INFORMATION TECHNOLOGY IN THE EMERGENCY ROOMS: THE ROLE OF MINDFULNESS

by

ALLEN J. CURRERI

Submitted in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

Weatherhead School of Management

Designing Sustainable Systems

CASE WESTERN RESERVE UNIVERISTY

May, 2017

CASE WESTERN RESERVE UNIVERSITY

SCHOOL OF GRADUATE STUDIES

We hereby approve the thesis/dissertation of

Allen J. Curreri

candidate for the degree of Doctor of Philosophy*.

Committee Chair

Kalle Lyytinen, Ph.D., Case Western Reserve University

Committee Member

Ritu Agarwal, Ph.D., University of Maryland

Committee Member

David Aron, M.D., Case Western Reserve University

Committee Member

Richard Boland, Jr., Ph.D., Case Western Reserve University

Date of Defense

January 19, 2017

*We also certify that written approval has been obtained

for any proprietary material contained therein.

Dedication

I dedicate my dissertation to my family for their unconditional support and guidance. My parents, in particular, Joseph Curreri and Maureen Hall, set an early example of discipline, hard work, determination, education, kindness and personal growth. It is this foundation that set my course for continued learning and intellectual curiosity. Their words of encouragement to make a positive impact in everything I do will forever be an influence my life. I acknowledge with pride, my sister, Melissa Curreri-Levesque, who has been an extraordinary influence in my life. I watched her indomitable spirit and distinction as she moved up the ranks to a Major in the US Air Force. Melissa reminds me every day that hard work and compassion are tenants to an extraordinary life of pride and service to others.

This experience would have been impossible without the brilliant, selfless members of this cohort that shared this journey with me. I grew academically and became a scholar, but we all grew together as individuals. I learned every day from their experience, virtuosity and personal kindness. Their strong commitment to camaraderie continually reminds me that we are all stronger together.

Table of Contents

List of Tables

List of Figures

Acknowledgements

Most importantly, I wish to thank my committee members, Dr. David Aron, Dr. Richard Boland and Dr. Ritu Agarwal for agreeing to serve on my committee and who were exceptionally generous by sharing their experience, knowledge and time all the while, encouraging me every step of the way. A special thank you to Dr. Kalle Lyytinen, my committee Chair, mentor, academic guru, and friend. Kalle's countless hours of thoughtful direction, inspiration, and intellectual prowess was my ongoing guide. I knew that under his tutelage my research and academic growth would have an impact. Thank you for your patience throughout this process. I am proud that my Lyytinen number is one. Finally, the foundation of this program and in turn, all our experiences would not have been seamless without the care and attention of Marilyn Chorman, Sue Nartker, and Shelley Muchnikki. Their support has been instrumental to each student in the program. This dissertation would not be possible without you.

Information Technology in the Emergency Rooms:
The Role of Mindfulness

Abstract

by

ALLEN J. CURRERI

Split-second decisions in emergency departments often have life-or-death consequences for patients. Yet researchers are just beginning to understand the complexities of clinical decision making in emergency medical settings, where traditional, rule-based models are proving often inadequate. Meanwhile, hospitals are under increased pressure to cut costs while continuing to improve quality and safety of care and comply with new regulations. One way hospitals have responded to this pressure is by rapidly adopting healthcare information technology (HIT) systems, especially rule-based clinical decision support systems (CDSSs). By understanding what factors influence how physicians use HIT to reliably arrive at the correct diagnosis and treatment decisions, management can implement programs that improve the practice of emergency medicine. This sequence of three studies explores the role of mindfulness in emergency physicians' HIT-supported decision making. The first study qualitatively explores decision making among emergency physicians and finds that experienced physicians do not rely on rule-based decision strategies, instead they employ intuitive reasoning supported by mindful awareness of clinical contexts. The second study quantitatively tests a model of the relationship between HIT and emergency physician performance as mediated by mindfulness. Results reveal that mindfulness dampens a negative relationship between HIT use and performance, regardless of HIT characteristics. Finally, the third study sharpens the focus on mindfulness through a two-phase, embedded mixed-method design exploring the role of mindfulness in generating patterns of CDSS use. Findings reveal a significant positive correlation between mindfulness and performance. Results also show that more mindful physicians are open to change and may use CDSSs for confirmation only, rather than for initial diagnosis and treatment information. Overall, results reveal several important research directions and recommendations for healthcare management. It is clear that mindfulness has beneficial effects on physician performance, particularly in environments characterized by high HIT use. Managers should invest in training and interventions designed to improve mindfulness in ER physicians. They should also implement HIT use policies that allow physicians to use decision support tools in a supportive role. These findings should be of interest to HIT designers, who are advised to focus on designing tools that support, rather than hinder, user mindfulness.

Keywords: healthcare information technology; clinical decision support; emergency medicine; clinical decision making; mindfulness; situational awareness

CHAPTER 1: INTRODUCTION AND OVERVIEW

> *Technology today is so accurate that one doesn't need to risk diagnosing incorrectly*. (Study 1, participant, 37F)

> *There's a lot of science in medicine, but it is primarily still more of an art than science. All the science does is it informs and influences the art. When it comes down to it, it's still a patient, a person, and as we often say, patients don't read the textbooks.* (Study 1, participant 9F)

> *I make sure I spend more time engaged with the patient and not my paperwork. In fact, since you brought mindfulness to my attention, I've made it a habit to not depend on them [IT tools] as much. I will use them to verify my process and that's it. I won't look at it first now. This might be something that can be taught to us on a regular basis. I feel more empowered.* (Study 3, participant 17)

In the United States, an emergency room physician is a doctor specially trained to focus on the immediate decision making and action necessary to prevent death or further disability (Coget & Keller, 2010). In the prehospital setting, emergency physicians direct emergency medical technicians, and physicians themselves provide medical care inside the emergency department. The emergency physician provides immediate recognition, evaluation, care, stabilization, and disposition of a generally diversified population of adult and pediatric patients in response to acute illness and injury (Coget & Keller, 2010). Emergency departments differ significantly from other medical service settings in several ways: whereas physicians in non-emergency settings have extended time to consult with patients, access records and other information resources, and seek assistance from peers, ER physicians rarely have time for such luxuries.

For example, Coget and Keller (2010) reported a case study of an experienced emergency physician, Dr. Gene Keller. In one episode, Dr. Keller treated a man who complained of severe chest pain and had a medical history consistent with heart attack. However, based on his experience, the doctor noticed that the patient's description of his symptoms differed slightly from typical descriptions of heart attack pain. The authors described the physician’s dilemma:

> His intuition alerts him to the possibility that the patient may have a dissecting aneurysm. If indeed the patient suffers from a dissecting aneurysm and is directed to the Cath lab for treatment of a heart attack, he will probably die. However, if he is not treated for a heart attack within 90 min of the initial symptoms, he will suffer irreparable cardiac damage, and possibly die, in the process. (p. 58)

How does Dr. Keller decide whether to treat his patient for an aneurysm or a heart attack? Faced with such difficult situations, how do emergency physicians like Dr. Keller make the correct decisions quickly enough to save patients?

Understanding the decision-making process used by emergency room physicians is important because split-second ER decisions often have life-or-death consequences for patients. Researchers are just beginning to understand the complexities of clinical decision making in emergency room settings (Coget & Keller, 2010). Traditional, rule-based views of clinical decision making do not precisely reflect individuals’ lived experiences (Coget, 2004; Djulbegovic, Hozo, Beckstead, Tsalatsanis, & Pauker, 2012). From a management perspective, this topic is of crucial importance, because quality assurance programs need to account for the realities physicians face in treating patients with emergent conditions. Hospitals are under increased pressure to cut costs while continuing to improve quality and safety of care and comply with new regulations (Carr, DiGioia, Wagner, & Saef, 2013). By understanding how emergency physicians quickly and reliably arrive at the correct diagnosis and treatment decisions, management can implement key performance initiatives and quality assurance programs that improve the practice of emergency medicine.

IT-based clinical decision support systems (CDSSs) are increasingly appearing in emergency departments as tools to reduce costs, increase performance, enhance decision making, and save time (Carr et al., 2013; Dinh & Chu, 2006; Tsang, 2013). IT-based CDSSs range from mobile "applications" designed to recommend courses of action to modules that can be integrated with medical records to ensure treatments are consistent with patients' medical histories. The present research is concerned primarily with this class of IT tool, since it has the potential to change physicians' behaviors and, potentially, their performance. Some such tools have been found to be effective in emergency department settings to assess patient risk and determine treatment protocols (Anderson et al., 2014; Barrett et al., 2015; Watts, Fountain, Reith, & Herbison, 2003), but little research has examined the effect of healthcare information technology (HIT) use on physicians' performance and decision making strategies generally. In fact, one important review showed that, of 100 related studies, only 5 revealed improved outcomes from IT use in emergency departments, and none of these entailed improvements in overall mortality (Garg et al., 2005).

Reliable performance is typically studied in either in terms of automatic routines that produce desired results, such as diagnostic algorithms, or in terms of mindfulness, a non-automatic approach to solving problems that is characterized by highly context-dependent cognition (Langer, 1997; Spender, 1989). Butler and Gray (2006) argued that these two approaches to reliable performance are not mutually exclusive. Research also suggests that physicians' performance in emergency rooms is connected to multiple individual, organizational, and systemic factors (Wenghofer, Williams, & Klass, 2009). Among individual factors, physicians' level of mindfulness has recently been shown to positively correlate with improved performance: mindfulness increases the physician's ability to communicate effectively with patients (Beach et al., 2013) while reducing diagnostic errors (Sibinga & Wu, 2010).

The purpose of this research is to explore how emergency physicians use information technology, especially CDSSs, to make correct diagnosis and treatment decisions. Given the current equivocal findings on the effectiveness of HIT, there is an urgent need to understand the impact of environmental conditions and personal characteristics that lead better returns on HIT investment in the form of improved physician performance. The proposed sequence of three studies therefore needs to start with examining the multifaceted nature of physician decision making; then, the research subject will be about the role of mindfulness in HIT. Finally, I focus specifically on use patterns around CDSSs to determine how mindfulness alters physicians' use of these increasingly tools.

The remainder of this dissertation is organized as follows. Chapter 2 contains a review of research and theoretical literature related to the research topic. This literature review is organized according to the concepts that form the theoretical framework for the present research. Chapter 3 formulates the research questions and outlines the general research design for all three studies. Chapters 4-6 present in detail each of the three studies in the sequence. Finally, Chapter 7 contains the concluding discussion and notes limitations and practical implications of the findings.

CHAPTER 2: LITERATURE REVIEW

This chapter contains a review of theoretical and empirical literature related to the research topic, IT use in health care, mindfulness, decision making performance, and patient outcomes. We also introduce the concepts pertinent to the theoretical framework of this research. First, I summarize research related to clinical decision making, focusing on the multifaceted and complex nature of decision making in emergency medical environments. Reliable performance and mindfulness literature is reviewed in the next two sections. Next, I review literature related to healthcare information technology, which is central to all three studies, and restrictiveness, which is a key component of my quantitative model (see Chapter 5). Following this I conduct a review of literature related to clinical decision support systems (CDSSs), which form a particular class of HIT technologies with some unique features. The final section synthesizes what we know about the interactions among HIT, physician performance, and mindfulness from a clinical perspective.

Emergency Physician Performance

General Performance

Physician performance can be generally defined as the degree to which a physician performs well with regard to the outcome quality of patient care and communicates with patients or other professionals critical for rendering the care. Recent research suggests that physician performance is linked to several factors, including organizational factors (e.g., type of clinic), systemic factors (e.g., availability of basic diagnostic tests), and individual, physician factors (e.g., certifications held) (Wenghofer et al., 2009). Several studies have identified that personal and psychological differences are also important for explaining variations in physicians' performance (Mitchell et al., 2005). For example, Girard and Hickam (1991) found that emotions and attitudes among resident physicians explained 48% of the variation in their clinical performance, where depression was the strongest explanatory variable. The present study takes this finding into account by focusing on mindfulness, a physician attitude factor.

Several other factors which have been studied in the past may influence the relationship between IT environment features and physician performance. These are summarized in Table 1.

Table 1. Factors Influencing Emergency Physician Performance

Factor	**Definition**	**Effect on IT/performance**	**References**
Occupational stress	Perceived stress from work-related causes	Increased stress decreases physician performance.	Adler, Werner, and Korsch (1980); Mitchell et al. (2005)
Risk tolerance	The degree to which a physician is risk seeking or risk avoidant, compared to the mean	Risk tolerance leads to overuse of diagnostic technologies.	Andruchow, Raja, Prevedello, Zane, and Khorasani (2012); Tubbs, Elrod, and Flum (2006)
Years of medical experience	How long a physician has been practicing	More tenured physicians may perform better than less tenured ones.	Sparrow and Davies (1988); Van der Vaart, Vastag, and Wijngaard (2011)
Pay-for-performance availability	Whether a physician's workplace offers pay-pay-for-performance incentives	Performance incentives have been linked to increased performance.	Bruni, Nobilio, and Ugolini (2009); Rogers et al. (2015); Torchiana et al. (2013)
Extent of IT use at the point of patient care	How often physicians use IT tools during patient consultation	Increased IT use may distract physicians, resulting in lower performance	France et al. (2005); Hunt et al. (2009)

In addition to the factors listed in Table 1, scholars have suggested that mindfulness is crucial in situations where CDSSs are used (France et al., 2005), implying that more mindful users can be expected to make better use of CDSSs than those who are less mindful.

Clinical Decision Making Performance

Effective clinical decisions can be generally defined as those which lead to quality of patient care, which involves, not only accurate diagnosis and effective treatment, but also communication. Recent research suggests that effective clinical decision making is linked to several factors, including organizational factors (e.g., type of clinic, performance incentives), systemic factors (e.g., availability of basic diagnostic tests), and individual, physician factors (e.g., certifications held and length of experience) (Bruni et al., 2009; Rogers et al., 2015; Torchiana et al., 2013; Van der Vaart et al., 2011; Wenghofer et al., 2009). Several studies have identified that personal and psychological differences are also important for explaining variations in physicians' performance (Mitchell et al., 2005). For example, (Girard & Hickam, 1991) found that emotions and attitudes among resident physicians explained 48% of the variation in their clinical performance, where depression was the strongest explanatory variable. From a qualitative perspective, the same is true. Clinicians have been found to view organizational structure and support and psychological feelings of competence as important to effective clinical decision making, in addition to traditional medical education (Hagbaghery, Salsali, & Ahmadi, 2004; White, 2003). This research strongly supports the argument that classical, rational decision theory is inadequate for understanding clinical decision making in the real world, which involves not just utilities and probabilities, but is influenced by a wide range of other factors.

Nevertheless, programmed decision making procedures and routinized decision support systems (such as technology-based decision aids, described above) may also improve clinical practice in some cases. One review found that, in 68% of clinical trials of decision support tools, the systems improved clinical decision making effectiveness (Kawamoto, Houlihan, Balas, & Lobach, 2005). Not all decision support tools are created equal. Timing, workflow, ease of use, user expertise, decision support restrictiveness, and simplicity are all factors found to influence whether decision support systems lead to more effective clinical decisions (Arnold, Collier, Leech, & Sutton, 2004; Arnold & Sutton, 1998; Bates et al., 2003; Kawamoto et al., 2005). This underscores the importance of mindfulness at the organizational and policy levels; healthcare organizations increasingly invest in such decision supports, and mindfulness at the organizational level can therefore lead to more effective decision making among clinicians, who may use decision supports mindlessly (France et al., 2005; Williams, Asi, Raffenaud, Bagwell, & Zeini, 2015).

However, there is a gap in existing literature related to how mindfulness and other factors influence decision making, and how changes in decision making lead to behaviors that translate to improved performance. Therefore, I turn to a discussion of literature on decision theory in clinical settings, focusing on the link to performance.

Decision Theory and Clinical Decision Making

In the previous section, I defined emergency physician performance and summarized factors found to be related to performance. However, it is not yet known how these factors improve performance. This gap in the literature exists because performance factors have been insufficiently discussed in the context of physician decision making. Clinical and IT environments could influence how physicians make diagnosis and treatment decisions, and these decision behaviors could, in turn, affect patient outcomes. Therefore, it is important to understand the clinical decision making process. In this section, I review several competing theories of clinical decision making.

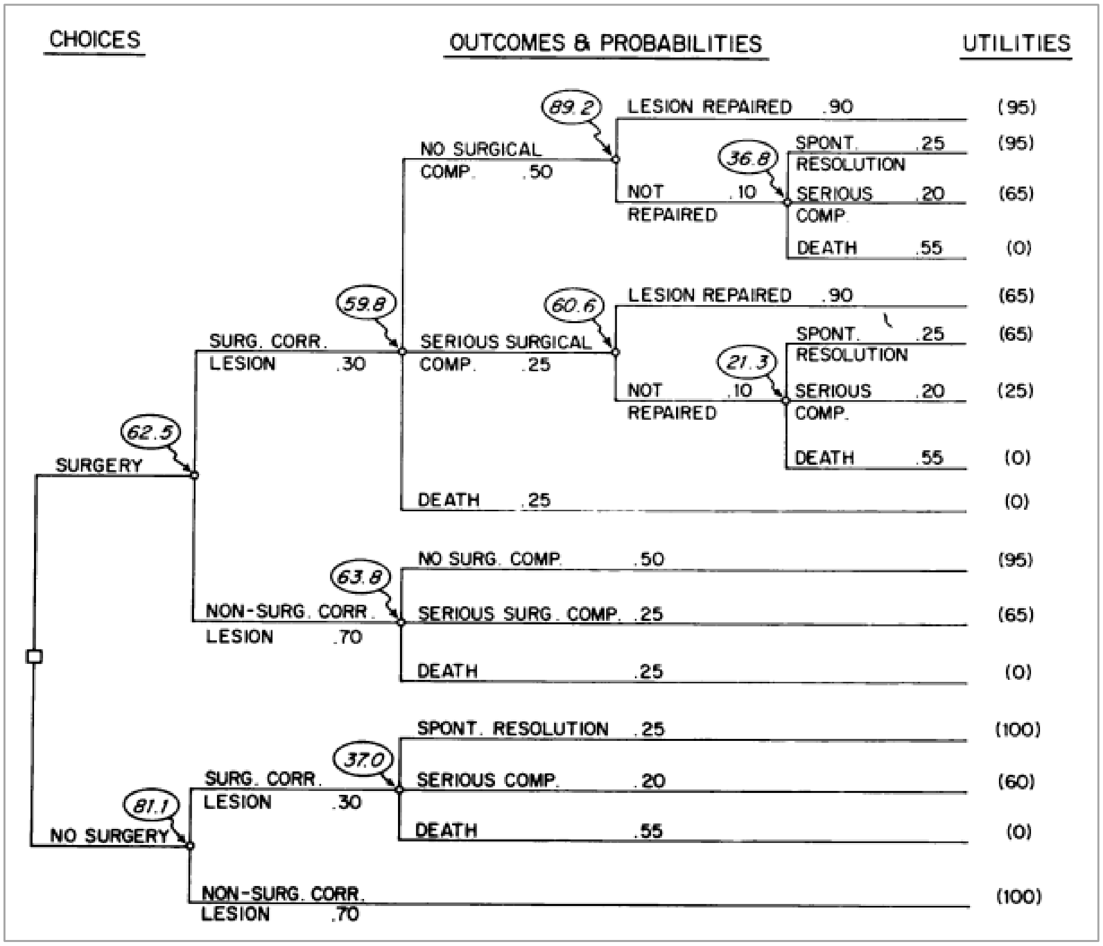
Classical Decision Theory and Clinical Decision Analysis

Decision making is a process whereby individuals "judge, evaluate and make choices about behaviors or goals" (Gong et al., 2013). Classical decision theory, which has roots in the fields of mathematics and economics, approaches decision making from the perspective of *values* (or *utility* based on some concrete criterion) and *probability*. On this model, individuals make decisions in accordance with their values (or the values/utilities assigned by a governing organization or social norm) and given an assessment of the probability that certain decisions will lead to outcomes consistent with their values (Bross, 1953; Chernoff & Moses, 2012; Edwards, 1954; von Neumann & Morgenstern, 1947). This view of decision making has been applied to many disciplines, especially that of organizational and managerial decision making, where decision theory has developed a firm footing. For example, according to Janis (1989), organizational decision making is goal-driven, and organizational leaders make decisions based on a belief that their strategic choices will be successful to the degree required to achieve the goal at which the decision is directed. Thus, the leader's or organization's values determine the goal, the leader's decision is based on an assessment of the probability of achieving that goal. The process of defining goals, weighing options, assessing probabilities, and selecting the optimal decision from among available choices is called *rational decision making* (Coget & Keller, 2010; Doyle, 1999). Although there are other models of human decision making (a few of which are considered later in this essay), the bulk of existing research on decision making focuses on the classical, rational model (Bazerman & Moore, 2012; Simon, 1979; Tversky & Kahneman, 1990), and the classical concepts serve as an important foundation for understanding more recent developments in decision theory.

Classical decision theory can be applied to emergency physicians' decision making in clinical contexts. A *clinical decision* is any decision that affects patient treatment (van der Velde, 2005). In some healthcare settings, such as surgery and emergency medicine, clinical decisions have particularly high stakes and may be associated with greater levels of stress and uncertainty, representing one extreme of decision making in general (Coget & Keller, 2010; Shepherd & Rudd, 2014).

The classical model of decision making has been applied to clinical decisions in the form of clinical decision analysis. Clinical decision analysis applies the mathematical approach of decision analysis to clinical decisions, based on utility and probability values determined from empirical research (Sisson, Schoomaker, & Ross, 1976; Weinstein & Fineberg, 1980). A description of the mathematical models underlying the clinical decision analysis approach would be beyond the scope of this thesis. The result of the process, however, is a structured guide to decision making, called a *decision tree*, that can be used to treat patients or develop treatment guidelines, given the probabilities of various outcomes. Kassirer (1976) provides the example of a patient suspected of having a subphrenic abscess (an infection in the abdomen following surgery); based on the patient's characteristics, medical literature, and the experience of other clinicians, alternative choices (to operate or not to operate) are analyzed on the basis of their probable outcomes. The resultant decision tree is reproduced in Figure 3.

Figure 1. Sample Clinical Decision Analysis Decision Tree



Reproduced from Kassirer (1976).

One benefit of the clinical decision analysis approach, which is based on the classical theory of rational decision making, is that it results in highly *programmed* decision making (Simon, 1979) at the level of individual patient care. As Kessler (2004) succinctly put it, "Programmed decisions deal with relatively repetitive, known phenomena and are ‘bureaucratically’ routinized to require only rule-directed behavior” (p. 278). In the medical professions, where errors in decision making can sometimes cost patients their lives, there has been a decades-long movement to program decision making. Using clinical decision analysis to program decisions is thought to reduce the potential for error caused by cognitive biases (Sisson et al., 1976). In recent years, technological advances have enabled clinical decisions to be programmed in a literal sense, resulting in the advent of *clinical decision support systems*, technology-based tools that script and model clinical decision making. Decision aids recommend courses of action in particular settings or for particular tasks, with varying degrees of context-specific input. Mobile technologies, such as tablets and smartphones increase the availability of IT use at the point of patient care and have ushered in a new generation of real-time interactive IT tools for clinical decision making. These are being rapidly adopted in United States healthcare facilities (Williams, 2014).

Despite its utility in many situations, critics argue that the clinical decision analysis model is inadequate because some clinical decisions cannot be made using pre-established rules; they are more complex and therefore require other cognitive processes, including but not necessarily limited to creativity, judgment, and situational awareness (Coget & Keller, 2010; Kessler, 2004). In emergency medicine, there may be situations where the numerically optimal decision is not the best decision. For example, an ER physician in Curreri’s (2014) study recalled a situation where following the traditional model would have led to a patient’s death. The physician had an 18-month-old patient who presented with worsening abdominal pain. The patient’s parents did not provide information on what was wrong with their daughter. Based on the lack of information, the classical decision making model directed the physician to order a barrage of tests in order of likelihood. However, if the physician had followed this process to its conclusion, the patient would have died. Instead, the physician's situational awareness alerted him to some strange features of the parents' behavior, which led him to conclude that the patient had accidentally ingested methamphetamine: "She [the patient] is no longer conscious and she's beginning to vomit. Instinct takes over now. I knew she ingested some meth… We barely saved her. Her toxicology came back and I was right." If he had adhered dogmatically to the traditional decision model, the physician might not have considered the behavior of the child's parents. This could have resulted in the patient's death because diagnosis and treatment would not have occurred quickly enough. The example shows that, in practice, multiple cognitive processes and decision making strategies lead experienced physicians to reliably make correct diagnosis and treatment decisions.

This conclusion is supported by the theoretical work of Dreyfus and Dreyfus (2005), who developed a five-stage model of skill acquisition in which individuals progress from a novice level to the level of expertise. At the novice level, individuals rely heavily on abstract concepts and discrete pieces of information, which they often learn from instructors. As people progress through the five stages of skill acquisition, the role of abstract concepts (such as those embodied by CDSSs) becomes less and less important, giving way to experience and situational responses. Speaking of physicians, Dreyfus and Dreyfus (2005) argued, "medical expertise in particular, cannot be captured in rule-based expert systems, since expertise is based on the making of immediate… situational responses" (p. 779).

Dreyfus also questioned the one-sided benefits of such computer-aided decision making models. CDSSs designers often assume incorrectly that, given enough information in a database, and sets of rules covering a wide variety of medical conditions computers can arrive most or all the time at correct medical decisions. But critics argue (see, e.g., Dreyfus, 1992) that the underlying assumption here is wrong. As Dreyfus notes, computers lack humans' ability to understand *when* knowledge and rules may or should apply, because they cannot account for all the elements present in the context. Thus, even if CDSS are understood as providing alternative courses of action rather than prescribed courses of action, an expert user is still required to select among alternatives. Because the context, especially in medicine, is inextricably linked to the applicability of rules and formulas, slavish CDSSs use alone is likely to miss important pieces of clinical information that is often critical to address correctly ambiguous diagnosis or treatment decisions faced by the physician. CDSSs simply cannot be made 'aware' of all the potentially relevant aspects of all patient's clinical contexts.

This research indicates that reliability among experts is more complex than rule-based decision making models suggest. I discuss reliable performance in detail in the next section of this chapter. Before doing so, however, I consider competing models to the classical clinical decision theory. Alternative theoretical perspectives have originated in disciplines like business and organizational decision making and are more recently finding their way into the field of medicine. I therefore turn now to of alternative decision making theories and consider their application to clinical decision making. I will discuss intuitive decision making, followed by dual process theory. Later in this chapter, I also discuss mindful decision making.

Intuitive Decision Making

Scholars have long recognized the potential limitations of classical decision theory, particularly in domains where it may be difficult or impossible to completely characterize the context in which decisions must be made (Simon, 1979). In the realm of management, which applies equally to the healthcare industry, contextual factors can include the external environment (e.g., a society with certain needs for and expectations of medical care) and decision-specific characteristics (e.g., a set of alternative choices, some of which may be unknown to the decision makers) (Shepherd & Rudd, 2014; Simon, 1979). These elements introduce a level of uncertainty into the decision making process, which exposes the notion of rational decision making as an unrealistic ideal. Decision makers may be able to make optimal decisions only in the simplified hypothetical world of the decision tree—in the real world, with all of its unknowns, optimal decision making may be out of reach (Simon, 1979).

Classical decision theory also suffers from a notable limitation in environments where decisions have high stakes and must be made rapidly, such as during military operations or in emergency medical settings. Emergency physicians make diagnosis and treatment decisions in environments "characterized by high stakes, high stress, rapidity, incomplete information, overwhelming data, and overlapping processes" (Coget & Keller, 2010: 57). Coget and Keller (2010) described an example in which a patient presented with symptoms of cardiac arrest. On the classical decision making model, using programmed the programmed decision methods he learned in his medical training, the physician should have treated the patient for a heart attack on the basis of his presentation. However, "His [the physician's] intuition alerts him to the possibility that the patient may have a dissecting aneurysm. If indeed the patient suffers from a dissecting aneurysm and is directed to the Cath lab for treatment of a heart attack, he will probably die" (p. 58). Indeed, in this example, the physician's intuition was correct, and the programmed decision model would have resulted in the patient's death. In high-stakes cases like these, classical decision theory may be inadequate to describe the additional factors, some of which may not confirm to the programmed decision making model, which are important to making correct decisions. Intuition, such as that exhibited in Coget's and Keller's example, has therefore been a focus of alternative decision making theories. Hence, I chose to focus on intuition in my first, qualitative study (see Chapter 4). To understand how intuition can be combined with routinized decision making for a fuller view of clinical decisions, I turn now to dual-process theory, an alternative model of decision making that incorporates both types of decision making.

Dual-Process Theory

The dual-process theory of decision making was developed in the 1990s in the field of cognitive psychology, and has gained traction in recent years as a way of understanding clinical decision making (Pelaccia, Tardif, Triby, & Charlin, 2011). This theory was important to the present research because it provides a framework for understanding clinical decisions as incorporating both routinized and intuitive processes. According to dual-process theory, two systems of reasoning, the intuitive system and the rational system, are used simultaneously to arrive at decisions. Westcott (1968) defined intuitive decision making as the process of "reaching a conclusion on the basis of less explicit information than is ordinarily required to reach that conclusion" (p. 71). Because intuition is important in rapid decision making and may be less useful in decisions where ample time is available for reflection, dual-process theory focuses on *tactical* (as opposed to strategic) decisions (Moxley, Ericsson, Charness, & Krampe, 2012). However, intuitive (i.e., automatic, non-deliberative) decision making processes may characterize even expert-level, skilled decision making (Kahneman & Frederick, 2005).

According to the dual-process theory, intuitive cognitive systems handle most routine, daily decisions, especially when the stakes and levels of uncertainty are low. The role of the rational cognitive system is to monitor intuitive decisions, consciously overruling them in situations where more deliberation is necessary. However, this monitoring process may be interrupted by factors like time constraints, stress, fatigue, and lack of motivation (Pelaccia et al., 2011).

This perspective has certain advantages for describing clinical decision making, especially in light of research showing that, in real-world settings, decision making is highly context-dependent (Gruppen & Frohna, 2002), such that programmed decision making may be better understood as a normative ideal rather than an adequate description of actual decision making. Given that, in practice and at the tactical level, rational and intuitive decision making processes are both important, there is a need to understand the effect of intuitive decision making on decision reliability. Decision-making improvements, including CDSSs and training, have the goal of making physicians more reliable at making effective decisions, even in high-stress, high-stakes settings. In such settings, which have a high degree of uncertainty and where patient loss may be inevitable (for example, in cases of extreme trauma or terminal illness), reliability may have different characteristics from reliability in other settings. To elaborate, I turn now to a review of literature related to reliable performance.

Reliable Performance: Routine and Non-Routine Behaviors

In organizational settings, *reliability* is defined as the ability to repeatedly produce outcomes “of a certain minimum quality” (Hannan & Freeman, 1984: 153). As stated before, physician performance is defined by the outcome quality of patient care. A physician can perform well in an individual patient’s case by making effective decisions for that patient, but to ensure quality of care for all patients department-wide, physicians must be able to perform as well as possible with regard to *all* patients; they must perform reliably. *Reliable performance* is crucial in high-risk settings like emergency rooms and is defined as the ability to “anticipate the evolution of unexpected events and promote resilience in times of crisis” (Gebauer, 2013: 205). According to high reliability theory (HRT), which is a classical model of reliability, there are two dimensions to reliability: routine reliability and mindful reliability (Butler & Gray, 2006; Roberts, 1990). Routine reliability is the reliability conferred by programmed decisions. (I describe mindful reliability, the converse of routine reliability, a little later.) Given a predefined situation and a set of steps that will reliably produce a desired effect, decision makers can routinely follow those steps any time they are faced with that situation. This is highly reminiscent of classical rational decision theory.

Routine-based reliability is only one dimension of clinical performance; for example, reliable physicians make and execute more correct diagnosis and treatment decisions than less reliable but they may not be fastest or most efficient in making such decisions. The concept of reliable performance hence goes beyond counting the amount resources used to generate the outcomes while in contrast seeking to account for the characteristics of the process by which outcomes of certain minimum quality are achieved and resiliency maintained. In other words, “reliable performance is not merely the attainment of a desired outcome level, but also the ability to control variance in outcomes” (Butler & Gray, 2006: 212).

At the organizational level, reliable performance has been associated with both routine-based activities and non-routine behaviors (Tsang, 2013). Here, a routine is “a … stimulus [that] produces a fixed response that involves a predefined pattern of choice from an established set of options without searching for new possibilities” (Butler & Gray, 2006: 213–214). Within clinical performance improvement, routine-based approaches are common as a means to increase reliability in patient outcomes. Generally, such procedures originate from higher echelons of the care organizations such as research, development, or management, and then are passed down as written or scripted guidelines for programmed decision making often aided by technology (Butler & Gray, 2006). The logic behind this approach is that, by minimizing the need for “creative human involvement in the moment” (Butler & Gray, 2006: 214), clinical organizations can minimize errors caused by physician’s cognitive bias, individual differences, fatigue, or task skill inefficiency. Clinical practice guidelines and other protocols used to routinize decision making are based on this same logic.

The reliability of intuitive cognitive processes is highly contested in the field of medical practice. Because decision makers are not consciously following a set of predefined rules, intuitive, non-programmed decision making is inherently more vulnerable to cognitive biases like emotion. This has led some to argue that intuitive cognition is unreliable (Pelaccia et al., 2011). However, dual-process theorists argue that intuitive and rational decision making processes are equally error prone (Norman & Eva, 2010).

This impasse highlights a major drawback of dual-process theory: its focus on tactical decision making leaves little room for higher-level analysis of organizational, cultural, and managerial factors that might influence decision making within the organization as a whole. Although dual-process decision making could admit of external influences to individual cognition, its emphasis on the individual ignores important organization-wide factors that may be essential to understanding organizational trends in decision making. Such organizational trends are essential to reliable performance, particularly in high-risk settings like medicine where organizational—not just individual—reliability is of extraordinary importance (Roberts, 1990). Taking a “big picture” approach is a prerequisite of developing high reliability at an organization-wide level (Roberts, Bea, & Bartles, 2001). By focusing on individual physicians’ decision making processes, dual-process theory sheds light on the inadequacies of classical decision theory but cannot support the level of analysis necessary to effect broad change in healthcare organizations and the industry writ large.

