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Mitigating nonurgent interruptions during high-severity intensive care unit tasks using a task-severity awareness tool: A quasi-controlled observational study☆,☆☆

Farzan Sasangohar, SM [a,b], Birsen Donmez, PhD [a,*], Anthony C. Easty, PhD [b,c], Patricia L. Trbovich, PhD [b,c]

[a] Department of Mechanical and Industrial Engineering, University of Toronto, 5 King's College Rd., Toronto, Ontario, Canada, M5S 3G8
[b] HumanEra, Techna, University Health Network, R Fraser Elliott Building, 4th Floor, 190 Elizabeth St, Toronto, ON, Canada, M5G 2C4
[c] Institute of Biomaterials and Biomedical Engineering, University of Toronto, 164 College St, Toronto, ON, Canada, M5S 3G9

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ABSTRACT

Purpose: In a previous study of interruptions to intensive care unit (ICU) nurses, we found that other personnel tend to regulate their interruptions based on nurses' tasks. However, nurses' tasks are not always immediately visible to an interrupter. This article evaluates a task-severity awareness tool (TAT) designed for nurses to inform others when they are performing high-severity tasks. When a nurse engages the tool within an ICU room, a "do not disturb please!" message is displayed outside the room.
Methods: Task-severity awareness tool was installed in a cardiovascular ICU room at a Canadian hospital. Fifteen nurses assigned to the TAT room and 13 nurses assigned to 11 other rooms were observed, approximately 2 hours each, over a 3-week period. Data were collected in real time, using a tablet computer.
Results: Interruption rate during high-severity tasks in the TAT room was significantly lower than in other rooms; interruptions with personal content were entirely mitigated during high-severity tasks. Furthermore, interruptions from nurses and medical doctors were also entirely mitigated during high-severity tasks but happened more frequently during non–high-severity tasks compared with rooms with no TAT.
Conclusions: Task-severity awareness tool proved to be effective in mitigating unnecessary interruptions to critical tasks. Future research should assess its long-term effectiveness.

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1. Introduction

Intensive care unit (ICU) nursing is an interruption-prone profession. Nurses receive frequent interruptions from other personnel, tools and equipment, patients, and visitors [1]. Although interruptions in general are associated with negative effects on task resumption [2], memory [3], and performance [4], previous research suggests that in the ICU setting, which is highly collaborative, interruptions may be necessary to convey important information for ensuring overall patient safety [5-9].

An observational study we conducted at the cardiovascular ICU (CVICU) of a Canadian teaching hospital showed that most interruptions experienced by nurses can be categorized as positive interruptions that convey information about the patient or other work-related information indirectly affecting the patient [1]. This study also showed that interruptions that can be categorized as negative, such as those with personal content (ie, interruptions that are not patient or work related), were significantly more frequent during low-severity tasks compared with medium- and high-severity tasks (in terms of consequence to patient in case of an error), suggesting that interrupters may have regulated their interruptions according to nurses' tasks. However, interruptions with personal content still happened during high-severity tasks. Hence, some of these unnecessary or nonurgent interruptions may have happened due to the interrupter's lack of information about the availability of the nurses or their primary tasks.

Although interruption mitigation methods have not been evaluated in ICUs, interruption mitigation has been studied in other health care settings. No-interruption zones [10], medication preparation booths [11], "do not disturb" vests [12], and signage [13,14] have all shown promise in reducing interruptions. However, these methods have been specific to a certain area or task and may not be practical to implement for a wider variety of areas and tasks that are of concern. These methods also aim to block interruptions without making a distinction for context and interruption content. As suggested by our previous study [1], ICU personnel appear to regulate their interruptions based on nurses' tasks. Follow-up interviews with nurses who participated in this earlier observational study revealed a general perception that many of the

unnecessary or nonurgent interruptions in their environment happened when the interrupters were not aware of the criticality of the nurses' tasks. Thus, tools or methods that improve the awareness of the ICU personnel on the criticality of the tasks performed by nurses may empower them to further modulate their behavior.

The term *awareness display* has been used in previous interruptions research [15-17] to refer to displays that provide information about other collaborators' cognitive or work status (eg, workload, task, availability, etc). These displays have been widely studied in office settings with positive results [18,19] and have also been applied, to some extent, to health care settings. For example, Prakash et al [14] used a motion-activated "busy" indicator for pump programming in chemotherapy and found a significant reduction in pump programming errors. Their intervention was a combination of an awareness display, a no-interruption zone, a speak-aloud protocol, and signage. Thus, it is not clear how much of the total effect can be attributed to the awareness display. Furthermore, we are not aware of any application of awareness displays in the ICU setting.

1.1. Objective and hypothesis

In this article, we present an awareness display, called the task-severity awareness tool (TAT), which we designed for the same CVICU observed in our earlier study [1]. The tool, described in detail in the following section, is designed for nurses to inform others when they are performing high-severity tasks. We hypothesized that with the tool, interruptions with personal content would be reduced during high-severity tasks. To test this hypothesis, we conducted an observational study at this CVICU.

