

Can You Multitask? Evidence and Limitations of Task Switching and Multitasking in Emergency Medicine



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Emergency physicians work in a fast-paced environment that is characterized by frequent interruptions and the expectation that they will perform multiple tasks efficiently and without error while maintaining oversight of the entire emergency department. However, there is a lack of definition and understanding of the behaviors that constitute effective task switching and multitasking, as well as how to improve these skills. This article reviews the literature on task switching and multitasking in a variety of disciplines—including cognitive science, human factors engineering, business, and medicine—to define and describe the successful performance of task switching and multitasking in emergency medicine. Multitasking, defined as the performance of two tasks simultaneously, is not possible except when behaviors become completely automatic; instead, physicians rapidly switch between small tasks. This task switching causes disruption in the primary task and may contribute to error. A framework is described to enhance the understanding and practice of these behaviors. [Ann Emerg Med. 2016;68:189-195.]

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INTRODUCTION

Interruptions that cause breaks in task contribute to medical errors and risk potential harm to patients.^{1,2} Interruptions are common in the emergency department (ED) and each increases the risk of task incompleteness.^{3,4} Although emergency physicians often consider themselves to be effective and efficient multitaskers, evidence indicates that multitasking does not exist in the way that physicians have historically assumed.

The theory behind task switching, a clinical model demonstrating task switching, and the limitations of human performance as they apply to simultaneous task management will be explored to better understand the process of task switching in the ED. In accordance with this literature, we will offer suggestions for how physicians can heighten their awareness of interruptions or breaks in task, as well as methods for handling interruptions to maintain efficient and safe patient care. Finally, we will explore the critical importance of modeling and teaching trainees how to task switch more effectively, as well as education methods for doing so.

Definitions and Theory

Physicians use both multitasking behavior, defined as the simultaneous performance of two discrete tasks, and task switching, defined as changing between two separate tasks,

sometimes rapidly.⁵ It is likely that task switching is the more common and accurate description of typical physician behaviors in the ED. The term *task switching* is used for the purpose of this article. We additionally use terminology including *interruption* (a type of task switching in which the original task is returned to after a brief switch) and *break in task* (in which a new task is started as a result of the task switch).⁴ Effective clinical task switching and efficient clinical task switching are behaviors that optimize task completion while minimizing additional cognitive load.

Evidence in Emergency Medicine

Although much of the literature in business and human factors engineering has focused on decreasing task switching behavior by decreasing external distractions, in the ED there are generally few options for reducing or eliminating the multiple, simultaneous demands that compete for a clinician's attention. Research in emergency medicine has focused on frequency and type of interruption. In 2000, Chisholm et al³ demonstrated that during a clinical shift, physician interruptions occurred a mean of 31 times in 180 minutes. This landmark study established the frequency with which interruptions draw an emergency physician's attention away from his or her primary task. Further work by Chisholm et al⁶ showed that emergency physicians experience more interruptions than office clinicians and

manage more patients. Emergency physicians also task switch more than physicians on the wards despite that ward physician work accounts for more total tasks. The nature and complexity of work and individual physician factors affected clinician strategy in both settings.⁷ A study evaluating the association of interruptions experienced by emergency physicians and task completion times and rates showed that tasks that were interrupted were less likely to be completed than uninterrupted tasks (18.8% versus 1.5%). Interrupted tasks were completed more quickly than uninterrupted ones. The authors hypothesized that physicians shortened the primary task to compensate for the interruption and to make up time, potentially hurrying to complete the task by taking shortcuts, not fully completing some aspects of the task. Each of these has the potential to increase medical errors and subsequent risk to patients.⁸

There are a number of different types of interruptions in the ED related to the diversity of personnel and variable communication behaviors and expectations. For example, in one emergency medicine study, nursing interruptions of attending physicians tended to be shorter than interruptions by residents, although nursing interruptions occurred more frequently and accounted for more total interruption time. When residents interrupted faculty, a break in task (eg, going to evaluate a patient after a resident presentation) was more likely to result.⁹ In another study examining interruptions of ED practitioners, postgraduate year two residents were interrupted less frequently than postgraduate year three residents or faculty. The authors theorized that this was because junior physicians cared for fewer patients.⁴

All of these studies highlight the need for emergency medicine-specific tools to address the reality of task switching and its effects in clinical practice. Communication-related issues, including interruptions, are a frequently cited issue contributing in the root cause analysis of sentinel events that result in adverse patient outcomes.¹ The actual effect of interruptions and task switching is uncertain because interruptions are one component of many that may contribute to adverse outcomes.^{2,10,11} The ability to effectively task switch is a skill that is assumed and expected to develop during emergency medicine training.¹² Understanding how physicians task switch is foundational for successful emergency medicine practice and to improve individual clinical practice and teach this critical skill.

