TEAM DYNAMICS AND LEARNING BEHAVIOR IN HOSPITALS: A STUDY OF ERROR REPORTING BY NURSES

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ABSTRACT

Lindsay Thompson Munn: Team Dynamics and Learning Behavior in Hospitals:
A Study of Error Reporting by Nurses
(Under the direction of Cheryl B. Jones)

Error reporting is the primary way that hospitals identify errors and near misses, and it is essential for organizational learning and improvement to occur. However, it is widely recognized that errors in hospitals are significantly underreported. As a result, there are numerous lost opportunities for health care organizations to learn from errors and improve the care delivered to patients.

The purpose of this study was to use the model of work-team learning as the theoretical foundation to examine the error reporting behaviors of nurses. The study examined the team factors of safety climate, leader inclusiveness, and psychological safety and their effect on nurses' error reporting.

A cross-sectional, descriptive design was used for the study. Data were collected from nurses and nurse managers through self-administered surveys. The research questions of the study were answered with data from up to 814 nurses and 43 nurse managers using methods for modeling correlated outcomes. Bootstrap confidence intervals with bias correction were used to determine the mediating effect of psychological safety.

The results of the study demonstrated that the team factors of safety climate, leader inclusiveness, and psychological safety positively predicted nurses' perceptions of the frequency of error reporting on their unit. Furthermore, the results indicated that these same

team factors of safety climate, leader inclusiveness, and psychological safety negatively predicted the number of error reports that nurses reported submitting over a 12-month period. The study findings also showed that psychological safety mediated the relationship between the interprofessional relationships dimension of the safety climate and nurses' perceptions of error reporting frequency on their unit as well as the relationship between leader inclusiveness and nurses' perceptions of error reporting frequency on their unit.

This study's findings underscore the complexity of error reporting in hospitals and the need for more advanced research methods that allow for deeper investigation and explanation of error reporting in hospitals. This study lays the groundwork for future study by demonstrating the importance of safety climate, leader inclusiveness, and psychological safety to help explain error reporting by nurses.

To my husband, Andy, and my son, George.

I could not have completed this without your love and support.

I love you both!

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INTRODUCTION

The identification of errors that occur in the treatment of patients is central to the ability of hospitals to learn from errors and thereby improve the quality and safety of care delivered to patients (Institute of Medicine [IOM], 2000; Leape, 2002). However, research indicates that errors in hospitals are grossly underreported (Levinson 2012; Sari, Sheldon, Cracknell, & Turnbull, 2006). As a result, countless opportunities to improve quality and safety in hospitals by learning from errors are missed because errors are not reported. Past studies of error reporting have often lacked a strong theoretical foundation to inform the relationships and variables of study examined (Holden & Karsh, 2007; Russo, Buonocore, & Ferrara, 2015). This study will assess unit/team level factors that affect error reporting, specifically the variables of safety climate, leader inclusiveness, and psychological safety derived from the model of work-team learning (Edmondson, 1999). Such an approach will enhance our understanding of clinician error reporting behaviors and help to identify improvements that may foster better error reporting in hospitals.

Background

In 2000, the IOM released a landmark report, *To Err is Human,* the first in a series of reports on quality and safety of patient care. This report brought national attention to the number of patient care errors that occur in the U.S. health care system, particularly in hospitals. It acknowledged that error reporting provides factual documentation of errors and

near misses, and gives healthcare leaders the knowledge needed to improve the safety and quality of care delivered to patients. This report also called for the expansion of error-reporting activities in hospitals to enhance organizational learning[1] (IOM, 2000; Leape, 2002). The IOM recommendations have led to the universal adoption of error-reporting systems in hospitals nationwide as a mechanism to facilitate clinicians' reporting of errors as they occur, and as a way for organizations to learn from these recorded errors (Farley, Haviland, Haas, & Pham, 2010; Levinson, 2012; Mitchell, Schuster, Smith, Pronovost, & Wu, 2016).