Despite these drawbacks, the idea of routine-based reliability still underpins much of the current use motivation of CDDSs. Because CDDSs match patient-specific information with a broader database of medical knowledge and then use algorithms and probabilities to arrive at recommendations for specific courses of action, they reduce variance (Shortliffe, Buchanan, & Feigenbaum, 1979). According to Shortliffe et al. (1979), patient-specific CDSSs specifically “improve the *reliability* of clinical decisions by avoiding unwarranted influences of similar, but not identical cases (a common source of bias among physicians), and by making the criteria for decisions explicit" (p. 1208). Although there is some evidence that CDSSs can improve physicians' reliability, research has failed to show that the increasing routinization of decision making alone has had positive results overall for patient outcomes (Jaspers, Smeulers, Vermeulen, & Peute, 2011).

Mindfulness

Mindfulness Theory

The converse of routine reliability is mindful reliability, which is reliability conferred by a non-automatic approach to solving problems that is characterized by highly context-dependent cognition (Langer, 1997; Spender, 1989). Another definition of *mindfulness* is "the capacity to be aware of one's internal condition and external situation as fully and as consciously as possible" (Coget & Keller, 2010: 69). Classical decision theory fails to account for nonprogrammed decisions, and dual-process theory fails to allow for multi-level analysis, confining decision theory to the individual level and leaving little room for understanding decision making at an organizational level. By contrast, the theory of routine and mindful reliability provides sufficient power to account for all facets of decision making in complex settings. Butler and Gray (2006) argued that these two approaches to reliable performance are not mutually exclusive, and that in fact they must be viewed as parts of a dynamic whole in order to understand reliable decision making. Using the example of software use, the authors explained: "While software that is easy to use increases users' efficiency, it also increases their vulnerability to change or failure because it makes task execution more automatic" (Butler & Gray, 2006: 220). Mindfulness thus provides an attractive alternative to less robust theories.

Recently, mindfulness has received a great deal of attention in multiple fields. In organizational literature, mindfulness is viewed both as an individual and an organizational characteristic (Weick, Sutcliffe, & Obstfeld, 1999). Karl E. Weick is one of the most prominent researchers of mindfulness in organizational settings. Weick and Sutcliffe (2006) described the relationship between mindful decision making and routinized decision making processes, which they called "codes." The authors argued that mindfulness involves being introspective about the process of altering codes and interpreting codes. Mindful individuals and organizations, on this view, are less dependent on codes (or routines such as those programmed into CDSSs) than their less mindful counterparts. Similarly, Weick and Putnam (2006) emphasized that mindful individuals minimize reliance on concepts, instead relying on their own conscious awareness.

At the organizational level, mindfulness involves an organization's ability to respond efficiently to changing and new environmental events and to bounce back from close failures. This form of mindfulness is highly relevant to healthcare services, because it can help organizations design processes and structures that can improve the organization's capability to respond to unexpected situations such as large scale accidents, novel health threats, and so on (Butler & Gray, 2006). Organizational mindfulness is also connected to individual mindfulness, which we focus on in this study. Without mindful individuals, it is not possible to create mindful teams or processes. Hence, individual traits as they pertain to clinical decision making and the clinical environment are of the utmost importance in improving overall reliability of healthcare operations. Individual mindfulness is a necessary condition for organizational mindfulness, but this does not apply in reverse; many participating physicians can be mindful, but the overall organizational process may not be.

One of the particular strengths of mindfulness theory is its ability to account for complex decision behaviors at multiple levels of a single organization. According to Weick et al. (1999), *collective mindfulness* characterizes organizations that recognize the inexorable nature of uncertainty at the level of daily operations. Mindful organizations are characterized as follows:

> These organizations spend (a) more time examining failure as a window on the health of the system, (b) more time resisting the urge to simplify assumptions about the world, (c) more time observing operations and their effects, (d) more time developing resilience to manage unexpected events, and (e) more time locating local expertise and creating a climate of deference to those experts. (Weick & Sutcliffe, 2006: 516)

As Carlo, Lyytinen, and Boland (2012) pointed out, collective mindfulness leads to mindfulness as an emergent property of organizations but will comprise both mindful and mindless behaviors at various levels of the organization. To borrow an example from their research, an architectural firm may send representatives to mindfully ensure that contractors' work will lead to the accomplishment of the goal for a building project. However, the work itself necessarily involves the mindless work of laying a brick wall; the mason is not expected to pay attention to the global impact of this activity, and, as an expert in the operation, is likely able to perform the work automatically, with a minimum of conscious decision making (Carlo et al., 2012).

Individual mindfulness, which is the concept of interest in this present research, is "the capacity to be aware of one's internal condition and external situation as fully and as consciously as possible" (Coget & Keller, 2010: 69). In this regard, mindfulness is closely related to situational awareness. Indeed, Ellen Langer defines mindfulness as a "sense of situational awareness" (Langer, 1997). However, mindfulness differs from situational awareness in that it "refers to the active construction of new categories and meanings when one pays attention" (Vago & Silbersweig, 2012: 3). Thus, mindfulness is a state of being situationally aware and of being capable of drawing new conclusions from, and, if necessary, acting on that situational awareness.

We can see that reliable clinical decisions may involve mindful processes at the individual level, like deliberations about investing in experimental oncology drugs and conscious awareness of patient-specific contexts, as well as mindless processes, like intuitive decision making and automated use of evidence-based decision trees. The desired result of all such processes is improved healthcare outcomes for patients and improved efficiency of medical treatment (in terms of accuracy, speed, and cost). Maximizing these outcomes should involve a robust understanding of mindful and mindless decision making, their points of interaction and mutual dependence, and their modes of operation among various decision makers and at various levels of the healthcare organization. Research shows that mindful attention can be developed and enhanced through interventions (e.g., Desbordes, Negi, Pace, Wallace, Raison, & Schwartz, 2012; Semple, Less, Rosa, & Miller, 2010; Westbrook, Creswell, Tabibnia, Julson, Kober, & Tindle, 2013). If mindfulness is linked to physician performance, managers could implement such interventions to develop mindfulness in everyday clinical work.

It is important at this stage to differentiate between the individual mindfulness at issue in the present research and some related but distinct concepts. Mindfulness is sometimes viewed as a state of mind generated by reflective, meditative processes such as open monitoring and meditations (Vago & Silbersweig, 2012). Although some research indicates that meditation or other spiritual practices are useful in developing individual mindfulness, the present study is not concerned with such practices. Rather, we are interested in personal traits or tendencies as exhibited by physician's actions in clinical settings. Neither should mindfulness be confused with other individual characteristics such as intuitive decision making, defined as the process of "reaching a conclusion on the basis of less explicit information than is ordinarily required to reach that conclusion" (Westcott, 1968: 71). Mindful physicians may make decisions on the basis of explicit information, such as the parents' behavior in the example above, or non-explicit information, such as difficult-to-define hunches. Consequently, mindful physicians may make many or few intuitive decisions, depending on the context. Intuitive decision making presents a challenge in clinical decision making, because it tends to increase variance, which is often related to errors. Finally, mindfulness should not be confused with pattern recognition as such. Though mindfulness draws upon abductive processes of pattern recognition, in that mindful physicians are more likely to identify *new* patterns and make decisions based on such patterns, pattern recognition forms an essential element of *all* clinical decision making and therefore has an equivocal relationship with mindfulness. Consequently, the direction of pattern recognition is different: mindful physicians are more likely to recognize individual situations as unique and not rely on established patterns to force situations to fit those patterns. Thus, mindfulness reduces biased, inaccurate pattern fitting, which often leads to clinical mistakes (Shortliffe et al., 1979). Because not all clinical situations require overtly mindful decisions and responses (even if a physician is mindful) mindfulness as a personal trait is difficult to observe.

I turn now to empirical research on reliable decision making in clinical settings, which will shed light on the real-world utility of mindfulness theory.

Empirical Research on Mindfulness in Clinical Settings

In the current healthcare climate of dwindling resources and breakneck technological advancement, empirical research on clinical decision making has been popular. Two research streams are of particular relevance here: research on effective clinical decision making among physicians (i.e., physician performance) and research on collaborative decision making, whereby diagnosis and treatment decisions happen in collaboration with other medical professionals or with patients themselves. I discuss these in the paragraphs below, following which I discuss mindfulness research in the healthcare field, which is incipient, but promising.

Mindfulness may have an effect on physicians' wellbeing and performance (Beach et al., 2013). Because mindful individuals engage in both awareness of their surroundings and critical self-reflection, mindfulness may enable them to "listen attentively to attentively to patients' distress, recognize their own errors, refine their technical skills, make evidence-based decisions, and clarify their values so they can act with compassion, technical competence, presence, and insight" (Epstein, 1999). Caregiver mindfulness has been empirically linked decreased morbidity in some conditions (Matte, 2012). Coget and Keller (2010), using an illustrative case study of an experienced emergency physician, listed "capacity for mindfulness" as one of four skills and traits necessary to make effective decisions in critical contexts such as emergency medicine. Epstein (2003) found that exemplary physicians often exhibit mindfulness, despite the fact that mindfulness is not explicitly taught in medical education.

Other clinical decision makers also benefit from mindfulness. Among nurses in emergency departments, mindfulness interventions (i.e., training programs intended to increase nurses' level of mindfulness [not to be confused with mindfulness meditation]) have been shown to improve work–life balance (Cunningham, Bartels, Grant, & Ralph, 2013) and job satisfaction (Kwok, 2012) and to reduce anxiety, depression, and burnout (Westphal et al., 2015). Among first-year medical students, mindfulness intervention has been shown to decrease stress and increase self-compassion (Erogul, Singer, McIntyre, & Stefanov, 2014). These studies have all been conducted within the past five years, indicating the incipient state of research on mindfulness in emergency medicine settings. These findings support the body of empirical mindfulness research from other fields, which shows, according to a recent multidisciplinary review, being mindful at work contributes to heightened attention, which has downstream effects on physiology, psychology, and behavior (Good et al., 2016). The present series of studies is one of the first to investigate the role of mindfulness in emergency department physicians' decision making and performance.

To summarize, reliable decisions can be made using routine-based and mindfulness-based processes. Crucially, routines are "helpful when they provide options, but detrimental when they hinder detection of changes in the task or environment" (Butler & Gray, 2006: 214). Therefore, the two approaches to reliable performance must be viewed as parts of a dynamic whole in order to understand reliable decision making. Using the example of software use, Butler and Gray explained: "While software that is easy to use increases users' efficiency, it also increases their vulnerability to change or failure because it makes task execution more automatic" (Butler & Gray, 2006: 220).

Similarly, physicians who rely on routine-based CDSSs may be vulnerable to errors caused by a lack of mindfulness. It seems, therefore, that the optimal situation would be one in which CDSSs promoted routine-based reliability without hindering mindfulness-based reliability.

Empirical Research on Mindfulness and Information Technology

Despite the lack of evidence on mindfulness among emergency physicians in particular, there is a growing body of research from other industries related to mindfulness and its relationship with IT. Recent reviews have revealed that the large majority of mindfulness research shows physical, psychological, and performance benefits, including stress reduction and motivation increase, as a result of which many workplaces have begun to offer mindfulness interventions for employees (Choi & Tobias, 2015; Hyland, Lee, & Mills, 2015; Kroon, Menting, & van Woerkom, 2015). These interventions take many forms, which may or may not include meditation or instructor-led activities. The common theme linking effective mindfulness interventions is a focus on training participants to pay attention to their environments "on purpose, in the present moment, and nonjudgmentally" (Kabat-Zinn, 2005: 4). Such trainings enable participants to retain mindfulness (to reiterate: defined as the ability to be consciously aware of internal and external contexts) in their daily work. Brief mindfulness trainings can also improve group task performance (Cleirigh & Greaney, 2015).

One of the most important theoretical works on the subject was written by Butler and Gray (2006). The authors develop a theoretical model of mindfulness and its relationship to reliable performance on both the individual and organizational levels. Taking an information systems (IS) perspective, they argue that complex information systems are subject to failure and may not be reliable (e.g., computers may crash), and that mindfulness can act as a paradigm for securing reliability in the face of unpredictable systems and chaotic contexts (e.g., by ensuring that someone within the organization knows what automated systems are designed to do and can replicate the tasks in case of system failure). Butler and Gray distinguish between individual mindfulness and collective mindfulness, which are both required to complement routine processes and unreliable systems.

This perspective is highly applicable to emergency physicians' decision making, since CDSSs aim at increasing process consistency and guideline adherence at the expense of context-specific decision making (Dean et al., 2015). Mindfulness enables individuals to "change their perspective to reflect the situation at hand. From this perspective, routines are a double-edged sword. They are helpful when they provide options, but detrimental when they hinder detection of changes in the task or environment" (Butler & Gray, 2006: 214). The implication of this is that, without a clear understanding of how to mitigate the risks routines can entail, investment in routine-based operations may not yield net performance benefits. Thus, focusing on a single perspective (such as that of a CDSS) is likely to lead to "unexpected detrimental consequences" (Butler & Gray, 20016: 215). Mindfulness has also been identified as a key component of reliable performance in fast-response organizations where critical decisions must be made at a moment's notice (Faraj & Yan, 2006; Weick et al., 1999).

A growing body of literature has examined the relationship between mindfulness and IT generally. Some suggested early on that IT can promote mindfulness at the organizational level by promoting communication of key information across different roles and functions (Boland Jr, Tenkasi, & Te'eni, 1994). At the individual level, however, the effects of IT are more mixed. For example, (Butler & Gray, 2006) found that reliable IT systems can, in fact, promote mindlessness (i.e., a lack of awareness of one's internal and external situation) at the individual level by enabling routine, repetitive performance of tasks. The 2008 financial crisis has provided a paradigm case of this mechanism; Eastburn and Jr.Boland (2015) described how IT-based decision support systems encouraged mindless behaviors among bankers and investors, eventually leading to detrimental financial outcomes. These outcomes were surprising to the investors involved, who had not been paying sufficient attention to the specifics of the financial and economic contexts, relying instead on technologies designed to maximize investment profits.

At the organizational level, this type of individual mindlessness may be beneficial when taken together with mindfulness at other parts of the organization—in fact, mindfulness as an organizational trait involves both mindful and mindless behaviors (Carlo et al., 2012). Therefore, mindfulness is a complex phenomenon which may have varying effects on individual and organizational performance, depending on the specifics of the IT functionality and extent of its use, its context, and user's personal characteristics.

Information Technology in the ER

In 2009, the United States government passed the Health Information Technology for Economic and Clinical Health (HITECH) act, allocating $27 billion over a 10-year period to hospitals for investing in healthcare information technology systems (Sharma, Chandrasekaran, & Boyer, 2014). The result has been a significant increase in both public and private investment in healthcare information technology, as well as a large body of research literature examining the hospital-level effects of this investment (Adler-Milstein, Everson, Shoou-Yih, & Lee, 2015). The general consensus appears to be that healthcare IT investment leads to performance gains in the form of cost reduction (Adler-Milstein et al., 2015; Williams et al., 2015), but researchers have failed to unequivocally substantiate other types of performance benefits. For example, Williams et al. (2015) found that hospitals with the highest quality (measured as 30-day readmission rates and 30-day mortality rates) did not use statistically more types of IT (the possible types included electronic medical records, computerized physician order entry systems, and electronic diagnostic results, among others). Further, the researchers conducted a sensitivity analysis, which revealed that IT variables were the least important variables in their model for predicting hospital quality. The researchers include both electronic records and CDSSs in their analysis and concluded that "an aggressive technology adoption practice…does not necessarily lead to increased quality of patient care" (Williams et al., 2015: 11). However, hospitals continue to adopt new IT tools, investing resources that may not be leading to positive outcomes. Thus, it is important to continue to study IT systems like CDSSs to discover potential avenues for improving the return on IT investment.

A few studies have focused specifically on the role of CDSSs in physicians' decision making, as I did in the present mixed-method study (see Chapter 6). CDSSs that provide physicians with information on prescribing medications have been found to improve prescription accuracy and reduce the influence of pharmaceutical firms, including in intensive care settings (Bochicchio et al., 2006a; Epstein & Ketcham, 2014).

Computerized physician order entry systems (CPOEs) allow physicians to input orders for medications, procedures, and tests electronically and also provide a degree of decision support by requiring situation-specific inputs (Williams et al., 2015). There is robust evidence supporting the claim that CPOEs lead to decreased medication errors and adverse drug-related events at the hospital level (e.g., by making it difficult or impossible for physicians to make careless mistakes), and that this connection is strengthened when CPOEs include decision support (Charles, Cannon, Hall, & Coustasse, 2014; Nuckols et al., 2014).

The major limitation of this body of research, however, is that it does not take into account physician factors, such as mindfulness, that may influence performance outcomes. While some models have considered organizational factors like hospital size and length of operation (Williams et al., 2015), few have investigated IT-related performance differences at the individual physician level. Those that have focused on physician characteristics reveal a much more mixed view of the benefit of CDSSs. For example, CPOEs are associated with significant increases in emergency department personnel's time spent on computers—up to 11.3% for emergency department physicians (Georgiou et al., 2013). This increased computer time may lead to decreased time spent with patients (since physicians are required to spend time completing computerized tasks) and, potentially, decreased mindfulness (since physicians may be more rushed or more attentive to computerized tools, as described above). Additionally, the benefits of CPOEs becomes less visible in more complex models, such that the evidence in favor of their use is far from straightforward (Georgiou et al., 2013). Indeed, when it comes to predicting patient outcomes, physicians' opinions may still outperform algorithms and routinized tools (Farion, Wilk, Michalowski, O'Sullivan, & Sayyad-Shirabad, 2013).

CDSSs are increasingly implemented using handheld devices like smartphones and tablets (Bochicchio et al., 2006b). However, very little existing evidence supports a connection between mobile device use by emergency department physicians and improved patient outcomes (Dexheimer & Borycki, 2015). Despite the lack of evidence, scholars have viewed the increased investment in mobile devices by emergency departments as inevitable (Dexheimer & Borycki, 2015), strongly supporting a need for more research in this area. On the basis of the available literature, performance gains associated with CDSSs cannot yet be firmly linked to the IT tools themselves, and existing evidence suggests that any such gains may entail significant tradeoffs.

Clinical Decision Support Systems

Clinical decision support systems are a particular class of HIT. Broadly, a CDSS is "any computer program designed to help healthcare professionals to make clinical decisions" (Musen, Middleton, & Greenes, 2014). With the proliferation of applications and clinical technologies, many of which blur traditional boundaries or incorporate multiple types of functionality, defining CDSS concretely can be a difficult task. Existing literature on CDSSs tend to avoid the question of definition, deferring to common-sense understandings or exploring specific applications without attempting to define them. Because the present study focuses on clinical decision making, it is important to attempt to define CDSSs more clearly.

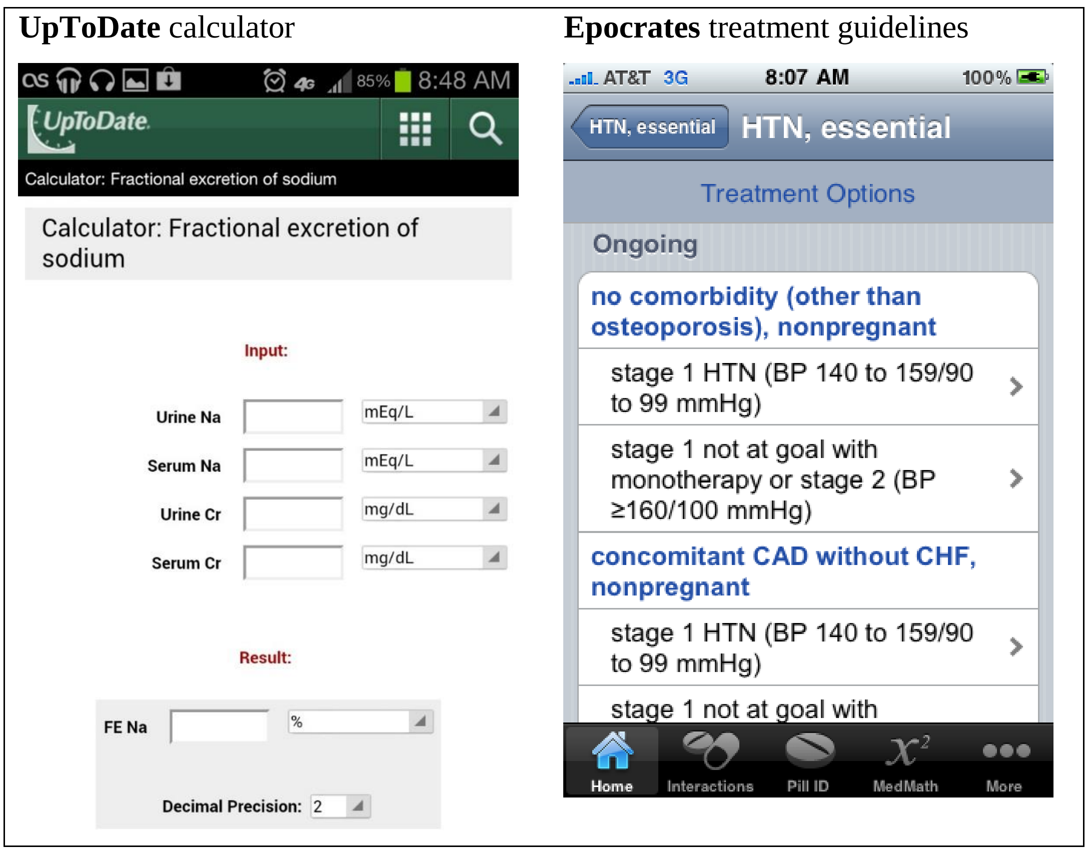
A clearer definition can be achieved by recalling the traditional model of clinical decision making, which emphasizes statistical probabilities in ruling out various options for diagnosis and treatment to arrive at decisions that are most likely to result in desired outcomes. At their heart, CDSSs are an attempt to automate this clinical decision model. Therefore, I exclude from the definition of CDSSs any system that merely provides warnings or alerts based, for example, on medicine compatibilities or patients' medical history. To qualify as a CDSS under my definition, a system must provide outputs based on a statistical calculation using the physicians' inputs about patients' symptoms and characteristics. In adopting this definition, I am both adhering to the traditional theory of clinical decision making and following leaders in the CDSS field, such as Spiegelhalter and Knill-Jones (1984), who pioneered CDSS theory by emphasizing both the importance and the pitfalls of probabilistic approaches to computerized clinical decision support.

Other researchers in the field of medical information systems distinguish between knowledge management systems, on the one hand, and patient-specific CDSSs, on the other (Pluye & Grad, 2004). Knowledge management systems provide clinicians with knowledge and data grounded in professional literature, acting simply as information retrieval tool. Patient-specific systems provide patient-specific recommendations by matching knowledge in a computerized database with information specific to a patient's condition (Pluye & Grad, 2004). For example, a CDSS may suggest a best explanation for a patients' symptoms or may provide differential diagnoses (i.e., alternative explanations for the same clinical presentation) with their associated statistical probabilities. Patient-specific CDSSs match generic rule-based information stored in databases with patient-specific inputs as to aid in clinical decision making. Again, to qualify as a CDSS under my definition, the rule-based information must use a probability calculation to arrive at the output, rather than simply noting that patient is due for a particular test or cannot tolerate a particular medication based on interactions with existing prescriptions. Because of their rapid and reliable input–output conversion, CDSSs fit well with the needs of emergency medicine, where accurate, life-saving decisions need to be made fast.

In the past decades, CDSSs have become an important element of emergency medical practice. Although it is difficult to determine exactly the extent to which CDSSs are currently in use in emergency departments (Ash et al., 2012), CDSS adoption is increasing. As of 2012, only 11.9% of hospitals in the United States had any kind of electronic record system (with or without decision support; Ash et al., 2012). That number had risen to 75% by 2014, with an increase in use of clinical decision support functions (Adler-Milstein et al., 2015).

In practice, clinical CDSSs can take a number of forms. They can, for example, be integrated into test outputs, where abnormal test values are flagged on printed results or images. In cases where clinicians interact directly with CDSSs using computers, the location and integration of these computers into clinical practice can differ. For example, computers can be located on hospital floors for use by multiple clinicians at the point of patient care (defined as in patients' rooms or at their bedsides, when physician and patient are present together in the same room), or they can be carried with clinicians in the form of mobile devices like smartphones and tablets (Musen et al., 2014). Each of these different types of CDSSs can alter clinical decision making procedures in multiple ways depending on clinicians' patterns of CDSSs use. For example, a physician may use CDSSs to input a patient's symptoms during consultation, reviewing the system's recommendations before making a diagnosis. In this case, the physician relies on the system to simplify the decision making process. Alternatively, a physician can consult a CDSS after a patient consultation as a way to confirm and check his or her own diagnosis and treatment decisions. In this case, the physician treats the CDSS use as secondary 'line' in the decision making process by relying more on her owing training and situational knowledge and to make sure that he or she did not miss anything. Figure 2 provides screenshots of two such systems: UpToDate and Epocrates.

Figure 2. Sample CDSS Screens



Next, I turn to the concept of restrictiveness, which further classifies the interaction between HIT systems and physician decision making.

Clinical IT and Restrictiveness

Mobile technologies, such as tablets and smartphones, by increasing the availability of HIT use at the point of patient care, have ushered a new generation of real-time interactive IT tools for clinical decision making. These are being rapidly adopted in United States healthcare facilities (Williams, 2014). Research also indicates that physicians who use such HIT tools make significantly different diagnosis and treatment decisions compared with those who do not (Bochicchio et al., 2006b; Epstein & Ketcham, 2014). For example, one study of an electronic decision support system for calculating drug dosages revealed that, when physicians used the system, their decisions were significantly more aligned with the calculation programmed into the system than those of their counterparts who did not use the system (Epstein & Ketcham, 2014).

At the same time, the outcomes of investing in HIT tools have been highly conflicting (Cash, 2008). For example, at the hospital level, the highest performing institutions (in terms of mortality and readmission rates) do not use such HIT tools at a greater rate than their lower performing counterparts (Williams et al., 2015). In their study, Williams et al. (2015) found that, among hospitals with the highest quality rating, 70% used only one type of IT, whereas 45% of lower performing hospitals used two or more types of HIT. Therefore, it is far from established that HIT tools improve physician performance under all conditions.

Indeed, such tools may discourage context awareness, thereby reducing performance. Preliminary evidence already suggests that accessing tools such as mobile devices at the point of patient care can alter physicians' treatment decisions and potentially lead to differences in performance compared with physicians who do not use such technologies (Bochicchio et al., 2006b; Epstein & Ketcham, 2014). Particular characteristics of the HIT environment may play a role in how HIT alters performance. HIT *restrictiveness* is defined as the extent to which HIT tools guide physicians' decisions and thereby restrict their decision-making behaviors (Tsang, 2013). For example, a highly restrictive CDSS might provide an exact dose for a particular drug given a patient's weight; a less restrictive tool might suggest a range, allowing physicians to prescribe more aggressively or conservatively, as they prefer.

However, it is not clear how this influences performance. Physicians may become overly reliant on restrictive HIT tools and their scripts, and access to embedded scripts is likely to interfere with situation-specific decision making, potentially drawing attention away from evidence or details that are not captured in the HIT programming. This could be very important. It could also be argued that restrictiveness could improve performance owing to its role in standardizing best practices in patient care and by doing so decreasing variance in decision process and performance (e.g., by ensuring that doctors do not over-prescribe a particular medication based on drug company recommendations).

Summary

Existing research supports the conclusion that physician factors, such as mindfulness, are important to ER physician performance. HIT, though it has been increasingly implemented in emergency departments in the United States, does not by itself lead to increased performance or patient outcomes. In emergency medicine settings, where decisions must often be made quickly and with incomplete information, mindfulness (defined as a conscious awareness of internal and external contexts) is required to catch subtle cues which may suggest alternative decisions. Information technologies like CDSSs, by turning physicians' attention toward programmed, routinized decision making strategies, may take attention away from these important contexts. Therefore, mindful use of CDSSs is important to realize the benefits of these technologies. However, existing research does not explain *how* mindful physicians differ in their use of CDSSs. Without this knowledge, it is impossible for hospitals to ensure that their HIT investment will yield the hoped-for returns. Therefore, I seek to explore how emergency physicians use information technology, especially CDSSs, to make correct diagnosis and treatment decisions. This research will address a gap in the existing literature by describing how physician characteristics interact with HIT to lead to more or less reliable decision making.

Over the next three chapters, I present the findings of the three studies in this sequence. Chapter 4 contains the findings from a qualitative study focusing on the presence and role of intuitive decision making among emergency physicians. Chapter 5 contains findings from a quantitative study testing a model of HIT and ER physician performance when mediated by mindfulness. Chapter 6 presents the findings of a mixed-method case study exploring how mindfulness influences patterns of CDSS use among ER physicians.

CHAPTER 3: RESEARCH QUESTIONS AND DESIGN

In this chapter, I present the overall purpose of the present research and formulate key research questions, including an overarching research question and specific research questions for each of the three studies. This enables me to expand the overall design for the three-study sequence.

Research Purpose

The problem of practice explored in this research is that despite decades of research results on the effectiveness of HIT—particularly CDSSs—remains equivocal. To date, the primary purpose of CDSSs has been to routinize clinical decision making, taking the "guess work" out of the practice within emergency medicine. Although there is some evidence that CDSSs can improve physicians' reliability, research has failed to show that increased routinization of decision making has a positive effect on either patient care outcomes or healthcare costs (Jaspers et al., 2011; Jones, Rudin, Perry, & Shekelle, 2014; Kellermann & Jones, 2013; Landrigan et al., 2010; Williams et al., 2015). Nevertheless, the United States government has continued to promote HIT, allocating billions of dollars to hospitals for investing in HIT systems and penalizing hospitals that do not comply (Sharma et al., 2014). The outcome of this movement is a potential loss of investment for institutions and at the federal level, a potential increase in healthcare costs for consumers, and a failure to improve standards of care.

Therefore, there is a need to determine conditions what make HIT use effective, identify factors which might hinder their effective implementation, and analyze patterns of effects how they jointly alter patient outcomes. More specifically, there is a need to determine how HIT systems interact with complex clinical decision-making contexts and processes, which cover both routine and non-routine behaviors both at the individual and team levels. Such an understanding can help hospitals create and promote conditions that can lead to more reliable decision making in HIT rich environments that will improve patient outcomes and realize return on HIT investment. The overall purpose of this research is *to explore how emergency physicians can use healthcare information technology, especially CDSSs, more effectively by increasing the level of correct diagnosis and treatment decisions*.

Research Questions

To address the general research question above I decided to conduct a series of three studies. In my qualitative research, the first in the series of three studies, I examined the use of automatic decision making, called intuitive reasoning, on emergency physicians' decision making process. The purpose of the study was to address the following questions:

- *How emergency room (ER) physicians make diagnosis and treatment decisions and what influences those decisions?*
- *How and to what extent does intuitive decision making take precedence over routinized decision making in ER physicians' diagnosis and treatment decision processes?*

The results revealed that less experienced physicians tended to rely more heavily on technologies, which they described broadly, whereas more experienced physicians maintained a mindful awareness of each individual context.

To further investigate the role of IT use in ER physician performance, I conducted a second study modelling IT (again considered broadly at this initial stage) as a predictor of performance. The follow-up study, a quantitative survey project, explored a model of mindfulness, IT access, and ER physician performance. The research question was:

- *What is the relationship between information technology use, access, and restrictiveness and ER physician performance, and to what extent are such effects mediated by mindfulness?*

This study yielded results that supported the potential risks of IT use and the importance of mindfulness in mitigating those risks.

In a third, mixed-method study, I sought to develop a fuller understanding of the ways in which mindfulness affects the performance gains or losses generated through use of IT. I focused specifically on IT-based CDSSs and their use. The third study was guided by the following research question:

- *What, if anything, do highly mindful emergency physicians do differently when using clinical decision support systems that will lead to improved performance when compared with less mindful physicians?*

Results revealed six patterns of CDSS use: confirmation only, disengaged use, electronic charts, extension of consultation, no use, and preparation for consultation. The results also suggested that more mindful physicians are more open to change and to consider how different use practices could result in better patients outcomes. Mindfulness leads physicians to more circumspectly consider all possibilities, as they remain aware of their own potential limitations.

Research Design

Overall, this sequence of studies follows a sequential, exploratory mixed methods design. Mixed-methods research enables researchers to take advantage of the strengths of both qualitative and quantitative approaches while using a robust, multifaceted approach to overcome the weaknesses of each (Castro, Kellison, Boyd, & Kopak, 2010). This type of research is especially appropriate for conducting in-depth explorations of understudied topics, because it results in rich and robust findings that can guide the development of future research.

Mixed-methods studies are usually categorized as either concurrent or sequential. Concurrent mixed-methods research involves collecting both quantitative and qualitative data at the same time, whereas quantitative and qualitative aspects follow one another in sequential designs (Castro et al., 2010). Concurrent designs are appropriate when researchers hope to accurately define relationships among predefined variables of interest (Creswell, Plano Clark, Gutmann, & Hanson, 2003). In the present research, however, the variables of interest were not clearly defined at the outset, making a concurrent design inappropriate. Therefore, I chose a sequential mixed-methods design for this study.