HOW THE BRAIN TASK-SWITCHES: A MODEL AND IMPLICATIONS FOR SAFETY IN THE EMERGENCY DEPARTMENT

For larger task completion in a complex or demanding environment, the brain divides the task into smaller, discrete

components. For the purposes of this model, we consider the first task to be the primary one and any additional task a secondary one, without regard to relative importance of an activity. Components of two larger tasks may be performed separately in sequence, which is often perceived as the two larger tasks being performed simultaneously because completion of the smaller components intermixes. This can lead to a high rate of task incompleteness because of incomplete or inadequate performance of all necessary steps to accomplish one of the primary, larger tasks.¹³ The risk of incompleteness of a task is also increased by interruptions, making return to a partially completed task even more difficult.

The frequency of task switching and multitasking is uncertain. Observable interruptions noted in clinical settings are only a portion of the total number of interruptions that occur. For every interruption from an external source, it is estimated that there is at least one more “internal” interruption occurring in which the practitioner’s mind “moves” to a new task rather than being interrupted by an external stimulus.^{14,15} Such internal interruptions can also contribute to a lack of completion of physicians’ primary activities, ie, recalling the need to review a test result or enter an order and moving to this task while engaged in another primary task.¹⁶ Regardless of whether external or internal, interruptions reduce the overall accuracy of tasks being performed and increase the rate of error when tasks are performed.¹⁷⁻¹⁹

Behavioral research suggests that, despite having the knowledge of potential negative consequences, humans are unable to stop changing focus between multiple tasks.^{20,21} External interruptions can be reduced (eg, by disabling e-mail pop-ups, closing the office door, turning off telephones); however, these options are often not available or practical in the ED.²² Therefore, emergency physicians need to understand the basis and behaviors of task switching and multitasking to consciously improve their ability to return to and complete tasks.

Cognitive Load Theory

Human memory consists of both working, or short-term, memory and long-term memory. Working memory can process only a finite number of new information elements at one time, usually limited to two to seven items, whereas the capacity of long-term memory is virtually unlimited.¹¹ Therefore, the characteristics of working memory serve as an important limit to learning and recall of new information, as well as information processing. Cognitive load describes the mental processing requirements that affect the use of limited working memory. There are three types of cognitive load, or the mental effort being used by working memory: intrinsic,

extraneous, and germane load.^{23,24} They are described here. Intrinsic load is related to the difficulty of a task itself. For example, the intrinsic load associated with recalling a previously memorized common drug dose is low, whereas the intrinsic load associated with calculating a weight-based dose is high. Extraneous load refers to the means by which a task or element of new information is presented and can vary, depending on the presentation of the material. For example, history taking associated with a meandering or unclear history increases the extrinsic load of information processing compared with a history reported in a succinct, orderly fashion. Germane load is complex in definition, but refers to the load associated with building mental structures that will subsequently be used to solve other similar tasks. In medicine, germane load may include the building of mental schema required for creating a differential diagnosis or recalling the order of procedural steps. An example of this is chunking, in which like items are grouped for easier, more efficient recall. Chunking requires some cognitive load devoted to the structure (germane), but overall decreases load on working memory and hastens coding to long-term memory. With time and practice, these behaviors become automatic, but early development of supporting mental schema may use significant working memory. Intrinsic, extraneous, and germane loads all contribute to the limitations and flexibility of working memory. The limitations of working memory help to explain why multiple distractions result in poor performance: when working memory is unable to manage frequent, simultaneous, competing stimuli or information, inefficient task switching and task incompleteness occur, and performance suffers. Finally, knowledge of these limitations can further the understanding of the effects of interruptions on complex tasks.¹¹

