

The Stay S.A.F.E. Strategy for Managing Interruptions Reduces Distraction Time in the Simulated Clinical Setting

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Interruptions occurring during the delivery of health care are frequent and create a serious threat to patient safety. It is important to test strategies directed at decreasing the negative effects of interruptions. The purpose of this pilot study was to test the Stay S.A.F.E. strategy for managing interruptions. A pretest, posttest quasi-experimental design was used to test the primary hypothesis that the Stay S.A.F.E. interruption management strategy would significantly ($P < .05$) reduce distraction time away from a primary task following an interruption. Twenty nurses with a median of 12 years of experience (range: 1–45 years) participated in the study. There was a significant decrease in the amount of time that participants were distracted away from the primary task between the pretest (134.47 seconds, $SD = 6.87$) and posttest (6.08 seconds, $SD = 1.27$) periods; $P = .0004$. The results of this study suggest that the Stay S.A.F.E. interruption management strategy was effective in reducing the length of time participants were distracted from the primary task in a simulated clinical setting. In addition, nurses confirmed the reports of others that interruptions are frequent, dangerous, and result in errors. **Key words:** *clinical simulation, eye tracking, human factors, interruption management, medication administration, patient safety, Stay S.A.F.E. strategy*

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INTERRUPTIONS occurring during the delivery of health care are frequent and create a serious threat to patient safety.^{1–6} Interruptions disrupt the performance of a task putting the primary task and interruption task at risk. It is well described that interruptions result in an increase in medical errors.^{6–9} Errors associated with interruptions include patient identification and medication errors,^{6,10} failure to complete tasks,⁸ and omission of critical safety processes such as pretransfusion blood checks.⁷ Researchers have reported that some interrupted tasks are never resumed^{3,11} and others are resumed only after completing up to 8 other tasks.³ In a recent observational study, emergency physicians were interrupted 12 times per hour and

three-quarters stopped their primary task and engaged in the interruption task. Few used interruption management strategies to handle the frequent interruptions.¹

Research to date has focused on evaluating interventions aimed at reducing the frequency of interruptions during the medication administration process. Visual alerts (eg, red vests, signage, no interruption zones), checklists, and combinations of interventions have been shown to be effective in reducing the frequency of interruptions¹²⁻¹⁵ but have not always been well received by patients or nurses leading some researchers to question their sustainability.¹⁵ In addition, few studies have been conducted in critical care units where interruptions can have especially significant patient safety consequences. In a pilot study by Anthony and colleagues,¹⁴ implementation of a no interruption zone was shown to significantly reduce interruptions in intensive care units. Grundgeiger et al¹¹ described factors that influence intensive care unit nurses' ability to resume tasks following an interruption and reported on behaviors nurses used when responding to an interruption. These behaviors included finishing the primary task before attending to the interrupting task and holding onto artifacts related to the primary task while attending to the interrupting task.

Interruptions are not always preventable and are often necessary to provide safe patient care. As a result, it is important to test strategies directed at decreasing the negative effects of interruptions when they do occur. The purpose of this pilot study was to test an investigator-developed strategy for managing interruptions, termed Stay S.A.F.E. This innovative interruption management strategy is based on Altmann and Trafton's¹⁶ empirically supported "Memory for Goals" model. The model provides an explanation for how environmental and mental cues can be used to create a "place mark" that aids in effectively and efficiently resuming a task. A number of investigators in other domains have demonstrated support for the memory for goals model.^{17,18}

This pilot study was conducted to inform a future, large study. Study objectives were to (1) describe nurse participants' experiences with interruptions in the workplace, (2) evaluate the impact of the Stay S.A.F.E. interruption management strategy on the length of time participants were distracted away from the primary task following an interruption, (3) measure participants' perceived workload during the simulation scenarios, and (4) describe participants' perceptions of the usefulness and applicability of the Stay S.A.F.E. interruption management strategy.

METHODS

A pretest, posttest quasi-experimental design was used to test the primary hypothesis that the Stay S.A.F.E. interruption management strategy would significantly ($P < .05$) reduce distraction time away from a primary task following an interruption.

