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NURSING INTERRUPTIONS IN A POST-ANESTHETIC CARE UNIT: A FIELD STUDY

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ABSTRACT

The nursing workplace is a complex environment in which nurses are frequently interrupted and distracted while they care for patients. Interruptions in the nursing workplace could be a factor in medical errors, which can result in patient injury or death. When designing medical devices to be used in the nursing workplace, it is important to take into consideration the cognitive demands that the work environment places on nurses. Furthermore, it is important to conduct user testing of devices under realistic conditions. To this end, a field study was conducted in the Post-Anesthetic Care Unit at the Toronto General Hospital, whereby 10 nurses were observed as they cared for patients. The types and frequencies of interruptions that they encountered were recorded, along with any observed detrimental effects on performance. Results showed that the most frequently occurring interruptions involved “face-to-face” verbal conversation with another nurse or physician. These results are currently being used to simulate interruptions during experiments to evaluate two patient-controlled analgesia devices under more representative conditions.

INTRODUCTION

Adverse drug events, or medication errors, are commonly defined as events that could have led to, or did lead to, undesirable outcomes, such as increased hospital stay, permanent disability, or death (Cooper et al., 1978). Typical medication errors include wrong dosage, wrong concentration, wrong infusion rate, incorrect drug, mistaken patient, wrong route and incorrect time (Walters, 1992; Gladstone, 1995; O’Shea, 1999). Adverse drug events account for 19.4% of documented medical injuries, according to the Harvard Medical Practice Study, making them the leading cause of adverse events (Leape et al., 1991). Furthermore, a majority of these adverse events are associated with the misuse of drug infusion devices, such as patient-controlled analgesia (PCA) devices. PCA devices allow patients to self-administer analgesics, such as morphine, by simply pressing a button when they

feel pain. There are several parameters that a nurse must program into the device through a human-computer interface, including the concentration of the analgesic, the initial bolus dose that is infused into the patient, and the lockout period, which determines the minimum length of time that must pass between doses. A patient who presses the button during the lockout period is denied the dose. Programming errors can cause patients to receive overdoses of analgesics, which can be fatal (Vicente et al., 2003). Patient safety can thus be improved by making the human-computer interfaces of these devices less complex and easier to program (Lin et al., 1998, 2001).

In a previous study, Lin et al. (1998, 2001) redesigned the interface for a commercially available patient-controlled analgesia device, using human factors principles. Experiments were conducted whereby nurses performed simulated programming tasks on the new and old

interfaces. Performance time was faster and concentration programming errors eliminated with the new interface. However, nurses are frequently interrupted when they program PCA pumps in a clinical setting, and so the effect of interruptions should be investigated. In another study, Ford and Rollinson (2001) redesigned the interface for a patient-controlled epidural analgesia machine, using human factors principles. Again, performance time was faster and errors were reduced with the new interface. However, these experiments also did not simulate interruptions to which nurses are subjected in clinical practice.

Interruptions are an inherent and necessary characteristic of many safety critical environments, such as the nursing workplace. Several studies have investigated the negative effects that interruptions have on nurses' performance. Through surveys, interviews, questionnaires, and observations, these studies have shown that interruptions and distractions are a main cause of adverse drug events (Walters, 1992; Gladstone, 1995; Wakefield et al., 1998; Coiera and Tombs, 1998; Chisholm et al, 2000; Paxton et al, 1996). However, there does not appear to be any study, even in the nursing literature, that has both qualitatively and quantitatively determined the types and frequencies of interruptions encountered by nurses.

Several studies have investigated the effects of interruptions on performance while users perform tasks with interfaces. The interfaces were databases, calculators, flight simulators, or computer games. The simulated interruptions involved simple math problems, word searches, or memory and recall tasks. These studies found that performance was slower and more errors were committed in interrupted trials (Cutrell et al, 2001; Field, 1987; Latorella, 1996; Kreifeld and McCarthy, 1981; Gillie and Broadbent, 1989; McFarlane, 1999).

