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Impact of a Critical Care Clinical Information System on Interruption Rates During Intensive Care Nurse and Physician Documentation Tasks

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Abstract

Computerized documentation methods in Intensive Care Units (ICUs) may assist Health Care Providers (HCP) with their documentation workload, but evaluating impacts remains problematic. A Critical Care clinical Information System (CCIS) is an electronic charting tool designed for ICUs that may fit seamlessly into HCP work. Observers followed ICU nurses and physicians in two ICUs in Edmonton, Canada, in which a CCIS had recently been introduced. Observers recorded amounts of time HCPs spent on documentation related tasks, interruptions encountered by HCPs, and contextual information in field notes. Interruption rates varied depending on the charting medium used, with physicians being interrupted less frequently when performing documentation tasks using the CCIS, than when performing documentation tasks using other methods. In contrast, nurses were interrupted more frequently when charting using the CCIS than when using other methods. Interruption rates coupled with qualitative observations suggest that physicians utilize strategies to avoid interruptions if interfaces for entering textual notes are not well adapted to interruption-rich environments such as ICUs. Potential improvements are discussed such that systems like the CCIS may better integrate into ICU work.

Keywords:

Intensive care, Clinical information systems, Interruption, Time and motion study

Introduction

Health Care Providers (HCPs) working in Intensive Care Units (ICUs) attend to highly acute and complex patients. Effective care requires continuous monitoring by specialized and costly HCPs. Coordinated care among different HCPs and over time is called continuity of care and is a central determinant of patient outcome [1-3]. Continuity of care depends on the communication of patient condition changes and care plans to pertinent care team members, frequently using patient charts. Information contained within patient charts is vital for decision making, and ideally should be current, complete, and correct.

One approach aimed at assisting HCPs working in ICUs with their documentation workload uses computerized clinical information systems. A Critical Care clinical Information System (CCIS) is designed to replace paper charts and interface with ICU bedside equipment and laboratory systems to automate some documentation tasks for HCPs [4]. It is believed that a CCIS may aid communication among HCPs but little evidence currently exists.

This paper reports part of a larger project evaluating whether a CCIS in two ICUs in Edmonton, Canada is beneficial for patient care [5]. Trained observers followed physicians and nurses to record the amount of time spent on documentation related tasks and numbers of interruptions HCPs encountered while going about their work. Needs for timely communication in environments such as ICUs and emergency departments result in HCPs interrupting and being interrupted more frequently than in other hospital environments [6,7]. Rates of adverse medical events in ICUs are more frequent than in other hospital wards [8]. Interventions aimed at reducing error, along with more methodologically sound research investigating relationships between medical error and work interruptions, are needed [9,10].

To formulate effective plans to manage and reduce the consequences of interruptions recent work has investigated reasons HCPs initiate interruptions in high acuity health care settings [11]. Interruption recipients may block or delay interruptions [12] suggesting that recipients can take an active role in prioritizing interruptive communication patterns above or below their current or 'primary' task [13]. HCPs are likely to prioritize patient care tasks above documentation tasks [14]. We suggest that interruption rates during documentation tasks may provide a measure of the extent to which this prioritization occurs.

We report interruption rates during documentation tasks for nurses and physicians in two ICUs before and three months after the introduction of a CCIS. The findings are discussed with reference to frequent types of documentation completed by nurses and physicians. The results demonstrate needs for more interruption tolerant data entry mechanisms in ICUs and emergency departments.

Methods

Setting & Participants

The University of Alberta Human Research Ethics Board approved this study prior to data collection. The study was conducted at the Pediatric ICU (PICU) at the Stollery Children's Hospital and the General Systems ICU (GSICU) at the University Hospital, both in Edmonton, Alberta, Canada. Both are located within busy academic tertiary referral hospitals. The PICU has 17 beds. GSICU has 30 beds with 24 operational due to staff shortages. Laboratory results are accessed with computers at nursing stations and throughout the unit. The ratio of patients to nurses is 1:1 in PICU. In GSICU, the patient to nurse ratio is 1:1 70% of the time and 2:1 30% of the time depending on patient acuity.

