



Review article

Interruptions in the wild: Development of a sociotechnical systems model of interruptions in the emergency department through a systematic review

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ABSTRACT

Interruptions are unavoidable in the “interrupt driven” Emergency Department (ED). A critical review and synthesis of the literature on interruptions in the ED can offer insight into the nature of interruptions in complex real-world environments. Fifteen empirical articles on interruptions in the ED were identified through database searches. Articles were reviewed, critiqued, and synthesized. There was little agreement and several gaps in conceptualizing sociotechnical system factors, process characteristics, and interruption outcomes. While multiple outcomes of interruptions were mentioned, few were measured, and the relationship between multiple outcomes was rarely assessed. Synthesizing the literature and drawing on ergonomic concepts, we present a sociotechnical model of interruptions in complex settings that motivates new directions in research and design. The model conceptualizes interruptions as a process, not a single event, that occurs within and is shaped by an interacting socio-technical system and that results in a variety of interrelated outcomes.

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1. Introduction

Interruptions are unavoidable in healthcare environments and the “interrupt driven” Emergency Department (ED) is no exception (Chisholm et al., 2000). A critical review and synthesis of the literature on interruptions in the ED offers insight into the nature of interruptions in complex real-world environments, i.e., “in the wild.”

1.1. The importance of studying interruptions in the wild

The complexity of the ED provides an ideal environment for examining and understanding interruptions in the wild. Wears and colleagues (2002) describe six environmental features that make the ED particularly complex as compared to other health care settings: 1) an “unbounded” potential for patients, 2) simultaneous evaluation of patients with varying characteristics, 3) high levels of

uncertainty, 4) extreme time constraints, 5) lack of feedback regarding level of treatment success, and 6) unpredictable need for risky medical procedure. Although this list is not an exhaustive account of the complexities within the ED, it describes some of the key features that make the ED a particularly complex environment (Wears and Perry, 2002; Walter et al., 2014).

Perhaps due in part to the factors just described, the ED is particularly susceptible to preventable medical errors and adverse events (Wears et al., 2010). However, the specific factors contributing to these high rates of error in the ED are not yet known (Wears et al., 2010). Interruptions may be one such factor, but it is difficult to be sure based on the limited current understanding of the outcomes associated with interruptions in complex environments.

Prior reviews note that few studies capture or conceptualize the nature of interruptions in higher-complexity versus lower-complexity environments (Grundgeiger and Sanderson, 2009; Coiera, 2012; Li et al., 2012; Westbrook, 2014). The bulk of general interruptions research has been conducted in laboratory settings, where work system and interruption process factors are controlled or minimized and where certain outcomes (e.g., distal

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ones that take hours to occur and actual patient or organizational outcomes) cannot be or are not measured (McFarlane and Latorella, 2002; Hodgetts and Jones, 2006; Altmann and Trafton, 2007; Monk et al., 2008; Cane, 2012; Brumby et al., 2013; Altmann et al., 2014; Blumberg et al., 2014; Foroughi et al., 2014; Sasangohar et al., 2014; Altmann and Trafton, 2015; Drews and Musters, 2015; Foroughi et al., 2015; Werner et al., 2015).

Laboratory studies of interruptions have produced a conceptualization of interruptions that assumes a linear process and a singular interruption event (see Fig. 1). The typical anatomy of an interruption developed from laboratory research consists of a person working on a primary task and then suspending that task to attend to a secondary task (i.e., the interrupting task) (Altmann and Trafton, 2007; Boehm-Davis and Remington, 2009). The interrupting task may or may not be combined with an alert to the need to suspend the primary task. In this conceptualization, when the interrupting task ends, the person returns to the suspended primary task. Much of the practical concern over and documented detrimental effects of interruptions centers on the resumption of the original task – namely the time it takes to resume the primary task and the likelihood of making an error at the point of resumption.

However, a linear one-task-one-person interruption scenario is rarely the case in health care environments (Wears and Perry, 2002; Karsh et al., 2006; Holden et al., 2013; Carayon et al., 2014; Werner and Holden, 2014). Although laboratory models can be useful for understanding “micro”-level process characteristics and potential impact of interruptions, they have not successfully accounted for interrupted task performance in the complex socio-technical system environment (Carayon et al., 2006; Carayon et al., 2013; Carayon et al., 2014). For example, in health care delivery settings, and in particular the ED, multiple tasks occur in parallel and often involve multiple care providers, patients and sometimes their families. Interruption begets further interruption until the primary task itself may become unclear or forgotten. Primary and secondary task lines become blurred and the intensity and temporal demand of the environment may only create further layers of complexity. For example, a nurse may be providing discharge instructions to a patient and hear another patient calling for her from the other side of the curtain. Meantime, the nurse is remembering to ask the physician to enter orders that she needs for another patient's pain medication request. She also remembers that she has blood vials in her pocket to finish labeling and send to the lab.