From an organizational learning perspective, error reporting is viewed as valuable because it provides an opportunity to learn from failures and near misses (Edmondson, 2004). However, it is difficult for leaders of organizations to take actions that promote learning from errors because organizational structures often prevent error identification and social factors may inhibit transparent discussion and analysis of errors in a way that facilitates collective learning by the organization (Canon & Edmondson, 2005). Subsequently, relatively few organizations truly learn from their errors (Canon & Edmondson, 2005). Canon and Edmondson (2005) identified three essential elements that must exist for organizational learning to occur: organizations must identify errors, they must evaluate them, and they must engage in purposeful experimentation to address these errors. Formal error reporting is the foundation of organizational learning because it initiates evaluation of errors and the development of interventions or experimentations to address them.

[1] Organizational learning is an area of organizational science that proposes organizations, like individuals, learn from experiences (Argyris & Schön, 1996; de Feijter, de Grave, & Koopmans, 2012).

Errors and Error Reporting

Error-related events in patient care include both actual errors and near misses in preventive care, diagnosis, and treatment (Garrouste-Orgeas et al., 2012; IOM, 2000; Taylor et al., 2004). ***Errors*** are defined as the unintended outcome of care that may or may not result in physical harm to the patient, while ***near misses*** are defined as potential errors that could have resulted in actual harm to a patient if not intercepted by clinicians or other means (Garrouste-Orgeas et al., 2012; IOM, 2000). ***Error reporting*** is the communication of errors and near misses to managers and healthcare administrators (Leape, 2002). Throughout this dissertation, the term "errors" encompass both near misses and errors because error reporting typically captures both types of events.

Errors in healthcare are caused by both human error and system factors (Garrouste-Orgeas et al., 2012; IOM, 2000). James Reason (2008), a noted patient safety researcher and theorist, said the following:

> Fallibility is part of the human condition. Errors cannot be eradicated but they can be anticipated and managed accordingly. We can't fundamentally change the human condition, but we can change the conditions under which people work in order to make errors less likely and more easily recoverable. (p. 34)

As Reason (2008) asserted, human error is a relatively unchangeable characteristic of individuals that renders admonitions for increased vigilance or individual efforts by healthcare providers ineffective in reducing error (Garrouste-Orgeas et al., 2012). Instead, system factors, elements of the work environment, and the processes in organizational systems must be changed in a way that shifts the culture from one of blaming and punishing individuals to one that examines and encourages organizational learning through introspection and analysis, and, in turn, supports individuals to do the right thing by reporting errors (IOM, 2000; Reason, 1998, 2000).

Error-Reporting Systems

Error-reporting systems are put in place by organizations as a mechanism to formally collect error reports. An estimated 90% of hospitals have such systems in place (Mitchell, Schuster, Smith, Pronovost, & Wu, 2016). The majority of error-reporting systems are voluntary, but some are mandatory (Robinson & Hughes, 2008). Almost all error-reporting systems are confidential, meaning that no legal action can be taken for the reports filed. Some systems go a step further and are anonymous, keeping the identity secret of the individual reporting the error (Agency for Healthcare Research and Quality [AHRQ], 2014). Medication errors and patient falls generally account for the largest number of error reports submitted to error reporting systems (AHRQ, 2014). Ideally, the purpose of error reporting systems is to promote organizational learning and improve the safety and quality of care. In reality, however, error-reporting systems are often used for risk management purposes because errors that cause harm to patients also pose the threat of substantial litigation costs to hospitals (Helmreich, 2000).

Error-reporting systems in hospitals necessarily rely on clinicians (e.g., nurses, physicians, pharmacists, etc.) to report errors. Because individual clinicians are directly involved with errors by identifying them, observing them, or contributing to them, they are the ones who must ultimately report errors. However, because most error reporting systems are voluntary; individuals may choose whether to report an error and how to report it. Thus, error reporting in hospitals has both an organizational component through the formal reporting system as well as an individual component, because individuals can choose to identify and report errors through the system.