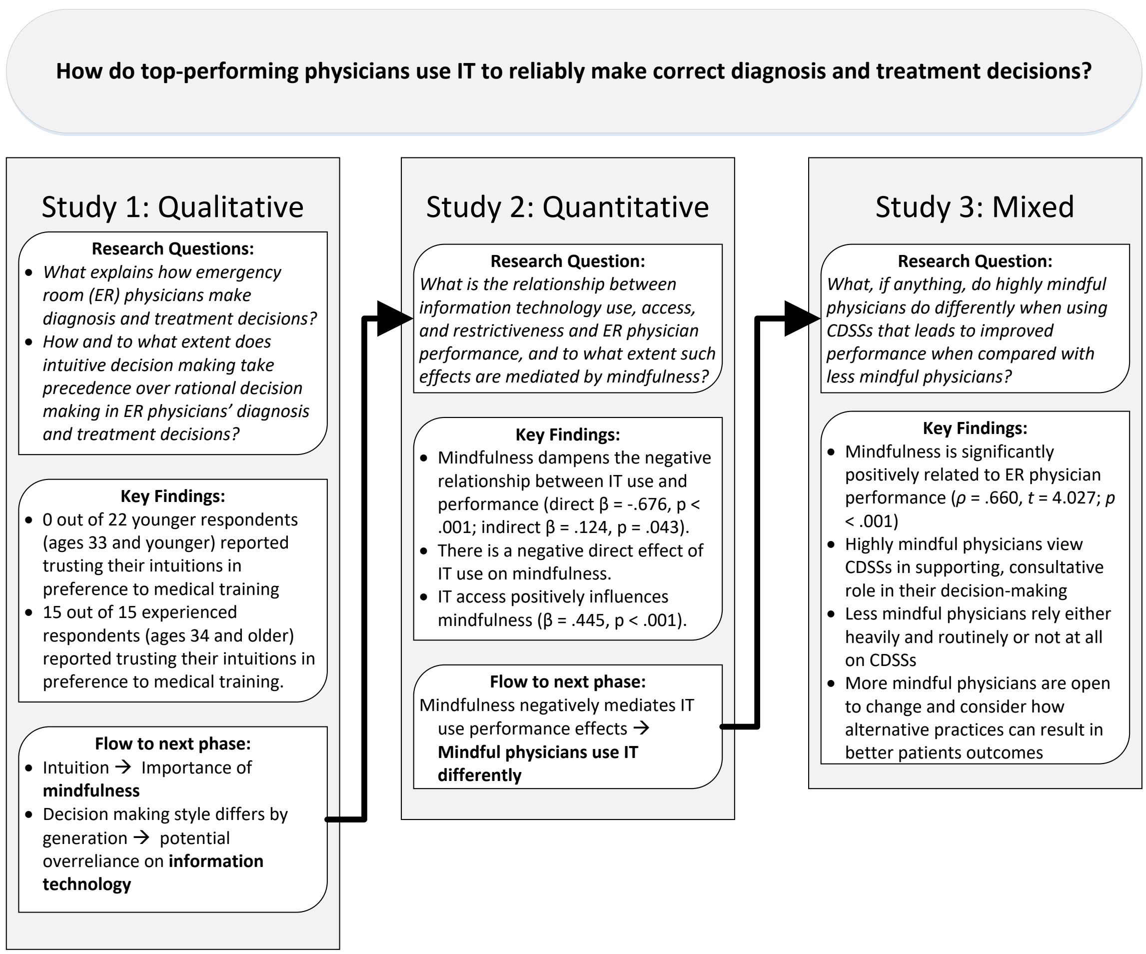
Sequential mixed-methods designs are further subdivided into exploratory, explanatory, and transformative research (Castro et al., 2010). Transformative designs seek explicitly to bring about social change, rather than to bring about understanding of a research area, making transformative research inappropriate for the present study. An explanatory design was also inappropriate for this research because it involves, first, conducting quantitative research to test a research hypothesis or model and then, second, using qualitative methods to explain the quantitative results (Castro et al., 2010). However, for this study, I did not have an a priori hypothesis or model; instead, I sought to better understand an understudied research area. Therefore, exploratory sequential mixed-methods design was the most appropriate for this study. In this type of study, the researcher begins with qualitative data collection, seeking to narrow down the research topic through open-ended exploration. Next, the researcher conducts quantitative research on the basis of qualitative results to better understand the relationships among important variables that emerged from the first research phase.

The present research process consists of a sequence of three studies. The results of each study informed the design of the following study. First, I conducted a qualitative study to broadly understand problems in ER physician decision making by looking particularly at times when physicians' decisions came into conflict with the decisions suggested by routinized systems or training. The results revealed, first, the importance of mindfulness (specifically, awareness of internal factors such as emotions or potential biases, and awareness of external factors such as subtle patient cues or information from patients' relatives) in experienced ER physicians' approach to clinical decisions. Second, results revealed an increasing level of reliance on HIT tools among less experienced physicians (see below for a detailed description of results).

Based on these results, I formulated a quantitative model of mindfulness, HIT, and physician performance, with the goal of characterizing the causal relationships among these variables and thereby testing hypotheses related to the effects of mindfulness. As expected, the study revealed that increased HIT use decreases performance except when mindfulness acts a 'dampening' mediator (see below for a detailed description of results). This suggests that mindful physicians use HIT differently from their less mindful counterparts, so mindfulness is a crucial component to consider in the attempt to optimize hospital HIT investment.

To better understand how mindfulness influences HIT use, I designed an embedded, mixed-method study with the goal of discovering what mindful emergency physicians do differently while using CDSSs and how their different behaviors might lead to improved performance. Through in-depth interviews, mindfulness questionnaires, and objective performance data, I performed a multi-faceted exploration of the connections among mindfulness, patterns of CDSS use, and emergency physician performance. The integrative research model and the key findings of each study are summarized in Figure 3.

Figure 3. Integrative Research Model



The following paragraphs provide a brief overview of the design of each of the three studies in this sequence. For a detailed description and justification of the design and methods for each study, see Chapter 4 (quantitative study), Chapter 5 (qualitative study), and Chapter 6 (mixed-method study).

Qualitative Study Design

The qualitative study explored intuitive decision making in general among ER physicians. Table 2 summarizes the demographic characteristics of the sample. The interview protocol can be found in Appendix A.

Table 2. Participant Demographics

Characteristic		**Number of participants (total: 37)**
Gender	Male	20
	Female	17
Age	≤ 33	22 (12 women, 10 men)
	> 33	15 (5 women, 10 men
*City size**	Large	20
	Small	17
Utilization†	High	20
	Low	17
Region‡	East	18
	West	19

*Small city size was defined as < 100,000 inhabitants according to U.S. Census data, and large city size was defined as ≥ 100,000 inhabitants.

†Low and high utilization were defined being below or above the national utilization of 42.8 ER visits per 100 persons per year, respectively (Centers for Disease Control and Prevention, 2014).

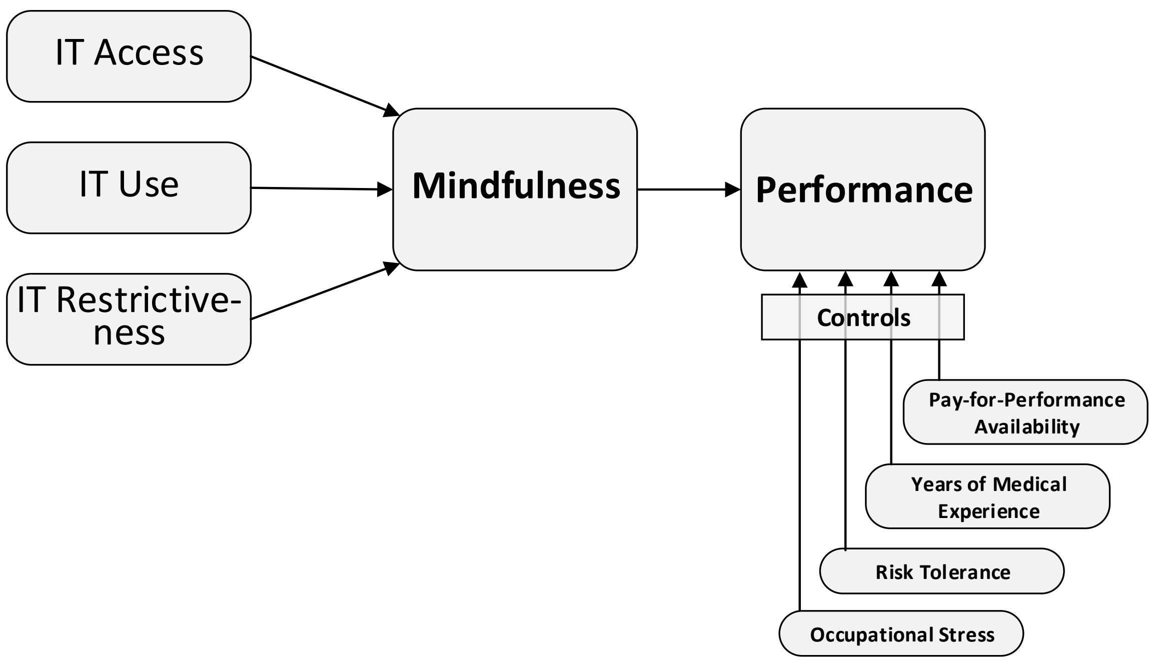
‡East refers to Boston, MA, Cleveland, OH, Atlanta, GA, and Melbourne, FL, and West refers to Los Angeles, CA, San Francisco, CA, Portland, OR, and Las Vegas, NV.

Semi-structured interviews revealed that less experienced physicians rely more on technologies and treatment protocols learned during training. Although there are some similarities between protocols learned in training and CDSSs (many of which automate the same protocols), I chose to focus on CDSSs, rather than on medical training, owing to the timeliness of IT use as a research topic and its underrepresentation in existing research literature when compared with research on medical training. This led us to the important topic of mindfulness, which was central to the second, quantitative study.

Quantitative Study Design

The second study explored the correlations between three dimensions of IT (IT use, IT access, and IT restrictiveness) and peer-rated performance, considering the role of mindfulness as a mediator. The quantitative research model is presented in Figure 4.

Figure 4. Quantitative Research Model



Results of the quantitative study revealed that mindfulness dampened a negative relationship between IT use and mindfulness. This suggested that mindful physicians use available IT tools differently, allowing them to realize the benefits of IT, whereas less mindful physicians may experience performance decreases with increased IT use.

Therefore, I developed a third mixed-method study to investigate the differences in IT use tendencies among more and less mindful physicians.

Mixed-Method Study Design

The third study explored differing patterns of CDSS use among high- and low-mindful emergency physicians. An embedded mixed-method approach was chosen because I needed to (a) identify physicians with high and low levels of mindfulness, (b) identify physicians with high and low performance, and (c) understand how these physicians used CDSSs. Mindfulness and performance (items [a] and [b]) can be assessed quantitatively using established research instruments, but differences in CDSS use is suited to qualitative examination, since it does not involve measuring a variable or testing a hypothesis, but rather involves an open-ended exploration of a process phenomenon. Because the study involved both qualitative and quantitative aspects, a mixed-method study was most appropriate.

CHAPTER 4: MULTIFACETED DECISION MAKING AMONG EMERGENCY PHYSICIANS

The research questions for this qualitative study were:

- *How emergency room (ER) physicians make diagnosis and treatment decisions and what influences those decisions?*
- *How and to what extent does intuitive decision making take precedence over* routinized *decision making in ER physicians' diagnosis and treatment decisions?*

In this chapter, I present the design, method, results, discussion, and limitations for the study.

Design

A qualitative, grounded theory approach, as formulated by Corbin and Strauss (2008), was used to conduct this research. Grounded theory is an integrative methodology in which new theory is constructed from "the past and present involvements and interactions with people, perspectives and research practices" (Charmaz, 2006: 10). Through semi-structured interviews, the researcher explored the perspectives and practices of a sample of 37 emergency room physicians in order to determine how and to what extent intuitive decision making takes precedence over rational decision making in their physicians' diagnosis and treatment decisions. The methodology for the research takes into account the knowledge obtained from the review of related academic literature, the nature of the research subject, and the objectives that this researcher hopes to achieve.

Utilizing a qualitative method in the form of semi-structured interviews and a narrative approach enabled the researcher to understand the decision making processes used by emergency room physicians. Crossley (2000) suggested that narrative research is concerned with identity and is appropriate when understanding the experiences of trauma and sensitive information. It is understood that the information provided may be of a sensitive nature, individuals may become upset or concerned with confidentiality. As a result, the participants were free to stop the interview process at any time during the interview. A disadvantage of using semi-structured interviews is that the interview can lack direction (Padgett, 2008). Therefore, the researcher must be mindful that the interview did not lead or coerce participants in divulging information that could sway the outcomes of the research being undertaken.

Sample

This research used a purposive sampling method to select 37 ER physicians from a pool of for-profit and not for profit hospitals. With the help of staff at the emergency departments being studied, participants were chosen based on their knowledge and experience (Torr, 2000). This sampling procedure ensured that all participants were emergency room physicians and that the most robust possible perspective was gained through the interview process. See Table 3 for a summary of participant demographics, including age and gender. Specifically, it was the intent to interview physicians in the East Coast region (Boston, MA, Cleveland, OH, Atlanta, GA & Melbourne, FL) of the United States and physicians in the West Coast (Los Angeles, CA, San Francisco, CA, Portland, OR & Las Vegas, NV) region.

Table 3. Qualitative Research Participant Demographics

Characteristic		Number of participants (total: 37)
Gender	Male	20
	Female	17
Age	≤ 33	22 (12 women, 10 men)
	> 33	15 (5 women, 10 men
*City size**	Large	20
	Small	17
Utilization†	High	20
	Low	17
Region‡	East	18
	West	19

*Small city size was defined as < 100,000 inhabitants according to U.S. Census data, and large city size was defined as ≥ 100,000 inhabitants.

†Low and high utilization were defined being below or above the national utilization of 42.8 ER visits per 100 persons per year, respectively (Centers for Disease Control and Prevention, 2014).

‡East refers to Boston, MA, Cleveland, OH, Atlanta, GA, and Melbourne, FL, and West refers to Los Angeles, CA, San Francisco, CA, Portland, OR, and Las Vegas, NV.

Data Collection

Data collection commenced in April, 2014 and continued through August, 2014. The interviews were conducted in person or through the use of Skype and video conferencing adhering to proper protocol. The chosen physicians were asked to participate in a confidential, semi-structured interview estimated to take 60 to 90 minutes. The preferred method of conducting the interviews was in person when possible.

Prior to commencing the interviews, the physicians were advised of the established methods to protect their identity as well as their privacy. It was clearly communicated to the research participants that their participation in the research was voluntary and that they could end the interview at any time they chose. They were informed that, if they chose not to participate in the research before the end of the interview, the data gathered would be destroyed and would not be included in the study.

After the participants had been fully briefed about the protocol of the interview, understood the process, and had signed the authorization form, the voice recorder was turned on and the interviews began. See Appendix A for the interview protocol.

All of the recordings are stored in a password-protected computer secured by the researcher. The services of a reputable commercial transcription service were utilized for transcriptions. All transcription records are secured in a locked and fireproof safe. The recordings and the transcribed documents of the interviews will be destroyed no later than three years from the recordings and transcriptions. This date is estimated to be August 31, 2017.

Data Analysis

Thematic analysis with a constant comparative method and an open coding approach was employed for the purpose of this study. This approach involves identifying relevant themes and other findings from the interviews (Corbin & Strauss, 2008) that could help answer the research questions and construct a theory grounded in the research findings. Braun and Clarke (2006) described thematic coding as a method for "identifying, analyzing and reporting patterns (themes) within data" (p. 79) and noted that "a theme captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set" (p. 82). Subsequently, axial coding was employed after the open coding process in order to identify emerging themes across the interviews. Finally, selective coding was used to merge or split existing axial codes in order to best represent the composite themes emerging from the data.

I continued to examine interview data for themes that emerge pursuant to the research questions. After themes were identified, the researcher read the transcripts a second time to identify other instances of the themes, search for disconfirming evidence, and to check for accuracy. To ensure reliability of the data, third party reviewers, including two colleagues and one professional editor, were asked to review the codes. The third-party reviewers checked to ensure that the emergent themes were reflected in the interview transcripts and that the coding process aligned with the research question. Figure 5 contains the list of codes for each step, and Table 4 presents the frequencies of theoretical codes.

Figure 5. Qualitative Research Coding Results

Initial open coding (sample of 341 codes)		***Axial coding (19 codes)***	***Theoretical coding (6 codes)***	***Emergent themes***
Accountability Awareness Conflict Decision Making Discipline For Other People Generational Differences Honor Instinct intrinsic Rewards Personal Accomplishment Praise Proper Protocol Recognition Relationship with Patients Self-Esteem Sensemaking Sprituality Teamwork Trust	Assertion Collaboration Control Depersonalization Emotion For Self Good Feeling Humility Interaction Opportunities Intuitive Reasoning Personal View Problem Solving Reasoning Reflection Satisfaction Self-Reporting Skill Structure Transparency Work/Life Balance	Clarity Cognitive Dissonance Compassion Concentration Education Equanimity Focus Honesty Internalization Interpretation Intuition Prayer Relationships Resolve Saving Lives Stress Struggle Training Values	Accountability Age Differences Decision Making Diagnosing Experience Process	Generational Decision Making Intuitive Reasoning Medical Training

Table 4. Frequencies of Thematic Codes

Thematic Codes	Total Instances, Participants ≤ 33	Total Instances, Participants > 33	% of Interviews
Accountability	34	78	93%
Age Differences	86	101	88%
Decision Making	98	129	67%
Diagnosing	134	131	75%
Experience	84	97	72%
Process	73	122	78%

After coding, I used a grounded theory approach to answer the research question and build a hypothesis related to the role of intuitive reasoning in emergency physicians' decision making processes. The findings of the thematic analysis and the grounded theory are presented in narrative format in the following section.

Results

Findings relevant to each theme are presented in the following subsections. Table 5 indicates how each of the participants answered the key research question and contributed to the findings.

Table 5. Evidence for Findings by Participant

Participant	Age > 33?	Finding 1: Participant reported experiencing intuitions about clinical cases?	Findings 1A & 1B (research question): Participant reported using intuition in preference to training while making a diagnosis or treatment decision?	Findings 2A & 2B: Participant reported reflecting on loss of life after work?	Finding 3: Participant mentioned deep-vein or mesenteric-vein thrombosis?
1F	●	●	●	●	●
2M		●			
3M		●			●
4F		●			
5F	●	●	●	●	●
6M		●			●
7M	●	●	●	●	●
8M	●	●	●	●	●
9F	●	●	●		
10M		●			●
11M	●	●	●		●
12F		●			●
13F		●			
14F		●			
15M	●	●	●	●	●
16M	●	●	●	●	●
17M	●	●	●	●	●
18F		●			
19F		●			●
20M		●			●
21F		●			
22F	●	●	●	●	●
23M		●			●
24M		●			
25M		●			
26M	●	●	●	●	●
27F		●			
28F		●			
29M		●			
30M	●	●	●	●	●
31M		●			
32F		●			●
33M	●	●	●	●	●
34F		●			●
35M	●	●	●	●	●
36F	●	●	●	●	●
37F		●			●

Shaded rows represent participants > 33 years old. Dot (●) represents “yes.”

Finding 1: All (37 of 37) participants reported instances in which they experienced intuitions or gut feelings about particular clinical cases

Finding 1A: 0 out of 22 of younger respondents (ages 33 and younger) reported trusting their intuitions in preference to medical training. Figure 6 contains a quote tree summarizing quotations for this finding. These selected quotes are representative of the responses of all participants aged 33 and younger.

Many of the participants aged 33 and younger emphasized the reliability of medical training and new technologies in their responses. For example, participant 4F said, "Medical training definitely saves lives. We have protocol for every possible situation. I've never used my instinct to treat anyone."

Figure 6. Quote Tree for Finding 1A

Finding 1A: **0 out of 22 of younger respondents (ages 33 and younger) reported trusting their intuitions in preference to medical training.**

Medical training definitely saves lives. We have protocol for every possible situation. I've never used my instinct to treat anyone.

—Participant 4F

We're trained to rule certain things out and to funnel them down to a manageable list of possibilities. Further testing and blood work usually pegs it for me. With all of the technology and training we have today, one wouldn't have to rely on instinct to diagnose. Why would you want to risk it?

—Participant 19F

So you can use those [scoring systems] to guide your clinic decision-making but at the same time relying on your gut instinct. Now, on the other hand, if all you did was rely on your gut and didn't use evidence-based medicine, then you'd end up looking for that disease in all kinds of people who didn't really have it.

—Participant 33M

I think you'd have to be an old school doctor to trust intuition. Technology today is so accurate that one doesn't need to risk diagnosing incorrectly.

—Participant 37F

There's all these like scoring systems for like headache, this is what you should do for this and this is what you should do for this, this could rule out that; that getting physicians to abide by those clinical decision-making rules, I think, would be helpful. But a lot of us are either not aware of them or don't know them.

—Participant 33M

Participant 19F emphasized the algorithm-based nature of medical training and suggested that intuitive reasoning in clinical decisions may be altogether unnecessary, thanks to technological advances:

> "We're trained to rule certain things out and to funnel them down to a manageable list of possibilities. Further testing and blood work usually pegs it for me. With all of the technology and training we have today, one wouldn't have to rely on instinct to diagnose. Why would you want to risk it?"

Participant 37F held a similar view: "I think you'd have to be an old school doctor to trust intuition. Technology today is so accurate that one doesn't need to risk diagnosing incorrectly." This suggests that the younger generation of physicians may view intuitive decision making as archaic.

Participant 33M, who had 6 years of experience in emergency medicine, emphasized the potential utility of algorithms, validated clinical scoring systems, and other evidence-based practices in making diagnostic decisions. According to the participant:

> "There's all these like scoring systems for like headache, this is what you should do for this and this is what you should do for this, this could rule out that; that getting physicians to abide by those clinical decision-making rules, I think, would be helpful. But a lot of us are either not aware of them or don't know them."

Additionally, the participant emphasized the importance of using both rational and intuitive reasoning in everyday clinical decisions:

> "So you can use those [scoring systems] to guide your clinic decision-making but at the same time relying on your gut instinct. Now, on the other hand, if all you did was rely on your gut and didn't use evidence-based medicine, then you'd end up looking for that disease in all kinds of people who didn't really have it."

Interestingly, when prompted to give a general description of his decision making process, Participant 33M seemed to indicate a tendency *not* to focus on patients' history and context:

> "As an ER doctor, I'm really focused on what brought [the patient] in… What's the potential life-threatening condition? They may have diabetes and they may smoke, but that's not relevant to—you have chest pain, well, what is the cause of your chest pain, that's what I'm focused on."

This contrasts sharply with reports from more experienced physicians, who often reported considering contextual factors in their decision making process.

Finding 1B: 15 out of 15 of experienced respondents (ages 34 and older) reported trusting their intuitions in preference to medical training. Figure 7 shows a quote tree summarizing the quotations related to this finding. These selected quotes are representative of the responses of all participants aged 34 and older.

Figure 7. Quote Tree for Finding 1B

Finding 1B: **15 out of 15 of experienced respondents (ages 34 and older) reported trusting their intuitions in preference to medical training.**

She [the patient] is no longer conscious and she's beginning to vomit. Instinct takes over now. I knew she ingested some meth… We barely saved her. Her toxicology came back and I was right. …Meth isn't prevalent in our part of the city so I think—I know most physicians might miss it.

—Participant 11M

I believe that an ER physician's brain is ruling out other causes, diagnoses, etc., but this is happening in the background of our minds. It's not even cognitive to me. It's just years of experience and seeing what I've seen.

—Participant 11M

We got an IV in him very quickly. We got the initial meds in him very quickly… And medically, that would be an indication to go ahead and intubate him while you still can because it can get so swollen that you can't see well enough to put a tube into your trachea. But I really did not want to intubate him. So I called ENT and I said, you need to come down here and scope him. …So ENT comes down, they scope him. The back of his tongue is also swollen. Normally, [the ENT physician] would just go ahead and say we're just going to intubate him, which would have meant he would have been on a ventilator for 24 to 36 hours, extubated, ICU, prolonged hospital, blah, blah. …If you don't intubate soon enough, you end up having to … create an airway, a surgical airway, which is a traumatic thing to do. …[The ENT physician said], well, he's swollen and he meets all the criteria for intubation. And I said, you know what, he's visibly better in the last 20 minutes since we gave him the meds. Can we wait another half hour? Will you come back and re-scope him so we can see? If we're not making progress, we'll do it. But if he's getting better, maybe we can avoid an intubation. I would not normally do that. I think I bent the rules a little bit because it was a colleague.

—Participant 35M

Most doctors are interested in making diagnosis and then start a treatment. We treat and then we make a diagnosis… The emergency physicians … are MacGyver types. …The job that's there, we got to get it done, rules shmules.

—Participant 9F

Medical training is—there's a lot of science in medicine, but it is primarily still more of an art than science. All the science does is it informs and influences the art. When it comes down to it, it's still a patient, a person, and as we often say, patients don't read the textbooks.

—Participant 9F

After 25 years of driving, I want to drive, I get in the car, throw it in gear and go. …You don't even think about what you're doing with your body because that's become—you can't say instinct because no human has the instinct to drive.

—Participant 9F

Participant 11M recalled two times when the use of intuitive reasoning had led to life-saving decisions. One involved an 18-month-old girl who presented with abdominal pain and whose symptoms worsened during her ER visit. The patient's parents were not forthcoming with information about the situation. Based on the participant's observations of the parents and on his clinical intuition, he concluded that the patient had accidentally ingested methamphetamine:

> "She [the patient] is no longer conscious and she's beginning to vomit. Instinct takes over now. I knew she ingested some meth… We barely saved her. Her toxicology came back and I was right. …Meth isn't prevalent in our part of the city so I think—I know most physicians might miss it."

When probed for more detail about his decision making process, the participant indicated that he never doubted or second-guessed his decision, and he gave the following account of ER physicians' reasoning: "I believe that an ER physician's brain is ruling out other causes, diagnoses, etc., but this is happening in the background of our minds. It's not even cognitive to me. It's just years of experience and seeing what I've seen." This suggests that years of experience contribute to the creation of intuitive diagnostic models that physicians can employ without the use of rational, algorithm-based decision making.

Another example of intuitive reasoning was given by participant 35M, who had nearly 30 years of medical experience. The participant reported an incident in which a colleague at the university medical center presented with symptoms of a severe allergic reaction:

> "We got an IV in him very quickly. We got the initial meds in him very quickly… And medically, that would be an indication to go ahead and intubate him while you still can because it can get so swollen that you can't see well enough to put a tube into your trachea. But I really did not want to intubate him. So I called ENT and I said, you need to come down here and scope him. …So ENT comes down, they scope him. The back of his tongue is also swollen. Normally, [the ENT physician] would just go ahead and say we're just going to intubate him, which would have meant he would have been on a ventilator for 24 to 36 hours, extubated, ICU, prolonged hospital, blah, blah. …If you don't intubate soon enough, you end up having to … create an airway, a surgical airway, which is a traumatic thing to do. …[The ENT physician said], well, he's swollen and he meets all the criteria for intubation. And I said, you know what, he's visibly better in the last 20 minutes since we gave him the meds. Can we wait another half hour? Will you come back and re-scope him so we can see? If we're not making

> progress, we'll do it. But if he's getting better, maybe we can avoid an intubation. I would not normally do that. I think I bent the rules a little bit because it was a colleague."

Participant 35M indicated that years of experience in emergency departments had contributed to his decision in this situation, and that, if the situation had occurred earlier in the participant's career, he may not have made the same decision. "I might have just gone ahead and intubated him." This participant also emphasized an awareness that intuitive reasoning was overriding medical training and reported taking extra caution to ensure that the decision did not harm the patient:

> "I don't think it was reckless because I stood there and I'm reassessing. … And I'm watching changes at the bedside. I rarely spend 20 minutes at the bedside continuously. I trust the nurse to come get me if or him to push the button. …I made the decision, but I also knew it was a risk decision. And, therefore, to fully own that decision, I had to stay there and make sure."

A final example comes from a 60-year-old participant, Participant 9F who described an interesting approach to emergency room medicine. According to the participant, ER physicians approach treatment and diagnosis differently from other physicians: "Most doctors are interested in making diagnosis and then start a treatment. We treat and then we make a diagnosis." Participant 9F observed that this is an inherently more intuitive way of operating. She stated this emphasis on intuition explicitly later in the interview, stating, "The emergency physicians… are MacGyver types. …The job that's there, we got to get it done, rules shmules." This participant was one of the most experienced, and she was the only one to directly equate medical training with the development of clinical intuition:

> "Medical training is—there's a lot of science in medicine, but it is primarily still more of an art than science. All the science does is it informs and influences the art. When it comes down to it, it's still a patient, a person, and as we often say, patients don't read the textbooks."

Participant 9F used an interesting analogy to describe the ER physician's clinical decision making process. She described the process of learning to drive a car; at first, the new driver thinks consciously about all the steps involved. After many years of driving experience have been accumulated, however, driving becomes intuitive. According to the participant,

> "After 25 years of driving, I want to drive, I get in the car, throw it in gear and go. …You don't even think about what you're doing with your body because that's become—you can't say instinct because no human has the instinct to drive."

This account suggests that medical training is a process of developing clinical intuition, such that the experienced physician can use the same diagnostic criteria and heuristics that novice physicians use, but the process of employing those algorithms has become automatic. Participant 9F appeared to be familiar with the dual processing model of decision making, calling this intuitive reasoning process "type-two thinking."

Finding 2A: 0 out of 22 respondents aged 33 or younger reported reflecting on patient loss of life after work

Figure 8 contains a quote tree summarizing the quotations related to this finding. These selected quotes are representative of the responses of all participants aged 33 and younger.

Figure 8. Quote Tree for Finding 2A

Finding 2A: **0 out of 22 respondents aged 33 or younger reported reflecting on patient loss of life after work.**

I don't reflect too much. This can really weigh you down.

—Participant 4F

I don't recall reflecting on it. I just went to the next patient.

—Participant 12F

Do I reflect on the loss of life afterwards? I'm human, I do think about it but I leave it at work.

—Participant 6M

I will think about it as I'm leaving for home but I don't bring this home with me. I don't think I would be able to function if I constantly reflected on the loss of life.

—Participant 18F

It's harder to psychologically stop a resuscitation on somebody who is younger and healthier than somebody who is old, sick, demented and in a nursing home.

—Participant 33M

Four of the younger participants interviewed for this study had not yet experienced loss of patient life (e.g., participant 2M). Those who had experienced losses of life unanimously reported not reflecting on the events after work. Some participants reflected during their shifts. Participant 6M noted, "Do I reflect on the loss of life afterwards? I'm human, I do think about it but I leave it at work," and participant 18F similarly reported, "I will think about it as I'm leaving for home but I don't bring this home with me. I don't think I would be able to function if I constantly reflected on the loss of life." Other participants reported not reflecting on patient loss of life at all. According to participant 4F, "I don't reflect too much. This can really weigh you down." Participant 12F, who had only experienced dead on arrival patients, said, "I don't recall reflecting on it. I just went to the next patient."

Participant 33M, a younger participant with 6 years of ER experience, indicated that patient loss of life did not often affect him emotionally. However, when discussing cardiac arrest situations, he stated that "It's harder to psychologically stop a resuscitation on somebody who is younger and healthier than somebody who is old, sick, demented and in a nursing home." This suggests that the participant did not reflect on patient outcomes, but that some reflection may have occurred during treatment.

Finding 2B: 13 out of 15 more experienced respondents reported reflecting on patient loss of life after work

Figure 9 contains a quote tree summarizing the quotations related to this finding. These selected quotes are representative of the majority of responses from participants aged 34 and older; quotes from the two participants who did not support this finding are also included.

Figure 9. Quote Tree for Finding 2B

Finding 2B: **13 out of 15 more experienced respondents reported reflecting on patient loss of life after work.**

I've cried on my way home from work before. I just hate to lose a patient and I take it very personally when I do. Regardless of age. I do take it home with me. —Participant 1F	*I'll pray about [losses of life] on the way home. I usually talk it over with my husband and he usually helps me get through it. I tend to make mental notes on what I saw so that If I see it again, I might be able to save the next person.* —Participant 5F
You'll hear my younger colleagues say that it only affects them if the patient was young. That's not true for me. I took an oath to save lives and I lost one. —Participant 36F	*I have a ritual I do when I get home. I kneel at the end of my bed and I pray to God. I ask him to show me if I could have done anything differently. If He does, I self-report.* —Participant 30M
I think about patients that die under my watch. I learn from it and move on. If you don't, it'll eat you up. You can't bring this stuff home with you. —Participant 11M	*One of my survival mechanisms is that at the end of each shift when I leave, I try not to think about the patients and the shift. I wipe the slate clean.* —Participant 9F

Participant 1F said, "I've cried on my way home from work before. I just hate to lose a patient and I take it very personally when I do. Regardless of age. I do take it home with me." The age of patients who lose their lives was mentioned by several of the participants aged 34 or older. Participant 36F, for example, commented, "You'll hear my younger colleagues say that it only affects them if the patient was young. That's not true for me. I took an oath to save lives and I lost one."

Among the older participant group, reflecting on loss of life after work was often described as an important coping mechanism, and many participants described rituals or processes that they used to process their emotions. For example, participant 5F stated

> "I'll pray about [losses of life] on the way home. I usually talk it over with my husband and he usually helps me get through it. I tend to make mental notes on what I saw so that If I see it again, I might be able to save the next person."

Similarly, participant 30M reported reflecting on loss of life after work:

> "I have a ritual I do when I get home. I kneel at the end of my bed and I pray to God. I ask him to show me if I could have done anything differently. If He does, I self-report."

There were some outliers to the trend. For example, Participant 11M who had over 20 years of experience in a large East-Coast emergency department. The patient described his response to patient loss of life: "I think about patients that die under my watch. I learn from it and move on. If you don't, it'll eat you up. You can't bring this stuff home with you." Similarly, Participant 9F, a 60-year-old female, stated, "One of my survival mechanisms is that at the end of each shift when I leave, I try not to think about the patients and the shift. I wipe the slate clean."

Finding 3: 24 out of 37 respondents mentioned deep-vein thrombosis or mesenteric-vein thrombosis in narratives regarding life-saving decisions

Physicians frequently described stories related to blood clots, specifically deep-vein thrombosis and mesenteric-vein thrombosis, during their interviews. Of the 37 physicians interviewed, 24 recounted stories related to one of these two types of thrombosis. Participants had experienced both positive and negative outcomes with this type of condition. Figure 10 contains a quote tree summarizing the quotations related to this finding. These selected quotes are representative of the responses of all 24 of the respondents who provided evidence for this finding.

Figure 10. Quote Tree for Finding 3

Finding 3: **24 out of 37 respondents mentioned deep-vein thrombosis or mesenteric-vein thrombosis in narratives regarding life-saving decisions.**

Everything [every test] I could think of came back negative… She [the patient] had a superior mesenteric-vein thrombosis that is extremely rare and when it does present itself, it's usually a stroke or pulmonary embolism. In this case, a stroke.

—Participant 15M

She complained of pain in her lower back. …When something like this happens, there's a set of protocol hospitals follow… In this case, we did everything we were trained to do. …My instinct and my training didn't catch this.