Multitasking

Multitasking, the simultaneous performance of two discrete tasks, can occur only when two tasks are automatic. Automatic tasks are those that are solidified in long-term memory through practice, learning, and repetition, almost subconsciously. Dually performed automatic tasks are more typically those that are practiced most frequently; for example, walking and talking. In contrast, nonautomatic tasks require conscious, deliberate attention and are limited to the capacity of working memory. The result is that simultaneous performance of nonautomatic multiple tasks is not possible.²⁵ Providers often perceive that they are multitasking when in reality they are often task switching. As providers become more experienced, commonly performed deliberate tasks become automatic. True multitasking becomes possible only when dual tasks are both automatic

and can occupy working memory simultaneously. Therefore as practitioners develop experience, tasks that might have saturated a novice's working memory begin to tax only a portion of available working memory. As an example, novice practitioners may not be able to react to a sudden clinical change while intubating a patient; they are required to task switch. In contrast, an experienced clinician may be able to multitask to make a diagnostic or therapeutic decision while performing the intubation.

Effects of Task-Switching

Each mental switch in task distracts the mind from the primary task. The [Figure](#) suggests a model for how emergency physicians may be confronted with multiple distractions, resulting in task switching. These switches come with the cost of mental delay, prolonged duration of activity, reduced quality, and increased workload. There is increasing literature citing the danger of distractions in air flight, driving, and health care.^{21,26,27} When a task is interrupted, the time to resume the initial task varies and depends on the duration, cognitive demand, and timing of the interruption.²⁸ Consequently, not all interruptions are equal in their potential disruptiveness. The ability to return to the primary task after interruption is affected by cues to return to the primary task, control over the timing of the interruption, the relatedness of the primary and secondary tasks, and the complexity of the interruption.²⁹ The complexity of work in the ED can be high, the timing of interruptions is rarely in the clinician's control, and many tasks in the ED are similar (task similarity). All of these factors contribute to a potential risk for errors in this model, through failure to return to task when interrupted because the mind incorrectly assumes the primary task is complete, a similar secondary task having just been completed.³⁰

Interruptions occurring just before task completion or during a key step in a task increase the risk of error through task component incompleteness. Task component incompleteness (leaving a step of a multistep task unfinished) is distinct from task incompleteness (leaving the entirety of a task unfinished). Both may lead to error through poor or failed performance of the overall task.¹³ This is critically important for tasks that involve specific, ordered steps such as medical procedures and is highly relevant for patient safety in the ED, in which both procedures and interruptions are common occurrences. Although the ED can also be rich with cues to return to task, including electronic medical record alerts, monitor alarms, or nursing reminders, these are not always consistent or predictable, again contributing to potential patient safety concerns.^{1,10}

Task switching in other fields, including aviation, driving, nursing, and business, is associated with an increased error rate.^{16,21,26,27,31,32} There is limited similar

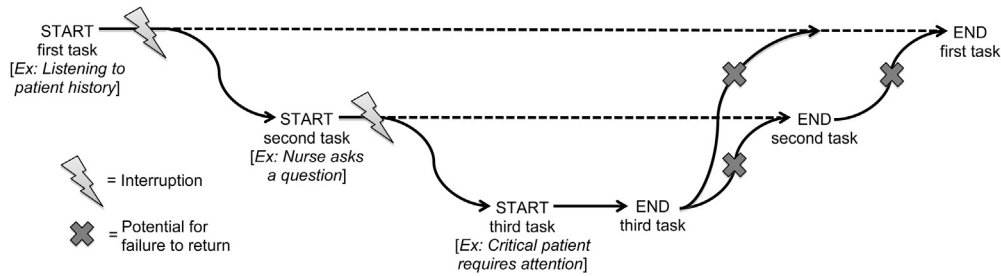


Figure. Model of distractions from the task in the ED.

research on the association between the interruption of physicians' work and rate of error. However, the Institute of Medicine report on errors in 2000 stated that environments that are more heavily distracted and have higher patient acuity are at greater risk for error, specifically EDs, ICUs, and operating rooms.¹ Although all health care workers constantly have to reorganize priorities in the clinical setting, emergency providers are interrupted at a rate almost three times that of providers in an outpatient office setting.^{6,7,33} Given the increasing body of literature documenting the association between errors and interruptions, it is reasonable to infer that actions to decrease interruptions should have a positive effect on patient safety.