Error-reporting systems are the formal, primary way through which healthcare professionals report errors in hospitals (Garrouste-Orgeas et al., 2012; Levinson, 2012). Unfortunately, error-reporting systems are not always used in the way or to the degree intended. Research demonstrates that healthcare professionals sometimes engage in "informal" reporting practices that include verbally discussing an error-related event with a manager or team colleague instead of making a formal report, which allows clinicians the opportunity to acknowledge that something happened while protecting themselves from being exposed for reporting or committing an error (Espin, Lingard, Baker, & Regehr, 2006; Espin et al., 2007; Hewitt & Chreim, 2015; Lederman, Dreyfus, Matchan, Knott, & Milton, 2013). Sometimes clinicians may forgo formal error reporting altogether if they are unsure of what constitutes an error (Levinson, 2012; Sari et al., 2006). The reasons that individuals engage in formal or informal reporting practices or choose not to report an error at all are sometimes complex.

Past Studies of Error Reporting

We know that knowledge deficits related to what should be reported and the time-consuming nature of error reporting are common reasons cited by clinicians for not reporting errors (Hartnell, MacKinnon, Sketris, & Fleming, 2012; Jeffe et al., 2004; Kaldjian et al., 2008; Mayo & Duncan, 2004). Past studies have also documented surprising findings related to error reporting. In a study examining how healthcare professionals (e.g., nurses, physicians, and pharmacists) made a choice between fixing a safety problem and moving on with their work versus fixing the problem and then reporting it, researchers found that healthcare professionals refrained from reporting near misses because the error was not realized. They also found that health professionals refrained from reporting safety problems

they could either fix themselves or were so common that the problem was accepted as part of the everyday work routine (Hewitt & Chreim, 2015). These findings are similar to Tucker and Edmondson's (2003) study of nurses in nursing units where they inferred that a lack of organizational learning from failures may be explained, in part, by empowerment of nurses to fix problems themselves.

In a mixed-methods case study examining the effects of an electronic error-reporting system in two large Australian hospitals, researchers identified several barriers that inhibited error reporting. These obstacles included the need for further training and familiarity with the system, fear of blame from others for reporting errors, and the use of informal error reporting (Lederman et al., 2013). The researchers also found that clinicians sometimes engaged in error reporting system for more unexpected reasons, such as using it as a defensive tool to justify their clinical decisions or to protect themselves from the possibility of perceived future threats (e.g., threats of blame from the manager for clinical decisions). These findings are consistent with other qualitative studies reporting that clinicians used error-reporting systems as legal protection or to protect themselves from managers or physicians who they feared (Hartnell et al., 2012). Studies have also documented that clinicians sometimes used the reporting system as a way to complain to upper management about problems in the work place that were not being addressed (Lederman et al., 2013). Thus, clinicians do or do not report error-related events for reasons that seem counter-intuitive but reflect the complicated nature of error reporting.

Similarly, the reasons that individuals forego formal error reporting in favor of informal reporting practices or not reporting errors at all are just as convoluted. Informal error reporting practices include verbally notifying a manager or team colleague about an

error, documenting the error in a clinical note in the patient's chart, or discussing the error with the multidisciplinary healthcare team during patient rounds (Espin et al., 2006, 2007; Lederman et al., 2013). Studies indicate that these informal reporting practices fulfill clinicians' felt obligations to report errors and thus explain why they may refrain from submitting an error report to the hospital error reporting system (Lederman et al., 2013). The reasons that clinicians choose to engage in informal rather than formal methods differ. In some cases, seemingly positive factors lead clinicians to forgo formal error reporting. For example, one study (Espin et al., 2007) found that a clinician's choice to discuss an error with a team colleague rather than formally reporting the error was significantly influenced by strong interpersonal dynamics within the team. In this case, positive team dynamics were associated with informal reporting methods. However, the same researchers found in another study that nurses were hesitant to report errors they observed by individuals with a higher scope of practice or those with whom they perceived a greater power differential, such as physicians (Espin et al., 2006, 2010). Instead, nurses felt more comfortable informally reporting errors involving physicians by verbally discussing the events with a peer or nurse manager or documenting the events in a clinical note rather than submitting an error report.