—Participant 15M

Participant 15M recalled a 35-year-old female patient who had come to the ER with lower back pain, and had been prepared with lists of dates and times the pain began, as well as medications she had been taking to alleviate the pain. Despite this information, the participant was unable to determine the cause of her pain. The physician ordered numerous tests; however, he said, "Everything I could think of came back negative." The patient was discharged and instructed to use a heating pad. Several days later, she returned to the ER. According to Participant 15M, "She had a superior mesenteric-vein thrombosis that is extremely rare and when it does present itself, it's usually a stroke or pulmonary embolism. In this case, a stroke." The patient lost her life as a result of the stroke. Participant 15M emphasized the use of medical training in this situation: "She complained of pain in her lower back. …When something like this happens, there's a set of protocol hospitals follow… In this case, we did everything we were trained to do. …My instinct and my training didn't catch this."

Owing to the unexpected nature of this finding, the researcher contacted participants via e-mail to solicit their interpretations of the finding and to gather more information. The participants indicated that, in particular, mesenteric-vein thrombosis patients typically present with symptoms that do not, according to standard medical training, result in an immediate diagnosis. Participants indicated the importance of ruling out other conditions before looking for thrombosis, unless there are known risk factors such as preexisting blood clotting disorders.

Discussion

Intuitive versus Rational Decision Making

Groopman and Prichard (2007) gave one of the most thorough accounts to date of the clinical decision making process that emergency care physicians use. Groopman's account emphasized established procedures, algorithms, evidence-based practice, and rational decision making. The findings of the present study significantly contradict Groopman; many of the participants gave examples of times when their reasoning processes diverged from the established procedures or when they were able to make medically sound decisions without consciously referencing the rules they had learned. These accounts are more in line with existing research related to decision making processes used in other medical professions. The process that emerged from this research, which involves physicians' developing intuitive reasoning skills that are informed by medical training, is similar to the reasoning style described among nurses (Muoni, 2012; Weick, Sutcliffe, & Obstfeld, 2005).

Additionally, the decision making process described by Coget and Keller (2010) seems to fit the findings of this research well. The authors proposed a model for emergency medical decision making wherein emergency physicians and managers alike should equally take into account their rational, training-based conclusions and their clinical intuitions. This model was exemplified particularly well by participant 35M, who described being very aware, in the moment of treatment, that a decision contradicted his training and that his decision might have been influenced by his emotions. Thus reason, intuition, and emotion were all actively involved in his clinical decision making process. Coget and Keller recommended including the robust nature of clinical decision making into discussions during medical apprenticeships and peer-to-peer reviews. The findings of this study support their recommendations.

One explanation for the differences between the findings of this research and existing literature could be the unique role of ER physicians. Several participants emphasized this unique role, stating that there is often not enough time to employ rule-based decision making. Instead, when time is of the essence, ER physicians and their patients are better served by remaining alert (or mindful) and acting quickly. This supports research by Xu, Xu, Yu, Ma, and Wang (2012), who found that algorithm-based decision making was the least commonly used among a sample of ER physicians, most preferring experience-based pattern recognition as a decision making strategy. This points to the concept of mindfulness, which can enhance pattern recognition through attention to contextual detail. This accords with previous research (Cioffi, 2000).

The dual-process theory of decision making aids in understanding the results of this study. According to the theory, both intuitive and rational reasoning processes are at work in decision making (Calder et al., 2011). Interestingly, Calder et al. (2011) conducted a survey of emergency physicians and found that physicians, in general, used rational decision making—a finding which this current study contradicts. This discrepancy could be explained by the fact that Calder et al. (2011) did not investigate physicians' lived experiences, instead using a self-report survey, which may have introduced bias.

When physicians in this study were probed to explain their decision making processes, many unabashedly emphasized the important role of intuitive reasoning. This raises a crucial question for the management of emergency medicine: if intuitive reasoning is such a crucial part of the ER physician's decision making process, why do many practitioners and scholars report an emphasis in training on rule-based decisions? Further, how can management ensure that emergency physicians make appropriate use of complex decision making processes in order to optimize patient care and improve overall medical facility performance? Exploring these issues further could be relevant to improving ER physician training and performance, as well as to developing ER quality control systems that better reflect the realities of emergency medicine.

Transition to Mindfulness

The first, qualitative study focused on the role of intuition in decision making. The results of the qualitative study showed that emergency physicians who rely on automatic, intuitive decision processes appear to be highly mindful (i.e., consciously aware of the details of their immediate internal and external environments). It also showed a stark generational divide in the use of intuitive reasoning, with younger physicians demonstrating a strong preference for reliance on tools like diagnostic algorithms and information technology (IT). Many younger physicians believed that relying on IT made them more effective and less prone to errors. Although it would not be surprising to see young physicians relying on their training, their dogmatic trust in IT was striking.

By contrast, older physicians suggested that, without intuition gained through experience, physicians might be more prone to miss subtleties related to patient contexts, in effect decreasing their performance. The results of my qualitative study did not allow me to draw a firm conclusion regarding this question, so I developed the second, quantitative study, to better understand these relationships.

Limitations and Future Research

As with all narrative interview-based research, these findings are not generalizable to other physicians working in other settings. However, the insights gained from this research are important for directing future research studies, as indicated in the previous section. Additionally, because the researcher conducted semi-structured interviews to gather data, there is a possibility that bias was introduced during the interview process. Participants may have given responses they thought the interviewer wanted to hear, and the interviewer may have influenced responses in the process of probing. Every attempt was made to mitigate the effect of these biases; all participants were informed that their responses would be kept strictly confidential, and open-ended questions were used to ensure that participants felt free to disagree with the researcher.

Another limitation of the present study is that it did not investigate differences in the medical training programs in which participants participated, and it did not investigate the procedures at the hospitals where the participants worked. Thus, some of the trends identified could be related to factors that the present study failed to uncover. Despite this limitation, the trends identified could be used to guide future studies accounting for other factors.

An important question for future research is whether discrepancies in the use of intuitive reasoning among ER physicians of different generations are linked to length of experience, or whether we are seeing a shift in the way ER physicians diagnose and treat patients. To examine this, researchers should compare experienced and novice physicians' perceptions of the reliability of medical technology and diagnostic algorithms. Researchers should also continue to investigate the mechanisms of intuitive decision making. It is not yet known whether the use of intuitive decision making in ER medical settings has an impact on patient outcomes and quality of care. Researchers should investigate this issue. To explore the relationship between IT use and performance, and to begin to investigate the role of mindfulness, I conducted a quantitative study to test a model of ER physician performance. This second study is described in the next chapter.

CHAPTER 5: A MODEL OF INFORMATION TECHNOLOGY, MINDFULNESS, AND PHYSICIAN PERFORMANCE IN EMERGENCY ROOMS

The first, qualitative study (described in the preceding chapter) yielded fruitful results regarding the use of multiple types of reasoning in ER physicians' decision making. Although the concept of mindfulness was not central to the first study, the results clearly pointed to this timely concept, since physicians frequently described situations in which attention to detail and situational awareness (captured in the concept of mindfulness, as described in Chapter 3) were crucial to their ability to make life-saving decisions on short order. To further explore these findings, I conducted a quantitative study, focusing on the role of mindfulness as a mediator of the effects of IT use, IT access, and IT restrictiveness on physician performance. The research question for this quantitative study was:

- *What is the relationship between information technology use, access, and restrictiveness and ER physician performance, and to what extent are such effects mediated by mindfulness?*

In this chapter, I present a brief review of the theory behind the quantitative model, alongside the hypotheses for the study. Then, I present the design, method, results, discussion, and limitations for the study.

Theory Review and Hypotheses

Physician Performance, Information Technology, and Mindfulness

Physician performance can be generally defined as the degree to which a physician performs well with regard to the outcome quality of patient care and communicates effectively with patients or other professionals critical for rendering the care. Recent research suggests that physician performance is linked to several factors, including organizational factors (organizational structure), systemic factors (e.g., availability of diagnostic tests), and individual factors (e.g., certifications held) (Wenghofer et al., 2009). Several studies have identified that personal and psychological differences are significant predictors in explaining variance in physicians' performance (Mitchell et al., 2005). For example, Girard and Hickam (1991) found that emotions and attitudes among resident physicians explained 48% of the variation in their clinical performance (depression being the strongest predictor). Performance is also commonly attributed to the level of access to clinical information and the way in which this information is integrated with clinical decision making. Therefore, a recent goal has been to increase information availability by introducing information technology (IT) tools at multiple points of patient care. These tools come in multiple kinds, including rich information-provisioning tools such as high quality visual CT scans and x-rays (Andruchow et al., 2012) or tools that allow inquiries into the patient's medical history and current status (electronic patient record systems). Recently, the impact of such tools on physicians' information use and decision-making behaviors has become more systematic and deeper due the increased introduction of a new breed of tools that script and model clinical decision making. Mobile technologies, such as tablets and smartphones also increase potential for IT use at the focal points of patient care and have ushered a new breed of real-time interactive tools that can support clinical decision making. Such tools are now rapidly adopted in the US healthcare facilities (Williams, 2014). As described in Chapter 3, research also suggests that physicians who use such IT tools make significantly different diagnosis and treatment decisions when compared with those who do not (Bochicchio et al., 2006b; Epstein & Ketcham, 2014). At the same time, the outcomes of investing in such clinical IT tools have been highly conflicting (Cash, 2008). For example, at the hospital level, the highest performing institutions (in terms of mortality and readmission rates), do not use such IT tools at a greater rate than their lower performing counterparts (Williams et al., 2015). Therefore, it is far from established that such tools will improve under all conditions physician's performance.

These equivocal results create a need to investigate further the impact of IT tools on physician performance. Though the tools may positively influence decision making by decreasing decision outcome variance and avoiding errors of omission, they may also reduce context awareness and guide physicians' decision behaviors to be less attentive to situational specifics as physicians act increasingly on an 'automatic pilot'. By doing so, IT tools can, in fact, decrease performance. Conversely, types of IT use that stimulates mindfulness could lead to increases in performance. Hence, I next consider the diverse effects of different types of IT use on mindfulness and how they jointly influence ER physician performance.

A growing body of literature has examined generally the relationship between mindfulness and IT. Some research suggested early on that IT can promote mindfulness at the organizational level by promoting communication of key information across different roles and functions (Boland Jr et al., 1994). At the individual level, however, the effects of IT are more mixed. For example, (Butler & Gray, 2006) suggest that reliable IT systems can, in fact, increase mindlessness (i.e., a lack of awareness of one's internal and external situation) by enforcing routine, repetitive tasks. At the organizational level, however, the effects may be mixed in that individual mindlessness may be beneficial when combined with mindfulness at other parts of the organization- in fact, mindfulness as an organizational trait involves both mindful and mindless behaviors (Carlo et al., 2012). These considerations suggest that mindfulness is a complex phenomenon which may have varying effects on individual and organizational performance, depending on the specifics of the IT functionality and extent of its use, its context, and user's personal characteristics.

Mindfulness has also gained increased attention as a factor influencing physician performance (Fernando, Consedine, & Hill, 2014). Interventions designed to increase physician mindfulness have been found to decrease stress and burnout among physicians (Lovell, 2015; Martín-Asuero & García-Banda, 2010; Westphal et al., 2015). Additionally, research suggests that increased mindfulness could be associated with increased physician performance including improved ability to communicate effectively with patients (Beach et al., 2013) and reduction of diagnostic errors (Sibinga & Wu, 2010). These effects can be attributed to the fact that mindfulness improves cognitive attention and richness of cognitive functions thereby reducing physician's emotional and cognitive biases (Sibinga & Wu, 2010). Mindful clinicians are more aware of their surroundings and also engage in critical self-reflection, which enables them to "listen attentively to patients' distress, recognize their own errors, refine their technical skills, make evidence-based decisions, and clarify their values so they can act with compassion, technical competence, presence, and insight" (Epstein, 1999).

From the perspective of mindfulness, IT access at the point of patient care may also have detrimental effects. Many of the new IT tools, for example, recommend automatically courses of action or remind physicians to educate patients on certain aspects of their conditions (Hunt et al., 2009). This can curtail performance by reducing mindfulness, since physicians may not be properly attending to individual patient's contexts. Indeed, scholars have suggested that situational awareness is crucial in situations where IT decision aids are used (France et al., 2005) in that mindful users can be expected to make better use of decision aids than those who are less mindful. Because research on IT tools for clinical decision making is still in a nascent state, I considered three salient features of the IT environment that could influence physician performance:

1. **IT access**, defined as the extent to which physicians see that they have access to use IT tools when they need them in their clinical work,
2. **IT use** defined as the extent to which physicians actually use IT tools in their clinical work, and
3. **IT restrictiveness** defined as the extent to which IT tools are perceived to guide physicians' decisions and restrict their decision making behaviors (Tsang, 2013).

Preliminary evidence suggests that growing IT access offered by mobile IT tools at the point of patient care is altering physicians' decisions and had led to differences in physician performance (Bochicchio et al., 2006b; Epstein & Ketcham, 2014). Likewise, Tsang (2013) argued that, as health information technologies become more prevalent, they have become critical elements in physician performance evaluations; physicians often use them as time-saving tactics and may spend a great deal of time using IT. Because hospitals and wards differ widely in the types of IT they offer access to, and because little is known about the potential long-term effects of the proportion of time used with IT tools, we chose to analyze the effects of time spent on the tools. Finally, the focus on restrictiveness is motivated by the increased use of such restrictive tools and the mixed effects they may have on physicians' performance.

The Effect of Organizational and Individual Factors

Several additional factors have been found in the past to influence physician's performance, including occupational stress, risk tolerance, years of medical experience, and pay-for-performance availability (Adler et al., 1980; Andruchow et al., 2012; Rogers et al., 2015; Van der Vaart et al., 2011). Therefore, these were included in the study in order to better isolate the specific effects of how IT features and mindfulness jointly influence performance. We will next explain the choice of these factors.

Physicians' job performance have been inversely linked to increased stress (*occupational stress*) (Mitchell et al., 2005). One study has found specifically a significant association between occupational stress and decreased physician performance (Adler et al., 1980). *Risk tolerance* (defined as the degree to which a physician is risk seeking or risk avoidant) can also be expected to influence the relationship between used IT features and physician performance. Risk tolerance has been found to impact emergency physicians' decisions (Tubbs et al., 2006) and researchers often cite low risk tolerance as one reason the overuse of diagnostic technologies such as CT scans (Andruchow et al., 2012).

Length of experience has been linked to improved performance in ER settings (Van der Vaart et al., 2011). One reason could also be that there are generational differences in the way in which IT tools are used between younger and older physicians. Finally, *pay-for-performance* incentives, whereby physicians receive compensation in addition to their regular pay if they meet certain performance objectives, have been linked in some studies to improved performance (Bruni et al., 2009; Rogers et al., 2015; Torchiana et al., 2013). Table 6 summarizes key constructs used in this study.

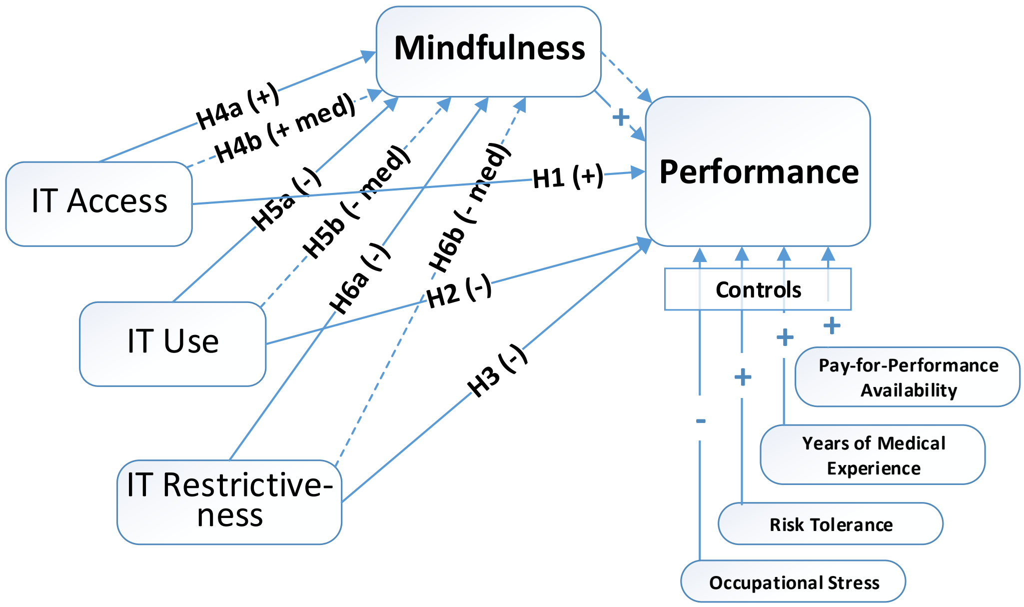
Table 6. Mindfulness, IT Features, and Organizational Factors

Factor	Definition	Source
Mindfulness	"the capacity to be aware of one's internal condition and external situation as fully and as consciously as possible" (Coget & Keller, 2010: 69).	(Coget & Keller, 2010)
IT access	The extent to which physicians have access to information technologies defined as online and offline medicine- and patient-related information accessed via computer or mobile device.	(Ilie, Van Slyke, Parikh, & Courtney, 2009b; Tsang, 2013)
IT use	The frequency with which physicians use information technologies defined as online and offline medicine- and patient-related information accessed via computer or mobile device.	(Tsang, 2013) (Ilie, Van Slyke, Parikh, & Courtney, 2009a)
IT restrictiveness	The extent to which physicians perceive that their decision making processes are restricted by clinical decision support systems and other information technology tools.	(Knoll & Jarvenpaa, 1994) (Lending & Chervany, 2002)
Performance	The degree to which an ER physician performs well on factors related to patient care, communication with patients or other professionals, and situational awareness.	(Overeem et al., 2012)
Occupational stress	Perceived stress from work-related causes.	(Lesage & Berjot, 2011)
Risk tolerance	The degree to which a physician is risk seeking or risk avoidant, compared to the mean.	(Burman, Zakariassen, & Hunskaar, 2014; Pearson et al., 1995)
Pay-for-performance availability	Whether a physician's workplace offers pay-pay-for-performance incentives.	(Bruni et al., 2009; Rogers et al., 2015; Torchiana et al., 2013)

Hypothesis Development

I tested a research model that explores antecedents of physician performance in ER settings (Figure 11). The model postulates 6 hypotheses that explain the performance by using IT access, IT use, and IT restrictiveness as predictor variables. Mindfulness is proposed as a mediating variable in that it mediates the effects of predictor factors by transferring their effects on physician decision making behaviors. I also noted mixed effects of different aspects of IT use on mindfulness. Next, I formulate the hypotheses.

Figure 11. Quantitative Research Model



Direct effects. Information technology in emergency departments has been shown to reduce costs, increase performance, and enhance decision making (Carr et al., 2013; Dinh & Chu, 2006; Tsang, 2013) because the help assess patient risks and determine targeted treatment protocols (Anderson et al., 2014; Barrett et al., 2015; Watts et al., 2003). Physicians will use such tools to aid in diagnostic and treatment decisions thereby reducing errors and improving decision effectiveness. In order to realize these benefits, physicians need to have constant access to the IT tools during critical decision situations. Accordingly, if physicians have greater access to IT tools (i.e., they are free to use IT whenever they want in the course of their clinical duties), they will have a greater ability to realize the performance-enhancing benefits of those IT tools. I posited:

Hypothesis 1. IT access positively influences ER physician performance.

Despite the hypothesized positive effect of IT access on ER physician performance, some physicians with access to IT are also likely to spend excess time in using such tools due to their attractiveness or just demands for effort. This may reduce attention to immediate patient concerns reducing the general benefit of technology availability and decreasing performance. Prior research indeed suggests that all clinical IT use does not necessarily lead to increased performance (Tarafdar, Pullins, & Ragu-Nathan, 2015) and may even decrease performance (Addas & Pinsonneault, 2015; Goodhue & Thompson, 1995). One reason can be that too much cognitive effort and attention is spent on using the IT tools. Therefore, among physicians who use IT tools for larger proportion of their time I posited that:

Hypothesis 2. Extent of IT use negatively influences ER physician performance.

Preliminary evidence already suggests that mobile IT tools at the point of patient care are likely to guide physicians' decisions and lead to differences in performance (Bochicchio et al., 2006b; Epstein & Ketcham, 2014). Such performance differences are not always positive (Cash, 2008). Physicians may become overly reliant on IT tool scripting and enactment of embedded scripts is likely to interfere and thwart attention to conflicting evidence or specific details. Restrictiveness could also improve performance owing to its role in standardizing 'best' patient care practices and thereby decreasing variance in decision processes. No existing research has substantiated the possible direction of the effect. Therefore, I hypothesized that that IT restrictiveness has an effect- either negative or positive- on physician performance:

Hypothesis 3. IT restrictiveness influences ER physician performance.

Physicians who are generally more mindful are known to perform better in that they engage in reflective knowledge use to defer or evaluate proper diagnostic and treatment decisions even when these decisions contradict the official script or common practice (Beach et al., 2013; Coget & Keller, 2010). Physicians who have free access to various IT tools will have a greater ability to select the correct decision aids and diagnostic tests for a particular situation. The greater the degree to which IT-based information is available, the more possibilities the physician will have in seeking additional information while making the decision. A physician who has a higher degree of IT access will pay more attention to her surroundings and chooses to use the most appropriate IT tool(s) to support his or her decisions. Rather than relying on memorized lists and scripts, the physician is also more likely to approach each situation as unique. Accordingly, open IT access will increase performance by increasing mindfulness and this increased mindfulness will benefit more from the availability of different tools. Thus, we posit:

Hypothesis 4a. IT access positively influences mindfulness.

Hypothesis 4b. Mindfulness partially and positively mediates the positive relationship between IT access and performance.

Conversely, physicians who use IT frequently at the point of patient care may develop an overreliance on IT tools, to the extent that they fail to pay adequate attention to their surroundings (i.e., their mindfulness decreases). For example, a physician who uses IT frequently may fail to notice a subtle but important detail in a patient's clinical presentation. Because this clinical detail does not fit with the information she is used to receiving from the IT tool, she may overlook it, leading to an incorrect diagnosis and treatment decision. Hence, the more physicians use IT, the less they will interact mindfully with their patients, and the decrease in performance from IT will therefore be mediated by a decrease in mindfulness (which is important to performance, as above):

Hypothesis 5a. Extent of IT use negatively influences mindfulness.

Hypothesis 5b. Mindfulness partially and negatively mediates the negative relationship between extent of IT use and performance.

Finally, as noted IT restrictiveness decreases performance. Similarly, this mechanism will decrease also mindfulness. Highly scripted IT tools that require physicians to follow particular protocols could lead to cookie-cutter behaviors, thus decreasing mindfulness by rendering situational awareness unnecessary. For example, a physician who knows that she will be required to follow an IT tool's recommendations has no incentive to remain mindful at the point of patient care, since attention to context-specific detail cannot change the outcome of the clinical encounter. Therefore, I posited:

Hypothesis 6a. IT restrictiveness negatively influences mindfulness.

Hypothesis 6b. Mindfulness partially and negatively mediates the negative relationship between IT restrictiveness and performance.

Design

I validated the research model using a survey study. A survey design was followed because it was deemed appropriate to test these hypotheses in realistic settings and because one of the authors had an access to a large pool of physicians at multiple health care providers across the United States. Access to physicians at multiple organizations ensured also that the sample consisted of a high variety of IT and support environments, leading to more robust data sets. Two alleviate mono-method bias, two separate survey instruments were administered for physicians and physician peers who evaluated performance.

Construct Definition and Operationalization

Physician performance. I adapted the Overeem et al. (2012) robust multisource feedback (MSF) measure of physicians' professional performance. Performance is a formative construct. Items ask about a wide range of aspects related to physician performance including e.g. personal appearance. I used only those items that directly relate to patient care and communication with patients or other professionals. Additionally, the original questionnaire includes open-ended questions for narrative feedback, which were not applicable to this quantitative study. The final scale consisted of 16 items. All items used a five-point, Likert-type scale ranging from 1 (completely disagree) to 5 (completely agree).

Mindfuless. The Mindful Attention Awareness Scale (MAAS) by Brown and Ryan (2003) was adapted for measuring mindfulness for its demonstrated reliability and validity. It is also relatively brief and easy to complete. Items relate both to situational awareness and to the mindfulness-specific capacity to draw new conclusions from, and, if necessary, act on situational awareness. Specifically, items 8, 9, 10, and 14 refer to actions that may not be captured by simple internal situational awareness. Mindfulness is a reflective construct. The MAAS consists of 15 items scored on a 6-point Likert scale.

Information technology access and use. To my knowledge, no research instrument is available to measure IT access and level of use in health care settings. Most of the research in this area has been qualitative (Georgiou et al., 2013; McAlearney, Chisolm, Schweikhart, Medow, & Kelleher, 2007; Pluye & Grad, 2004; Prgomet, Georgiou, & Westbrook, 2009). Therefore, I developed new scales to measure these variables. Both are reflective constructs. I adapted Tsang's (2013) instrument which contains seven items related to the intent to use health information technologies and the Ilie et al. (2009a) scale on physicians' decisions to use IT tools. The access and use scales consisted of three and four items, respectively, scored on a 6-point Likert scale.

Restrictiveness of information technology. I adapted Lending and Chervany (2002) instrument to measure the restrictiveness of computer-aided software engineering tools and changed the task focus on diagnosis and treatment decisions in a medical setting. The scale consisted of five items scored on a 6-point Likert scale.

Controls. I adopted a visual analog scale (VAS) to measure occupational stress. The VAS consists of one item: a non-calibrated horizontal line 100 mm in length. The scale ranges from 0 (very low) to 100 (very high). Dutheil et al. (2013) used this scale to measure occupational stress among emergency physicians, and it has been shown to have good validity when compared with the Perceived Stress Scale (Lesage & Berjot, 2011).

The Pearson Risk Scale (PRS) was used to measure risk tolerance (Pearson et al., 1995). The scale was initially developed to measure risk tolerance among emergency room physicians responsible for triage care. It consists of six items scored on a six-point Likert scale. The instrument divides participants into three groups: a risk seeking group, a risk avoiding group, and a middle group. However, for the purpose of this study, this three-group scoring system was not used; instead, risk tolerance will be treated as a continuous variable based on PRS total scores.

Years of experience was measured as a continuous numeric variable. Finally, pay-for-performance incentive availability was included as a control and measured as a categorical variable with two possible values (1 = no pay for performance available, 2 = pay for performance available).

Instrument Development

Focus groups. I sought to ascertain that the target population would understand and interpret survey accurately and that the items are perceived as related to the variables under examination. I conducted a focus group to elicit feedback from the target population regarding the wording of items. The focus group consisted of nine physicians, who were asked to take the survey and make comments. The respondents identified several grammatical mistakes and duplicate questions. These errors were fixed based on their responses. The focus group did not recommend removal of any items and noted that they understood the question items.

Q-sort. I conducted a q-sort with four raters using Qualtrics to assess the convergent and discriminant validity of the survey items. The results of the q-sort indicated that the survey had strong content and discriminant validity; one physician incorrectly sorted one item, but the other three physicians sorted correctly that item, while the remainder of items were sorted with 100% accuracy.

Sample

Two target populations were sampled for the proposed study. The primary population consisted of physicians who, at the time of the study, were employed in emergency departments at hospitals or other medical institutions. The secondary population consisted of peers of the participant physicians and they rated their performance. In order to identify eligible physicians, we sent e-mail announcements to hospitals with which one of the authors had have established business relationships. The inclusion criteria for physicians were (a) at the time of study, employed as a physician by an emergency department.

A total of 1,557 physicians were identified for participation in the study and contacted via e-mail. I informed them of the purpose of the study and the nature of participation and invited to participate. I also explained that, should they choose to participate, they would be asked to solicit responses from their peers for their willingness to participate. After physician participants had agreed to participate and had provided written, informed consent, they were directed to the survey. At the end of the survey, they were asked to generate a unique code by which peer data could be associated with their responses on an anonymized individual level. They were also provided with an e-mail template they could use to request participation from others. This procedure was used because it assured respondents the anonymity and was convenient for respondents. A total of 447 physicians responded, for a response rate of 28.7%. Owing to the sampling method for peers, however, it is not possible to know the response rate, since we cannot know how many physician respondents requested participation from others. If we assume that all 447 physician respondents invited peers to participate, the response rate for peers would be 34.6%. Table 7 summarizes the final characteristics of each sample.

Table 7. Sample Characteristics

Sample	***n* (before screening)**	**Response rate**	**Years of experience in emergency medicine (Mean ± SD)**	**Caseload frequencies**	
Physicians	447	28.7%	18.3 ± 10.9	0-13	0 (0%)
				14-20	37 (8.3%)
				21-27	315 (70.9%)
				28-34	88 (19.8%)
				35+	1 (0.2%)
Peers	155	34.6%	N/A	N/A	

On the basis of their years of experience in emergency medicine the sample is similar in its experience to the overall emergency medicine workforce (Counselman et al., 2009).

Data Collection

Surveys were administered using Qualtrics online survey software. The peer and physician surveys included a description of the study. The description also informed them of their right to withdraw from the study. Participants had the option to complete the survey in parts, saving their work and returning later. Participants who had not completed the survey after 2 weeks were excluded for the data analysis process.

Data Analysis

Data Cleaning and Multivariate Assumptions

Three cases had missing values for greater than 10% of items and were removed. The remaining missing values (fewer than 10% missing in 134 cases) were replaced with median scores. Since outliers are not meaningful for theoretically reliable Likert-type scales (Liu & Zumbo, 2007), I removed no cases due to extreme values. The final sample consisted of 443 physician responses. A visual inspection of cases was conducted to assess respondent's engagement and no cases were identified. High kurtosis scores applied to items 15 (mindfulness; kurtosis 14.06) and 36 and 37 (technology access; kurtosis 10.80 and 7.32, respectively). Therefore, I considered these items as candidates for removal during the factor analysis stage, but did not remove them, because they did not cause problems.

I determined that all hypothesized relationships were sufficiently linear and significant and met the assumption for structural equation modeling. Multicollinearity diagnostics indicated that all VIF values were within the acceptable range (below 3). Homoscedasticity was present in four variables, so error variance was consistent across all levels of each variable and the data meet the assumption for multivariate analysis.

For the peer dataset, no cases had missing values greater than 10% of items. Six cases were imputed based on item means. Thirty-three cases had standard deviations below 0.5, indicating potentially unengaged responses. However, because the peer performance items were measured on a five-point Likert scale, some small standard deviations are acceptable where respondents genuinely had uniform opinions of participants' performance. Therefore, I elected to retain all responses with a standard deviation above 0.3. This left 19 cases for removal, of which 15 had an SD of 0 (indicating they responded with the same value for all survey items). After removing these cases, I obtained a final sample size of 134 peer responses. I noted high kurtosis in items P1 (2.69), P2 (3.61), P5 (2.77), P13 (5.84), and P14 (2.95) indicating low standard deviations and suggesting potential social acceptability bias. This potential was tempered by the fact that the remainder of peer performance items had acceptable kurtosis scores between -2 and 2. However, since normality is one of the assumptions of multivariate analysis, and since a large number of items were available for this measure, I decided to remove these items from the dataset.

Peer responses were linked to individual participant (physician) responses by creating a composite datasets containing peer performance data along with participant data (henceforth the "peer dataset"). Because participants were asked to share the survey with multiple peers and coworkers, some participants had multiple peer scores, but some did not. To overcome this issue, I created a composite performance variables by averaging the performance scores across peers. For example, participant J4011 received two peer ratings, summing to 43 and 55, so that participant's coworker performance score was set to 49 (the average of the two ratings). The final peer dataset consisted of 76 cases. The final sample is smaller than anticipated, which I discuss in the Discussion section, below.

Measurement Model

Exploratory factor analysis. Statistical tests for factorability were described in Data Cleaning and Multivariate Assumptions, above. I used principal axis factoring with a Promax rotation and maximum likelihood estimation. In the physician data, I observed a perfect inter-item correlation between items 22 ("I make the correct diagnosis following consultation") and 23 ("I select appropriate treatments". This yielded a correlation matrix that was not positive definite. Therefore, I removed item 23 before beginning the EFA. I considered items for removal based on the following criteria: low communalities (< .3), low factor loadings (< .5), loading on no factors, and cross-loading with only negative scores (hence not contributing to the formation of positive factors). I also strove to retain at least three items per construct. I used these criteria as guidelines though the final EFA solution contained one factor with only two items and some loadings between .3 and .5; loadings below .3 were uniformly considered unacceptable.

I performed EFA using data for all multi-item variables with the full sample of 443 physicians and had to remove the following items: mindfulness: 9, 11, 12; technology use: 41; technology restrictiveness: 44, 46. In the final solution EFA, all five constructs loaded cleanly on separate factors explaining 66.13% of variance. All item loadings were greater than .3. All inter-factor correlations had absolute values below .5, suggesting initial good discriminant validity. The pattern matrix for the five-factor EFA is presented in Appendix B. Using only the data from the IT access scale, I constrained to two factors, and the EFA results supported a two-dimensional structure consisting of IT access (items 36, 37, and 39) and IT use (35, 38, and 40). Based on this empirical support and on the design of the instrument (Tsang, 2013), I considered IT use and IT access as separate factors.

Confirmatory factor analysis. By co-varying some error terms in the same factor I obtained a CFA model that fit the data to an acceptable degree (χ^2/df = 4.193; CFI = .881; RMSEA = .084). The CFI value fell between the .85-.89 range, which after Dimitrov, Al-Saud, and Alsadaawi (2015) indicates not great, but acceptable, fit. All items had loadings greater than 0.3 on the expected factors (Bagozzi & Yi, 1988). The final measurement model is featured in Appendix B. The validity and reliability measures are summarized in Table 8 and are all within acceptable range showing strong discriminant and convergent validity. I did not conduct common method bias analysis, because the dependent and independent variables were measured at different times using different survey instruments with different respondents. The final CFA model is reproduced in Appendix B as Figure B1.