RECOMMENDATIONS FOR PRACTICE

An emergency physician is expected to task switch and multitask effectively to function successfully in the ED. "The 2011 Model of the Clinical Practice of Emergency Medicine"³⁴ identified multitasking as one of the key skills of emergency physicians. The American Board of Emergency Medicine uses this model to determine content specifications for the certifying examination of emergency physicians, and thus the oral board examination includes a multiple-patient scenario to test the ability to manage and care for multiple patients while being distracted by new patient information. Furthermore, the emergency medicine residency and fellowship milestones require the assessment of multitasking (task switching).³⁵

In the clinical setting, how do physicians and other health care providers manage the large number of simultaneous, competing demands placed on them at any given time? Lessons from a multitude of fields, ranging from clinical medicine, the military, business, and air flight, can provide a framework for learning and teaching effective, efficient task switching. Techniques that can develop effective task-switching skills exist at the levels of the provider and the practice environment (Table). Individual providers can practice effective task switching by being cognizant of prioritizing tasks according to acuity, recognizing when an interruption can be delayed or

redirected, and practicing how to recognize interruptions that increase the risk for error.³⁶ Providers can develop long-term memory and decrease cognitive load by practicing procedural and cognitive tasks repeatedly. Practice and exposure to material through continuing education, clinical practice, simulation, and teaching can decrease cognitive load and increase pattern recognition of disease processes. Another way for providers to decrease cognitive load is to use simple mental frameworks for cognitive work, such as developing a differential diagnosis. The mnemonic AMPLE (*allergies, medications, past medical history, last meal, events/environment*) as a structured history for a potential surgical patient is an example of a simple framework.³⁷

The ED environment can be optimized to decrease interruptions and increase reminders to return to incomplete tasks. Interruptions to individual providers can be minimized through team-based interventions that use other ED resources to decrease interruption, decrease anxiety, and increase task completion. For example, nonurgent questions can be redirected to alternate providers during critical moments.²² Team members should train to recognize the signs of high-risk distraction times and practice how to deal with these conditions safely. Team debriefing of critical resuscitations or patient safety concerns should include specific time for team members to identify and analyze instances of task-switching behaviors and set goals for improved efficient task completion. This work can be accomplished in both the clinical setting and during simulation practice.^{36,38} Tools in the electronic medical record can streamline common work and provide reminders of commonly used tests in specific disease processes through order sets. Although not inclusive, these can offload some cognitive effort, leaving working memory for other tasks. With electronic medical records, there is the potential for "alert fatigue" and increased interruptions when electronic medical record-generated reminders become routine; in this case, provider-driven electronic medical record techniques (eg, lists, comments, sticky notes) may be as effective as or more effective than electronic medical record-driven alerts. Recent work

Table. Tips for developing effective task switching skills.**Task-Switching Skills****Provider skills**

Attend vs delay	Prioritize primary vs secondary task according to clinical acuity Consider whether interruption/switch can be delayed
Practice	Repetition of procedural skills to make tasks automatic Repetition of cognitive skills, eg, history taking or differential diagnosis development, to build and solidify mental schemas Improve clinical knowledge base to increase pattern recognition
Heuristics	Build/practice standard mental frameworks for repetitive procedural and cognitive work, eg, during procedures, history taking, and differential diagnosis building

Environmental interventions

Minimize	Turn off or ignore telephone/pager when not needed Recruit help with secondary tasks that are anticipated during a critical primary task performance, eg, hand off telephone/pager Reduce distractions in physical environment, eg, turn off patient TV, music Reduce unnecessary cross talk, distracting or off-topic discussion
Decrease anxiety	Train awareness and coping strategies to decrease anxiety and stress with interruptions Model calm behavior in chaotic or highly distracted conditions regardless of emotional state Teach mind-body techniques to increase focus on key tasks in the present moment
Situational awareness	Reflect on instances of good and bad task switching in provider and team practice Identify differences in scenarios Set specific goals about positive behaviors identified Train providers to ask other personnel for reminders at later, less critical times Train team members to identify critical times when interruptions might be more safely deferred Provide feedback to providers, team members, and trainees on their task switching and situational awareness
Department work flow policies	Dedicated systems to offload work from clinically working providers, ie, transfer requests Well-defined systems for real-time positive result reporting designed to limit interruption while minimizing missed results
EMR cue optimization	Development of EMR common use order sets and preference lists Development of standard documentation cues Focused, appropriate use of EMR tools for reminders, eg, use notes on EMR tracking board or EMR patient list functions Minimization of noncritical EMR alerts Customized EMR tools specific to practice environment
Physical space design	Quiet (“safe”) spaces for critical tasks Physical reminders during critical work where interruption should be minimized (ie, signs: “sign-out in progress”)