Staff members were informed of our study with presentations given by the research team, and with posters distributed around the units. Research team members approached nurses and physicians to obtain their consent to be observed. Of 215 nurses in permanent staff positions, 97 agreed to participate. Of 36 physicians, 34 agreed to participate. Chief residents and sub-specialty fellows were included in the group of observed physicians.

Observations

Observers were trained for at least 12 hours prior to conducting observations. In training sessions, trainees were paired with experienced observers to observe and score a single participant. Inter-rater reliability scores were then calculated from the reported amounts of time spent on the task categories. Observers conducted their own observations after obtaining inter-rater reliability scores above 85%. Observations were conducted for a maximum of 90 minutes without advance notice to participants. Equal numbers of nurse observations were conducted during mid-day (07:00-19:00), mid-night (19:00-07:00), morning shift change (06:30-08:00), and evening shift change (18:30-20:00). Physician observations were conducted during morning rounds (08:00-12:00), sign-out rounds (16:00-17:00), and at night rounds (20:00-00:00). Observers kept field notes recording how busy units appeared, whether students were present, and contextual information to help with interpreting observational data. Observations were suspended if participants left the unit.

Baseline observations were conducted between September and November 2008 in PICU, and between January and February 2009 in GSICU. The CCIS was introduced to the GSICU and PICU in March, 2009. Once connected, patient vital signs were automatically recorded in charts. Lab results, ventilators and dialysis machines did not interface with the system at the time of observation. Medication orders were handled with paper records. Post-CCIS observations were conducted between May and June 2009 in both units. Before the system was introduced, 57 hours of physician observations and 60 hours of nurse observations were conducted. After the introduction, 50 hours of physician observation and 56 hours of nurse observations were completed.

PDA Data Collection Tool and Work Definitions

The WOMBAT software runs on Hewlett-Packard iPAQ hx2490 or 110s [15]. Time stamped data was extracted into Excel spreadsheets via a laptop computer. Westbrook and colleagues provided detailed task definitions which we refined to include tasks specific to the observed units [16]. Observers carried the paper work definitions to assist in recording the tasks observed into PDA categories. Documentation tasks were scored when participants wrote or typed in information into permanent records, CCIS, other computer applications, or other paper. The complete definitions are described elsewhere [16]. Observers recorded the medium using the WOMBAT software. Interruptions were also recorded using the WOMBAT software if any external factor (e. g., an alarm, another care provider, a patient) appeared to cause the participant to cease their task and perform a secondary task [15].

Statistics

Interruption rates and proportions of time spent on documentation tasks were calculated for observations. Interruption rates when completing documentation tasks using the CCIS and other Non-CCIS methods (permanent records, paper, or other computer applications) were compared using t-tests assuming unequal variances. The significance level was set at 0.05.

Results

Amount of time spent on documentation tasks

During our observations, physicians spent 15.2% of their time (mean, +/- 5.3%; 95% Confidence Interval) and nurses 26.4% (+/- 3.1%) performing documentation tasks before the CCIS introduction (Figure 1A). After the CCIS implementation, both physicians and nurses used CCIS and non-CCIS methods of completing documentation tasks. The percentage of time spent on documentation tasks while using the CCIS was 1.6% (+/- 1.9%) for physicians and 14.8% (+/- 3.2%) for ICU nurses. The time spent on documentation tasks after the CCIS introduction using Non-CCIS methods was 7.3% (+/- 2.8%) for physicians and 5.7% (+/- 1.8%) for nurses.

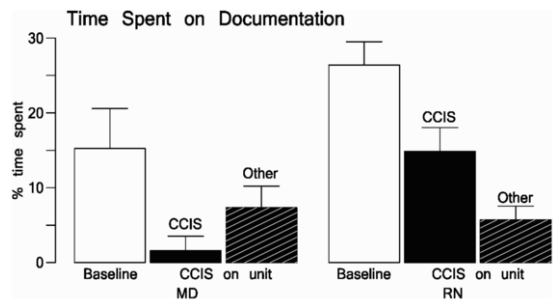

Figure 1- Mean percentages of time spent on documentation tasks before the CCIS and after by ICU physicians and nurses using the CCIS or Non-CCIS media (+/- 95% Confidence Intervals).