Existing research demonstrates that error reporting is a multifaceted phenomenon in hospitals, where there are multiple diverse and complicated reasons that explain why error-reporting processes breakdown. While much of the past research on error reporting has sought to identify facilitators and/or barriers to error reporting, these studies have not fully explained how more complex factors within an organization may affect error reporting by clinicians. Theory and research from organizational and team literature may help to better explain the more complex reasons that clinicians do or not report errors in a way that past

research on error reporting has failed to do. Based on past error reporting research, the variables of safety climate, leader inclusiveness, and psychological safety are especially relevant to understanding error reporting in hospitals, particularly in patient care units.

Safety climate. Past studies of error reporting indicate that the environment of the patient care unit where clinicians work is an important influence on error reporting (Edmondson, 1996); in particular, work environments where safety is prioritized encourage more error reporting (Kagan & Barnoy, 2013). Past studies demonstrate that the safety climate, which is defined as the shared perceptions and experience of employees about the practices, policies, and procedures related to the safety of patients (Katz-Navon, Naveh, & Stern, 2005; Vogus, Sutcliffe, & Weick, 2010), is a characteristic of patient care units that have a higher incidence of error reporting. A few past studies have examined the safety climate and similar concepts in relationship to error reporting. These studies lend support for safety climate as an important factor to consider relative to error reporting (Naveh, Katz-Navon, & Stern, 2006).

Leader inclusiveness. Past studies of error reporting have also demonstrated that leadership behavior is another important influence on error reporting. In a study that examined how the behaviors of healthcare leaders (e.g., nurse managers, physicians, etc.) influenced error reporting and error management among their subordinates in hospital teams, findings demonstrated that leadership behavior related to safety was a more important influence on staff error reporting than the words they spoke (Van Dyck, Dimitrova, de Korne, & Hiddema, 2013). *Leader inclusiveness* is when leaders are available, open, and accessible to employees by inviting input and demonstrating an appreciation for their contributions (Hirak, Peng, Carmeli, & Schaubroeck, 2012; Nembhard & Edmondson, 2006).

Past organizational and team research underscores that leader inclusiveness is important to the functioning of patient care teams. In particular, a past study demonstrated that leader inclusiveness led to greater team engagement in quality improvement intitiatives on nursing units (Nembhard & Edmondson, 2006). Similarly, some of the key behaviors embodied in leader inclusiveness (i.e., availability and accessibility of nurse managers) have been demonstrated to positively affect the willingness of clinicians to report errors (Edmondson, 1996). More research is needed to determine the effect of leader inclusiveness on error reporting, but findings from past team studies support the use of this variable to study error reporting.

Psychological safety. Past studies of error reporting also show that fear of reporting errors and speaking up about unsafe practices greatly inhibits error reporting. In a study employing focus groups of clinicians to determine the facilitators and barriers to error reporting, researchers found that fear of retribution was one of the factors inhibiting error reporting (Hartnell et al., 2012). Similarly, another study examining the use of an electronic error-reporting system in two hospitals in Australia found that fear of negative repercussions over reporting was a significant barrier to error reporting (Lederman et al., 2013).

A concept similar to fear that has been explored more widely in the team and organizational literature is that of psychological safety, the degree to which individuals feel safe to speak up about problems or unsafe conditions in their work team (Edmondson, 1999). Recently, researchers studying error reporting in VA hospitals found that psychological safety was related to perceptions surrounding error reporting (Derickson, Fishman, Osatuke, Teclaw, & Ramsel, 2015). While the study examined both psychological safety and error

reporting at the organizational level, the findings support the relationship between psychological safety and error reporting as well as demonstrate the need for more study.

