Interruptions in Workflow for RNs in a Level One Trauma Center

Juliana J. Brixey, MSN, MPH, RN[1], David J. Robinson, MD[1,2], MS, Zhihua Tang, PhD[1], Todd R. Johnson, PhD[1], James P. Turley, PhD, RN[1], Jiajie Zhang, PhD[1]

[1] The University of Texas Health Science Center at Houston, Houston, TX
[2]Memorial Hermann Hospital Houston, TX

ABSTRACT

An understanding of interruptions in healthcare is important for the design, implementation, and evaluation of health information systems and for the management of clinical workflow and medical errors. The purpose of this study is to identify and classify the types of interruptions experienced by ED nurses working in a Level One Trauma Center. This was an observational field study of Registered Nurses employed in a Level One Trauma Center using the shadowing method. Results of the study indicate that nurses were both recipients and initiators of interruptions. Telephone, pagers, and face-to-face conversations were the most common sources of interruptions. Unlike other industries, the outcomes caused by interruptions resulting in medical errors, decreased efficiency and increased cost have not been systematically studied in healthcare. Our study presented here is an initial step to understand the nature, causes, and effects of interruptions, and to develop interventions to manage interruptions to improve healthcare quality and patient safety. We developed an ethnographic data collection technique and a data coding method for the capturing and analysis of interruptions. The interruption data we collected are systematic, comprehensive, and close to exhaustive. They confirmed the findings from early studies by other researchers that interruptions are frequent events in critical care and other healthcare settings. We are currently using these data to analyze the workflow dynamics of ED clinicians, identify the bottlenecks of information flow, and develop interventions to improve the efficiency of emergency care through the management of interruptions.

INTRODUCTION

Health informatics recognizes that user-centered design of health information systems and medical devices reduces medical errors. In turn, an understanding of the clinical setting using a user-centered approach would be useful in determining how human factors such as interruptions contribute to medical error. New technology can introduce more interruptions (e.g., alerts and reminders) as well as reduce interruptions (e.g., automation). An understanding of interruptions in healthcare is important for the design, implementation, and evaluation of health information systems and for the management of clinical workflow and medical errors.

Patient safety organizations such as The Joint Commission for the Accreditation Organization (JCAHO)[1, 2] and the United States Pharmacopeia through MEDMARX acknowledge that interruptions contribute to preventable medical errors. Analysis of medication error reports submitted to MEDMARX indicates that hospitals attribute 43% of medication errors to workplace distractions[3, 4]. In a Sentinel Event Alert, JCAHO recognizes that distraction factors contributed to wrong site surgery errors[2]. A recent report from Morbidity and Mortality Weekly Review (MMWR) shows how an environment full of multi-tasking and interruptions contributed to a nurse making a medication error. The following excerpt describes the event "*… As she (nurse) was about to telephone the pharmacy for clarification, a physician demanding her immediate assistance with another patient distracted her. Several minutes later, when she re-entered the room of the leukemia patient, she forgot what she had been planning to do before the interruption and simply hung the medication The nurse had been "yelled at" the day before by another physician—she attributed her immediate and total diversion of attention in large part to her fear of a similar episode ... "* [5]. However, these reports do not provide detailed information about the clinical environment where the interruptions occur. A review of literature found revealed few studies that examined how the number of interruptions influences nurses working in various clinical settings[6-10]. Therefore, a study is needed that identifies the types of tasks nurses are performing when receiving an interruption, the interrupting tasks, and the impacts of interruptions on workflow, efficiency, and productivity. The purpose of this study is to identify and classify the types of interruptions experienced by ED nurses working in a Level One Trauma Center. The dynamics of the environment of the ED provides an ideal setting for studying interruptions.

Healthcare settings, especially nursing settings, have been described as an environment full of interruptions and multi-tasking[11], where work is interruptive[6] and performance is inefficient[9]. This environment, in conjunction with professional roles and responsibilities, may influence the number of interruptions that a clinician experiences. For example, nurses that performed tasks that were previously assigned to physicians in a primary clinics experienced a decrease in the number of interruptions they received[9]. Finding from studies in hospitals indicate that professional titles and responsibilities influence the