Table 8. Construct Validity and Reliability

CFA	**Factor**	**CR**	**AVE**	**MSV**	**ASV**
	TechRestrictiveness	0.774	0.550	0.162	0.084
	Mindfulness	0.891	0.428	0.082	0.053
	RiskTolerance	0.924	0.674	0.151	0.077
	TechAccessUse	0.871	0.534	0.162	0.106

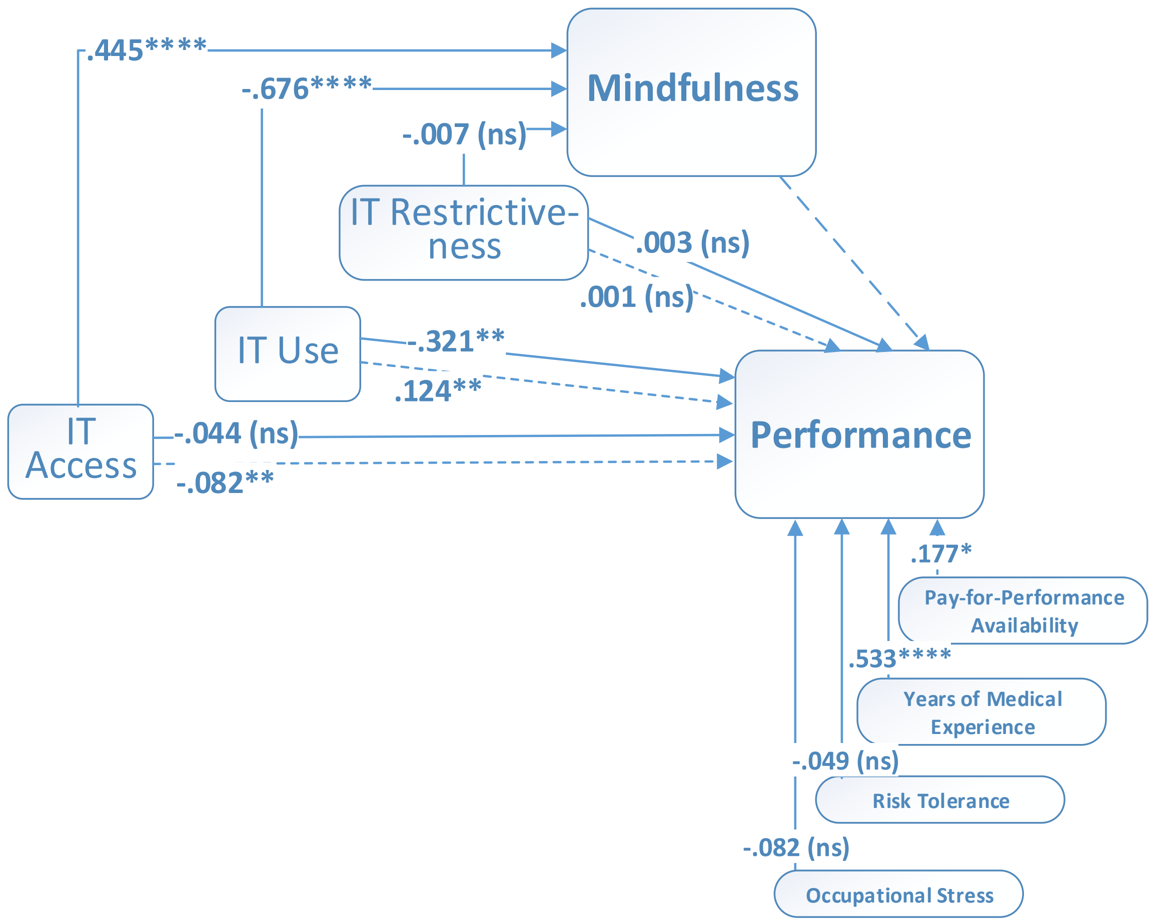
Structural Model

I used Amos version 22 to test all hypotheses. First, I created a direct effects model, and then I added mediators to generate the final model. I tested mediation hypotheses using bootstrapping with a 95% confidence interval based on 2,000 samples (Mathieu & Taylor, 2007).

Results

I interpreted all hypothesized paths from the final mediated model. The final model demonstrated good model fit after co-varying pay-for-performance availability with occupation stress, co-varying years of medical experience with risk tolerance, and co-varying IT use with years of medical experience and occupational stress. These latter two co-variances are theoretically justified by the results of the qualitative study (see Chapter 4). The final model fit statistics were as follows: CFI = .906, $\chi 2/df = 2.015$, and GFI = .902. After adding the mediator R^2 for performance improved slightly from .504 to .514. The final model, including significant mediation paths, is presented in Figure 12. The results of the hypothesis tests are summarized in Tables 9 and 10.

Figure 12. Final Statistical Model



Dashed lines represent indirect effects. * $p < .1$; ** $p < .05$; *** $p < .01$; **** $p < .001$.

Results indicate that physicians with greater access to IT were not rated as higher performing (β = -.044, *p* = .713) (**H1** is **rejected)**. A significant negative relationship between IT use and performance is detected (β = -.321, *p* < .001; **H2** is **supported)**. There was no significant relationship between IT restrictiveness and performance (β = .003, *p* = .974; **H3** is **rejected**). I observed a significant relationship between IT access and mindfulness, such that greater IT access correlates with greater mindfulness (β = .445, *p* < .001; **H4a** is **supported)**. I observed a significant indirect correlation between IT access and performance when mindfulness is modeled as a mediator (indirect β = -

.082, $p = .047$; see Table 9 below). Thus, greater access to IT tools tends to slightly decrease performance by decreasing mindfulness. Per Zhao, Lynch, and Chen (2010)) the presence of a significant indirect effect with a non-significant direct effect indicates that the mediator effect is consistent with the theoretical framework, and that no unobserved mediators are likely to exist. However, the direction of the effect differs from that of hypothesized (**H4** is **rejected**).

Results show a strong, significant negative relationship between IT use and mindfulness, indicating that greater IT use is associated with decreased mindfulness ($\beta = -.676$, $p < .001$; **H5a** is **supported**). I observed also a significant indirect positive effect of IT use on performance when modeling mindfulness as a mediator ($\beta = .124$, $p = .043$). Additionally, the indirect correlation is positive, whereas the direct correlation is negative, indicating a negative mediation effect of mindfulness (**H5b** is **supported**). I did not observe a significant effect of IT restrictiveness on mindfulness ($\beta = -.007$, $p = .946$; **H6a** is **rejected**). Similarly, I did not observe an indirect effect of IT restrictiveness on performance when using mindfulness as a mediator (**H6b** is **rejected**).

Table 9. Direct Effects Results

		Hypothesis	B	*p*	Supported?
H1	+	IT Access → performance	-.044	.713	No
H2	-	IT Use → performance	-.321	.010	**Yes**
H3	-	IT Restrictiveness → performance	.003	ns	No
H4a	+	IT Access → mindfulness	.445	< .001	**Yes**
H5a	-	IT Use → mindfulness	-.676	< .001	**Yes**
H6a	-	IT Restrictiveness → mindfulness	-.007	ns	No
Con		Risk tolerance → performance	-.049	ns	
Con		Experience → performance	.533	< .001	
Con		P4P → performance	.177	.056	

Con = Control path.

Table 10. Mediation Results

	Hypotheses	Direct β	Indirect β	Mediation type	Supported?
H4	IT Access → mindfulness → performance	Ns	-.082*	Indirect	No
H5	IT Use → mindfulness → performance	-.321*	.124*	Partial	**Yes**
H6	IT Restrictiveness → mindfulness → performance	Ns	ns	None	No

* $p < .05$; ** $p < .01$; *** $p < .001$.

Among the included controls, years of medical experience was strongly correlated with performance (β = .533; $p < .001$). Pay-for-performance availability was also, albeit just approaching significance, associated with performance (β = .177; $p = .056$).

Discussion

The results yield several interesting insights that, while not always consistent with the proposed theoretical model, reveal an abundance of directions for future research. Perhaps the most fascinating finding is that, when I included the mindfulness construct in the model, the direction of the effect of IT use on performance is reversed. In other words, all else being equal, more IT use leads to decreased performance. This finding adds to the growing body of evidence that extensive IT use is not unequivocally positive in hospital environments (Cash, 2008; Williams et al., 2015), conflicting previous research linking IT use levels to better performance in hospitals (Devaraj & Kohli, 2003). In other words, there remains a strong "pro-innovation emphasis" in existing research (Sundaram, Schwarz, Jones, & Chin, 2007); although researchers have emphasized the importance of training and efficient use in maximizing IT-derived performance benefits, most research begins from the assumption that IT will always lead to performance gains. In high-risk environments like emergency medicine, this assumption may need to be re-examined.

However, when the effects of mindfulness are explicitly included, more IT use leads to increased performance. This shows that more mindful physicians use IT to their advantage. By contrast, less mindful physicians—or those whose mindfulness is reduced by the extensive use of IT—may suffer in their performance from the overuse of IT tools. This complex relationship is one of the major findings and strongly invites future research into the ways in which mindful physicians leverage IT to their—and the organization's—advantage. At least one previous study (Zha, Zhang, Yan, & Zha, 2015) has revealed that mindfulness influences how IT users seek information; more mindful individuals, in their study, were less likely to rely on the quality of information provided by information systems in making decisions. My finding also supports earlier research into the importance of user orientation toward IT systems for maximizing IT benefits (Sundaram et al., 2007). However, a bulk of previous research has primarily focused on knowledge of IT and its relationship to tasks (Bravo, Santana, & Rodon, 2015; France et al., 2005) rather than personal characteristics like mindfulness that influence information use. In this regard my finding contributes understanding individual-level performance factors that builds upon recent findings that mindfulness at the organizational level is instrumental in rendering effective use of IT innovations (Wolf, Beck, & Pahlke, 2012).

IT access demonstrates a similar pattern with respect to mindfulness. When I added mindfulness into the model, IT access has a small yet significant indirect, inverse relationship with performance. Because there was no significant direct effect, this suggests that any differences in performance stemming from IT access can be entirely explained by the extent to which IT affects mindfulness (Zhao et al., 2010). Although this finding led to the rejection of H1 and H4, it suggests support for my theoretical contention that the IT environment is likely to change physician performance by contributing to or detracting the degree to which physicians are mindful. It also led to the focus on mindfulness in the third study (see the following chapter).

Regardless whether mindfulness was included in the model, IT restrictiveness had no significant effect on performance. Given the other results, this suggests that performance benefits stemming from IT access rely more on personal characteristics than on the scripting of the IT tools themselves. However, this finding cannot be explained by a lack of variation in IT restrictiveness, since the data were normally distributed. It could indicate that effects depend on personal characteristics i.e. some physicians may ignore the recommendations of highly scripted IT tools. Another reason is that the tools do not truly restrict in ways that affects in any way performance in the overall population i.e. there can be simultaneously negative and positive effects which cancel each one out in the overall population. Or the effects can be inverted U-shaped. However, my small sample size did not permit analysis of such conditions. My finding is however generalizable to some extent, because the sample was drawn from multiple organizations across the United States. It indicates good variability in the restrictiveness data and minimizing the possibility of attributing this result to the unique characteristics of a single IT environment.

Limitations and Future Research

My data set suffers from sample size limitations that should be taken into consideration when interpreting the results. The low sample size for peer respondents is the primary limitation. However, this limitation is to some extent ameliorated by the simplicity of the model used in regression analysis. Per Cohen, Cohen, West, and Aiken (2013) regression with eight predictors with a sample size of 76 and $R^2 = 0.275$ yields a statistical power of 0.97 when significance is set at $\alpha = .05$ (Soper, 2016). If we assume that all 447 physician respondents invited peers to participate in the survey, the peer response rate of 34.6% is acceptable, but a large number of responses were removed owing to their incompleteness or little variation. This may have been due to physicians' failure to communicate the nature of the survey to their peers. In the future, measures should be taken to avoid this issue, perhaps by soliciting peer contact information from physicians to provide a clearer description of the nature of participation and discourage incomplete responses.

Another limitation relates to less than perfect model fit. The model fit statistics are not strong due to small sample size. Future research should therefore strive to improve the fit through improved construct operationalization, instrument development and better sample size. To further investigate the strong influence of mindfulness on emergency physicians' performance within IT environments, I chose to focus on this characteristic in the third study, which I describe in the next chapter.

CHAPTER 6: THE ROLE OF MINDFULNESS IN CLINICAL DECISION SUPPORT USE AND EMERGENCY PHYSICIAN PERFORMANCE

The results of the first two studies indicated that the extent of use of CDSSs may be negatively associated with emergency physician performance. In the previous, quantitative study, it was revealed that physicians who use IT tools (broadly defined in that study) were lower performing ($\beta = -.329$, $p = 002$). Mindfulness, however, dampened this effect. This suggests that mindfulness may be one factor that influences CDSS use, leading to increased physician performance. Therefore, I developed an embedded, mixed-method framed theoretically by the concepts of reliable performance and mindfulness (Arnold & Sutton, 1998). Technology may have the effect of reducing reliable performance if it does not account for both routine and mindful reliability (see Theoretical Framework): "While software that is easy to use increases users' efficiency, it also increases their vulnerability to change or failure because it makes task execution more automatic" (Butler & Gray, 2006: 220). The research question for this mixed-method study was:

- *What, if anything, do highly mindful emergency physicians do differently when using clinical decision support systems that could lead to improved performance when compared with less mindful physicians?*

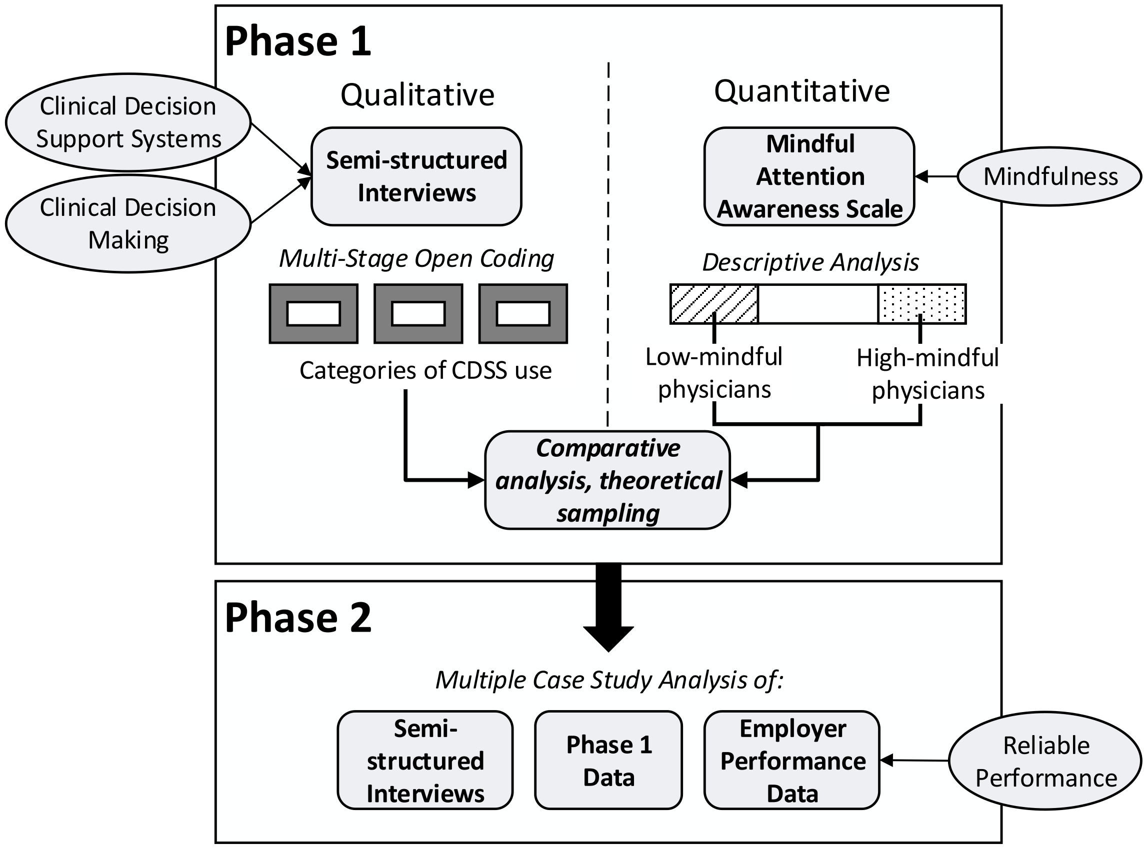
In this chapter, I present the design, method, results, discussion, and limitations for the study.

Design

A mixed-method study was deemed most appropriate to answer the question, because I needed to (a) identify physicians with high and low levels of mindfulness, (b) identify physicians with high and low performance, and (c) understand how these physicians used CDSSs. Mindfulness and performance (items [a] and [b]) can be assessed quantitatively using established research instruments. I had to first understand how physicians access CDDSs at the point of patient care. This question is suited to qualitative examination, since it does not involve measuring a variable or testing a hypothesis, but rather involves an open-ended exploration of a process phenomenon. There is no quantitative measure of patterns of CDSS use, in large part, because the different patterns of clinical CDSS use are not yet known Yet, understanding variations in CDDS use is not sufficient to generate insights into the connections with mindfulness, CDSS use and physician performance. To accomplish this, I have to link observed differences in patterns of physician’s CDDS use with levels of mindfulness. This calls for measuring mindfulness quantitatively. This is accomplished by obtaining self-reported data using the Mindful Attention Awareness Scale (MAAS) (Brown & Ryan 2003; see Appendix C). Because the study involved both qualitative and quantitative aspects, a mixed-method study was most appropriate.

I used a sequential embedded design with two phases. The research question for the first phase was: “How do emergency physicians use CDSS, and what are their levels of mindfulness?” The research question for the second phase was: “How do emergency physicians’ mindfulness levels affect their CDSS use, and what is the role of mindfulness in their performance?” Figure 13 illustrates the conceptual framework and research design for this study.

Figure 13. Conceptual Framework and Study Design



Legend: Ellipses represent key theoretical concepts; rounded rectangles represent data collection and analysis steps; rectangles represent phase-1 results; arrows represent the procedures through time.

Based on the scale I can categorize physicians into the two categories: 1) High-mindful and 2) Low-mindful physicians. These categories are defined by MAAS scores that are more than one standard deviation above or below the mean, respectively. At this stage I also assess whether a significant relationship can be observed between experience and mindfulness as to show that they are distinct traits. Accordingly, in the first phase I conducted qualitative semi-structured interviews using a purposive sample among emergency physicians. The aim of interviews was to gauge their approach to use CDSSs in aiding in diagnostic and treatment decisions (interview guide is attached in Appendix

D). The emphasis of the interviews was on understanding how CDSS use fits into physicians' decision making process. To this end, I formed panel of 3-4 experts to review my interview guide for the clarity of questions and adherence to the research goal. After implementing the suggestions of the expert panel to revise the interview guide. In particular, the interview focused on the following aspects of CDSS use:

- *What types* of CDSS do physicians use at the point of patient care? E.g, drug dosing calculators? Mobile devices? Differential diagnosis information? What particular brands/applications do they use?
- *When* do physicians use CDSS at the point of patient care during ER encounters? E.g., before or after consulting with the patient?
- *Why* do physicians use CDSS at the point of patient care? E.g., to confirm their beliefs? To identify potential alternatives they might have missed? To generate a list of possibilities to choose from?
- *How often* do physicians use CDSS at the point of patient care? This was reflected by the quantitative measure, but the interviews revealed further insights. E.g., with every patient? Only in difficult cases? Only in straightforward cases? More often when tired?
- *What* are physicians' opinions about CDSS at the point of patient care? E.g., are they distracting? Indispensable? Time-saving?
- *Under what conditions* might ER physicians violate the recommendations of a CDSS or choose a low-probability option from those given?

The participants used a variety of CDSS systems and were able to name several systems they had used when answering questions (e.g., MDCalc, AgileMD, ERres)[1]. During this phase I next open coded transcribed interviews to identify patterns of CDSS use. The coding procedure is described in the Data analysis section, below.

Following the first phase, in phase II I employed a theoretical sampling to collect further data on differences of using CDSS among high and low mindful physicians. The scores of mindful trait and information about CDSS use were used as a primary criterion for theoretical sampling. In CDSS use I sought to include both high frequency users and non-users of CDSS. In contrast to *a priori* purposive sampling, the theoretical sampling followed an *a posteriori* strategy as to identify a set of participants who would enable extend initial findings and test emerging patterns developed out of previous results (Bagnasco, Ghirotto, & Sasso, 2014; Charmaz, 2006). The theoretical sampling procedure used the categories of participants identified in previous phase. First, I obtained data on physician's clinical performance included in the final sample.

Perhaps, the most objective way to measure physician performance is to rely on third-party observations by peers using established scales. However, such a method is subject to unreliable rater behavior (Govaerts, Van de Wiel, Schuwirth, Van der Vleuten, & Muijtjens, 2013). Additionally, owing to time and resource limitations this workplace observation was not feasible. Therefore, I decided to collect preexisting quantitative data regarding physician performance. To ensure alignment with the concept of reliable performance and physician effectiveness in decision making, the best dependent variables

[1] For descriptions, see http://www.mdcalc.com/ (MDCalc), https://www.agilemd.com/ (AgileMD), and http://eres.com/ (ERes).

would have been the correctness (or not) of diagnosis and treatment decisions. However, it was not possible to use these variables for two reasons. First, these data are not readily available at the physician level. Second, owing to the complexities of acute illness, it is difficult to define whether treatment decisions were correct if the patient does not recover. Traditionally, medical decision making is based on probability; there is rarely if ever a 100% chance of the desired outcome. Therefore, even a decision based on the most likely outcome can have a negative result—defining such decisions as correct or incorrect is conceptually challenging, which in part accounts for the lack of availability of such data.

Instead, I used reported performance data obtained from a third party consulting company who had a contract with participants' workplaces. The consulting company provides management services and products for hospitals across the country including physician performance tracking. Therefore, the company has access to physician-level performance data for a large number of physicians across the country. I was able to work with the consulting company to draw participants from their client hospitals, and therefore extract performance data for all participants. The included data consisted of an overall performance score for each physician as well as scores for four distinct performance variables discussed below. As a result, I could probe how physician's mindfulness relates to differences in physicians' patterns of CDSS use given their performance ratings. Next, I sampled participants from high- and low-mindfulness categories for interviewing. To this end I endeavored to sample physicians with a wide range of experience levels as to ensure a diversified sample. During the second interview, I presented participants with their patterns of CDSS use observed during phase one and use emergent typology to guide a discussion about participants' CDSS use and how it supported their decision making. The emphasis in this interview was on the degree to which and forms whereby participants relied on CDSS at the point of patient care; in particular, I investigated to what extent they blended routine-based and mindfulness-based processes as to improve their decision making. Appendix E includes the phase-two interview guide.

Sample

The target population consists of clinical physicians who, at the time of the study, are employed in emergency departments at hospitals or other medical institutions in the United States. To identify eligible physicians, I sent e-mail announcements to hospitals with which I have established business relationships. The inclusion criteria for physicians are (a) at the time of study, employed as a physician by an emergency department and (b) over age 18. Accordingly, I invited participants by e-mailing a letter that explained the intent of the study and requesting participation. As result I scheduled next one-on-one interviews with 23 physicians. During the initial contact I informed them of the purpose of the study and the nature of participation. Further, I explained that, should they choose to participate, performance data would be solicited from their employers. I provided assurances that all identifying information would be removed from all data collected for the study, and that they faced no work-related or personal consequences from participation in the study.

I adhered to the qualitative goal of data saturation in determining the final sample size (Bagnasco et al., 2014), and conducted interviews until data saturation is reached, as determined through ongoing qualitative analysis. Data saturation was achieved after 23 interviews; this was clear from the fact that the final 3 interviews yielded no new themes related to CDSS use but rather reinforced the existing theme structure. Physicians' years of experience ranged from 3 to 41 years.

Data Collection

Data collection for phase I took place on August 1 and August 4, 2016. All subjects participated in a one-on-one interview following the interview guide. All interviews took place via Skype and lasted one hour. Each interview was ended after one hour, and no interviews were shorter than one hour. After the interviews, I asked each physician to complete the mindfulness scale online via Qualtrics. Participants completed the scale immediately upon completion of the interviews. All participants therefore completed the mindfulness scale, and no participants had to be excluded from the study. Only basic demographic data were collected to ensure anonymity. I did not collect information about participants' location or type of hospital. Table 11 lists participants with their demographic information. Data saturation was achieved after 23 interviews. To guard against bias and protect participants I gathered performance data only after conducting all interviews. Therefore, I neither discussed nor knew participants' performance data during the interviews.

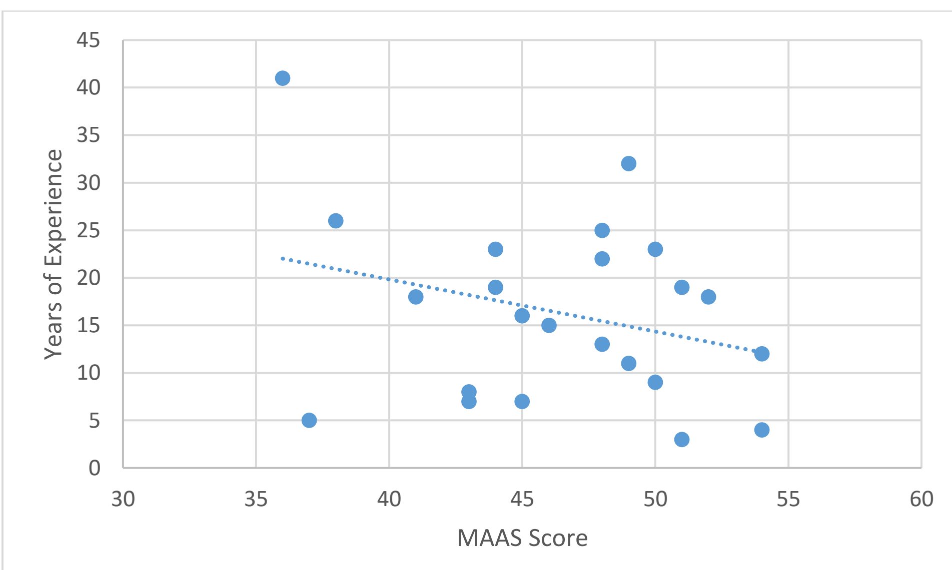
Table 11. Participants

Participant	Age	Gender	Experience (yrs.)
1	48	M	16
2	54	M	22
3	49	M	18
4	33	F	3
5	46	M	18
6	42	F	12
7	39	F	8
8	37	M	9
9	57	M	26
10	44	M	13
11	42	M	11
12	54	M	23
13	35	F	7
14	43	M	15
15	62	M	32
16	48	F	19
17	34	F	4
18	52	M	23
19	36	F	5
20	46	F	19
21	68	M	41
22	36	F	7
23	56	F	25

As soon as possible after each interview, I used a third-party transcription service to obtain transcripts of the interviews, then coded responses using a multi-stage open coding. The concurrent data analysis process was necessary to identify the achievement of data saturation.

Next, I analyzed quantitative data to ensure that results were correctly distributed with respect to mindfulness scores and to help categorize the sample to high and low mindful scores. The possible score range of the MAAS is 15–90. For this sample, the actual range was 36–54, with a mean score of 46.3 and a standard deviation of 5.1. With a small sample size of 23, the sample mean may differ from the population mean; the mean mindfulness score for the entire population of ER physicians may be higher or lower than the mean for this sample. Owing to the small sample size and the lack of previous research on this topic, I make no conclusions about the population mean. As described in the above, high and low scores for mindfulness were defined as those scores that fell more than one standard deviation above and below the mean, respectively: “high mindfulness” was defined as MAAS score > 51.4, and “low mindfulness” was defined as MAAS score < 41.2. In what follows, I report the phase-one results considering mindfulness as a continuous variable, and adopt the categorization only for the purposes of theoretical sampling for phase two. Three participants had high mindfulness scores, and five had low mindfulness scores. I also calculated Pearson’s correlation to determine whether there was a significant relationship between mindfulness scores and years of experience. Results indicate a non-significant correlation (ρ = -.294, t = -141; p = .173) suggesting that years of experience has no significant relationship to mindfulness (Figure 14).

Figure 14. Scatterplot of Years of Experience and MAAS Score with Trend Line



Phase two data collection consisted of interviews with a sample of high and low mindful physicians and gathering related quantitative performance data. As such, data points for each participant were quantitative and directly comparable. For the phase II participants, data were available around four performance variables: *patient satisfaction* (PSAT; average score given by patients, on a scale from 1 [low] to 5 [high]), *efficiency* (score based on the amount of time spent per patient, from 1 [low] to 5 [high]), *productivity* (average number of patients per hour in 12-hour shifts), and *utilization* (score based on management of healthcare costs per patient, from 1 [low] to 5 [high]). The interview transcripts from phase-one interviews totaled 392 pages of text.

Data Analysis

Because the study was conducted in two phases, analysis took place throughout the duration of the study. I quantitatively analyzed data from the first phase to identify physicians with high and low mindfulness scores. Next, I analyzed phase-one interview transcripts using thematic analysis using a constant comparative method and an open coding approach. I ensured that codes focused on patterns of CDSS use by considering the questions listed earlier in this section (and repeated again in the next paragraph) throughout the coding process.

The coding involved primarily identifying patterns of CDDS use (Corbin & Strauss, 2008). Per Braun and Clarke (2006), thematic coding focused on “identifying, analyzing and reporting patterns (themes) within data” (p. 79) where the “a theme captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set” (p. 82). In our case, the “themes” were patterns of use— therefore in the coding process, I focused on patterns of use, rather than other themes such as work satisfaction that might emerge from the same data. A facet of use was defined as any theme that answered one of the following questions: *What types* of CDSS do physicians use at the point of patient care? *When* do physicians use CDSS at the point of patient care? *Why* do physicians use CDSS at the point of patient care? *How often* do physicians use CDSS at the point of patient care? *What* are physicians' opinions about CDSS at the point of patient care? *Under what conditions* might ER physicians violate the recommendations of a CDSS or choose a low-probability option from those given? A *pattern* of use was defined as any pattern emerging from the combinations of the use facets when viewing them together.

I derived several patterns of use categories from interview transcripts. Overall, qualitative analysis proceeded along a four-stage coding process. The first stage, open coding, generated over 400 tags related to participants CDSS use patterns and attitudes, such as "calculated risk" and "unwilling to learn technology". These tags were then grouped using axial coding, resulting in broad 20 themes related to participants' relationship to CDSSs, including "confidence" and "pattern recognition". Next, the set of 20 axial themes were reduced by triangulating with the theoretical background and main research aim as to identify key themes related to the CDSS use: accountability, technical training, decision making, diagnosing correctly, experience level, and processes of CDSS use. The result formed group of nine patterns of CDSS use, as well as three categories of CDSS users related to those patterns.

To integrate the qualitative and quantitative data, I next compared the results of the scores of mindfulness questionnaire with the outcomes of the qualitative coding and looked for patterns that related to high and low mindfulness scores. This comparison formed also the basis of the interview guide that I used in the second round of interviews (Appendix E). The interview transcripts from phase-two interviews totaled 71 pages of text.

The second phase of the study performance data were quantitative and were therefore analyzable using descriptive statistics and Pearson's correlations as to analyze the relationship between mindfulness scores and performance scores. To integrate qualitative and quantitative data in ways that would inform the second phase of the study, I next proceeded to explore relationships between participants' patterns of CDSS use and mindfulness score. I especially looked for differences in CDSS use that could be linked to mindfulness scores.

Phase-two qualitative analysis consisted of multiple case study analysis following the procedure recommended by Yin (2013). First, I conducted within-case analysis of each subject (case) by reading through both interview transcripts and evaluating all related quantitative data. Next, I prepared a detailed write-up for each case, prioritizing information and patterns identified according to their relevance for the research question and looking for similarities and differences between subjects and among data sources (Yin, 2013). Using these detailed write-ups, I proceeded to cross-case analysis, wherein I sought similarities and differences between and among cases. As patterns emerged, I added them to a cross-case analysis write-up file, including information of any deviating evidence that did not fit with emerging patterns. In preparing the final report, I condensed the within-case and cross-case analysis write-ups by focusing on information pertaining to the key research question (Yin, 2013).

Reliability and Validity

Reliability and validity were addressed in several ways. The most important guarantee of validity is the use of multiple data sources where data is collected at multiple time points providing a case for triangulation (Yin, 2013). For quantitative data, I performed reliability and validity checks as described above. For qualitative data, I ensured reliability by audio-recording interviews and by triangulating findings with quantitative data and triangulating first- and second-round interview findings. For qualitative data, I ensured validity of the results by verifying findings with a third-party research consultant to ensure that findings accurately reflected research transcripts for both phases. With both quantitative and qualitative research instruments, I solicited third-party reviews to ensure that questionnaire items and interview questions reflected the concepts and questions of interest. The MAAS has been tested for reliability and validity and has proven to have good psychometric properties (Brown & Ryan, 2003). No reliability or validity information is available for the instruments used to calculate physicians' performance scores. The consulting firm that provided the research data claimed that its instruments are reliable and valid.

Findings

How Do Emergency Physicians use CDSS, and What are Their Levels of Mindfulness?

We observed nine non-mutually-exclusive facets of CDSS use; three described *when* physicians use CDSSs (before, during, or after patient contact), three described *how often* physicians use CDSSs (with every patient, for record keeping only, or avoid at all costs), and three described *what role* the CDSSs play in physicians' decision making processes. Additionally, the results revealed three mutually exclusive categories of CDSS user (those who love CDSSs, those who say they do not need CDSSs, and those who hate CDSSs), which take into account all of the nine more specific facets. Based on these results, we identified six mutually exclusive overall CDSS use patterns (confirmation only, disengaged use, electronic charts, extension of consultation, no use, and preparation for consultation). The aggregate results are presented in Table 12, and the results per participant are presented in Table 13. Not all physicians commented on all of these aspects.