In summary, past research on error reporting supports numerous reasons that clinicians do and do not report errors. Research on error reporting has not yet sufficiently explained the complexities of error reporting in hospitals. Knowledge of this information is critical for addressing errors and improving the quality and safety of care in hospitals. Research from organizational and team science may help better explain the organizational and relational factors that affect error reporting. Based on past research from these fields and research on error reporting, the variables of safety climate, leader inclusiveness, and psychological safety seem to be particularly important factors to consider in relationship to error reporting.

Nurses and Error Reporting

The clinician group that most consistently uses error-reporting systems in hospitals is nurses (Farley et al., 2010; Levinson, 2012; Robinson & Hughes, 2008). Past research also suggests that nurses are in an important position to identify errors and intervene to keep patients safe from harm. For example, a study that examined errors in the Intensive Care Unit (ICU) of a hospital found that nurses intercepted as many as 62% of the errors observed by researchers, thereby preventing harm to patients (Rothschild et al., 2006). Due to their important role in the healthcare team and their integral involvement in patient care, nurses have knowledge of errors and error reporting that is different from other clinicians and is therefore essential to examine when studying error reporting. Thus, this study of error reporting focuses on nurses.

The Nursing Unit

The structure of patient care delivery and work in hospitals is hierarchical in nature. Both patients and nurses are admitted or report to work on nursing units in hospitals. Nursing units are grouped into departments, which are then organized in clusters within the hospital. In recent years, hospitals are often part of a larger hospital system or affiliation of hospitals. Importantly, the fundamental work group of the hospital is the nursing unit (Leppa, 1996). That is, the care delivered to patients is predominantly delivered within the context of nursing units; moreover, the professional and institutional identity of nurses is tied to the unit where they work (Leppa, 1996).

Nursing units are also unique, with distinctions that can vary from unit to unit. For example, past studies demonstrate that error-reporting rates can vary significantly between units in a hospital (Edmondson, 1996). In a study of learning from errors conducted in different nursing units across several hospitals, Edmondson (1996) found that error detection rates, which were measured in part by the number of errors reported, varied between units of a hospital. In explaining the variation, Edmondson (1996) observed that the climate of the unit and the leadership behaviors of the nursing unit manager were important influences on error detection. Thus, the study findings suggested that not only can error reporting vary by nursing unit, but the factors that affect error reporting may also vary by unit. This study examines error reporting at the nursing unit level and conceptualizes the nursing unit as a team.

Purpose

Building on past research and addressing the need for future research, this study sought to determine how team dynamics influence error reporting. Specifically, the study

examined the team dynamics of safety climate, leader inclusiveness, and psychological safety and their effects on error reporting by nurses. The model of work-team learning provided the theoretical foundation by informing the development of the conceptual model used in this study and the relationships and variables examined.

Theoretical Foundation and Conceptual Model

The theoretical foundation used in this study was the model of work-team learning from which the study's conceptual model was derived. The model of work-team learning was developed and tested by Amy Edmondson (1999) to study learning behavior in work teams and provides an explanation for how team structures (conceptualized as organizational context and team leader coaching) and interpersonal dynamics (described as the construct of team beliefs and conceptualized as team safety) affect the specific team behavior of learning. The conceptual model operationalizes the concepts of organizational context, team leadership behavior, team safety, and team learning behavior in this study as safety climate, leader inclusiveness, and psychological safety, and examines how these factors affect the team learning behavior of error reporting.

The model of work-team learning provided an appropriate theoretical basis for studying error reporting for at least two reasons. First, error reporting is a necessary condition for organizational learning and can thus be considered an indicator of learning behavior. Second, the model of work-team learning is a team level theory and is thus designed to explain learning behavior in teams. Nursing units can be conceptualized as teams, and past researchers have studied them as such (Edmondson, 1996; 2003). Thus, to the extent that error reporting is necessary for organizational learning and the factors that

affect error reporting are team level factors, this theoretical model is ideal for studying the phenomenon of error reporting.

