face Sheet*, which is printed

from the EMR system. The Face Sheet contains mostly non-clinical information, such as demographic information, emergency contacts, guarantor account information and insurance information. By doing so, the cases that the case manager manages are visually displayed on the desk and the case manager could note down the bed status on the charts.



Figure 6. Case manager's desk: One screen showed the EMR system and the other displayed the Tracker system.

Discussion

The case manager takes care of the admitting process for all patients in the ED. It is the case manager's responsibility to monitor the bed status on the Tracker system, and even call in-patient units to ensure a quick ED turnaround. The case manager's dual monitors station helps facilitate information copying between the EMR and the Tracker for a single patient. However, similar to the room nurses and ED doctors, the information displayed in the systems is not compatible with the case manager's workflow of managing multiple patients simultaneously. In addition, the case manager is not able to enter notes on the EMR system. These notes include the pending status of the beds and what has already been performed for each patient because such non-clinical tasks are transitional and not part of the patients' official records. The information may get lost in transition if it is not written down on the Face Sheet. For that matter, the case manager's work is also reliant on the transitional artifacts showing the number of active patients that the case manager currently manages, the status of these patients and eventually the key information extracted from both the Tracker and the EMR system in the middle of an in-patient admission process.

DESIGN IMPLICATIONS

The transitional artifacts described in this article play a crucial role between the formal EMR documentation and the actual clinical workflow. Even though the ED staff have already developed many ways to workaround the gap in the EMR documentation, it is notable that the use of these

artifacts has more or less increased their workload. The heavy use of transitional artifacts calls for design opportunities that support *transitional clinical documentation*. This section provides a coherent view towards the transitional artifacts in the ED work and discusses design implications that would help the EMR take on some of the time-consuming transitional documentation automatically.

Documenting Sporadic Information

The sporadic nature of the ED information flow has led the ED staff into using various notes to capture key information during patient interviews. These notes are later entered into the EMR as formal documentation. It is notable that even though the information is non-sequential, what has been jotted down by the ED staff is often simple and standard. The triage nurses merely scribbles a few numbers for the vital signs and abbreviations for home medications. The ED doctors also write down a few keywords on the paper charts. These informal notes are crucial for ensuring later formal EMR documentation.

The observation indicates that it is possible to capture the transitional information in the EMR and link it to the formal documentation. One example would be to display the *T-Sheet* system on mobile devices during ED consultations. Doing so would allow the ED doctors to jot down the transitional information that can be directly integrated into the EMR documentation and stay unobtrusive to the original clinical workflow. Likewise, even though many vital sign parameters have to be chosen in the patient's formal records, the EMR can be designed to capture only key vital sign numbers in the triage processes and transit them into the formal documentation automatically. In this way, the information can be entered into the formal ED documentation without undergoing a transition from various notes.

Following Individual Workflow

The information presented in the EMR does not comply with the actual clinical workflows. The standard view on the EMR main page in our field site is a patient list, either from “the whole ED patients” view or “my patients” view. These patient lists look like colored spreadsheets showing names, room numbers, ED doctors, nurses and chief complaints. However, this standard view does not always fit with the ED staff's actual work practice. Most of the time, the conflict lay in the discrepancy between the single patient-centric display and the practice of handling multiple patients simultaneously. The room nurses would prefer a workload view that shows the scheduled check-up times for all the patients they manage, but this information is deeply embedded in each individual patient's chart and it takes time to dig it out from the EMR. Similarly, the ED doctors and case managers, who are in charge of multiple patients, also require information presentations to follow their workflow – a view that is ED work-centric.

Recording Procedural Information

The current EMR system is designed for storing patients' permanent records. However, as discussed earlier, certain clinical orders may involve long processing times and multiple procedures. The one-time sign-on function in the EMR eliminates the ability to record the multiple procedures involved in an order. While this procedural information may only be meaningful for facilitating the clinical work, and are not part of the permanent patient records, the lack of proper support in documenting the procedural information in the EMR interrupts the normal clinical workflow. For instance, the EMR can list an order of taking a urine test as a three-step process: 1) intending to get the urine sample, 2) waiting for the sample, and 3) sending the sample to the lab department. Detailing the procedural information would enable each step to be shown on the nurses' task list. Orders that are under processing can remain unfinished on the nurses' task list so that they do not need to rely on the transitional artifact to carry this information.

Other factors, such as the physical layout of bedside computers and the lack of support of non-clinical tasks (for the case managers), also lead to the use of transitional artifacts on the ED floor. Nevertheless, these issues are not as serious as the fundamental design concept of the inability to support the transitional documentation in the EMR.

CONCLUSIONS

This paper presents a field study investigating the reasons for the decreased efficiency and increased workload after the introduction of an EMR system. More specifically, the focus of the study was on the workflow issues associated with the EMR documentation among four main EMR users' tasks: triage nurses, room nurses, ED doctors and case managers.

This study has found that the lack of support in documenting the *transitional information* has led to the gap between the formal EMR documentation and the actual clinical workflow. To alleviate this gap, the ED staff has adapted a huge amount of artifacts to carry the transitional information, including personal notes, printed paper charts and whiteboards.

The transitional artifacts are either informal documentation-to-formal EMR documentation or formal charts-to-meaningful information that is integrated with the clinical workflow. The analysis of each user's workflow show that the reasons that the ED staff engage in the transitional artifacts are multi-faceted, but primarily caused by the non-sequential information flow during patient interactions and the lack of support in documenting procedural information in the EMR system. For these reasons, the fundamental conflict lay in the contradiction between “only-formal charts-documentation” in the EMR and “meaningful informal-notes which support clinical workflow” on the ED

floor. This gap causes the inefficiency in the use of EMR and results in the duplicate documentation practices.

This study suggests that the goal of the EMR system design should not merely be for keeping patients' formal records and presenting them in a patient-centric way. The information that is transited in the process of clinical documentation and clinical workflow should also be documented in the EMR, even if it is not a part of the patients' formal records.

The findings of this study detail the understanding of the workflow issues in the EMR system design. The solutions provided in the design section endorse *computerized transitional documentation* in the EMR system. This finding is especially meaningful since the majority of US hospitals are expecting their EMR eras in the next 5-10 years [18]. Beyond healthcare, documenting transitional information may inform many other practices that involve diverse information flow and complex workflow. Thus, the findings of this particular study may help shed light on other types of documentation systems in consideration of transitional information in the system design.

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