Participants and setting

Registered nurses with 1 or more years of experience were invited to participate in the study. The study was conducted in a clinical simulation laboratory. Participants signed a written consent form and were compensated with a \$75.00 cash stipend. The institutional review board of the affiliated university approved the study.

Simulation scenario

Participants were instructed to provide care as they normally would in the practice setting and were assigned tasks that needed to be completed. The tasks included medication administration, medication reconciliation, and manual calculation of 12-hour intake and output totals. The participants were told that they could perform the tasks in whatever order they determined appropriate.

Instruments

Eye tracker

Participants wore an eye-tracking device (SensoMotoric Instruments, Teltow, Germany) during the simulation, which allowed

the investigators to observe the participants' eye movements as they carried out assigned tasks. The eye-tracker is a lightweight, tetherless system that allows participants to move freely through the simulation environment. The device records a video of the area in front of the wearer and uses pupil-corneal reflection to measure the position of the eye in relationship to the environment. The eye-tracker software program overlays crosshairs on a video, showing the exact locations in a scene where the individual is directing his or her gaze throughout the simulated scenario.

After completing the simulation, participants completed 3 written instruments: (1) a demographic data form (2) the NASA Task Load Index (TLX) instrument, and (3) an open-ended survey. The demographic data form asked participants for their clinical specialty area, years of experience, and prior experience with clinical simulation. The NASA TLX measures the perceived workload of a task, assessing performance demands across 6 dimensions: mental, physical, temporal, effort, performance, and frustration as well as overall weighted workload.^{19,20} In this study, the NASA TLX instrument was used to measure participants' perceived workload associated with the simulation experience. The open-ended investigator-developed survey was designed to capture the participants' experience with interruptions and their perception of the usefulness and applicability of the Stay S.A.F.E. strategy in the clinical setting. We also asked for suggestions for improving the Stay S.A.F.E. intervention and increasing the fidelity (realism) of the clinical simulation.

The intervention

The Stay S.A.F.E. interruption management strategy was developed on the basis of the memory for goals model,¹⁶ evidence from disciplines that successfully manage distractions using attention-based training in high-risk, error-prone environments,²¹ and previously described techniques used by nurses to stay on task following an interruption.^{11,22} We developed the acronym Stay S.A.F.E. to

make the interruption management strategy easy to remember and implement, not adding measurably to the cognitive burden imposed by the interruption.²³ The Stay S.A.F.E. interruption management strategy was taught to participants via a PowerPoint slide presentation that included a short video showing an actor demonstrating the strategy. See Table 1 for details of the Stay S.A.F.E. interruption management strategy and example statements given during the presentation.

The interruption

The interruption used in the simulation scenario was designed to maximize the impact of the interruption but it did not require an immediate change in the primary task. For the purpose of the study, an interruption was defined as a distraction away from the primary task, which could result in a complete cognitive break. The interrupting trigger (also called an alert or prompt) was a knock on the door by the interrupter, an actor posing as a health care professional. The interruption was a verbal patient report given to the participant (see Figure 1).

Data analysis

Eye-tracking videos were reviewed to measure the amount of time participants gazed at predetermined areas of interest (AOI) in the simulated environment. The eye movement metric was the gaze time on each AOI. Eye movement data were divided into 2 categories, informational and transitional. Informational data included eye gaze on the 5 AOI, the interrupter, medications, medication administration record, medical record (medication reconciliation and intake and output forms), and patient. Transitional data included scanning eye movements between the 5 AOIs. Two researchers (C.N., K.D.) independently reviewed an initial set of eye-tracking videos to ensure that coding methods were consistent and then coded the remaining videos separately. Eye-tracking videos were coded using the predefined informational (AOI) and transitional categories. Analyses of the eye movement data extended