number of interruptions received and generated. Lower ranking individuals commonly receive more interruptions. Coiera and Tombs contend that doctors working in the hospital as house staff officers were interrupted more often than those in higher-ranking positions such as consultants6. In contrast, Spencer and Logan found that both interruption rates were higher for positions of authority for ED clinicians. The physician Registrar and the RN coordinators received 23.5 and 24.9 interruptions per hour, respectively. Conversely, staff RNs and junior physicians were interrupted at a rate of 9.2 and 8.3 per hour, respectively[10]. The conflicting results point out that it is unclear how role and status influence the number of interruptions a clinician receives. Specifically, nurses and doctors working in the same departments such as the Emergency Department (ED)[7] and Post Anesthesia Care Unit (PACU)[8] expect to be interrupted by the unscheduled arrival of patients and the coordination of different clinical specialty services for each patient. Contacting the various clinical specialists relies on the use of synchronous communication channels such as the telephone. In the follow-up to an earlier study, Coiera, Jayasuriya, Hardy, Bannan, and Thorpe studied communication patterns for doctors (n=6) and nurses (n=6) in two EDs. Results indicated that collectively, doctors and nurses received 11.15 interruptions per hour. As separate groups, doctors and nurses had similar rates of interruptions occurring at a rate of 11.1 (95% CI, 9.7-12.7) and 11.2 (95% CI, 9.5-12.7), respectively. A related study of ED nurses and doctors, shows a slightly higher overall rate of interruption for doctors and nurses with a rate of 14.8 interruptions per hour[10].

Clinical care depends on communications between nurses and doctors and other providers. Clinicians do not consider making a phone call or stopping a colleague in the hall as an interruption. Little regard is given for what effects the telephone call interruption has on the recipient because higher priority is given to completion of a personal task[6]. Unplanned, synchronous communication such as face-to-face and telephone calls can be considered an interruption. Coiera and Tombs argue that clinicians' preference for synchronous communication contributed to an interruptive work environment. Results indicated that doctors and nurses initiated about twice (65) as many calls as they received (31) involving either the telephone or paging. Specifically, the nurses initiated 22 calls while being the recipient of 8 calls[6].

The literature review provides evidence that researchers have begun to study interruptions that nurses and doctors encounter in the clinical setting. The studies indicate that nurses and doctors working in either ambulatory care setting or in hospitals are frequently interrupted. However, these studies provide little information about the types of tasks the nurses were performing when receiving an interruption, the nature of the interrupting tasks, and the impact of interruptions on workflow, efficiency, and productivity.

METHODS

Study design This was an observational field study using the shadowing method. Shadowing is a qualitative technique that does not necessarily involve the use of statistical analysis of data. In shadowing, observers follow the subjects unobtrusively and take notes of what, why, and how the subjects perform their routine tasks in real world settings.

Participants A convenience sample of six female and two male Registered Nurses with at least six months of experience in the ED were asked to participate. Participation was voluntary and written consent was obtained prior to an observation session. The observations were made during October of 2004 with each session lasting a minimum of two hours but not exceeding twelve hours. The subjects had to be at least 21 years of age to participate.

Ethical approval Approval was obtained from institutional ethic committees prior to initiating the study.

Setting All observations were made in the trauma section of the ED of a large teaching hospital. The hospital is situated in a major medical center in the Gulf Coast region of the US. The organization is certified as a Level 1 Trauma Center, providing 24-hour emergency and trauma care to approximately 52,000 patients a year. The ED occupies 51,000 square feet and contains major trauma and cardiac resuscitation rooms.

Data Collection Observers typically worked in teams of two and they recorded observations using a semi-structured field note implemented on Tablet PCs. Subjects were shadowed for a minimum of 2 hours but did not exceed 12 hours. Recording of observations began when the subject had completed the informed consent. Observations were recorded on a semi-structure field note in one-minute increments. Observations included task initiated, location, description of the task including person(s) involved and tools used. Observers synchronized their stopwatches before the start of a session to assure accuracy in recording events.

Data Analysis Each time-stamped observation was transcribed and entered into an Excel spreadsheet. Analysis of observations relied on using constant comparison as a strategy to identify categories of interruptions[12]. Two coders analyzed the data for agreement of tasks and interruptions. A percent agreement score was calculated. The data in Excel spreadsheet were entered into MacShapa for further analyes of the temporal data. MacShapa is a Macintosh-based qualitative data analysis software application for sequential data. It was designed to assist the researcher who is engaged in observing human operators interacting with complex systems, and each other, in laboratory simulators or in the field. MacShapa supports both qualitative and quantitative statistical analyses of data and includes various visual tools such as a timeline report and tree outputs. It is easy to modify or change coding syntaxes and vocabulary in MacShapa.