Table 12. Mixed-Method Phase 1 Interview Results in Aggregate

Facet of CDSS use	***n* (%)[a]**	**Category of CDSS user**	***n* (%)**
When physicians use CDSSs		Love CDSSs	9 (39.1%)
Use CDSSs before patient contact	8 (34.8%)	Doesn't need CDSSs	7 (30.4%)
Use CDSSs after patient contact	12 (52.2%)	Hate CDSSs	7 (30.4%)
Use CDSSs during patient contact	5 (21.7%)		
How often physicians use CDSSs		**Pattern of CDSS use**	***n* (%)**
Use CDSSs with every patient	11 (47.8%)	Confirmation only	5 (21.7%)
Avoid CDSSs at all costs	8 (34.8%)	Disengaged use	5 (21.7%)
Use CDSSs for record keeping only	3 (13.0%)	Electronic charts	3 (13.0%)
What role CDSSs play		Extension of consultation	5 (21.7%)
Huddle in cases of disagreement	8 (34.8%)	No use	3 (13.0%)
Rely on nurses to use CDSSs	7 (30.4%)	Preparation for consultation	2 (8.7%)
Use CDSSs only to the extent required	5 (21.7%)		

[a] Participants may have fallen into more than one CDSS use group.

Table 13. Mixed-Method Phase 1 Interview Results by Participant

Participant	When	How Often	What Role	Type of User	Overall pattern
1	After	[no comment][a]	Huddle	Don't need	Confirmation
2	Before, After	Records	Huddle	Hate	Electronic charts
3	Before, After	Avoid	Nurses	Hate	Unengaged
4	During	Every patient	[no comment]	Love	Extension
5	After	Avoid	As required	Hate	Unengaged
6	Before	Records	As required	Hate	Electronic charts
7	During	Every patient	[no comment]	Love	Extension
8	Before, After	Every patient	[no comment]	Love	Preparation
9	After	Avoid	As required	Don't need	Confirmation
10	During	Every patient	Huddle	Love	Extension
11	Before, After	Every patient	Nurses	Love	Preparation
12	[no comment]	Every patient	As required, Nurses	Don't need	No use
13	After	Every patient	Huddle	Love	Confirmation
14	After	Avoid	[no comment]	Don't need	Confirmation
15	[no comment]	Avoid	[no comment]	Hate	Unengaged
16	[no comment]	Avoid	Huddle	Don't need	No use
17	After	Every patient	Nurses	Love	Confirmation
18	Before	Records	Nurses	Hate	Electronic charts
19	During	Every patient	Huddle	Love	Extension
20	After	Every patient	Huddle, As required	Don't need	Unengaged
21	[no comment]	Avoid	Nurses	Don't need	No use
22	Before, During, After	Every patient	Nurses	Love	Extension
23	Before	Avoid	Huddle	Hate	Unengaged

[a] Not all participants commented on all aspects of CDSS use.

I calculated Pearson's correlations at this stage to determine whether the overall use patterns correlated with contextual factors. Results revealed no significant correlations between CDSS use pattern, on the one hand, and experience (ρ = -.054; p = .806), age (ρ = -.059; p = .789), gender (ρ = -.047; p = .831), or performance (ρ = -.285; p = .187) on the other. Interestingly, the correlation for performance and CDSS use pattern, though nonsignificant, was much closer to significance than the other contextual factors. This supports the theory for the present study, which suggests that differences in CDSS use, mediated by mindfulness, contribute to performance differences.

The following paragraphs contain descriptions and sample quotes for each of the nine facets of CDSS use. Following these descriptions, we present the results for the overall CDSS patterns that emerged from considering the facts and user categories together.

Use before patient contact. Physicians in this category (*n* = 8) used CDSSs before entering patients' rooms. The reasons for using CDSSs before patient contact varied. For example, some participants used CDSSs' integrated patient management functions to identify the next patient they needed to see and to review information already entered by intake staff. Others used CDSSs to generate recommended diagnoses and treatments using information provided by nurses regarding patients' symptoms. These physicians tended to view patient consultation as merely confirmatory, rather than as a central part of the treatment process. Participant 2, who doesn't need CDSSs, stated, "A typical day for me would be to login and see what the intaking admin wrote up. I look for previous medical records. When I'm with the patient, I'm focused on them."

Use after patient contact. Physicians in this category (*n* = 12) used CDSSs only after consulting with each patient. A typical pattern would involve visiting with a patient, completing the consultation, and developing a provisional diagnosis and treatment plan. Then, after leaving the patient's room, the physician might enter information about the patient into a CDSS to verify that the CDSS output agreed with her or his initial assessment. These physicians tended to use CDSSs at computer stations on the department floor, rather than on handheld mobile devices. Participant 14, who doesn't need CDSSs, stated, "I feel it takes too long to enter the information and to get a decision.

I think it makes sense to use my training first and then re-evaluate with the support tool after."

Use during patient contact. This category describes physicians (*n* = 5) who reported using CDSSs at patients' bedsides, concurrently with the patient consultation. A typical pattern of use in this category was to enter information given by the patient (regarding, for example, symptom severity) into a CDSS application in real time. Physicians in this category tended to use CDSSs on handheld mobile devices like smartphones, rather than using the applications on computer stations around the department. Participant 7, who loves CDSSs, stated, "Personally, I like to enter the data as I'm assessing the patient. I'm asking questions and putting answers in while I'm getting the information first hand."

Use with every patient. Physicians in this category (*n* = 11) strongly supported the use of CDSSs, believing that the systems made their work more efficient, saved time, and allowed them to avoid errors. This category does not imply anything regarding when or for what purpose physicians used CDSSs. For example, some physicians in this category might consult CDSSs before entering each patient's room, whereas others might enter patient symptoms into a CDSS in real time during their consultation with the patient. Participant 11, who loves CDSSs, stated, "I use DXplain for every patient. … I don't like going home and wondering if I could have done anything different for anyone so I'm constantly using it."

Avoid at all costs. Physicians in this category (*n* = 8) had a strong aversion to CDSS use, and preferred not to use CDSSs at all if they could avoid it. In some cases, physicians used CDSSs, for example for data entry, owing to requirements of their departments or organizations, but indicated that they would not do so if they had the choice. Participant 9, who hates CDSSs, stated, "I don't use them. You spend all of your time entering data and the decision aid doesn't come up with anything. I was putting an order in for an advanced image, MRI and CT Scan, and program told me it couldn't give me any guidelines. It happened so much, we're all real negative about using it. It's a waste of time and money."

Record keeping only. Participants in this category (*n* = 3) expressed an aversion to using CDSSs to assist in decision making. They reported using only the record keeping functionality of CDSS applications. These physicians might use CDSSs to access patient records either before, during, or after patient consultation, and they might access the records using computer stations or handheld devices. For all physicians in this category, accessing patient records and medical history was viewed as the only useful function of CDSSs. Participant 6, who doesn't need CDSSs, stated, "Personally, I find it particularly useful when looking at medical history only. If the patient has a family history of heart attacks or strokes, it's good to have this information available to help clinically. If I don't find previous medical history on the patient, I don't use it at all."

Huddle for disagreement. This category describes participants (*n* = 8) who stressed the importance of collaborating with other professionals in cases where their own judgments disagreed with CDSS recommendations. In most cases, these physicians would seek out other physicians to get additional opinions if they found that a CDSS's recommendation did not fit with their own initial analysis. They viewed CDSSs as tools to confirm their own suspicions about patients' conditions, but would neither accept nor reject a CDSS result they disagreed with, instead relying on other professionals to help them make the best decisions. Participant 13, who loves CDSSs, stated, “If I have questions or if I disagree with something, I collaborate with the on-duty director for feedback and guidance.”

Rely on nurses. Participants who relied on nurses (*n* = 7) preferred not to use CDSSs themselves. Rather, they viewed CDSS use as part of the nurse’s role, and depended on nurses to provide them (the physicians) with information from the CDSSs. This category does not imply anything with respect to when or for what purpose physicians consult nurses for CDSS results. For example, some participants consulted nurses to obtain CDSS results before entering patients’ rooms, whereas others expected nurses to report CDSS recommendations in real time during patient care. Participant 19, who hates CDSSs, stated, “I depend on the nurses to give me the information from the CDS’s before I make any rounds.”

Only as required. This category describes physicians (*n* = 5) who reported using CDSS only because their departments, organizations, or third-party payers required them to do so. In most cases, these physicians did not support CDSS use, viewing it is an inconvenience at best and a detriment to patient outcomes at worst. If possible, these physicians avoided using CDSSs during patient consultation, preferring instead to do “data entry” tasks at computer stations. Physicians in this category might use decision support or record keeping functionality, but they did not use any functionality they were not explicitly required to use. Participant 5, who hates CDSSs, stated, “We’re forced to use CDSSs. Our reimbursement amounts are lower if you don’t have these systems implemented in the ER. … These systems are not perfect and it's a shame we’re incentivized to use them when it’s clear they’re hurting more than helping our patients.”

Patterns of CDSS use. By considering the emergent facets and CDSS user categories together, we identified several overall patterns of CDSS use to answer the research question. By sorting the data in Table 3 by each of the four facets in turn, we were able to identify trends conforming to the interview data and providing an understanding of participants' decision making processes as they pertain to CDSS use. These patterns are mutually exclusive (i.e., each participant fits only one pattern). The patterns we identified were as follows:

No use. These participants (n = 3) do not use CDSS at all. Defined as those who stated that they *avoid CDSSs at all costs*, who did not comment on when they use CDSSs, and who *do not need CDSSs*.

Confirmation only. These participants (n = 5) use CDSS only to confirm their own diagnosis and treatment decisions. Defined as those who stated that they use CDSSs only *after patient contact* and who *do not need CDSSs* or *love CDSSs.* Compared to other patterns, these participants are more likely to stress the importance of *huddling for disagreement*.

Electronic charts. These participants (n = 3) have access to comprehensive tools that include both record keeping and decision support functionalities. Although they use the tools, they avoid the decision support applications. Instead, they use the technologies only as computerized medical charts. They consult these charts (principally containing patients' medical histories) exactly as they would paper charts. They resent the CDSS functionality and view other physicians as too reliant on these applications. Defined as those who use CDSSs *before patient contact*, who use CDSSs for *record-keeping only*, and who *hate CDSSs*.

Unengaged use. These participants (n = 5) perform basic data entry or decision confirmation tasks required of them by their employers, often doing so grudgingly and with disdain for the CDSS systems. They are not likely to voluntarily consult CDSSs, and are likely to review CDSS outputs with disdain, particularly, if the CDSS disagrees with the physicians' own decisions. Defined as those who stated that they *avoid CDSSs at all costs* or who *hate CDSSs*. Participant 20 also fit this pattern, though she uses CDSS *as required* and *does not need CDSS*. This participant was less overtly negative about CDSSs but described her use as unengaged: "I do login it to see if I'm missing anything but the scope of the feedback is extremely limited."

Extension of consultation. These participants (n = 5) input data on patients' history, symptoms, and treatment plans concurrently with the patient visit. They believe that using CDSSs at patients' bedsides makes them more efficient and relieves the stress inherent in treating emergent medical conditions. Defined as those who use CDSSs *during patient contact, with every patient,* and who *love CDSSs*. These physicians may or may not also use CDSSs before or after patient contact.

Preparation for consultation. These participants (n = 2) use CDSSs to retrieve patients' history, intake nurses' comments, symptoms, and decision support as a first step before consulting with patients. They believe that, with CDSS tools at their fingertips, the patient visit is used only to confirm what they already know. Defined as those who use CDSSs *before patient contact,* who *rely on nurses* to input information into the CDSS systems so that they can access the information before seeing patients, and who *love CDSSs*. These physicians may or may not refer to CDSSs again after patient contact.

The high- and low-mindfulness participants were relatively evenly distributed among the patterns of CDSS use. Table 14 shows the facets, category, and pattern for each high- and low-mindfulness participant. The table also includes a representative quote from each participant describing her or his CDSS use pattern.

Table 14. High- and Low-Mindfulness Participants

Participant	MAAS Score	CDSS Use Facets	CDSS User Category	CDSS Use Pattern
		High Mindfulness		
6	54	Before; record keeping only; as required	Hate	Electronic charts
	“Personally, I find it particularly useful when looking at medical history only. … If I don't find previous medical history on the patient, I don't use it at all.”			
17	54	After; every patient; nurses	Love	Confirmation only
	“I make sure that not only am I using it for every patient, I expect our nurses to use the resources as well.”			
3	52	Before; after; avoid; nurses	Hate	Unengaged use
	“From admission to diagnosis, we’re constantly adding information to the patient profile…I can't stand using those computers. Its suggestions are too narrow and prescriptive.”			
		Low Mindfulness		
5	41	After; avoid; as required	Hate	Unengaged use
	“We’re forced to use CDSSs. … Physicians are required to login at one of 6 workstations throughout the ED. I use them to enter information but don't rely on them for diagnosis or guidelines.”			
9	38	After; avoid; as required	Don’t need	Confirmation only
	“I don’t use them. You spend all of your time entering data and the decision aid doesn't come up with anything.”			
19	37	After; every patient; huddle	Love	Extension
	“Compared to other physicians I work with, I'm one of the top three users….I probably look up info 50+ times a day.”			
21	36	Avoid; nurses	Don’t need	No use
	“Personally, I depend on the nursing staff to provide me the initial information from them. … I really don’t need to use them.”			

On the basis of these results, I conducted theoretical sampling. Because the goal of the second phase was to focus on how mindfulness affects CDSS use, I only considered participants who were in the high- and low-mindful categories, as defined above. Owing to the wide-ranging distribution of CDSS use patterns among these participants (see Table 14), I did not use CDSS patterns to guide sampling. Rather, I strove to select one very experienced and one less experienced physician for each mindfulness category, and I chose the final sample with a view to the participants who were the most forthcoming during their first-round interviews, with the goal of generating rich, the sample for qualitative data during second-round interviews. Thus, the second phase of the study consisted of the following participants: 3, 5, 17, and 19.

How Do Emergency Physicians' Mindfulness Levels Affect Their CDSS Use, and What Is the Role of Mindfulness In Their Performance?

Quantitative performance data for the four phase-two participants are presented and compared by mindfulness score in Table 15.

Table 15. Phase-Two Participants, Performance Scores

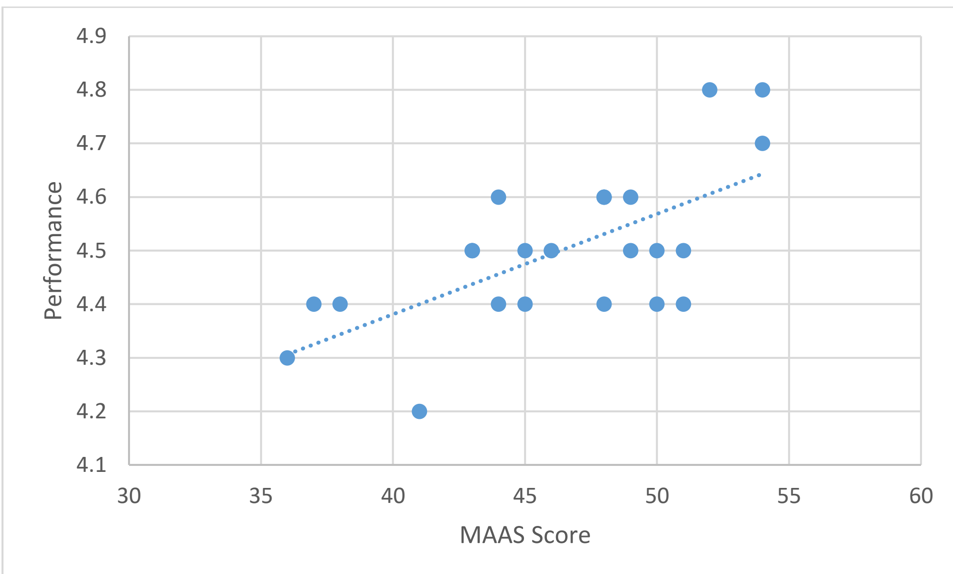
Participant	**Mindfulness**	**PSAT**	**Efficiency**	**Productivity**	**Utilization**	**Pattern**
3	52	4.71	4.88	3.0 p/h	4.5	Disengaged
17	54	4.5	4.9	2.8 p/h	4.5	Confirmation
5	41	4.33	4.8	3.3 p/h	4.2	Disengaged
19	37	4.35	4.72	3.5 p/h	4.4	Extension

p/h = patients per hour; shaded rows represent low-mindful participants.

For all participants, a single, aggregate performance score was available. Aggregate performance consisted of a simple arithmetic average of the physician's patient satisfaction and internal performance review scores. The average aggregate performance score was 4.5 (SD = 0.145), and performance scores ranged from 4.2 to 4.8. All performance data were for the month of August, 2016. Although internal performance reviews may take into account health outcomes, it should be noted that patient satisfaction is the only patient-specific outcome considered here. I discuss this further with the limitations, below.

Performance and mindfulness. Because performance scores were available for the full sample, I calculated Pearson's correlation to determine whether there was a significant relationship between mindfulness and performance scores. Results indicated a strong, significant positive correlation ($\rho = .660$, $t = 4.027$; $p < .001$). Figure 15 presents a scatterplot of this result. The result is subject to certain caveats with respect to the performance data, for which the research instruments and reliability information were not available; I discuss this further in the Discussion and Conclusion section.

Figure 15. Scatterplot of Performance Score and MAAS Score with Trend Line



This result indicates that physicians with higher mindfulness scores tend to have higher performance scores.

Case I. Participant 3 has 18 years of experience and a high mindfulness score of 52. Participant 3's patient satisfaction (4.71) and utilization (4.5) scores were the highest of the four phase-two participants. Participant 3's aggregate performance score was 4.8; this is the highest performance score of any physician in the sample and is about 2 standard deviations above the average. This suggests that Participant 3 is a very highly experienced, very high performing, and highly mindful physician. On the basis of the phase one results, Participant 3 was placed in the "Hates CDSSs" category, with CDSS use facets of "Use CDSS before patient contact," "Use CDSS after patient contact," "Avoid CDSSs at all costs," and "Rely on nurses to use CDSSs." Overall, participant three is a *disengaged user* of CDSSs.

In the phase-two interview, Participant 3 mentioned that s/he had been experimenting more with CDSSs since the first round of interviews:

> I'm definitely not an early adopter on most new IT products that come out. However, since we last met I've started working them more in each case. When I'm with the patient, I'm focused on them. After I reach a conclusion, I will now log in and see if there is anything more than what I know. I haven't been surprised yet.

Despite this experimentation, Participant 3 still expressed a high distrust of CDSSs: "*I think the detriment of use is that we depend on them too much. … These computers and apps are just tools. They're not meant or designed to solve all problems in the emergency department."* Participant 3 stressed that, apart from the aforementioned experimentation, s/he does not use CDSSs in clinical work at all.

When asked what changes s/he would make if placed in a management position, Participant 3 stated, "The thing I would change first would be that you can access the clinical aids after you've made a preliminary diagnosis. I bet they [preliminary diagnoses] would be right every time." Participant 3 suggests an approach to CDSS use that prioritizes medical education and training and places CDSSs in a supporting, rather than guiding, role.

When informed that s/he had one of the highest mindfulness scores, Participant 3 expressed surprise, stating, *"I've been practicing for nearly 20 years and I don't feel any different today than I did when I first started."* This perhaps suggests an assumption that mindfulness is a skill developed over time, and with experience—an assumption which, my research has shown, is not accurate. Rather, the case of Participant 3 perhaps supports the conclusion that mindful awareness is a personal trait that, in the absence of specific training, some physicians may be more prone to than others.

When asked how mindfulness helps or hinders in clinical work, Participant 3 answered, *"I definitely pay attention to what my patient is saying. I try to stay focused and engaged with them. I believe being highly mindful allows me to be patient centered."* Participant 3's high patient satisfaction score suggests that her/his approach to patient-centeredness is effective.

Case II. Participant 5 has 18 years of experience and a low mindfulness score of 41. Participant 5's patient satisfaction (4.33) and utilization (4.2) scores were the lowest of the four phase-two participants. Participant 3's aggregate performance score was 4.2; this is the lowest performance score of any physician in the sample and is about 2 standard deviations below the average. This suggests that Participant 5 is a very highly experienced, low performing (compared to the average), and low mindful physician. On the basis of the phase one results, Participant 5 was placed in the "Hates CDSSs" category, with CDSS use facets of "Use CDSSs after patient contact," "Avoid CDSSs at all costs," and "Use CDSSs only to the extent required." Overall, Participant 5 is a *disengaged user* of CDSSs.

In the phase-two interview, Participant 5, like Participant 3, expressed a belief in the importance of mindfulness and of engaging with patients:

> I consider myself as extremely mindful. … I believe in spending time with the patient, ruling out everything and successfully implementing a plan to get them on the road to being happy and healthy. I find my patients heal much faster when I'm engaged with them. … I think being mindful helps in my work daily because it allows me to focus on each of [my patients] individually.

This contrasts with Participant 5's low patient satisfaction score, suggesting that s/he has an inaccurate view of her/his own performance. Participant 5 was surprised to learn that s/he had a low mindfulness score, and appeared to attribute this result either to a mistake ("*I must have done something wrong on your survey*") or to an ambiguity in the definition of mindfulness.

When asked whether s/he would recommend any amendments to the CDSS use typology, Participant 5 stated, *"Maybe, you could add a spot for someone who believes they're mindful based on meditation and prayer and yet don't use the aids enough?"* This suggests that Participant 5's belief in her/his own mindfulness may have been related to engagement in meditation practices outside work, rather than to mindful awareness during work. Participant 5 seems to wonder whether increased use of CDSSs could direct her/his awareness, resulting in increased mindful attention at work. This interesting finding is discussed further in the Discussion section, below.

Despite Participant 5's surprise at the mindfulness finding, the participant continued to express a distrust of CDSSs: *"I see an unhealthy dependence on this technology and I find it very disturbing."* Nevertheless, the participant seemed to suggest that CDSS use was not incompatible with the type of patient engagement Participant 5 supported. When asked how s/he would change things if put in a management role, Participant 5 said, "I would like to see them [physicians] engage the patient more so that would be where my focus would be. Patient engagement."

Case III. Participant 17 has 4 years of experience and a high mindfulness score of 54 (the highest mindfulness score of any participant). Participant 17's efficiency (4.9) score was the highest of the four phase-two participants, and Participant 17's productivity score (2.8 patients per hour) was the lowest. Participant 17's aggregate performance score was 4.7, about 1.4 standard deviations above the average. This suggests that Participant 17 is relatively inexperienced, high performing, and highly mindful. On the basis of the phase one results, Participant 17 was placed in the "Loves CDSSs" category, with CDSS use facets of "Use CDSSs after patient contact," "Use CDSSs with every patient," and "Rely on nurses to use CDSSs." Overall, Participant 17 uses CDSS for *confirmation only*.

During the phase-two interview, Participant 17 described her/his CDSS use as follows: *"I use the aids to confirm that I'm accurate and that I've covered everything. Have I ever been wrong? No, not really. But they do open your eyes to look at other causes to rule out."* This closely mirrors the CDSS strategy Participant 3 suggested. However, it represents a slightly more reserved view of CDSSs compared with the first round interview, during which Participant 17 stated, *"I don't know what I would do without it [CDSSs]. I remember my medical training well but what we have is more efficient and stress free. … I have saved many patients and I would contribute that success to the CDSSs and my personal training."* The more tempered second-round response appears to have been a result of a more conscious focus on mindfulness. When asked how mindfulness influences her/his CDSS use, Participant 17 responded:

> Well, I make sure I spend more time engaged with the patient and not my paperwork. In fact, since you brought mindfulness to my attention, I've made it a habit to not depend on them [CDSSs] as much. I will use them to verify my process and that's it. I won't look at it first now. This might be something that can be taught to us on a regular basis. I feel more empowered.

These excerpts suggest that Participant 17 values the ability to use CDSSs to confirm diagnoses, thus relieving stress-inducing uncertainty. Participant 17, a relatively inexperienced physician, appears to have been transitioning from high reliance on CDSSs to using CDSSs for confirmatory purposes only.

Participant 17 described an interesting potential adverse effect of CDSS use and incentivization in emergency departments. In Participant 17's workplace, physicians are given incentives to use CDSSs regularly. When asked about the effects of this policy, Participant 17 stated, *"I would say that the detriment is to the patient. If the powers that be look at what we did and we concurred with the aids, we're perfect."* The participant seems to imply that CDSS incentivization and overuse are associated with the risk that physician performance will become detached from patient outcomes.

When asked about changes s/he would make, Participant 17 answered, "*I would make it mandatory for all to not use the aids for one day a week. On that day, you would have to collaborate with the team on the floor to confirm your treatment plan."* This response aligns with the participant's experience attempting to become less dependent on CDSSs following the first-round interview. Regarding mindfulness and its effect on performance, Participant 17 indicated being aware of her/his lower-than-average productivity score, and suggested that this is a natural consequence of remaining attentive to patients:

> I know that I have an average number of patients per hour [lower] than others, but it's not a major performance factor. I would rather spend more time with each patient to ensure they're going to be as healthy as they can be.

This is discussed further in the Discussion section, below.

Case IV. Participant 19 has 5 years of experience and a low mindfulness score of 37. Participant 19's utilization (4.5) score was the highest of the four phase-two participants (tied with Participant 3), and Participant 19's productivity score (3.5 patients per hour) was also the highest. Participant 19's aggregate performance score was 4.4, about 0.7 standard deviations below the average. This suggests that Participant 19 is relatively inexperienced, average performing, and low mindful. On the basis of the phase one results, Participant 19 was placed in the "Loves CDSSs" category, with CDSS use facets of "Use CDSSs during patient contact," "Use CDSSs with all patients," and "Huddle in cases of disagreement." Overall, Participant 19 uses CDSSs for *extension of consultation*.

During the second-round interview, Participant 19 affirmed her/his trust in CDSSs and clarified the role CDSSs play in the decision-making process:

> I'm speaking for myself, and I may be out of the norm, but I trust the decision making aids we have on the floor. Make no mistake, I'm well aware of my clinical training but I've never seen the tools I use ever be wrong. Now, do these tools take the mystery out of clinical diagnosis? No, they don't. They simply confirm what I'm already thinking. I trust them one hundred percent.

Here, Participant 19, like the other participants, seems to place CDSSs in a confirmatory role; however, Participant 19's language in favor of CDSSs is much stronger than that of the other participants. Later in the interview, Participant 19 stated, *"I take advantage of the tool for initial diagnosis assistance as well as helping me to verify my treatment plan is appropriate,"* and *"I'm of the opinion that the computer is always correct,"* suggesting that s/he views CDSSs as useful at multiple stages in the diagnostic decision-making process.

After learning of the results of the mindfulness questionnaire, Participant 19 said:

> You are making me realize that I may be spending more time in front of the treatment aids than my patient. It's possible, right? I will definitely make more of an effort to engage with my patient and less with my phone. We'll see where my comfort level is after a few patients.

This excerpt suggests that Participant 19 viewed CDSS reliance and patient engagement as issues of "comfort," rather than of diagnostic accuracy. It might be supposed on this basis that Participant 19 felt less comfortable engaging with patients without the assistance of mobile CDSSs. Indeed, when asked what changes s/he would make, Participant 19 replied, *"I would make it mandatory for each physician to verify with aids so that we can ensure the patient is getting the proper care."* The participant also suggested that "a supervisor" should confirm every diagnosis and treatment plan "if the system is down." This suggest a strong support for confirming diagnosis and treatment decisions with multiple sources.

Cross-case comparison. With respect to productivity, mindfulness appeared to play an important role among these four participants. The low-mindfulness participants (5 and 19) exceeded their high-mindfulness counterparts (3 and 17) in terms of patients seen per hour. In the phase-one interviews, Participant 17 indicated using CDSSs for every patient: "I'm definitely a high user and a high promoter." Participant 17 also expressed a belief that CDSSs are "more efficient" than relying on training and memory alone.

However, this same participant had the lowest productivity score (2.8 patients per hour), suggesting that high CDSS did not lead to more productive work in this case. However, Participant 19, who had the highest efficiency score, states *"I probably look up info [using CDSSs] 50+ times a day."* This suggests that CDSS use may not have made the participants more or less productive, perhaps despite their perceptions of CDSS.

Comparing the high-mindful and low-mindful participants, there is a clear distinction in their attitudes of openness. The high-mindful participants, 3 and 17, both expressed an interest in exploring different approaches to CDSS use. Participant 3 stated, "Since we last met I've started working them more in each case. … I'm trying to work them in more in my daily interactions but I haven't been successful yet." These quotes show an interest in openly and objectively assessing the possibilities of CDSS use. On the opposite end of the CDSS use spectrum, Participant 17 was also open to change: "Since you brought mindfulness to my attention, I've made it a habit to not depend on them [CDSSs] as much. I will use them to verify my process and that's it. I won't look at it first now." By contrast, the low-mindful participants, 5 and 19, expressed more unchanging attitudes toward CDSSs. However, after the second-round interview, Participant 5 said, "I guess if you say I'm on the low end of mindfulness and I'm not using the technology at all, I may need to re-examine where I am and what I can do to make it better for everyone all around."

When considering efficiency and productivity scores together, however, more information emerges. Participant 17, who had the lowest productivity score, also had the *highest* efficiency score (4.9), indicating that Participant 17 spent the least amount of time with patients. Conversely, Participant 19 had the highest productivity (3.5 patients per hour) and the lowest efficiency (4.72). Both of these participants described themselves as high CDSS users, as mentioned above. However, Participant 17 was much more adamant that CDSSs be used after initial diagnosis, for confirmation purposes only, and appeared to be concerned about potentially becoming overly reliant on the tools. Participant 19 did not have any such reservations. This perhaps points to a difference in CDSS use patterns, whereby Participant 17 spends more time using CDSS away from the patient's bedside (e.g., using a computer to confirm a diagnosis after the fact), whereas Participant 19 spends more time using CDSS while engaged in patient contact. This suggests that the "extension of consultation" approach (Participant 19's CDSS use pattern) may decrease efficiency, whereas the "confirmation only" approach may increase efficiency by decreasing productivity.

It is interesting to note that, of the four phase-two participants, the highest and lowest performing (based on aggregate performance scores) both described themselves as low CDSS users, and both fit the "Unenaged use" pattern (see Phase 1 results). Participant 3, the highest performer and a highly mindful physician, gave the following opinion during the phase-one interview:

> I was using it [a CDSS] on a suspected overdose case and it was taking too long to get suggestions for treatment. I felt like my patient was going to be in a bad place had I kept waiting for confirmation. I will never use it again.

This quote suggests that Participant 3 was, while using the CDSS, maintaining a mindful awareness of the patient context and the potential changes in the patient's condition, even while attending to the CDSS. Participant 5, the lowest performer, focused in the first interview on the CDSSs themselves, on the organizational context (incentivization to use CDSSs and procedural requirements for computer use): *"Our reimbursement amounts* *are lower if you don't have these systems implemented in the ER. … I've used it to try and diagnose difficult cases and the aid didn't help with any information."* This perhaps illustrates the difference between the mindful and non-mindful approaches to CDSS use. Whereas Participant 3 described a focus on the patient context, Participant 5 appeared to see CDSSs as tied to the organizational, rather than the clinical, context. During the phase-two interview, Participant 5 strongly emphasized the importance of patient engagement, but nevertheless suggested that physicians should be encouraged to *"utilize the aids in every way they saw fit that would allow us to meet our key performance indicators."* This supports the conclusion that Participant 5 may have been more organization-focused than Participant 3. The fact that both were *unengaged users* suggests that mindfulness as a personal trait may be even more important than specific CDSS use patterns in contributing to physician performance.

An interesting comparison might be made between Participants 17 and 19, the two CDSS promoters. During the phase-two interviews, Participant 19 indicated relying heavily on CDSSs and spending more time during patient visits on the phone than on engaging with patients (the "extension of consultation" pattern). By contrast, Participant 17 had shifted to viewing CDSSs in a more confirmatory role, and attempting to engage with patients more. Participant 17 had an above-average performance score and a high mindfulness score, whereas Participant 19 had a below-average performance score and a low mindfulness score. This fruitful comparison begins to bring into focus the connection between CDSS usage patterns and attitudes, on the one hand, and mindful awareness and performance, on the other. Although these inferences are based on a small sample of qualitative analysis and not generalizable, they reveal important insights and directions for future research. These connections are explored in more detail in the following section.

Discussion

The purpose of this study was to generate insights into the link between mindfulness, CDSS use, and performance by exploring the nature and patterns of physicians' CDSS use. Based on the cases, highly mindful physicians conceptualize CDSSs differently from their less mindful counterparts. More mindful physicians viewed CDSSs as playing a supporting role in their decision-making, whereas less mindful physicians relied heavily (Participant 19) or not at all (Participant 5) on CDSSs. Additionally, more mindful physicians were more open to change and to consider how different practices could result in better patients outcomes. This is an important toward understanding how mindfulness shapes CDSS use to positively influence physician performance. Mindfulness leads physicians to more circumspectly consider all possibilities, as they remain aware of their own potential limitations. This is supported by prior work suggesting that clinical decision making involves complex cognitive processes and cannot be reduced to diagnostic algorithms alone (Coget & Keller, 2010; Kessler, 2004). The conclusions suggested in this section must be taken to be provisional and reflecting only the sample of this study; nevertheless, they may provide interesting directions for future research.

By examining various dimensions of performance (e.g., patient satisfaction, efficiency), the case analysis revealed an important issue related to mindful practice. Although mindfulness is significantly associated with overall performance, it appears to be incompatible with selected individual performance metrics, such as efficiency and productivity. As the case of Participant 17 shows, spending more time mindfully engaging with patients may result in a lower number of patients seen per hour. This has important implications for emergency department management, because it suggests that there may be an inverse relationship between certain performance metrics, on the one hand, and patient outcomes, on the other. If managers and health care organizations are interested in improving patient outcomes, they may need to reconsider the metrics they use to measure performance. Similarly, Participant 17 pointed out that performance assessment may become disconnected from patient outcomes, if too much emphasis is placed on CDSSs and diagnosis confirmation, rather than patient healing.

This study, like the first study in this series, found that mindfulness (measured by the Mindful Attention Awareness Scale) is significantly and positively correlated with performance- in this case among a sample of 23 emergency physicians. Mindfulness was not, however, correlated significantly with years of experience. This is an important finding that demonstrates the difference between mindfulness as a personal trait or tendency and clinical experience. This also shows that mindfulness is not associated with expertise or experience solely. High-mindful participants ranged from the highly experienced to the relatively inexperienced, as did low-mindful participants. This supports the research conceptualization of mindfulness primarily as an individual trait (Weick et al., 1999). The finding also supports existing research which suggests a connection between mindfulness and physician performance (Beach et al., 2013; Fernando et al., 2014; Lovell, 2015; Martín-Asuero & García-Banda, 2010; Sibinga & Wu, 2010; Westphal et al., 2015).