1.2. Task-severity awareness tool

A participatory design approach was used where design requirements of the awareness display (eg, shape, size, type, and location of buttons; displayed message; and color and location of the display) were identified based on interviews with senior CVICU nurses and a focus group consisting of 2 senior CVICU nurses and 2 human factors researchers.

The resulting intervention was a display we built comprising 1 Tri-Color Red-Green Type Programmable Scrolling Light Emitting Diode (LED) sign[1] that was hung on top of an ICU room entrance; 2 big dome LED buttons; and a foot pedal, controlled by an Arduino Uno microcontroller[2] (Fig. 1). Pressing any of the 2 buttons or the foot pedal turned the display on or off, which displayed the scrolling message "do not disturb please!" In addition, when the display was on, this status was confirmed for the nurses by the flashing of the 2 LED buttons at a rate of 1 Hz. The light was dimmed to minimize any distractions that the flashing light might cause.

2. Methods

2.1. Setting and participants

The CVICU of a Canadian hospital affiliated with the University of Toronto Faculty of Medicine was observed during weekdays over a 3-week period. The unit is a 24-bed closed CVICU that only accepts cardiovascular or vascular (both elective and emergent) surgery patients. The number of patients within the unit varies over the week, with approximately 12 patients cared for on Sunday, 16 on Monday, 20 on Tuesday, and 22 for the rest of the week.

There are approximately 20 registered nurses present during the day shifts, including 1 clinical resource registered nurse and 1 nurse manager. Overall, there are approximately 100 nurses working in this CVICU. Other personnel generally available during day shifts on weekdays are 1 patient care coordinator (PCC), 2 staff medical doctors (MDs), 2

vascular fellows, 2 unit clerks, 3 patient care assistants, and 3 to 4 cardiovascular surgeons. Each day, there are 2 rounds (at 07:30 AM and 3:00 PM) in which the CVICU team participates. There are also vascular team rounds at 08:00 AM. For our study, rounds were treated as a special case due to the significant volume of communication-related events and the presence of many clinicians (sometimes up to 10), and so no observations were conducted during these periods.

On a given day, the CVICU nurses who were rostered for that shift (~20) were randomly approached and asked to participate in the study. The first nurse to agree, who had not participated in the study before, was selected to participate. Overall, 28 (75%) of the nurses who were approached participated in the study.

2.2. Task-severity awareness tool intervention and study design

Task-severity awareness tool was installed in 1 CVICU room that was close to the nursing station and was considered by the nurses to be in a busy section of the unit. The tool was installed 2 weeks before the start of observations and was operational outside the data collection periods. The LED buttons and the floor pedal were positioned for ease of access during high-severity tasks. One of the LED buttons was installed on a wall close to the patient bedside, the other button was installed on the medication preparation desk, and the floor pedal was also installed close to the patient bed (Fig. 1). The nurses who were observed were instructed to use TAT for high-severity tasks. The classification of tasks as high- vs non–high severity was based on our earlier study that was conducted in the same CVICU [1] and is presented in Table 1. In this previous study, ICU tasks were categorized by 4 experienced CVICU nurses (their mode rating was used) as high or non-high in terms of the consequences to the patient in the event of an error.

Observations were conducted on weekdays between 10:00 AM and 6:00 PM during day shifts (07:30 AM to 07:30 PM) over a 3-week period. The study was approved by the University Health Network Research Ethics Board (file no. 13-7147-AE; Toronto, Canada), which oversees research activities for the hospital studied. The nurses who agreed to participate signed an informed consent document. The observations were conducted in a specific ICU room that was under the care of the participant. The observer was stationed in this room and recorded interruptions experienced by the participant throughout the session. Patient data were not collected; thus, patient consent was not required for the study. Other nurses were only observed if they interrupted the participant. Their consent was also not required by the research ethics board.

Three observers (1 doctor of philosophy [PhD] candidate and 2 undergraduate engineering students) trained in human factors research and clinical observation conducted 28 observation sessions (1 observer per session): 15 in the room with TAT and 13 in the other 11 CVICU rooms. Observations of nurses ranged from 46 to 120 minutes, with an average of 104 minutes. The total observation time was approximately 40 hours. Each 2-hour block from 10:00 AM to 6:00 PM was observed at least 5 times. All three observers were also involved in the previous observational study that was conducted at the same CVICU [1]. In addition, the undergraduate students performed 2 pilot studies (2 hours each) along with the PhD student. The first pilot study was used to review and discuss event coding and scenarios, and the second pilot study was used to conduct interrater reliability. Furthermore, a codebook was used to ensure standard adoption of terminology and to homogenize event coding (Table 1); this book was based on our previous observational study [1].

2.3. Data collection instrument

To facilitate real-time time-motion data collection, a software tool inspired by Remote Analysis of Team Environments [20] was developed and was used on Apple iPad (with retina display) tablets (Fig. 2). This tool included 4 clickable and scrollable lists: interruption source, primary task, interruption content, and specific content (described in Table 1).

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[1] Shenzhen Jingzhi Electronic Technology Co, Ltd, China.
[2] Smart Projects Ivrea, Italy.