Significance

In order for organizational learning to take place in response to errors, awareness that errors have occurred is essential. Organizational awareness of errors can only happen if nurses, physicians, or other clinicians report that an error or near miss happened. This study sought to identify and explain factors that influence error reporting by nurses. By identifying factors that encourage nurses to report errors and uncovering the underlying reasons for error reporting, nurses and healthcare leaders can begin to work in tangible ways to improve the reporting of errors. By applying the model of work-team learning to error reporting in hospitals, this study also further contributes to theory development and adds to the cumulative understanding of how this theoretical model might be adapted to studying the phenomenon of error reporting in nursing units of hospitals.

Chapter Summary and Outline of This Dissertation

This chapter described the need for the present study, developed a better understanding of the multiple factors that influence error reporting, and outlined the general nature and direction of the research. The study's findings will point to important suggestions for organizational leaders and policy makers as well as significant implications for future research and theory.

Chapter 2 presents a literature review of the independent variables of the study and justification for conceptualizing the nursing unit as a team. Chapter 2 also discusses the study's conceptual framework, including a review of literature on the major aspects of the framework and a presentation of the research questions of the study. Chapter 3 presents the

methodology for the study including the research design, study setting and sample, operationalized variables and instruments, and data analysis. Chapter 4 presents the study findings. Chapter 5 explores study findings within the context of practice, research, and policy-making, as well as theoretical implications and future research.

CHAPTER 2

REVIEW OF THE LITERATURE AND THEORETICAL FOUNDATION

This chapter presents a summary of the literature on factors affecting error reporting in hospitals, and presents the theoretical foundation and conceptual model of the study. The chapter begins with a discussion of the conceptualization of the nursing unit as a team followed by a review of the literature on the key variables of the study: safety climate, leader inclusiveness, and psychological safety. Next, there is a discussion of the theoretical foundation of the study and the model of work-team learning (Edmondson, 1999). This is followed by an explanation of how the conceptual model of the study was derived from the theory with support from the literature for the operationalization of the key variables of the study. Chapter 2 concludes with a discussion of the study covariates and rationale for their inclusion in this study.

Literature Review

The existing body of research on error reporting indicates that error reporting in hospitals is exceedingly complex. Much of the past research in this area has worked to identify barriers and facilitators to error reporting and has not fully explained the complicated nature of error reporting. Research from organizational and team sciences as well as team theory may better explain error reporting in hospitals by identifying team characteristics that influence error reporting. Past research from these areas as well as past studies of error reporting indicate that the factors of safety climate, leader inclusiveness, and psychological

safety may be particularly important to error reporting. Past research demonstrates variability in error reporting between units and because the factors that may affect error reporting can differ between units of study, the team perspective is particularly important to error reporting.

The section that follows examines the relevant literature to explain how patient care units in hospitals relate to the context of teams. Next, key variables identified from the literature on patient safety and errors at the unit level—safety climate, leader inclusiveness, and psychological safety—are examined in relationship to error reporting. After a review of the literature, gaps in past research are identified, followed by a discussion of how this study seeks to fill these gaps through an examination of error reporting.

The Nursing Unit as a Team

Traditionally, scholars have defined teams as groups having a distinct and stable membership, where team members have clearly-defined roles, work in close coordination to carry out their work, and share resources to achieve common goals (Chen, Kirkman, Kanfer, Allen, & Rosen, 2007; Wageman, Gardner, & Mortensen, 2012). More recently, scholars have pushed for new conceptualizations of team that move beyond this strict definition of "a bounded, stable set of individuals interdependent for a common goal" (Wageman et al., 2012, p. 311). Broader definitions of teams have been proposed, recognizing that teams of individuals working toward a common goal might not be as bounded or stable as traditional definitions imply. Furthermore, researchers recognize that the changing landscape of organizations and the way work is conducted allows for a broader definition of team (Wageman et al., 2012).