Interruptions during documentation tasks

Before the CCIS introduction, the rate of interruption during documentation tasks was 2.2 (+/- 1.4) interruptions per hour for physicians and 4.5 hr^{-1} (+/- 1.9) for nurses (Figure 1B). When physicians performed documentation tasks using the CCIS the interruption rate was 0.35 hr^{-1}(+/- 0.45). Physicians were interrupted significantly more often when documenting with Non-CCIS methods, at a rate of 4.0 hr^{-1}(+/- 3.4). After the CCIS introduction, nurses were interrupted at a rate of 8.8 hr^{-1} (+/- 3.5), which is significantly more often than when performing documentation tasks using Non CCIS methods (1.4 hr^{-1}; +/- 1.2).

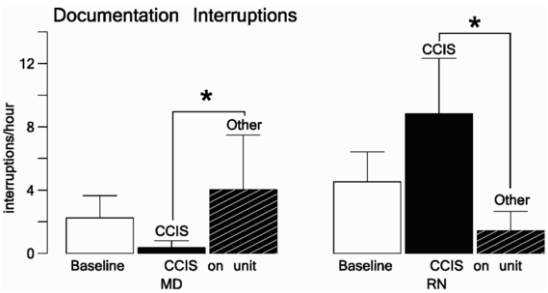

Figure 2- Mean interruption rates during documentation tasks observed before and after the CCIS introduction for ICU physicians and nurses. Interruption rates for documentation tasks were determined based on the media used, the CCIS itself or Non-CCIS media (=p<0.05)*

Discussion

The results identify role specific changes in interruption rates during documentation tasks depending on the media HCPs use after a CCIS introduction. In the two ICUs studied, physicians spent more time documenting care using Non-CCIS methods than they did using the CCIS after the CCIS introduction. When physicians performed documentation tasks using the CCIS, these tasks frequently consisted of long notes. If physicians were interrupted while writing notes, the session could time out due to inactivity. When the physician returned, they would spend additional time amending their note. As 'copy' and 'paste' functionalities were unavailable using this system, physicians would often need to rewrite the note completely.

Strategies used were documented by observers with field notes. For example, an observer noticed a senior physician approach a trainee to initiate a conversation. The senior physician first confirmed that the trainee was not busy writing a note in the CCIS before they continued their conversation. In another incident a physician accepted a newly admitted patient following a surgery. Once the immediate task of receiving the verbal information from the surgeons and providing orders to the care team was complete, the physician moved to an unused terminal at some distance from the patient to enter a note into the CCIS. In other instances, observers noted some nurses remarking that physicians using the CCIS could be less responsive to requests than when completing other tasks. Based on these observations, ICU physicians may attempt to reduce the likelihood of being interrupted when they use the CCIS. Strategies may include deferring communications to later times, or performing documentation tasks in locations more distant than using paper charts. The observational data are consistent with this as ICU physicians performing documentation tasks using the CCIS were interrupted less frequently than when using Non-CCIS documentation methods.

A contrasting situation exists for nurses completing documentation tasks using the CCIS. The observational data show that nurses were interrupted more frequently when performing documentation tasks using the CCIS than when using Non-CCIS methods. The increased rate of interruption during CCIS documentation tasks likely has causes and effects that are not yet identified. The workload associated with nursing care requires that nurses spend large proportions of their time at the bedside or at nursing stations near patients. Nurses may not have the same degree of flexibility to employ strategies that physicians use in deferring interruptions. Alternatively, nurses completing documentation tasks with the CCIS may be able to resume with less disruption compared with physicians. Nurses are discouraged from entering text notes into the CCIS. The increased rate of interruption could be accounted for if nurses have less incentive to delay or block interruptions.