Table 1. Stay S.A.F.E. Strategy for Managing Interruptions^a

		Example
Stay	Stay physically in your current location and stay engaged in the task at hand. Physically hold any items you are working with in your hand when possible.	Stay in the medication area, at the patient's bedside, in front of the computer. Do not leave the area to attend to the interrupting person. If you are giving a medication, keep it in your hand. If you are checking a patient's identification bracelet, hold it in your hand.
S	S ay aloud what you are in the middle of doing, being as specific as possible while still respecting patient privacy.	"I am in the middle of giving my patient her cefazolin."
A	A cknowledge the person interrupting you without looking away from your task.	Let the person know you are aware of his or her presence (either verbally or by gesturing).
F	F ixate on your place in the task for 1-2 s. F ind a natural break in the task when you can pause.	Fixate on the name of the medication, patient name on computer, and date of birth of patient. A natural break may be after giving oral or IV meds, or after completing documentation on a medication administered.
E	E stimate the time until you can attend to the interrupting person. Be reasonable but realistic.	"I'll be with you in 2 minutes after I finish giving my patient her antibiotic."

^aThe S.A.F.E. criteria can be performed in any order that is most comfortable for the user.

from 2 seconds prior to the interrupter knocking on the door to 5 seconds after the participant returned to the primary task.

A paired *t* test was used to compare the duration of participants' eye gaze on the interrupter in the pre- and posttest periods. Descriptive statistics were used for eye

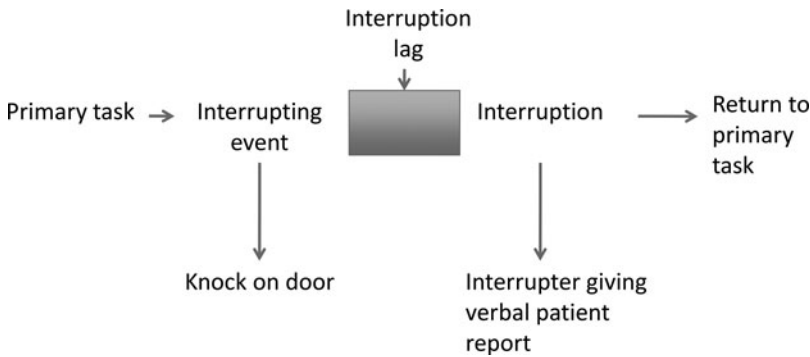


Figure 1. According to the memory for goals model, the interruption lag is the period of time between the interrupting event (prompt/alert) and the interruption. It is during this period that the person being interrupted can take steps to link mental and environment cues to the primary task being performed (called encoding), facilitating a return to the primary task.

movement and demographic data. Task load scores were calculated for each dimension of the NASA TLX and for the overall mean for the sample as described by Hart and Staveland¹⁹ using the paper and pencil version.²⁰ Open-ended participant statements related to experience with interruptions and usefulness and feasibility of the Stay S.A.F.E. strategy were reviewed and summarized by 2 study investigators (E.H., S.S.).

RESULTS

Twenty nurses with a median of 12 years of experience (range: 1-45 years) participated in the study. Participants had experience in a variety of clinical specialties including critical care, acute care, and emergency nursing. All participants had some prior experience with clinical simulation. Eye-tracking data were available for 16 of 20 participants. Complete task analysis scores were available for 17 of 20 participants. Missing eye-tracking data resulted from difficulty calibrating the

eye tracker because of thick eyelashes in 2 participants and placement of the eye-tracking glasses that resulted in 1 participant's line of vision to be blocked. In one case, no eye-tracking data, including video data, ever appeared on the computer screen. Three of the 20 participants did not complete the entire NASA TLX instrument.

Pre- and postintervention nurse behaviors

There was a significant decrease in the amount of time that participants were distracted away from the primary task between the pretest (134.47 seconds, SD = 6.87) and posttest (6.08 seconds, SD = 1.27) periods ($P = .0004$). A visual timeline of data demonstrating gaze times on the various AOIs in the pre- and postintervention periods is shown in Figure 2.