RESULTS

Observers The observers typically worked in teams of two. Observer 1 is a Registered Nurse with 26 years of experience in healthcare and is competent in human factors. Observer 2 is a human factors expert with 6 years of experience. Two observers were used to maximize the capture of interruptions in the fast-paced environment.

Demographics Eight nurses were shadowed for a total of 40 hours 9 minutes. Observations were made on either the 7a – 3p or 3p – 11p shift. The shifts were selected because of high activity and recommendations from a domain expert in Emergency Medicine. The charge nurse for the shift had pre-selected the subject for the observation based on consent of the subject. A summary of the shifts and length of observations are found in Table 1.

Table 1. Demographics

Subject Number	Gender	Shift	Total Hours Observed
1	Female	7a - 3p	7 hours 58 min
2	Female	7a - 11a	4 hours 33 min
3	Female	7a - 3p	6 hours 20 min
4	Female	7a - 3p	5 hours 8 min
5	Female	3p - 11p	7 hours 30 min
6	Male	3p - 7p	4 hours 14 min
7	Female	7p - 11p	2 hours 12 min
8	Male	3p - 7p	2 hours 14 min
Total			40 hours 9 min

Slightly more observations were made on the 7a -3p shift than the 3p -11p. This was attributed to availability of the observers.

Interruptions An understanding of interruption can only be made within the context of work and the number of tasks performed. Each observer recorded the tasks observed in a semi-structured field note. All observations were transcribed into an Excel spreadsheet. Observer 1 analyzed each time stamped cell to identify an interruption. The coded spreadsheet was sent to Observer 2 for verification and further identification of interruptions. The two coders met to resolve any disagreement in coding. If an agreement could be reached the observation in question was resolved. If no resolution could be reached, the observation was left as unresolved. A percent agreement was calculated for each session. An overall percent agreement was calculated. This is summarized in Table 2 and Table 3.

Table 2. A Summary of Coding Agreement for Observer 1

Total # of Interruptions	Agree	Disagree	Resolved	Unresolved	% Agreement
22	12	11	11	0	52.17%
12	7	8	5	3	46.66%
17	13	18	17	1	41.93%
21	19	5	3	2	79.16%
19	10	4	1	3	71.42%
19	15	8	7	1	65.21%
22	21	6	6	0	77.77%
27	11	3	2	1	78.57%
159	108	63	52	11	63.15%

Table 3. A Summary of Coding Agreement for Observer 2

Total # of	Agree	Disagree	Resolved	Unresolved	% Agreement
15	8	6	5	1	57.14%
15	10	7	6	1	58.82%
*	*	*	*	*	*
*	*	*	*	*	*
13	9	9	9	0	50%
10	15	5	5	0	75%
21	19	7	7	0	73.07%
26	8	7	6	1	53.33%
100	69	41	38	3	62.16%

* An observation was not made by the observer

Analysis of the data indicates a 63.15% percent agreement for observations identified as interruptions by Observer 1. A similar agreement was obtained with Observer 2 data. An agreement rate of 62.16%.

Table 4 shows a summary of the number of tasks and interruptions recorded. Observer 1 recorded more interruptions than Observer 2. This could be attributed to two observation sessions that were conducted with only one observer. Two recorders were planned for each observation to maximize the capture of data and the agreement of data between observers. From our experience in this study, one trained observer could accurately identify and record the observations.

Table 4. A Summary of Recorded Tasks and Interruptions

Subject Number	Total Number of Tasks Recorded by Observer 1	Total Number of Interruptions Recorded by	Percent Task Interrupted	Total Number of Tasks Recorded by Observer 2	Total Number of Interruptions Recorded by	Percent Task Interrupted
1	265	22	8.3	149	15	10.07
2	218	12	5.5	116	15	12.93
3	426	17	3.99	*	*	*
4	430	21	4.88	*	*	*
5	376	19	5.05	206	13	6.31
6	265	19	7.17	161	10	6.21
7	170	22	12.94	125	21	16.8
8	132	27	20.45	86	26	30.23
Total	2282	159	6.96%	843	100	11.86%

* An observation was not made by the observer

Analysis of the observations indicates that Observer 1 found that 6.96% tasks were interrupted, whereas observer 2 found 11.86%. This could be attributed to the smaller number of tasks observed.

All identified interruptions were entered into a MacShapa spreadsheet for additional coding using a variable called predicate. Each interruption was time stamped and coded. This process is shown in the following example. This example shows that each cell is coded for the initiator of the interruption, the recipient, handling, details of the event, location, and patient.