EMR, Electronic medical record.

suggests that electronic medical record tools customized to environment may reduce frequency of interruption.³⁹

Physical space in the department may also be optimized by providing quiet spaces for the performance of work that is potentially at high risk for error. For example, a department may have a separate area in which to perform critical tasks where all staff members are aware that no interruptions are allowed.^{26,40} Signs indicating critical work (“sign-out in progress” or “procedure in progress”) to signal staff to minimize interruption may also be helpful. Redirecting routinely communicated information such as transfers or radiology results to dedicated nonclinical personnel can decrease interruption.

Our recommendations for reducing the effect of and risks from task switching are summarized below:

- Decrease external interruptions
- Educate staff on the danger of interruptions
- Teach methods to improve task switching

- Use appropriate technology to increase rates of task completion
- Design standard department work flow to decrease interruptions

The [Table](#) includes several suggested modalities for developing the skills. The first is recognition of the risks associated with task switching and attempts to minimize interruptions or task switch more effectively. Ways to heighten recognition include role modeling and using key opportunities for teachable moments to reinforce the modeling behavior, such as sign-out rounds or after-shift debriefings. In addition, thinking out loud—or deliberate verbalization—may help describe, explain, and teach the efficient task switching that is being used by an expert.⁴¹ Opportunities for debriefing and reflecting on personal, peer, and mentor experiences may also improve skills.³⁸ Simulation can also be used to safely teach and develop improved task switching.³⁶ Residents and new providers

should have explicit clinical experiences intended to increase comfort and skills in task switching in a graduated fashion. These may include monitored and mentored gradual increase in patient volume load, patient acuity, and extraneous duties. Part of this progressive, developmental experience should focus on decreasing anxiety because higher levels of anxiety are associated with poorer primary task performance.⁴² Additionally, all ED staff should be educated to be aware of the effect that interruptions have on clinical work and the resulting potential for error, particularly for novices.

Summary and Future Directions

Effective and efficient task switching is a critical skill for successful emergency medicine practice. The ED environment is filled with interruptions. We have suggested a framework for understanding the cognitive science of task switching. Emergency physicians can improve their task-switching skills. Our suggestions on methods for improving and teaching efficient task switching are preliminary ones based on our analysis of the relevant literature. These suggestions are only the beginning.

A better understanding and evaluation of the development of clinicians' task-switching skills is needed to create educational interventions to achieve this aim for both trainees and practicing emergency physicians. Although further research on the association between task-switching behavior and clinical outcomes is necessary, as is the effect of electronic medical records and other technologies on this complex human behavior, it is clear that to optimize safe and efficient patient care, efforts to promote successful simultaneous task completion in the high-risk ED environment are warranted.

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DIAGNOSIS:

Chylous ascites. The patient received intravenous antibiotics and was admitted for suspected spontaneous bacterial peritonitis. Peritoneal fluid analysis showed normal white cell counts and Gram stain results and triglyceride levels of 2,196 mg/dL. Computed tomography (CT) of the abdomen and pelvis showed a para-aortic mass with chylous ascites (Figure 2). Biopsy of the mass confirmed a diagnosis of lymphoma. Chylous ascites is an uncommon finding, typically caused by disturbance of the lymphatic system¹ because of a mass or blunt trauma. Lymphomas are the malignancy responsible for most cases of chyloperitoneum.² The grim prognosis of chylous ascites as a result of lymphoma makes prompt diagnosis with lymph node biopsy or laparotomy imperative.² Surgery, chemotherapy, or radiation should soon follow.²

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