Preintervention

In the preintervention period, 4 of the 16 participants (25%) who were interrupted immediately stopped their task, turned toward

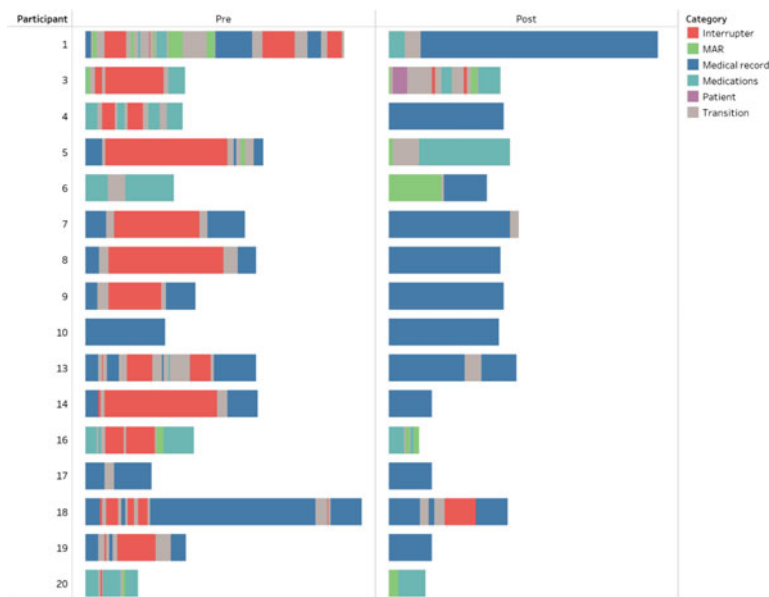


Figure 2. Timeline visualization showing duration of eye gaze on each area of interest and transition time in the pre- and postintervention periods for each of the 16 participants for whom eye-tracking data were available. MAR indicates medication administration record.

the door, and took report from the interrupter. Nine of the 16 nurses (56%) turned toward the door, looking away from their task, but did not take report and told the interrupter that they would be with them shortly. The remainder of the nurses (19%) did not turn toward the interrupter and kept their finger on the data they were attending to, although their visual scanning patterns showed disengagement with the task (Figure 3).

Postintervention

The majority of participants (14/16) used the entire Stay S.A.F.E. strategy when responding to the interruption. An example of the eye-tracking data of a nurse who used the complete Stay S.A.F.E. strategy is displayed in Figure 4. The remainder of the nurses (2/16) used parts of the Stay S.A.F.E. strategy but looked briefly at the interrupter before completing the entire strategy.

NASA TLX scores

The highest NASA TLX scores were related to temporal (56.9) and mental (51.0) demand and the lowest to physical demand (13.2). The overall average task load index was 45.8. (See Table 2 for scores in all dimensions.)



Figure 3. Visual scanning pattern following an interruption in the preintervention period.

Participant response to open-ended questions

Participants described interruptions as common, frustrating, and likely to result in errors. Common sources of interruptions reported by participants were other staff, physicians, patients, and family members. Themes related to the impact of interruptions included increased time to complete tasks, delay in resuming a task, forgetting to complete tasks, and the potential for medication and documentation errors.

Several nurses reported that they were often interrupted while engaged in tasks

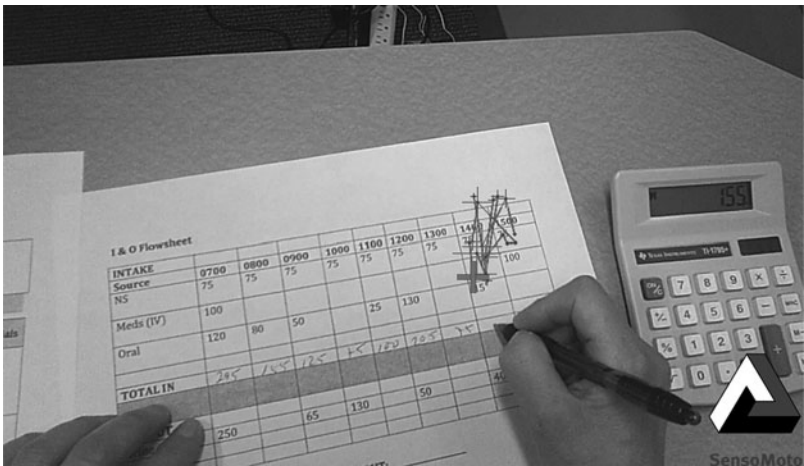


Figure 4. Visual scanning pattern following the Stay S.A.F.E. training.