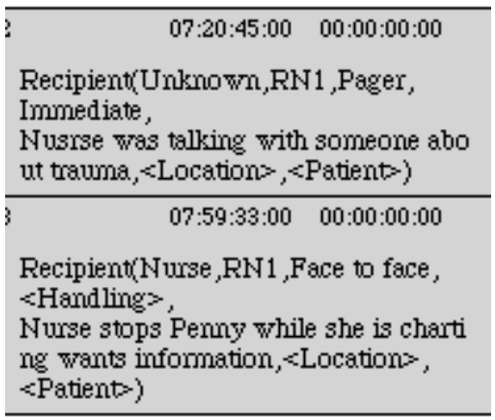

Figure 1. An example of a coded cell in MacShapa.
This example shows how the fields in the cell are populated. This example show how the fields are completed for an interruption recipient.

A timeline is run for each session to graphically depict in time when an interruption occurred and the type. This is illustrated in the following example.

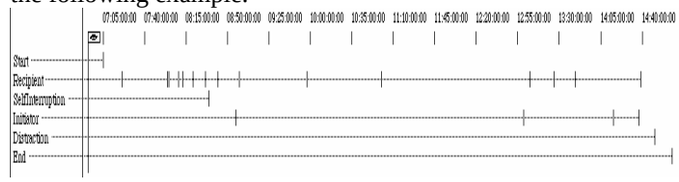

Figure 2. A timeline of the occurrence of interruptions.
This timeline shows the start and conclusion of the session. In this observation, the various types of interruptions are depicted.

Conclusion

Interruptions can not only decrease performance but can also cause human errors that sometimes lead to catastrophic events. Unlike other industries, the outcomes caused by interruptions resulting in medical errors, decreased efficiency and increased cost have not been systematically studied in healthcare. Our study presented here is an initial step to understand the nature, causes, and effects of interruptions, and to develop interventions to manage interruptions to improve healthcare quality and patient safety. We selected the ED as our study domain because ED is a high workload, information intensive, time sensitive, interruption-laden, and life-critical environment. Managing interruptions to reduce medical errors and increase efficiency in such an environment is of paramount importance for patient safety and healthcare quality. We developed an ethnographic data collection technique and a data coding method for the capturing and analysis of interruptions. The interruption data we collected are systematic, comprehensive, and close to exhaustive. They confirmed the findings from early studies by other researchers that interruptions are frequent events in critical care and other healthcare settings. More importantly, our data provide the necessary time-motion information about workflow that is essential for the understanding of interruptions and the management of interruptions through informatics interventions. We are currently using these data to analyze the workflow dynamics of ED clinicians, identify the bottlenecks of information flow, and develop interventions to improve the efficiency of emergency care through the management of interruptions.

ACKNOWLEDGEMENT

This project is supported by a training fellowship from the Keck Center for Computational and Structural Biology of the Gulf Coast Consortia (NLM Grant No. 5 T15 LM07093).

REFERENCES

1. JCAHO. Preventing ventilator-related deaths and injuries. In: Sentinel Event Alert; 2002.
2. JCAHO. A follow-up review of wrong site surgery. In: Sentinel Event Alert; 2001.
3. Bordon S. Medication errors in U. S. Hospitals. In; 2003.
4. Stevenson JG. Medication errors: Experience of the United States Pharmacopeia (USP). Journal of Quality and Patient Safety 2005;31(2):114-119.
5. Web Morbidity & Mortality Weekly. Caution, interrupted. In; 2004.
6. Coiera E, Tombs V. Communication behaviours in a hospital setting: An observational study. BMJ 1998;316(7132):673-676.
7. Coiera EW, Jayasuriya RA, Hardy J, Bannan A, Thorpe MEC. Communication loads on clinical staff in the emergency department. MJA 2002;176(9):415-418.
8. Hillel G, Vincente KJ. Nursing interruptions in a post-anesthetic care unit: A field study. In: 47th Annual Meeting; 2003; 2003. p. 1443-1447.
9. Paxton F, Heaney DJ, Porter AM. A study of interruption rates for practice nurses and gps. Nursing Standard 1996;10(43):33-36.
10. Spencer R, Logan P. Role-based communication patterns within an emergency department setting. In: Proceedings HIC 2002; 2002; Melbourne; 2002.
11. Chisholm CD, Collison EK, Nelson DR, Cordell WH. Emergency department workplace interruptions: Are emergency physicians "interrupt-driven" and "multitasking"? Acad Emerg Med 2000;7(11):Acad Emerg Med.
12. Glaser B, Strauss A. The discovery of grounded theory. New York: Aldine Publishing; 1967.