Another nurse walks in and asks for help with a challenging patient. At that moment, a code is called and both nurses must assist immediately.

Interruptions have been studied in several health care environments including pharmacies, medication administration processes, surgery, primary care, intensive care units, trauma resuscitation, and a myriad other settings (Grundgeiger and Sanderson, 2009; Rivera-Rodriguez and Karsh, 2010; Magrabi et al., 2011; Li et al., 2012). These studies suggest that interruptions occur frequently, can lead to communication challenges, and are associated with errors in some circumstances (Rivera-Rodriguez and Karsh, 2010). Studies of interruptions in the ED can offer unique insight into interruptions in complex settings because the ED is a prime example of a high-paced, high-volume, low-certainty, multiagent, and dynamic—in short, *complex*—environment (Cosby and Croskerry, 2009; Nugus et al., 2010; Wears et al., 2010).

Another limitation of the currently available interruption literature is that the focus is on the interruption process, to the detriment of considering the context in which the process occurs, how context may shape the process, and the many potential outcomes of interruptions. Sociotechnical work system models (e.g., Fig. 2) have been used in health care settings to: 1) account for the complexity of the environment, 2) provide a framework for understanding how multiple work system components interact to form and influence health care processes, and 3) understand how system interactions and processes affect multiple outcomes (Carayon et al., 2006; Karsh and Brown, 2010; Carayon et al., 2013; Holden et al., 2013; Carayon et al., 2014; Karsh et al., 2014). Specifically, sociotechnical models such as the Systems Engineering Initiative for Patient Safety (SEIPS) model – which depicts a person (or persons) interacting with tasks, tools and technology, physical environment, organization, and external environment to perform processes that produce multiple outcomes – can be used both to describe a specific sociotechnical system and how changes affect the system (Carayon et al., 2006; Holden et al., 2013).

SEIPS 2.0 (Fig. 2) depicts a sociotechnical work system of multiple interacting components that produces performance processes, which in turn result in outcomes for patients, professionals, and the organization. The model portrays change over time in the form of feedback loops that modify the work system and process; thus, it conforms to the cyclical input-transformation-output conventions of open systems and sociotechnical systems models (Katz and Kahn, 1966; Pasmore, 1988; Karsh et al., 2006).

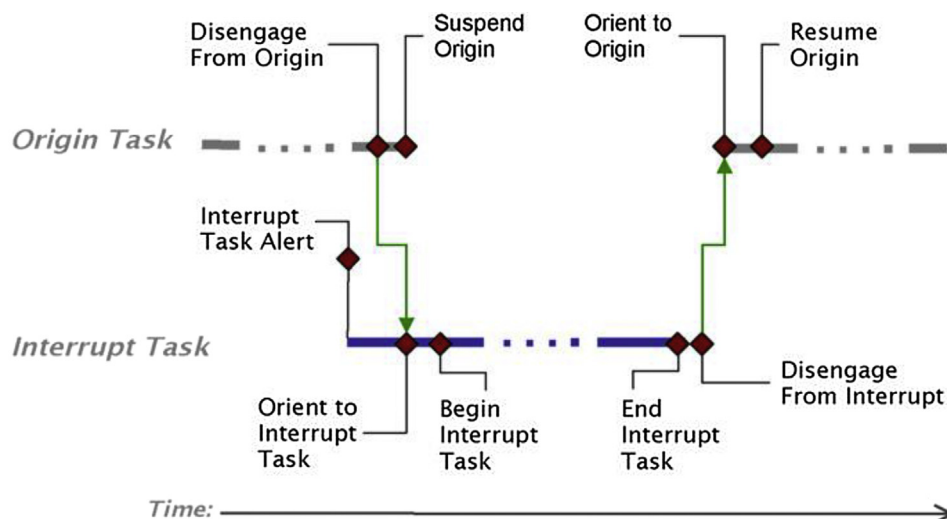


Fig. 1. Linear anatomy of an interruption with singular interrupting task from Boehm-Davis and Remington, 2009.

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