Significance

These findings may have implications for patient care provided in ICUs. One implication involves physician availability. HCPs value the convenience of being able to perform documentation tasks and review chart information remotely rather than at the bedside [17]. For some classes of information, such as lab results, physicians may more easily obtain current information at an unoccupied computer than at the bedside. Physicians accessing chart information remotely may be able to make better decisions about when they need to come to the bedside.

Care providers working at the bedside will typically prioritize patient care above documentation tasks [14]. Data entered into the chart about procedures performed and assessments of patient status may not be completely updated, depending on workload. If physicians choosing to work remotely so as to avoid interruptions during documentation tasks tend to spend less time on the unit, there is the potential for subtle reductions in physician availability to come about as an unintended consequence of introducing clinical information systems such as the CCIS. We posit that the inability of the CCIS to pause and later resume note entry represents a potential area of improvement for a system designed for the critical care environment.

Potential Solutions

One solution might involve physicians adopting documentation methods much like other HCP roles, where text entry is discouraged. Difficulties with this approach surround the complexities of medical documentation. Most physicians are trained to write text notes that are human readable rather than completing their documentation tasks using other data entry

mechanisms including drop-down boxes. As a result, physicians may resist this option.

A second potential solution involves enabling copy-paste functionality. Recent work has investigated some of the unintended consequences that can result when physicians use copy and paste functions [18]. Some of these consequences include the potential for notes from previous days to be brought forward inappropriately and thus fail to track changes in a patient's progress over time. Investigations into physicians' attitudes toward and usage of copy and paste functions from other hospitals where these functions are enabled in documentation tools have shown that physicians report that they value these functions to keep up with burgeoning workloads [19]. The percentage of time physicians in our study spend using the CCIS is highly suggestive that senior physicians tend not to use this system to complete their documentation tasks, but may delegate CCIS documentation tasks to more junior physicians, and resort to more flexible methods. These methods include using paper and other software including word processors where copy and paste functions are available. Although not including these copy and paste functions may avoid the potential unintended consequences described above, it may also severely limit the utility of the CCIS to physicians. Appropriate physician training regarding potential issues around the use of copy and paste functions could be included in medical school curricula, residency training, and continuing medical education, such that systems like the CCIS provide better utility to physicians.

Third, the system could save a partially entered note as a 'draft' when locking out a user. Other care providers could view the note with cues or notifications marking it as incomplete. Physicians returning to the computer could then complete their note. In a very busy environment many 'drafts' may be left on different charts. This solution should be no worse than is the case under paper charts if the CCIS facilitates the completion of documentation tasks.

Strengths and Limitations

The current study benefits from a clear, previously defined, definition of interruption [15], thus enabling comparisons to be made between our study and other units considering introducing a CCIS. We report interruptions occurring during one primary task, documentation, to investigate how well the CCIS fits in with the workload experiences of ICU physicians and nurses.

No studies, to our knowledge, have validated the WOMBAT method in ICUs, and this represents a potential minor weakness of this study. The results may not generalize to other wards, depending on the clinical information systems in place, particularly if those systems better tolerate interruptions to text entry. This study may have benefitted from collecting data from more junior physicians as they were more frequent users of the CCIS. We did not follow junior physicians as their varying familiarity with ICU work would present an obvious confounding variable. Future investigations of electronic documentation methods would clearly benefit from their inclusion in our study.

Conclusion

Currently, adoption rates of hospital based EMRs languish [20]. Challenges encountered by HCPs in ensuring informational continuity around their patients in the ICU environment may be either mitigated or aggravated by the tools they are provided. Clinical information systems designed for ICU environments may not take into account the interruption-rich environment. As HCPs become more familiar with the system, these effects may be lessened. Meanwhile, we posit that the lack of interruption tolerant data-entry mechanisms represents a deficiency that may impact documentation quality, communication between HCPs, and thus patient care.

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Author Contributions

MAB performed the data analysis and wrote the manuscript. MAB and KJA coordinated the data collection. NTS is the senior author on the CCIS research study. She designed the study and provided editorial advice. DCM provided statistical advice. MAB, NTS, KJA, DCM and RTNG provided input into the project design. All authors approved the final version of the manuscript.

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