METHOD

Since nurses frequently encounter interruptions and distractions, it is important that these interruptions be observed, quantified, and classified so that experiments in which medical devices are tested with users can be conducted under more representative conditions, with simulated interruptions. In so doing, generalizability of findings from interface evaluation studies from the laboratory setting to the actual workplace will be improved. To this end, a field study was conducted in the Post-Anesthetic Care Unit (PACU) at the Toronto General Hospital, a teaching hospital and a member of the University Health Network, during which nurses were observed as they cared for their patients. The PACU is essentially a critical care recovery room where patients are transported after undergoing surgery in the operating room. Most patients remain in the PACU for about half an hour while their anesthetic wears off, and are then transported to the floor or sent home. The most critical cases can remain in the PACU for hours, or even overnight. The PACU differs from most other hospital units in three main ways: (a) family members are not permitted to visit, unless the patient has a prolonged stay in the PACU, (b) approximately 90% of the hospital's infusion pump usage takes place here, and (c) the PACU has an open concept layout, whereby it is a large room divided into patient bays, but nurses can see and hear each other at all times and there are no curtains surrounding the patients. Both of the patient-controlled analgesia machines previously investigated in our research (see above) are frequently programmed in the PACU.

Ten nurses in total were observed as they cared for their patients. These nurses have worked in the PACU for an average of 6.4 years (ranging from 7 months to 22 years). All are Registered Nurses with completion of a critical care course and/or critical care experience. Informed consent was obtained from each nurse who was observed. The nurses were not specifically told that the observer was looking at interruptions, but rather that the overall work environment was being assessed. It was emphasized that their performance was not being

evaluated. This was done so as not to alter the behavior of the nurses during the observations.

In total, 25 hours of observations were conducted over several days. These observations were performed during the busiest times in the PACU, which are typically Tuesday-Thursday from 2-9pm. During these times nurses can care for up to three patients at once. The following information was recorded for each interruption that each nurse encountered:

- The time at which the interruption occurred,
- The time at which the interruption was attended to by the nurse,
- The time at which the nurse finished attending to the interruption,
- The time at which the nurse returned his/her full attention to the primary task,
- Whether the interruption resulted in task-switching (requiring the nurse to leave the primary task to attend to the interruption), or task-sharing (requiring the nurse to attend to both tasks at the same time),
- A description of the interruption task,
- A description of the primary task,
- The source of the interruption (i.e. another nurse, etc.),
- How the interruption was announced to the nurse (i.e. face-to-face, via a pager, etc.), and
- Observed detrimental effects of the interruption on the nurse's performance of the primary task.

RESULTS AND DISCUSSION

Table 1 summarizes the type and length of the interruptions that were observed. All observed interruptions were attended to immediately by the nurses, and for all of the interruptions that resulted in task-switching, the nurse resumed his/her primary task immediately following completion of the interruption task. This is a characteristic consistent with the nursing workplace, where issues concerning patient care must be dealt with as they arise. Primary tasks included charting, hooking up intravenous (IV) lines, administering medications, and drawing blood. In addition, all of the verbal interruption tasks, such as answering a question or listening to

a report, with the exception of the phone call, arose from "face-to-face" interactions, meaning that the source of the interruption was in the vicinity of the nurse, who was made aware of the interruption task via a verbal alert.

Figure 1 illustrates the number of times each of the interruptions in Table 1 were observed, for those interruptions that were not of a continuous nature. The most frequent interruption tasks required verbal cognitive resources, and either required the nurses to recall information from memory or commit information to memory.

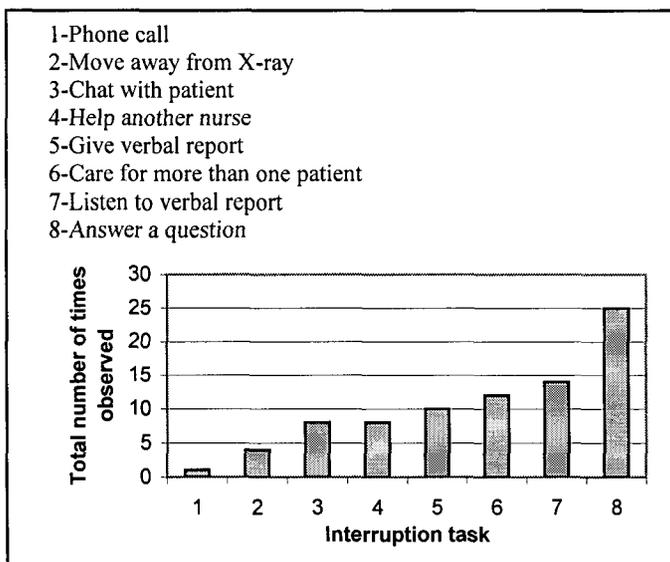
No obvious detrimental effects of the interruptions on performance, in terms of errors committed, were observed during the field study. However, the nurses who were interrupted occasionally exhibited frustration from the increased workload and mental demand imposed by the interruption. In addition, it is important to note that throughout this field study the PACU was not operating at maximum capacity. There are 21 operating rooms serviced by the PACU, seven of which were closed due to a shortage of anesthesiologists. Therefore, it would be useful to conduct a follow-up study when all 21 operating rooms are open and functioning. It is likely that the types of interruption tasks that were observed would occur even more frequently, and thus PACU nurses could potentially experience an even greater increase in workload and cognitive demand, and performance may be affected to a greater degree.