An important insight arising from this research is that, in practice, physicians may be uncertain about their level of mindfulness and its different impacts. Participant 5 seemed to link mindfulness with meditation and prayer. As discussed in the Theoretical Background, mindful attention as a personal trait may be promoted by, by is not identitical to, mindfulness medidation. Therefore, researchers and practitioners should take care to make a distinction between these two concepts, perhaps by establishing *mindful attention* as a distinct term to describe the multifacted situational awareness that is linked to physician perfmorance. It may be possible to improve mindful attention (situational awarness) using mindfulness meditation. However, there may also be other interventions, such as situational awarness practice in clinical simulations, that could improve mindful attention. Further research will be required to identify effective interventions that specifically target mindful attention.

Limitations, Implications, and Future Research

One limitation of the present study was that, despite the quantitative nature of the performance data, reliability information was not available for the full dataset, owing to limitations on third-party data collection. Future research should address this issue by attempting to ensure that instruments used within emergency departments to collect performance data are reliable and valid. Another important limitation is the fact that the physician sample was not random, which could introduce potential bias in CDSS use by types of patient seen. Not all physicians see the same types of patients (i.e., they may specialize in cariac emergencies or trauma), so it is possible that physicians who see a particular type of patient use CDSS differently than physicians who see other types of patients. To overcome this limitation, future research should incorporate random samples and larger sample sizes. Finally, the performance data available for this study included patient satisfaction, but no other patient-related outcomes measures. Therefore, it is possible that physicians' performance scores do not reflect patient health outcomes, which is the goal of research on physician performance. Similar studies incorporating short- and long-term patient outcomes is warranted.

Emergency physician performance has grave implications for patients whose life and limb are at risk. Therefore, emergency departments must be extremely circumspect any time they choose to implement new strategies, performance incentives, or clinical technologies. To date, CDSSs have been often too hastily adopted in emergency departments despite highly equivocal evidence of their ability to improve physician performance and patient outcomes (Garg et al., 2005). Therefore, there is an urgent problem created by inadequate knowledge of the antecedent factors that can promote performance-enhancing use of CDSSs in emergency clinical settings. Although technology changes rapidly, emergency department managers must examine conditions for improvement and be more nuanced in approaches that promote CDSS use until more is known about how intensive use of such tools alters physicians' decision making.

The results of this mixed-method study have significant implications for researchers and practitioners alike. Emergency room managers can use the results to develop targeted training to ensure that physicians use CDSSs primarily for confirmation purposes only and do not become overly reliant upon them. Additionally, they could develop training to introduce more 'resistant' physicians to the possibilities of mindful CDSS use. Additionally, the results suggest fertile directions for future experimental research to determine whether training or other forms of interventions (experienced vs.

non experienced physicians) can be successful at increasing mindfulness, changing CDSS use habits, and thereby increasing performance among ER physicians.

CHAPTER 7: DISCUSSION, LIMITATIONS, IMPLICATIONS, AND CONCLUSION

In this chapter, I summarize and discuss the findings for each of the research questions posed in Chapter 2. Then I describe the limitations and implications of the research, followed by a conclusion.

Summary and Discussion

When I began this research process, I was interested in defining new directions to improve the quality of emergency medicine at the physician level. As a leader in a healthcare management firm, my role is to identify improvements that can lead healthcare organizations to reduced costs and improved patient outcomes. Today, any discussion of improvements, cost reductions, and efficiencies is necessarily a discussion of how technology can improve operations, either by automating processes or by helping front-line employees perform at higher capacities. However, we know that a large percentage of investments in healthcare information technology (HIT) do not result in the promised improvements (Adler-Milstein et al., 2015; Williams et al., 2015). This results in a gap between the vast importance placed on HIT in healthcare organizations, on the one hand, and the impact of HIT, on the other. This research was conceived as an attempt to partly bridge that gap.

More and more, information systems researchers understand the effectiveness of technology depends, not only on the structure of the technology itself, but also on the characteristics of users and organizations that employ IT (Butler & Gray, 2006; Carlo et al., 2012; Wolf et al., 2012). This led me to a focus on physicians themselves. There may, I reasoned, be individual-level differences among physicians with respect to how they use HIT, and these differences might translate to differences in performance. Therefore, to guide this research, I asked the following overall research question: *How do emergency physicians use HIT to make correct diagnosis and treatment decisions?*

At first, this was not a question about mindfulness. Rather, I wanted to better understand the interaction between complex decision-making processes (whatever those might turn out to be) and various types of HIT to understand how management could implement performance initiatives, trainings, and HIT investment strategies to increase the likelihood that introducing new technologies into emergency departments will lead to better patient outcomes. To approach this goal, I focused on physician decision making, which I believed was more complex than traditional, protocol based models would have us believe. In particular, intuition was one facet of decision making that I supposed to be important to understanding medical decision making. Thus, to guide the first study in this sequence, I asked the research questions: *How emergency room (ER) physicians make diagnosis and treatment decisions and what influences those decisions?* and *How and to what extent does intuitive decision making take precedence over routinized decision making in ER physicians' diagnosis and treatment decisions?*

By approaching these broad research questions from a qualitative standpoint, I was able to explore, during in-depth interviews with physicians, how they conceive of their own decision making processes during their clinical work in emergency departments. The findings (presented in Chapter 4) pointed overwhelmingly to the importance of pattern recognition and context-based decision making. Although physicians in the qualitative study responded to the notion of intuitive decision making, their descriptions made it clear that intuition was, at best, only part of the story. In almost every case, when physicians described following their intuitions, they told stories about noticing subtle cues in the clinical environment that led them to reject the protocols and scripts they had learned in medical school. Some such cases led to life-saving decisions, and many also resulted in cost savings through the avoidance of unnecessary diagnostic tests. Indeed, after reflecting on these results, I found that there is a lack of clarity in literature related to intuitive decision making; many scholars use intuition as a generic term for pattern recognition based on long experience, but almost none connect intuition to the sense of situational awareness my participants described (Moxley et al., 2012; Muoni, 2012; Salas, Rosen, & DiazGranados, 2009).

These issues led me to a rejection of the dual-process theory of decision making which had provided the theoretical foundation for the first study. My results did not support a binary distinction between routinized and intuitive decision making, as dual-theory proponents would have us suppose (Pelaccia et al., 2011). Rather, there appeared to be a dimension of physician decision making that incorporated both routinized and intuitive processes, selecting among possible alternative paths by attending to subtle environmental cues. This process, I found, was captured very well by the concept of mindfulness, which Ellen Langer defines as a “sense of situational awareness” (Langer, 1997). In clinical contexts, mindfulness has been described as “the capacity to be aware of one’s internal condition and external situation as fully and as consciously as possible” (Coget & Keller, 2010: 69). Therefore, in answering the research questions for this study, I believe that intuitive decision making takes precedence over routinized decision making to the extent that mindful cognitive processes indicate deviation from algorithm-based decisions.

Although some scholars had previously written about mindfulness in emergency clinical contexts, these articles were limited to speculative approaches and tended to focus on the stress-reduction benefits of mindfulness meditation, rather than the influence of mindful attention (a personal trait rather than a meditative practice) on decision making processes (Coget & Keller, 2010; Cunningham et al., 2013; Westphal et al., 2015). Therefore, mindful decision making represented a new theoretical direction.

To test the theory, I developed a quantitative model of physician performance as a function of various facets of HIT engagement and hypothesized that mindfulness would act as a mediator, improving performance among HIT users. The research question for this second study was: *What is the relationship between information technology use, access, and restrictiveness and ER physician performance, and to what extent are such effects mediated by mindfulness?* Results showed that, all else being equal, physicians who used HIT more frequently tended to exhibit lower performance. However, as I predicted, mindfulness dampened this relationship, suggesting that *mindful HIT use* can improve physician performance. With this result, I was much closer to an answer to the overarching research question. It began to appear that mindful attention could explain performance differences among emergency physician who use HIT in their daily clinical work. This was an exciting implication, because it suggested that, by helping physicians improve their levels of mindfulness, healthcare managers could help ensure that HIT investments would lead to outcome improvements.

Before this conclusion could be asserted with certainty, there remained several questions to address. In particular, up to this point, I had been using HIT (or simply IT) in a broad sense, rather than investigating a particular type of HIT. In recent decades, healthcare technology has developed into several distinct categories, including electronic records systems, clinical decision support systems, and literature review and information summary systems. Because the primary focus of this research was on clinical decision making, I chose to focus on CDSSs. Next, I needed to understand *how* mindfulness influenced CDSS use among physicians. If, as I now believed, mindful physicians tended to perform better when using HIT, it remained to be seen how mindfulness translated into concrete behaviors that led to enhanced clinical performance. Brining these threads of the problem together, I asked the following research question in the third, mixed-method study: *What, if anything, do highly mindful emergency physicians do differently when using clinical decision support systems that could lead to improved performance when compared with less mindful physicians?*

With this, I had a research direction that focused on concrete behaviors, concrete technology applications, and their influence on physician performance. The quantitative, objective performance data collected during the third study reinforced a significant positive correlation between mindfulness and performance that could not be explained by age or years of experience, supporting the importance of mindfulness for emergency physicians. Through a multi-stage process of interviews and quantitative data collection, it emerged that more mindful physicians (to the extent they are represented by the cases in my multiple case study; see Chapter 6 for design limitations of the mixed-method study) may use CDSSs in confirmatory roles in their decision making processes. Rather than relying on CDSSs for information before they have seen a patient, they privilege patient contexts and use CDSSs to bolster, rather than replace, their own clinical decision making abilities. This focus on patient contexts was underscored by the fact that mindful physicians in the third study were more open to change than their less-mindful counterparts. They were interested in exploring improvements to their decision making processes in the hope of improving patient outcomes. An interest in the here-and-now of emergency medicine enabled these physicians to perform better, supported by CDSSs.

With this increased level of specificity and understanding of physician decision making, it was now possible to answer the overarching research question that guided this sequence of studies. Top-performing physicians may be characterized by a high degree of mindfulness, which enables them to remain open to clinical contexts and induces them to incorporate HIT, particularly CDSSs, in a supportive role in their diagnostic and treatment decisions. By contrast, less mindful physicians may take one of two approaches to HIT: they may reject these tools altogether, believing that they have no need for them or rejecting the possibility that they might improve clinical work; or they may become overly reliant on CDSSs and other tools, even to the point of dependence. These "mindless" approaches to technology may result in missed opportunities for performance increases, either because physicians are not taking advantage of the benefits of HIT or because they are not utilizing their own training and not accounting for aspects of patients' clinical presentation that are not accounted for in CDSS programming.

Some researchers have suggested that both mindful and mindless decision making processes are crucial to organizational effectiveness and reliability (Butler & Gray, 2006; Carlo et al., 2012). Although this may be true in a general sense of emergency department settings, my research reveals that mindfulness at the physician level is indispensable. This supports an emerging but still very underdeveloped body of work on mindfulness as a personal trait in emergency medical decision making (Beach et al., 2013; Coget & Keller, 2010). Indeed, the full importance of mindful decision making in high-knowledge fields is only beginning to gain prominence (Eastburn & Jr.Boland, 2015). This research, therefore, is important for healthcare management as well as for management in other knowledge-based, fast-paced fields like banking. As we continue to understand how mindfulness influences daily decision making processes, we may be able to build mindfulness into the technologies we develop, for example by prompting users to attend to features of the situations with which they are faced.

Recently, several scholars have pointed to the importance of mindfulness research for understanding workplace performance (Choi & Tobias, 2015; Hyland et al., 2015). The present research supports these early findings. The field of organizational performance improvement should benefit from a focus on mindful attention and its profound impact on reliable decision making.

Limitations

The overall study design is subject to some limitations. The primary limitation of the overall sequence of studies is their intense focus on emergency physicians. Because the study was designed from the beginning to examine mindfulness and IT among emergency physicians, the findings of the study are not generalizable to other industries. This limitation was necessary in order to address significant research gaps related to the emergency physician context. Additionally, this limitation is overcome by the enhanced applicability and generalizability to the field of emergency medicine management, which may have different characteristics from management in other fields.

Methodologically, there are some limitations inherent in sequential, exploratory mixed-methods studies. One of the greatest weaknesses in this study design is the difficulty of ensuring validity and reliability across samples (Castro et al., 2010). In the present sequence of studies, the sample for each of the three studies consisted of different physicians, and, with the possible exception of the quantitative study, the results of each study were not generalizable. Therefore, the progression of the studies was based on the assumption that the results of the preceding study would apply to the sample of the next study. This limitation is, to some extent, ameliorated by statistical triangulation of the second and third studies, with demonstrated similar quantitative relationships between performance and mindfulness. However, the validity of all mixed-methods studies is limited by cross-sample issues.

Contributions to Knowledge in the Field

I anticipate that this sequence of studies will provide significant contributions to the field of emergency medicine management specifically, to fast-paced and critical industries generally, and to academic research related to mindfulness, CDSSs, and physician performance. As a whole, this study contributes to the understanding of how various decision-making approaches might inform the use of HIT. This research shows that the classical model of decision making may be most compatible with mindless HIT use, which could lead to decreased performance. The intuitive model of decision making proved to be similarly inadequate, however, because it failed to account for the context-dependent reasoning used by high-performing physicians. Although the dual-process theory incorporates the strengths of both approaches, research on mindful decision making and organizational mindfulness appears to have strong potential for describing decision making in emergency departments in a way that adequately predicts and explains performance differences.

The major contribution of the first study is a clearer understanding of the role of mindfulness in ER physicians' decision making and physicians' subjective perceptions of decision making along restricted versus intuitive lines. Most strikingly, this study supports a complex understanding of clinical decision making that accounts for both routinized medical training and context-specific, mindfulness-based intuitions. When developing key performance initiatives, managers must be aware of these complexities. Asking physicians to justify their decisions on the basis of medical protocols overlooks an important aspect of emergency medicine.

The major contribution of the second study is a clearer understanding of the impacts of the IT environment on mindfulness, especially IT access and IT use and their potentially cancelling effects. Perhaps the most fascinating finding was that, when I included mindfulness in the model, the direction of the effect of IT use on performance is reversed. In other words, all else being equal, more IT use leads to decreased performance. Unfortunately, since differences in IT tools were outside the scope of my second study, it is not possible to draw conclusions about the reasons for this effect. It is my supposition that the decreased performance results from the tendency of IT use to change physicians' attitudes toward their environments, rather than from flaws in the IT tools themselves. This supposition is supported by the effect of mindfulness, which suggests that user characteristics, not IT characteristics, are what matter for performance. IT tools cannot be expected to understand everything about a patient context or emergent situation; therefore, failure to adequately attend to the specifics of context is not a failure of the IT. However, the possibility that the negative performance effect of IT would change with better IT tools cannot be ruled out.

Nevertheless, my research calls into question the strong pro-innovation emphasis to existing research (Sundaram et al., 2007); although researchers have emphasized the importance of training and efficient use in maximizing IT-derived performance benefits, most research begins from the assumption that IT will always lead to performance gains (Sundaram et al., 2007). In high-risk environments like emergency medicine, this assumption may need to be re-examined. To realized performance gains from CDSSs and other IT investments, health care organizations may need to emphasize training on mindfulness, which is required to use IT effectively.

In addition, the second, quantitative study contributed new insights into the role of mindfulness in promoting effective use of IT (considered broadly in the second study). When the effects of mindfulness were explicitly included in the model, more IT use led to increased performance. This shows that more mindful physicians use IT to their advantage. This finding contributes an individual-level perspective, building on recent findings that mindfulness at the organizational level is important for making effective use of IT innovations (Wolf et al., 2012).

Finally, the third study contributes new knowledge of how mindful physicians perform differently with respect to use of CDSSs. This represents a strikingly novel research direction, given the paucity of evidence on CDSSs and mindfulness generally, and the almost total lack of evidence on mindfulness and emergency physician performance. Based on the complete results of this sequence of studies, practitioners should be able to implement new interventions, key performance initiatives, and strategies to improve emergency department performance at the individual physician level.

Recommendations for Practice

It is clear that mindfulness has beneficial effects on physician performance, particularly in environments characterized by high IT use. Therefore, it is recommended that managers invest in trainings and interventions designed to develop mindfulness in ER physicians. Additionally, this study has practical implications for developers of CDSSs for use in emergency rooms. CDSSs that promote mindfulness, for example by requiring situation-specific inputs before recommending courses of action, are likely to lead to larger gains in physician performance and therefore better returns on investment. The results of the third study also suggest that hospital management can have a strong impact on performance by designing CDSS use policies that allow emergency physicians to use decision support tools in a supportive role, rather than relying on them for initial diagnosis. Interventions designed to improve physicians' overall mindfulness and openness to change could also lead to performance improvements and greater returns on IT investment in emergency departments.

Conclusion

Emergency medicine is both an important component of promoting public health and a key sector of the United States economy. New regulations and financial pressures such as those imposed by the Affordable Care Act, as well as legislation intended to promote and support investment in healthcare information technology (e.g., HITECH) has led to a rapid surge in IT use in emergency departments. Although such IT use may lead to cost reductions, it is not clear to what extent increased IT use improves emergency medicine quality. What is clear is that healthcare IT is not a single element and should not be considered as such. Rather, healthcare IT may come in a variety of different forms, and these different forms may be associated with different outcomes. CDSSs are one form that healthcare IT takes, and such CDSSs have indeed been associated with improved patient outcomes. However, the research in this area has scarcely focused on physician-specific factors, despite evidence that individual physician characteristics may account for the majority of differences in physician performance. Drawing on evidence from other fields, it can be supposed that the use of CDSSs affects individual, performance-related characteristics, especially mindfulness (i.e., situational awareness). Given the abundance of research from other industries on these topics, it is shocking that the mindfulness–IT–performance nexus has not been investigated among emergency physicians. The time is ripe for a thorough investigation.

Results of this three-study sequence support the need for a reinvestigation of the assumption that more IT in emergency departments is better. In particular, mindfulness has proven to be an important mediator of performance increases from IT use. Indeed, without mindfulness, IT may actually decrease physician performance. If we are to improve, not just bottom-line performance, but also patient outcomes and healthcare quality, we must pay close attention to the rapid development of healthcare IT, refusing to take innovations for granted. From the design of CDSSs through to their implementation, emergency medicine management will greatly benefit from increased clarity.

Appendix A: Qualitative Study Interview Protocol

Step 1: Introduction and Explanation

Introduction (Interviewer): "Hello (name). Thank you for taking the time to meet with me in person (or via video conference) today. Your participation in the interview is appreciated. Before we get started there are a couple of things I would like to cover."

Purpose and Format for the Interview (Interviewer): "The purpose of my research is to better understand how ER Physicians work within an emergency room.

Confidentiality (Interviewer): "Everything you share in this interview will be kept in strictest confidence, and your comments will be transcribed anonymously – omitting your name, anyone else you refer to in this interview, as well as the name of your current institution and/or past institutions. Your interview responses will be included with all the other interviews I conduct."

Audio Recording (Interviewer): "To help me capture your responses accurately and without being overly distracting by taking notes, I would like to record our conversation with your permission. Again, your responses will be kept confidential. If at any time, you are uncomfortable with this interview, please let me know and I will turn the recorder off."

"Do you have any questions before we begin?"

Step 2: Opening Icebreaker Question

Interviewer: "Before we start talking what happens when you're on call in the emergency department, I'd like to learn a little about you. Would you give me a brief bio of yourself?"

Probes
Family
Current work information
Past work information
Hobbies
Education and military experience (and rank)
What motivates you?
How many years have you been with the government?
What are your biggest concerns?
What do you aspire to become?
Who inspired you most?
If you weren't doing your current job and could do anything, what would it be?

Step 3: Experiential "lived experience" questions regarding emergency room diagnostic decisions

Question #1: "Tell me about a recent experience when you were tasked with making a lifesaving decision on a patient that resulted in that patient surviving. Please describe the incident in detail from beginning to end."

Probes:
Describe a high point during the incident and why it was a high point.
Describe a low point during the incident and describe why it was a low point.
What did you enjoy most about the outcome of your decisions? Be specific.
What frustrated you most about your decision? Be specific.
Was there anything unusual about this case?

Question #2: "Tell me about a recent experience when you were tasked with making a lifesaving decision on a patient that resulted in that patient not surviving. Please describe the incident in detail from beginning to end."

Probes:
Describe a high point during the incident and why it was a high point.
Describe a low point during the incident and describe why it was a low point.
What did you enjoy most about the outcome of your decisions? Be specific.
What frustrated you most about your decision? Be specific.
Was there anything unusual about this case?

Question # 3: "Can you tell me about an experience when you were diagnosing a patient in an emergency situation and you went with your gut instinct instead of your medical training?"

Probes:
Describe the case in detail. Be specific.
What made this emergency different from others? Be specific.
In the end, was your gut instinct correct?
How many other ER physicians were on hand to help diagnose?
What was your role in contrast to the other ER physicians on this case?
How many hours had you been on duty when this case presented itself?
Does anything keep you up at night about this case?
What surprised you about this program?
Describe a high point during the emergency and why it was a high point.
Describe a low point during the emergency and describe why it was a low point.

Question # 4: "Tell me about a time you were diagnosing and you chose to follow your medical training and not your gut instinct?"

Probes:
Describe the case in detail. Be specific.

What made this emergency different from others? Be specific.
In the end, was your gut instinct correct?
How many other ER physicians were on hand to help diagnose?
What was your role in contrast to the other ER physicians on this case?
How many hours had you been on duty when this case presented itself?
Does anything keep you up at night about this case?
What surprised you about this program?
Describe a high point during the emergency and why it was a high point.
Describe a low point during the emergency and describe why it was a low point.

Step 4: Closing

Interviewer: "Thank you very much for sharing your experiences. I had a wonderful time conducting the interview. We've covered a lot of ground and this will be very helpful. On the off chance that I missed anything, would it be possible to contact you again to meet or video conference if needed to fill in a gap or two? That would be very helpful.

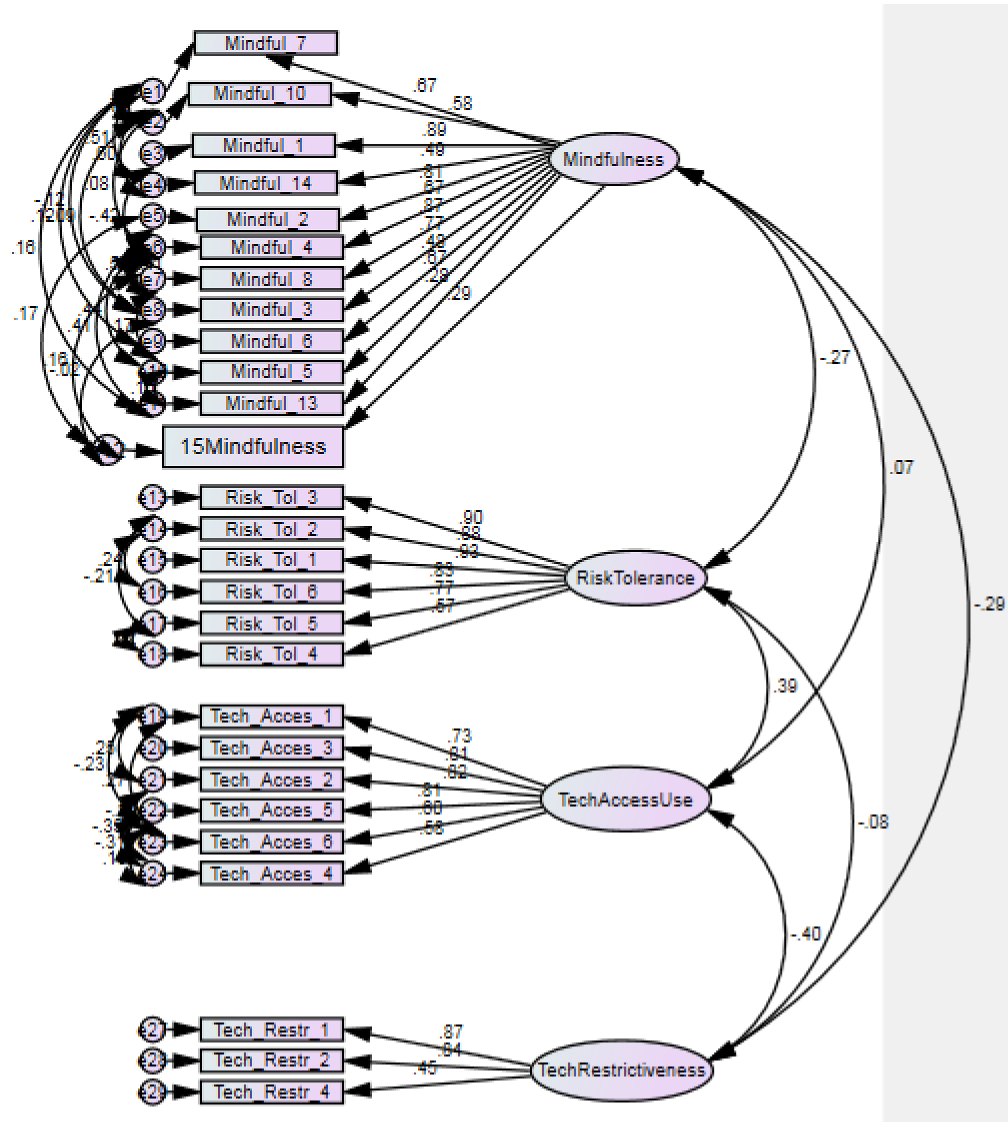
"Thank you again for your help and time. Is there anything that we didn't cover that you would like to add before we leave?

"Thank you!"

Appendix B: Quantitative Study Measurement Model

	Factor			
	Mindfulness	Risk Tolerance	IT access + extent of IT use	IT restrictive-ness
7Mindfulness	.924			
10Mindfulness	.868			
1Mindfulness	.794			
14Mindfulness	.733			
2Mindfulness	.711			
4Mindfulness	.663			
8Mindfulness	.646			
3Mindfulness	.570			
6Mindfulness	.532			
5Mindfulness	.501			
13Mindfulness	.400			
15Mindfulness	.337			
54RiskTol		.915		
53RiskTol		.914		
52RiskTol		.911		
57RiskTol		.859		
56RiskTol		.784		
55RiskTol		.689		
35TechAccess			.836	
37TechAccess			.823	
36TechAccess			.819	
39TechAccess			.743	
40TechUse			.599	
38TechUse			.472	
42TechRestrict				.776
43TechRestrict				.772
45TechRestrict				.500

Figure B1. Final CFA Model



Appendix C: Mindfulness Attention Awareness Scale

	Almost never	Very infrequently	Somewhat infrequently	Somewhat frequently	Very frequently	Almost always
1. While at work, I could be experiencing some emotion and not be conscious of it until some time later.						
2. While at work, I break or spill things because of carelessness, not paying attention, or thinking of something else.						
3. While at work, I find it difficult to stay focused on what's happening in the present.						
4. While at work, I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.						
5. While at work, I tend not to notice feelings of physical tension or discomfort until they really grab my attention.						
6. While at work, I forget a person's name almost as soon as I've been told it for the first time.						
7. While at work, it seems I am "running on automatic" without much awareness of what I'm doing.						
8. While at work, I rush through activities without being really attentive to them.						
9. While at work, I get so focused on the goal I want to achieve that I lose touch with what I am doing right now to get there.						
10. While at work, I do jobs or tasks automatically, without being aware of what I'm doing.						
11. While at work, I find myself listening to someone with one ear, doing something else at the same time.						
12. I drive places on "automatic pilot" and then wonder why I went there.						
13. While at work, I find myself preoccupied with the future or the past.						
14. While at work, I find myself doing things without paying attention.						
15. While at work, I snack without being aware I am eating						

Appendix D: Mixed-Method Study Phase 1 Interview Protocol

Step 1: Introduction and Explanation

***Introduction (Interviewer)*:** "Hello (name). Thank you for taking the time to meet with me today. Your participation in the interview is appreciated. Before we get started there are a couple of things I would like to cover."

***Purpose and Format for the Interview (Interviewer)*:** "The purpose of my research is to better understand how physicians use clinical decision support systems (CDSSs) at the point of patient care. I'm focusing only on CDSSs that are patient-specific and that are used at the patient's bedside or other point of care. Specifically, I'm interested in how different physicians might use these new technologies differently.

***Confidentiality (Interviewer)*:** "Everything you share in this interview will be kept in strictest confidence, and your comments will be transcribed anonymously – omitting your name, anyone else you refer to in this interview, as well as the name of your current institution and/or past institutions. Your interview responses will be included with all the other interviews I conduct."

***Audio Recording (Interviewer)*:** "To help me capture your responses accurately and without being overly distracting by taking notes, I would like to record our conversation with your permission. Again, your responses will be kept confidential. If at any time, you are uncomfortable with this interview, please let me know and I will turn the recorder off."

"Do you have any questions before we begin?"

Step 2: Decision-making process and performance questions

Question #0: How many years of experience do you have in emergency medicine?

Question #1: "Before we start talking about how you use CDSSs at the point of patient care in the emergency room, I'd like to learn a little about your work style in general. Please describe your major strengths and weaknesses as an emergency physician."

> **Probes**
> Test ordering
> Drug and dosage selection
> Catching important details
> Speed and efficiency
> "Bedside manner"

Question #2: "Please describe the process you use in making diagnosis and treatment decisions. How does your decision-making process differ from that of your colleagues?

Probes
Asking questions
Consulting literature
Consulting colleagues
"Talking to the room"
Using references (IT-based or not)
Maintaining current medical knowledge
Drawing on past experience
Trusting intuitions

Step 3: Experiential questions regarding use of CDSSs

Question #1: "For this study, I'm only interested in patient-specific CDSSs—things that give you advice or instructions about diagnoses and treatments based on patient-specific inputs like symptoms or weight and age.

"What types of CDSSs do you routinely use in your work? Please describe them in as much detail as possible."

Probes:
Are the decision aids handheld (on a mobile device like a phone or tablet)?
What specifically are they designed to help with? Types of conditions, tests, medications, etc.
What kinds of inputs do the decision aids require? Test data, patient characteristics, etc.
What kinds of outputs do the decision aids give? Medicine doses, specific tests to order, probable diagnoses, risk levels, etc.
Describe the interface of these decision aids. Graphics, touch screen vs. keyboard, search capabilities, etc.
What are some things the decision aids are *not* capable of?

Question #2: "Thinking about the CDSSs you told me about for the previous question, please describe in as much detail as possible how you use these tools in your daily clinical work *at the point of patient care*. Walk me through how you would use these tools on a typical day. Remember to focus only on CDSSs used right there with the patient."

Probes:
On a typical day, about how much time do you spend using CDSSs?
Describe, from start to finish, an incident where you used CDSSs.
At what point did you decide to use the CDSS? Why?
When assessing the CDSS's advice/instructions, what other information did you take into consideration? Where did you get this other information?
How did the CDSS affect your diagnosis and/or treatment decisions in this case?
What features of the CDSS do you use most regularly? Why?
What features of the CDSS do you use least regularly? Why?

Question #2.5: "In what ways is the scenario you just described similar to or different from a 'typical' clinical scenario with respect to how you would usually use CDSSs?"

Question #3: "How would you describe your overall approach to using CDSSs?"

Question #3.5: "Under what conditions might you violate the recommendations of a CDSS or choose a low-probability option from those given?"

Question #4: "Compared to other emergency physicians, how is your use of CDSSs at the point of patient care different?"

Question #5: "Is there anything else about CDSSs and how you use them that we haven't covered and that you'd like to discuss before we conclude?"

Step 4: Closing

"Thank you very much for sharing your experiences. I had a wonderful time conducting the interview. We've covered a lot of ground and this will be very helpful.

"The next phase in my research process will be to analyze these interviews, along with data from the questionnaire you'll complete, to identify a few physicians who might be able to give me more detailed information. Would you be open to conducting a second interview and going into a little more depth?"

"Thank you again for your help and time. Do you have any questions or concerns before we end?"

Appendix E: Mixed-Method Study Phase 2 Interview Protocol

Step 1: Introduction and Explanation

Introduction (Interviewer): "Hi again, (name). Thank you for taking the time to meet with me for this follow-up interview. Before we get started there are a couple of things I would like to cover."

Purpose and Format for the Interview (Interviewer): "As a reminder, the purpose of my research is to better understand how physicians use clinical decision support systems (CDSSs). I'm focusing only on CDSSs that are patient-specific and that are used at the patient's bedside or other point of care. For this interview, my focus is on how technology influences different types of decision making."

Confidentiality (Interviewer): "Everything you share in this interview will be kept in strictest confidence, and your comments will be transcribed anonymously – omitting your name, anyone else you refer to in this interview, as well as the name of your current institution and/or past institutions. Your interview responses will be included with all the other interviews I conduct."

Audio Recording (Interviewer): "To help me capture your responses accurately and without being overly distracting by taking notes, I would like to record our conversation with your permission. Again, your responses will be kept confidential. If at any time, you are uncomfortable with this interview, please let me know and I will turn the recorder off."

"Do you have any questions before we begin?"

Step 2: CDSS use typology questions

Introduction: "Based on the results of the first-round interviews, I found that physicians use CDSSs in a few different ways:

- Some avoid CDSSs at all costs
- Some rely heavily on CDSSs and use them before, during, and/or after consultation with every patient
- Some use CDSSs only to the extent they are required to do so
- Some use CDSSs only for record-keeping purposes (for example, to check the intake nurse's notes) or to confirm their own diagnosis and treatment decisions

Most physicians still rely on 'huddles' or round-table collaboration in cases where they disagree with CDSSs—only a few physicians suggested that they had seen CDSSs suggest correct diagnoses that the medical team had missed.

Question #1: "Based on this typology, what are your initial thoughts? Are there nuances or other types that you would add to this list?"

Probe
What category do you fall into?

Question #2: "In your opinion, which of these categories of CDSS use contributes the most to physician performance, which is the biggest detriment to physician performance, and why? Feel free to use a 'category' or pattern of CDSS use that I didn't list."

Question #3: "How would your clinical decision making process change if CDSSs disappeared from existence tomorrow?"

Probes
Ask patients more/fewer questions
Treat patients in more/less standardized ways
Feel more/less overwhelmed/stressed
Talk to more/fewer people (nurses, patient family)
Request more/less confirmation for decisions
Share more/less information with medical team
Feel more/less confident in decisions

Question #4: "If you were responsible for managing a team of emergency physicians, what guidelines or requirements would you issue regarding the use of CDSSs, particularly at the point of patient care?"