Table 2. NASA Task Load Index Scores by Dimension and Overall Weighted Workload

Dimension	Weighted Average
Mental demand	51.00
Physical demand	13.21
Temporal demand	56.90
Effort	49.53
Performance	34.85
Frustration	44.63
Overall weighted workload	45.81

requiring a high level of cognitive attention, such as when documenting on the computer. They described comments from colleagues such as “can you help me now while you’re not busy?” Also noteworthy was a novice nurse’s comments on the impact of the interruption on her ability to continue the primary task. She related that as soon as she was told that she would be getting a new admission, she was unable to concentrate and instead of focusing on the primary task, her thoughts turned to the new patient, including trying to remember whether or not she had cared for any patients with the same diagnosis.

All participants commented that the Stay S.A.F.E. strategy would be feasible and useful in the workplace setting for staying on task. The majority of nurses (17/20) commented that the Stay S.A.F.E. acronym was easy to remember. Several nurses (4/20) commented that the strategy would be beneficial to other clinicians including student nurses, medical students and resident physicians. Of note were that 3 nurses reported feeling uncomfortable with the Stay S.A.F.E. strategy initially because they were not immediately attending to the person doing the interrupting, believing that they were being disrespectful but later were able to appreciate that providing safe care was more important than trying to be polite.

Participants’ suggestions for improving the fidelity of the simulation included increasing the number of interruptions, having an in-

terruption by the patient, moving the medication area away from the patient, having more background noise such as family member conversations and alarms, and increasing the time demand of the simulation.

DISCUSSION

The results of this study suggest that the Stay S.A.F.E. interruption management strategy was effective in reducing the length of time participants were distracted from the primary task in a simulated clinical setting. In addition, nurses confirmed the reports of others that interruptions are frequent, dangerous, and result in errors.¹⁻⁹ Participants also reported that the Stay S.A.F.E. strategy was easy to remember, useful, and feasible to implement in the clinical setting.

Comments by some participants that the failure to immediately attend to the interrupter could be interpreted as being impolite speak to the variety of system and human factors other than cognitive processes that impact how interruptions are managed. System factors such as workplace norms that support hierarchical reporting structures can have a profound influence on how interruptions are managed including when and how to address an interrupting event. This decision is based, in part, on prior knowledge and experience with the task being performed and the cognitive load imposed by the interruption.²⁴ Other factors that influence how an interruption is managed include the urgency imparted by the interrupter and the level of trust the person being interrupted has in the interrupter’s evaluation of the level of urgency.²³

The cognitive load imposed by the interruption in this study is supported by the high mental NASA TLX scores of study participants, which were similar to those reported by physicians in a naturalistic setting.²⁵ Of note is that the mental workload scores in our study increased significantly (28.3-60.3, $P = .01$) after making minor changes (interrupter wearing white coat and increasing the time pressure) to the simulation intended to increase the fidelity of the

simulation. These increases in workload may have been related to the changes in the relationship between interrupter and the participant and sense of urgency that resulted from these modifications to the simulation. Experimental manipulations have previously been shown to be associated with significant changes in workload ratings.¹⁹

The potential negative impact of an interruption was described by a novice nurse participant who related being so distracted by the thought of getting a new admission that she could not concentrate on the task at hand. This finding suggests that the impact of an interruption is influenced not only by the individuals' knowledge and experience with carrying out the primary task but their knowledge and experience with the new task imposed by the interruption.²⁴

Limitations of the study include a small sample size and having the posttest evaluation immediately following the intervention. It is not clear that the results would be similar with a larger group or if the postevalu-

ation occurred at a later time. Noteworthy, participants in the study were from a number of different hospitals and health care settings, and the subjective comments of the nurses regarding concerns with interruptions and ways to improve the simulation were similar.

Future research

Research is needed to investigate the effectiveness and acceptance of the Stay S.A.F.E. interruption management strategy in the clinical setting. In particular, it will be important to evaluate whether the strategy is accepted and used over time. It is likely that real sustainability of any interruption management strategy including Stay S.A.F.E. will require an organizational commitment to an interruption management program that is framed within a culture of safety. Outcomes to the implementation of any interruption management strategy include time to return to task, noncompletion of tasks, postcompletion errors, and stakeholder satisfaction.

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