Finally, individual differences were a limitation of this study. Personality traits and individual processing and focusing abilities of each nurse may influence the interruptions that they experience and their consequences.

Table 1: Type and length of observed interruptions.

Interruption Task	Source	Length	Type
Answer a question	Another PACU nurse	Very brief (i.e. under 1 minute)	Task-sharing or task switching
Move 10 feet away from X-ray being taken	Nearby patient	Very brief	Task-switching
Keep an eye on the patient's monitor, while doing other tasks (i.e. injecting medications, drawing blood, charting, etc.)	Patient's monitor	Continuous	Task-sharing
Listen to verbal report while hooking patient up to PACU monitors, connecting IVs, etc (when patient first arrives)	Another PACU nurse, operating room nurse, or anesthesiologist	Brief (i.e. under 3 minutes)	Task-sharing
Talk with patient while performing various tasks	Patient	Brief or continuous	Task-sharing
Help another nurse, (i.e. check another patient's ventilator, draw blood, etc.)	Another PACU nurse	Brief	Task-switching
The nurse has two or three patients (usually stable ones), and therefore has to monitor all of them and perform tasks on each	Patients	Continuous	Task-sharing or task switching
Give verbal report on the patient's status	Another PACU nurse or a physician on rounds	Brief	Task-sharing or task switching
Phone call	Anyone	Brief	Task-switching

Figure 1: # of times interruption task observed.



CONCLUSIONS AND FUTURE WORK

The results obtained from this field study are currently being used to design more representative experiments that can evaluate medical devices

used in the nursing workplace. As a starting point, the new and old interfaces for a patient-controlled analgesia pump evaluated by Lin et al. (1998), and for a patient-controlled epidural analgesia pump evaluated by Ford and Rollinson (2001) will be evaluated under more representative conditions. Simulated interruptions are being designed to reflect the cognitive demands imposed by interruptions in the nursing workplace. Since a majority of interruptions observed were of a verbal nature, the simulated interruptions will use this same cognitive resource. Both the new and the old interfaces will be tested on experienced nurses and nursing students, with and without the simulated interruptions. Performance will be measured in terms of task completion time, the number of errors committed, and subjective mental workload. It will be determined if the new interfaces of both devices still eliminate concentration programming errors in the face of interruptions. If it is found that interruptions cause concentration programming errors to be

made with the new interfaces, then these interfaces may need to be further redesigned to provide more cues and reduce the load placed on the user's memory, to eliminate the need to remember one's place in the programming sequence when an interruption arises.

The findings of this study also have far reaching implications that extend beyond patient-controlled analgesia devices. For one, this study may help to shed some light on why certain medical errors occur. In addition, a robust interface should ideally show insignificant differences in performance between interrupted and uninterrupted tasks. If interfaces, which are designed based on human factors principles, are tested with users under realistic conditions that mimic an interruptive workplace, then we can be more confident that user performance will be similar to experimental results once the interface is introduced into the actual work environment. The first step in experimentally mimicking an interruptive workplace is to determine the types and frequencies of interruptions that occur. The next step is to create tasks or events that match the cognitive demands that are imposed upon a user by these interruptions. The results from this study can be used to design experiments to test many devices used in the nursing workplace. Furthermore, knowing the cognitive demands that exist in such a clinical setting can aid in designing human-computer interfaces for medical devices, by decreasing the workload involved in operating these interfaces, decreasing their complexity, and making them easier to use. These efforts will in turn serve to enhance patient safety. Finally, there are many other work domains in which interruptions exist but have yet to be studied. The methods employed in this field study can serve as a benchmark for future studies of this type.

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