Step 3: Mindfulness questions

Introduction: Decision-making researchers say that people can make decisions mindfully, with a full awareness of their surroundings, or routinely, based on training and experience. For example, some people have the same thing for breakfast every morning because they know what they like—it's a routine. Some people decide each day what to have for breakfast based on how they feel, what they ate yesterday, or other situation-specific factors—that's a mindful decision.

Question #1: "When you are with a patient, how do these two decision making styles interact?"

Probes
Patient consultation
Diagnosis/treatment algorithms
Medical school
Environmental cues

Question #2: "Based on the results of the mindfulness questionnaire you completed last time we met, you were one of the [most/least] mindful physicians I spoke to. Do you have any thoughts about that result?"

Probes
Were you surprised?
Importance of mindfulness
Definition of mindfulness

Question #3: "In what way does being [high/low] mindful help or hinder you in your work with patients?"

Probes
Medical intuition
State of medical knowledge
Human error
Reliability of technologies

Question #4: "In what way does your level of mindfulness alter the way in which you use CDSSs?"

Probes
Screen time vs. patient engagement
CDSS prompts to specific contextual factors
Tendency to trust/distrust CDSS
Tendency to use CDSS for initial diagnosis ideas vs. confirmation after the fact

Step 4: Consent to request performance data

"Now that I have a better idea of how your level of mindfulness influences how you use CDSSs, I would like to compare your answers with the performance data collected by your workplace. Since every workplace measures performance differently, I'll be analyzing performance data on a case-by-case basis, not comparing participants. Everything will be completely anonymized. Any performance data I collect will have no effect whatsoever on your relationship with your employer. Do you consent to allow me request performance data?"

Step 5: Closing

"Thank you very much for sharing your experiences. The results of this research will go a long way toward helping us understand how CDSSs influence the clinical decision making process. Do you have any final thoughts or questions before we conclude?"

REFERENCES

Addas, S., & Pinsonneault, A. 2015. The many faces of information technology interruptions: A taxonomy and preliminary investigation of their performance effects. ***Information Systems Journal***, 25(3): 231-273.

Adler-Milstein, J., Everson, J., Shoou-Yih, D. L., & Lee, S.-Y. D. 2015. EHR adoption and hospital performance: Time-related effects. ***Health Services Research***, 50(6): 1751-1771.

Adler, R., Werner, E. R., & Korsch, B. 1980. Systematic study of four years of internship. ***Pediatrics***, 66(6): 1000-1008.

Anderson, R. T., Montori, V. M., Shah, N. D., Ting, H. H., Pencille, L. J., Demers, M., Kline, J. A., Diercks, D. B., Hollander, J. E., Torres, C. A., Schaffer, J. T., Herrin, J., Branda, M., Leblanc, A., & Hess, E. P. 2014. Effectiveness of the Chest Pain Choice decision aid in emergency department patients with low-risk chest pain: Study protocol for a multicenter randomized trial. ***Trials***, 15(1): 1-22.

Andruchow, J. E., Raja, A. S., Prevedello, L. M., Zane, R. D., & Khorasani, R. 2012. Variation in head computed tomography use for emergency department trauma patients and physician risk tolerance. ***Archives of Internal Medicine***, 172(8): 660-661.

Arnold, V., Collier, P. A., Leech, S. A., & Sutton, S. G. 2004. Impact of intelligent decision aids on expert and novice decision-makers' judgments. ***Accounting & Finance***, 44(1): 1-26.

Arnold, V., & Sutton, S. 1998. The theory of technology dominance: Understanding the impact of intelligent decision aids on decision maker's judgments. ***Advances in Accounting Behavioral Research***, 1(3): 175-194.

Ash, J. S., McCormack, J. L., Sittig, D. F., Wright, A., McMullen, C., & Bates, D. W. 2012. Standard practices for computerized clinical decision support in community hospitals: A national survey. ***Journal of the American Medical Informatics Association***, 19(6): 980-987.

Bagnasco, A., Ghirotto, L., & Sasso, L. 2014. Theoretical sampling. ***Journal of Advanced Nursing***, 70(11): e6-e7.

Bagozzi, R. P., & Yi, Y. 1988. On the evaluation of structural equation models. ***Journal of the Academy of Marketing Science***, 16(1): 74-94.

Barrett, T. W., Storrow, A. B., Jenkins, C. A., Abraham, R. L., Liu, D., Miller, K. F., Moser, K. M., Russ, S., Roden, D. M., Harrell Jr, F. E., & Darbar, D. 2015. The AFFORD Clinical Decision Aid to identify emergency department patients with atrial fibrillation at low risk for 30-day adverse events. ***American Journal of Cardiology***, 115(6): 763-770.

Bates, D. W., Kuperman, G. J., Wang, S., Gandhi, T., Kittler, A., Volk, L., Spurr, C., Khorasani, R., Tanasijevic, M., & Middleton, B. 2003. Ten commandments for effective clinical decision support: Making the practice of evidence-based medicine a reality. ***Journal of the American Medical Informatics Association***, 10(6): 523-530.

Bazerman, M., & Moore, D. A. 2012. ***Judgment in managerial decision making*** (8th ed.). Wiley.

Beach, M. C., Roter, D., Korthuis, P. T., Epstein, R. M., Sharp, V., Ratanawongsa, N., Cohn, J., Eggly, S., Sankar, A., Moore, R. D., & Saha, S. 2013. A multicenter study of physician mindfulness and health care quality. ***Annals of Family Medicine***, 11(5): 421-428.

Bochicchio, G. V., Smit, P. A., Moore, R., Bochicchio, K., Auwaerter, P., Johnson, S. B., Scalea, T., & Bartlett, J. G. 2006a. Pilot study of a web-based antibiotic decision management guide. ***Journal of the American College of Surgeons***, 202(3): 459-467.

Bochicchio, G. V., Smit, P. A., Moore, R., Bochicchio, K., Auwaerter, P., Johnson, S. B., Scalea, T., Bartlett, J. G., & Group, P.-I. 2006b. Pilot study of a web-based antibiotic decision management guide. ***Journal of the American College of Surgeons***, 202(3): 459-467.

Boland Jr, R. J., Tenkasi, R. V., & Te'eni, D. 1994. Designing information technology to support distributed cognition. ***Organization Science***, 5(3): 456-475.

Braun, V., & Clarke, V. 2006. Using thematic analysis in psychology. ***Qualitative Research in Psychology***, 3(2): 77-101.

Bravo, E. R., Santana, M., & Rodon, J. 2015. Information systems and performance: The role of technology, the task and the individual. ***Behaviour & Information Technology***, 34(3): 247-260.

Bross, I. D. J. 1953. ***Design for decision***. Free Press.

Brown, K. W., & Ryan, R. M. 2003. The benefits of being present: Mindfulness and its role in psychological well-being. ***Journal of Personality and Social Psychology***, 84(4): 822.

Bruni, M. L., Nobilio, L., & Ugolini, C. 2009. Economic incentives in general practice: The impact of pay-for-participation and pay-for-compliance programs on diabetes care. ***Health Policy***, 90(2): 140-148.

Burman, R. A., Zakariassen, E., & Hunskaar, S. 2014. Chest pain out-of-hours–an interview study of primary care physicians' diagnostic approach, tolerance of risk and attitudes to hospital admission. ***BMC Family Practice***, 15(1): 1.

Butler, B. S., & Gray, P. H. 2006. Reliability, mindfulness, and information systems. ***MIS Quarterly***, 30(2): 211-224.

Calder, L. A., Forster, A. J., Stiell, I. G., Carr, L. K., Brehaut, J. C., Perry, J. J., Vaillancourt, C., & Croskerry, P. 2011. Experiential and rational decision making: A survey to determine how emergency physicians make clinical decisions. ***Emergency Medicine Journal***, 29(10).

Carlo, J. L., Lyytinen, K., & Boland, J. R. J. 2012. Dialectics of collective minding: Contradictory appropriations of information technology in a high-risk project. ***MIS Quarterly***, 36(4): 1081-A1083.

Carr, C. M., DiGioia, C. H., Wagner, J., & Saef, S. H. 2013. Primer in health information exchange for the emergency physician: Benefits and barriers. ***Southern Medical Journal***, 106(6): 374-378.

Cash, J. 2008. Technology can make or break the hospital-physician relationship: Contrary to popular myth, physicians are far from being technophobic. ***Healthcare Financial Management***, 62(12): 104-110.

Castro, F. G., Kellison, J. G., Boyd, S. J., & Kopak, A. 2010. A methodology for conducting integrative mixed methods research and data analyses. ***Journal of Mixed Methods Research***, 4(4): 342-360.

Charles, K., Cannon, M., Hall, R., & Coustasse, A. 2014. Can utilizing a computerized provider order entry (CPOE) system prevent hospital medical errors and adverse drug events? ***Perspectives In Health Information Management / AHIMA, American Health Information Management Association***, 11: 1b-1b.

Charmaz, K. 2006. ***Constructing grounded theory: A practical guide through qualitative analysis***. Thousand Oaks, CA: Sage Publications, Inc.

Charmaz, K. 2008. Grounded theory as an emergent method. In S. N. Hesse-Biber, & P. Leavy (Eds.), ***Handbook of emergent methods***: 155-170. Guilford Press.

Chernoff, H., & Moses, L. E. 2012. ***Elementary decision theory***. Courier Corporation.

Choi, E., & Tobias, J. 2015. Mind the gap: The link between mindfulness and performance at work needs more attention. ***Industrial and Organizational Psychology: Perspectives on Science and Practice***, 8(4): 629-633.

Cioffi, J. 2000. Nurses' experiences of making decisions to call emergency assistance to their patients. ***Journal of Advanced Nursing***, 32(1): 108-114.

Cleirigh, D. O., & Greaney, J. 2015. Mindfulness and group performance: An exploratory investigation into the effects of brief mindfulness intervention on group task performance. ***Mindfulness***, 6(3): 601-609.

Coget, J.-F., & Keller, E. 2010. The critical decision vortex: Lessons from the emergency room. ***Journal of Management Inquiry***, 19(1): 56-67.

Coget, J.-F. A. H. 2004. ***Leadership in motion: An investigation into the psychological processes that drive behavior when leaders respond to" real-time" operational challenges***. UCLA.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. 2013. ***Applied multiple regression/correlation analysis for the behavioral sciences***. Routledge.

Corbin, J., & Strauss, A. 2008. ***Basics of qualitative research*** (3rd ed.). London: Sage.

Counselman, F. L., Marco, C. A., Patrick, V. C., McKenzie, D. A., Monck, L., Blum, F. C., Borg, K., Coppola, M., Gerard, W. A., & Jorgenson, C. 2009. A study of the workforce in emergency medicine: 2007. ***The American Journal of Emergency Medicine***, 27(6): 691-700.

Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., & Hanson, W. E. 2003. Advanced mixed methods research designs. In A. Tashakkori, & C. Teddlie (Eds.), ***Handbook of mixed methods in social and behavioral research***: 209-240. Thousand Oaks, CA: SAGE Publications, Inc.

Crossley, M. 2000. ***Introducing narrative psychology***. McGraw-Hill Education (UK).

Cunningham, T., Bartels, J., Grant, C., & Ralph, M. 2013. Mindfulness and medical review: A grassroots approach to improving work/life balance and nursing retention in a level I trauma center emergency department. ***Journal of Emergency Nursing (JEN): Official Publication of the Emergency Department Nurses Association***, 39(2): 200-202.

Curreri, A. 2014. ***Millenial or non-Millenial ER physician? Which would you choose?*** : Unpublished Qualitative Research Report, Case Western Reserve University, Cleveland, OH.

Dean, N. C., Jones, B. E., Jones, J. P., Ferraro, J. P., Post, H. B., Aronsky, D., Vines, C. G., Allen, T. L., & Haug, P. J. 2015. Impact of an electronic clinical decision support tool for emergency department patients with pneumonia. ***Annals of Emergency Medicine***, 66(5): 511-520.

Desbordes, G., Negi, L. T., Pace, T. W., Wallace, B. A., Raison, C. L., & Schwartz, E. L. 2012. Effects of mindful-attention and compassion meditation training on amygdala response to emotional stimuli in an ordinary, non-meditative state. ***Frontiers in Human Neuroscience***, 6(292).

Devaraj, S., & Kohli, R. 2003. Performance impacts of information technology: Is actual usage the missing link? ***Management Science***, 49(3): 273-289.

Dexheimer, J. W., & Borycki, E. M. 2015. Use of mobile devices in the emergency department: A scoping review. ***Health Informatics Journal***, 21(4): 306-315.

Dimitrov, D. M., Al-Saud, F. A. A.-M., & Alsadaawi, A. S. 2015. Investigating Population Heterogeneity and Interaction Effects of Covariates: The Case of a Large-Scale Assessment for Teacher Licensure in Saudi Arabia. ***Journal of Psychoeducational Assessment***, 33(7): 674-686.

Dinh, M., & Chu, M. 2006. Evolution of health information management and information technology in emergency medicine. ***Emergency Medicine Australasia***, 18(3): 289-294.

Djulbegovic, B., Hozo, I., Beckstead, J., Tsalatsanis, A., & Pauker, S. G. 2012. Dual processing model of medical decision-making. ***BMC medical informatics and Decision Making***, 12(1): 94.

Doyle, J. 1999. Rational decision making. ***MIT encyclopedia of the cognitive sciences***: 701-703.

Dreyfus, H. L. 1992. ***What computers still can't do: A critique of artificial reason***. Cambridge, MA: MIT Press.

Dreyfus, H. L., & Dreyfus, S. E. 2005. Peripheral vision expertise in real world contexts. ***Organization studies***, 26(5): 779-792.

Dutheil, F., Trousselard, M., Perrier, C., Lac, G., Chamoux, A., Duclos, M., Naughton, G., Mnatzaganian, G., & Schmidt, J. 2013. Urinary interleukin-8 is a biomarker of stress in emergency physicians, especially with advancing age—the JOBSTRESS* randomized trial. ***PloS one***, 8(8): e71658.

Eastburn, R. W., & Jr.Boland, R. J. 2015. Inside banks' information and control systems: Post-decision surprise and corporate disruption. ***Information & Organization***, 25(3): 160-190.

Edwards, W. 1954. The theory of decision making. ***Psychological Bulletin***, 51(4): 380.

Epstein, A. J., & Ketcham, J. D. 2014. Information technology and agency in physicians' prescribing decisions. ***The RAND Journal of Economics***, 45(2): 422-448.

Epstein, R. M. 1999. Mindful practice. ***Journal of the American Medical Association (JAMA)***, 282(9): 833-839.

Epstein, R. M. 2003. Mindful practice in action (I): Technical competence, evidence-based medicine, and relationship-centered care. ***Families, Systems & Health: The Journal of Collaborative Family HealthCare***, 21(1): 1.

Erogul, M., Singer, G., McIntyre, T., & Stefanov, D. G. 2014. Abridged mindfulness intervention to support wellness in first-year medical students. ***Teaching & Learning in Medicine***, 26(4): 350-356.

Faraj, S., & Yan, X. 2006. Coordination in fast-response organizations. ***Management Science***, 52(8): 1155-1169.

Farion, K. J., Wilk, S., Michalowski, W., O'Sullivan, D., & Sayyad-Shirabad, J. 2013. Comparing predictions made by a prediction model, clinical score, and physicians: Pediatric asthma exacerbations in the emergency department. ***Applied Clinical Informatics***, 4(3): 376-391.

Fernando, A., Consedine, N., & Hill, A. G. 2014. Mindfulness for surgeons. ***ANZ Journal of Surgery***, 84(10): 722-724.

France, D. J., Levin, S., Hemphill, R., Chen, K., Rickard, D., Makowski, R., Jones, I., & Aronsky, D. 2005. Emergency physicians' behaviors and workload in the presence of an electronic whiteboard. ***International Journal of Medical Informatics***, 74(10): 827-837.

Garg, A. X., Adhikari, N. K., McDonald, H., Rosas-Arellano, M. P., Devereaux, P., Beyene, J., Sam, J., & Haynes, R. B. 2005. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: A systematic review. ***JAMA***, 293(10): 1223-1238.

Gebauer, A. 2013. Mindful organizing as a paradigm to develop managers. ***Journal of Management Education***, 37(2): 203-228.

Georgiou, A., Prgomet, M., Paoloni, R., Creswick, N., Hordern, A., Walter, S., & Westbrook, J. 2013. The effect of computerized provider order entry systems on clinical care and work processes in emergency departments: A systematic review of the quantitative literature. ***Annals of Emergency Medicine***, 61(6): 644-653.e616.

Girard, D. E., & Hickam, D. H. 1991. Predictors of clinical performance among internal medicine residents. ***Journal of General Internal Medicine***, 6(2): 150-154.

Gong, J., Zhang, Y., Yang, Z., Huang, Y., Feng, J., & Zhang, W. 2013. The framing effect in medical decision-making: A review of the literature. ***Psychology, Health & Medicine***, 18(6): 645-653.

Good, D. J., Lyddy, C. J., Glomb, T. M., Bono, J. E., Brown, K. W., Duffy, M. K., Baer, R. A., Brewer, J. A., & Lazar, S. W. 2016. Contemplating mindfulness at work: An integrative review. ***Journal of Management***, 42(1): 114-142.

Goodhue, D. L., & Thompson, R. L. 1995. Task-technology fit and individual performance. ***MIS Quarterly***, 19(2): 213-236.

Govaerts, M., Van de Wiel, M., Schuwirth, L., Van der Vleuten, C., & Muijtjens, A. 2013. Workplace-based assessment: raters' performance theories and constructs. ***Advances in Health Sciences Education***, 18(3): 375-396.

Groopman, J. E., & Prichard, M. 2007. ***How doctors think***. Springer.

Gruppen, L. D., & Frohna, A. Z. 2002. Clinical reasoning, ***International handbook of research in medical education***: 205-230. Springer.

Hagbaghery, M. A., Salsali, M., & Ahmadi, F. 2004. The factors facilitating and inhibiting effective clinical decision-making in nursing: A qualitative study. ***BMC Nursing***, 3(1): 2.

Hannan, M. T., & Freeman, J. 1984. Structural inertia and organizational change. ***American Sociological Review***, 49(2): 149-164.

Hunt, J., Siemienczuk, J., Gillanders, W., LeBlanc, B., Rozenfeld, Y., Bonin, K., & Pape, G. 2009. The impact of a physician-directed health information technology system on diabetes outcomes in primary care: A pre-and post-implementation study. ***Journal of Innovation in Health Informatics***, 17(3): 165-174.

Hyland, P. K., Lee, R. A., & Mills, M. J. 2015. Mindfulness at work: A new approach to improving individual and organizational performance. ***Industrial and Organizational Psychology: Perspectives on Science and Practice***, 8(4): 576-602.

Ilie, V., Van Slyke, C., Parikh, M. A., & Courtney, J. F. 2009a. Paper versus electronic medical records: The effects of access on physicians' decisions to use complex information technologies. ***Decision Sciences***, 40(2): 213-241.

Ilie, V., Van Slyke, C., Parikh, M. A., & Courtney, J. F. 2009b. Paper versus electronic medical records: The effects of access on physicians' decisions to use complex information technologies*. ***Decision Sciences***, 40(2): 213-241.

Janis, I. L. 1989. ***Crucial decisions: Leadership in policymaking and crisis management***. Simon and Schuster.

Jaspers, M. W., Smeulers, M., Vermeulen, H., & Peute, L. W. 2011. Effects of clinical decision-support systems on practitioner performance and patient outcomes: A synthesis of high-quality systematic review findings. ***Journal of the American Medical Informatics Association***, 18(3): 327-334.

Jones, S. S., Rudin, R. S., Perry, T., & Shekelle, P. G. 2014. Health information technology: An updated systematic review with a focus on meaningful use. ***Annals of Internal Medicine***, 160(1): 48-54.

Kabat-Zinn, J. 2005. ***Coming to our senses: Healing ourselves and the world through mindfulness***. Hachette UK.

Kahneman, D., & Frederick, S. 2005. A model of heuristic judgment. In K. J. Holyoak, & R. G. Morrison (Eds.), ***The Cambridge handbook of thinking and reasoning***: 267-293. Cambridge University Press.

Kassirer, J. P. 1976. The principles of clinical decision making: An introduction to decision analysis. ***The Yale Journal of Biology and Medicine***, 49(2): 149.

Kawamoto, K., Houlihan, C. A., Balas, E. A., & Lobach, D. F. 2005. Improving clinical practice using clinical decision support systems: A systematic review of trials to identify features critical to success. ***BMJ***, 330(7494): 765.

Kellermann, A. L., & Jones, S. S. 2013. What it will take to achieve the as-yet-unfulfilled promises of health information technology. ***Health Affairs***, 32(1): 63-68.

Kessler, E. H. 2004. Organizational innovation: A multi-level decision-theoretic perspective. ***International Journal of Innovation Management***, 8(03): 275-295.

Knoll, K., & Jarvenpaa, S. L. 1994. Information technology alignment or "fit" in highly turbulent environments: The concept of flexibility, ***Proceedings of the 1994 computer personnel research conference on Reinventing IS: Managing information technology in changing organizations: managing information technology in changing organizations***: 1-14. Alexandria, Virginia, USA: ACM.

Kroon, B., Menting, C., & van Woerkom, M. 2015. Why mindfulness sustains performance: The role of personal and job resources. ***Industrial and Organizational Psychology: Perspectives on Science and Practice***, 8(4): 638-642.

Kwok, W. O. 2012. ***The effects of an intervention program (medi) on reducing occupational stress in emergency department nurses***. ProQuest Information & Learning, US.

Landrigan, C. P., Parry, G. J., Bones, C. B., Hackbarth, A. D., Goldmann, D. A., & Sharek, P. J. 2010. Temporal trends in rates of patient harm resulting from medical care. ***New England Journal of Medicine***, 363(22): 2124-2134.

Langer, E. J. 1997. ***The power of mindful learning***. Addison-Wesley/Addison Wesley Longman.

Lending, D., & Chervany, N. L. 2002. CASE tool use and job design: A restrictiveness/flexibility explanation. ***The Journal of Computer Information Systems***, 43(1): 81.

Lesage, F., & Berjot, S. 2011. Validity of occupational stress assessment using a visual analogue scale. ***Occupational Medicine***, 61(6): 434-436.

Liu, Y., & Zumbo, B. D. 2007. The impact of outliers on Cronbach's coefficient alpha estimate of reliability: Visual analogue scales. ***Educational and Psychological Measurement***, 67(4): 620-634.

Lovell, B. 2015. When I say … Mindfulness. ***Medical Education***, 49(7): 653-655.

Martín-Asuero, A., & García-Banda, G. 2010. The mindfulness-based stress reduction program (MBSR) reduces stress-related psychological distress in healthcare professionals. ***The Spanish Journal of Psychology***, 13(2): 897-905.

Mathieu, J. E., & Taylor, S. R. 2007. A framework for testing meso-mediational relationships in organizational behavior. ***Journal of Organizational Behavior***, 28(2): 141-172.

Matte, L. E. 2012. ***The effects of caregiver's mindfulness on the perception of children's asthma symptoms***. ProQuest Information & Learning, US.

McAlearney, A. S., Chisolm, D. J., Schweikhart, S., Medow, M. A., & Kelleher, K. 2007. The story behind the story: Physician skepticism about relying on clinical information technologies to reduce medical errors. ***International Journal of Medical Informatics***, 76(11): 836-842.

Mitchell, M., Srinivasan, M., West, D. C., Franks, P., Keenan, C., Henderson, M., & Wilkes, M. 2005. Factors affecting resident performance: Development of a theoretical model and a focused literature review. ***Academic Medicine***, 80(4): 376-389.

Moxley, J. H., Ericsson, K. A., Charness, N., & Krampe, R. T. 2012. The role of intuition and deliberative thinking in experts' superior tactical decision-making. ***Cognition***, 124(1): 72-78.

Muoni, T. 2012. Decision-making, intuition, and the midwife: Understanding heuristics. ***British Journal of Midwifery***, 20(1).

Musen, M. A., Middleton, B., & Greenes, R. A. 2014. Clinical decision-support systems. In E. H. Shortliffe, & J. J. Cimino (Eds.), ***Biomedical informatics***: 643-674. London: Springer.

Norman, G. R., & Eva, K. W. 2010. Diagnostic error and clinical reasoning. ***Medical Education***, 44(1): 94-100.

Nuckols, T. K., Smith-Spangler, C., Morton, S. C., Asch, S. M., Patel, V. M., Anderson, L. J., Deichsel, E. L., & Shekelle, P. G. 2014. The effectiveness of computerized order entry at reducing preventable adverse drug events and medication errors in hospital settings: A systematic review and meta-analysis. ***Systematic Reviews***, 3: 56-56.

Overeem, K., Wollersheim, H. C., Arah, O. A., Cruijsberg, J. K., Grol, R. P., & Lombarts, K. M. 2012. Evaluation of physicians' professional performance: An iterative development and validation study of multisource feedback instruments. ***BMC Health Services Research***, 12(1): 1.

Padgett, D. K. 2008. ***Qualitative methods in social work research*** (Vol. 36). Sage.

Pearson, S. D., Goldman, L., Orav, E. J., Guadagnoli, E., Garcia, T. B., Johnson, P. A., & Lee, T. H. 1995. Triage decisions for emergency department patients with chest pain. ***Journal of General Internal Medicine***, 10(10): 557-564.

Pelaccia, T., Tardif, J., Triby, E., & Charlin, B. 2011. An analysis of clinical reasoning through a recent and comprehensive approach: The dual-process theory. ***Medical Education Online***, 16.

Pluye, P., & Grad, R. 2004. How information retrieval technology may impact on physician practice: An organizational case study in family medicine. ***Journal of Evaluation in Clinical Practice***, 10(3): 413-430.

Prgomet, M., Georgiou, A., & Westbrook, J. I. 2009. The impact of mobile handheld technology on hospital physicians' work practices and patient care: A systematic review. ***Journal of the American Medical Informatics Association***, 16(6): 792-801.

Roberts, K. H. 1990. Some characteristics of one type of high reliability organization. ***Organization Science***, 1(2): 160-176.

Roberts, K. H., Bea, R., & Bartles, D. L. 2001. Must accidents happen? Lessons from high-reliability organizations. ***The Academy of Management Executive***, 15(3): 70-78.

Rogers, R. L. G., Narvaez, Y., Venkatesh, A. K., Fleischman, W., Hall, M. K., Taylor, R. A., Hersey, D., Sette, L., & Melnick, E. R. 2015. Improving emergency physician performance using audit and feedback: A systematic review. ***The American Journal of Emergency Medicine***, 33(10): 1505-1514.

Salas, E., Rosen, M. A., & DiazGranados, D. 2009. Expertise-based intuition and decision making in organizations. ***Journal of Management***, 36(4): 941-973.

Semple, R. J., Lee, J., Rosa, D., & Miller, L. F. 2010. A randomized trial of mindfulness-based cognitive therapy for children: Promoting mindful attention to enhance social-emotional resiliency in children. ***Journal of Child and Family Studies***, 19(2): 218-229.

Sharma, L., Chandrasekaran, A., & Boyer, K. 2014. ***The impact of hospital information technology bundles on performance: An econometric study*** Paper presented at the Academy of Management Proceedings. 13895.

Shepherd, N. G., & Rudd, J. M. 2014. The influence of context on the strategic decision-making process: A review of the literature. ***International Journal of Management Reviews***, 16(3): 340-364.

Shortliffe, E. H., Buchanan, B. G., & Feigenbaum, E. A. 1979. Knowledge engineering for medical decision making: A review of computer-based clinical decision aids. ***Proceedings of the IEEE***, 67(9): 1207-1224.

Sibinga, E. M., & Wu, A. W. 2010. Clinician mindfulness and patient safety. ***Journal of the American Medical Association (JAMA)***, 304(22): 2532-2533.

Simon, H. A. 1979. Rational decision making in business organizations. ***The american economic review***, 69(4): 493-513.

Sisson, J. C., Schoomaker, E. B., & Ross, J. C. 1976. Clinical decision analysis: The hazard of using additional data. ***JAMA***, 236(11): 1259-1263.

Soper, D. 2016. ***Calculator: Post-hoc statistical power calculator for a student t-test***. Retrieved from http://www.danielsoper.com/statcalc/calculator.aspx?id=49.

Sparrow, P. R., & Davies, D. 1988. Effects of age, tenure, training, and job complexity on technical performance. ***Psychology and Aging***, 3(3): 307.

Spender, J.-C. 1989. ***Industry recipes***. Basil Blackwell Oxford.

Spiegelhalter, D. J., & Knill-Jones, R. P. 1984. Statistical and knowledge-based approaches to clinical decision-support systems, with an application in gastroenterology. ***Journal of the Royal Statistical Society. Series A (General)***, 147(1): 35-77.

Sundaram, S., Schwarz, A., Jones, E., & Chin, W. W. 2007. Technology use on the front line: How information technology enhances individual performance. ***Journal of the Academy of Marketing Science***, 35(1): 101-112.

Tarafdar, M., Pullins, E. B., & Ragu-Nathan, T. 2015. Technostress: Negative effect on performance and possible mitigations. ***Information Systems Journal***, 25(2): 103-132.

Torchiana, D. F., Colton, D. G., Rao, S. K., Lenz, S. K., Meyer, G. S., & Ferris, T. G. 2013. Massachusetts General Physicians Organization's quality incentive program produces encouraging results. ***Health Affairs***, 32(10): 1748-1756.

Torr, J. D. 2000. ***Euthanasia: Opposing viewpoints***. Greenhaven Press.

Tsang, S. 2013. Quantifying judicious use of health information technology. ***Journal of Evaluation in Clinical Practice***, 19(2): 393-399.

Tubbs, E. P., Elrod, J. A. B., & Flum, D. R. 2006. Risk taking and tolerance of uncertainty: Implications for surgeons. ***Journal of Surgical Research***, 131(1): 1-6.

Tversky, A., & Kahneman, D. 1990. Judgment under uncertainty: Heuristics and biases. In P. K. Moser (Ed.), ***Rationality in action: Contemporary approaches***: 171-188. Cambridge University Press.

Vago, D. R., & Silbersweig, D. A. 2012. Self-awareness, self-regulation, and self-transcendence (S-ART): A framework for understanding the neurobiological mechanisms of mindfulness. ***Frontiers in Human Neuroscience***, 6(296).

Van der Vaart, T., Vastag, G., & Wijngaard, J. 2011. Facets of operational performance in an emergency room (ER). ***International Journal of Production Economics***, 133(1): 201-211.

van der Velde, G. 2005. Clinical decision analysis: An alternate, rigorous approach to making clinical decisions and developing treatment recommendations. ***Journal-Canadian Chiropractic Association***, 49(4): 258.

von Neumann, L. J., & Morgenstern, O. 1947. ***Theory of games and economic behavior*** (Vol. 60) (2nd ed.). Princeton: Princeton University Press

Watts, M., Fountain, J., Reith, D. M., & Herbison, P. 2003. Clinical utility of an electronic poisons information and clinical decision support tool. ***International Journal of Medical Informatics***, 71(1): 3.

Weick, K. E., & Putnam, T. 2006. Organizing for mindfulness eastern wisdom and western knowledge. ***Journal of Management Inquiry***, 15(3): 275-287.

Weick, K. E., & Sutcliffe, K. M. 2006. Mindfulness and the quality of organizational attention. ***Organization Science***, 17(4): 514-524.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. 1999. Organizing for high reliability: Processes of collective mindfulness. In R. I. Sutton, B. M. Staw, R. I. Sutton, & B. M. Staw (Eds.), ***Research in organizational behavior***, (Vol. 21): 81-123. US: Elsevier Science/JAI Press.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. 2005. Organizing and the process of sensemaking. ***Organization Science***, 16(4): 409-421.

Weinstein, M. C., & Fineberg, H. V. 1980. ***Clinical decision analysis***. Philadelphia: W.B. Saunders.

Wenghofer, E. F., Williams, A. P., & Klass, D. J. 2009. Factors affecting physician performance: Implications for performance improvement and governance. ***Healthcare Policy***, 5(2): e141.

Westbrook, C., Creswell, J. D., Tabibnia, G., Julson, E., Kober, H., & Tindle, H. A. 2013. Mindful attention reduces neural and self-reported cue-induced craving in smokers. ***Social Cognitive and Affective Neuroscience***, 8(1): 73-84.

Westcott, M. 1968. Psychology of intuition: A historical, theoretical, and empirical inquiry. New York: Holt, Rinehart & Winston.

Westphal, M., Bingisser, M.-B., Feng, T., Wall, M., Blakley, E., Bingisser, R., & Kleim, B. 2015. Protective benefits of mindfulness in emergency room personnel. ***Journal of Affective Disorders***, 175: 79-85.

White, A. H. 2003. Clinical decision making among fourth-year nursing students: An interpretive study. ***Journal of Nursing Education***, 42(3): 113-120.

Williams, C., Asi, Y., Raffenaud, A., Bagwell, M., & Zeini, I. 2015. The effect of information technology on hospital performance. ***Health Care Management Science***.

Williams, T. R. 2014. ***A case study: The influence of incentives on the use of clinical information technology in physician organizations***. ProQuest Information & Learning, US.

Wolf, M., Beck, R., & Pahlke, I. 2012. Mindfully resisting the bandwagon: Reconceptualising IT innovation assimilation in highly turbulent environments. ***Journal of Information Technology***, 27(3): 213-235.

Xu, T., Xu, J., Yu, X., Ma, S., & Wang, Z. 2012. Clinical decision-making by the emergency department resident physicians for critically ill patients. ***Frontiers of Medicine***, 6(1): 89-93.

Yin, R. K. 2013. ***Case study research: Design and methods***. Thousand Oaks, CA: SAGE Publications, Inc.

Zha, X., Zhang, J., Yan, Y., & Zha, D. 2015. Sound information seeking in Web 2.0 virtual communities: The moderating effect of mindfulness. ***Behaviour & Information Technology***, 34(9): 920-935.

Zhao, X., Lynch, J. G., & Chen, Q. 2010. Reconsidering Baron and Kenny: Myths and truths about mediation analysis. ***Journal of Consumer Research***, 37(2): 197-206.