Nursing units fit this broader conceptualization of team. First, nursing units are bounded entities. As such, they have separate and distinct operating budgets, supplies, and for the most part, permanent staff members. There is generally a single nurse manager who leads the nursing unit, manages the budget and personnel, and oversees the day-to-day operations of the unit. Second, current conceptualizations of teams acknowledge that conventional definitions of stability may not necessarily apply to all teams (Wageman et al., 2012). This is true of the nursing unit. Nurses may enter and depart from nursing units at various times because of hiring and turnover or to "float" to other units during periods of organizational need.

Overall, however, nursing unit leaders desire a relatively stable work group. In order to achieve adequate staffing to care for patients 24 hours a day, seven days a week, nurses typically work in shifts. This means that the same nurses do not work the same shift all the time, all possible shifts, or even every day of the week. So while the traditional definitions of stability in teams may not perfectly fit nursing units in hospitals, these entities function as a collective and, generally, as stable groups.

Finally, members of nursing units typically share the common goal of providing safe, high quality care to their patients, and they must work in careful coordination to achieve this goal of patient care. Based on these criteria set forth in the literature on teams, this study conceptualizes the nursing unit as a team, which is also supported by past research studies (e.g., Edmondson, 2003; Van Bogaert et al., 2014). The emphasis on nursing units as teams is important to this study because much of the supporting literature used to inform this study is from the organizational sciences and the smaller subset of team literature.

Safety Climate

The environment of patient care units is important to error reporting, especially as it relates to the safety of patients. Researchers however are divided in how to study the safety environment, which has been described as having both a safety culture and a safety climate. There is a great deal of overlap and even confusion in the literature regarding the use of the terms "safety culture" and "safety climate" (Zaheer, Ginsburg, Chuang, & Grace, 2015). The two terms are often used interchangeably, which has led to confusion on the part of researchers and those in practice (Mearns & Flin, 1999). This confusion in terminology can be traced back to longstanding debates in organizational research over the related but broader concepts of organizational culture and organizational climate (Denison, 1995; Mearns & Flin, 1999; Schneider, Ehrhart, & Macey, 2013). The fundamental difference between culture and climate in the literature is that there are two differing, theoretical schools of thought—organizational sociology and organizational psychology—that lead researchers to study culture versus climate (Denison, 1995). Organizational culture typically focuses on the organizational system, while organizational climate typically focuses on the impact of the organization on individuals within the organization.

The literature on organizational culture is rooted in organizational sociology, which holds a social constructivist view of organizations where employees both work in and create the social systems of organizations (Denison, 1995). Organizational culture is defined as the values and beliefs of an organization that are embedded in the structure of the organization and observed in the norms, rituals, and behaviors of employees (O'Reilly, Chatman, & Caldwell, 1991). In past studies of culture, researchers have often used qualitative methodologies (e.g., ethnography) to study organizational culture because it is difficult to

separate out the employee and their perceptions from the organizational context (Denison, 1995; Glick, 1985).

In contrast, organizational climate is rooted in the field of organizational psychology (Denison, 1995). Organizational climate is defined as the shared beliefs and perceptions of employees about the practices, policies, and procedures of an organization, and focuses more on the influence of the organizational system on individuals (Denison, 1995; Schneider et al., 2013). Thus, the strength of the climate perspective is in studying the influence of organizational context on individuals (Denison, 1995) versus culture, which tends to focus on the values and beliefs within organizations. An additional strength of the climate perspective is that climate is thought to be more amenable to change than culture because it is a more surface level concept (Vogus et al., 2010). This perspective puts forth the idea that managers and organizational leaders are the creators of the organizational climate, and employees are subordinates in power who do not exert influence or control over the organizational climate (Denison, 1995). As a result, organizational climate research typically focuses on employees' perceptions of the organizational climate (Denison, 1995).

While the present study examines safety climate in relation to error reporting, past research on both safety culture and safety climate and their relationship to error reporting is relevant to this study. The majority of research on error reporting has examined safety culture rather than safety climate. In the discussion that follows, the literature on safety culture in relationship to error reporting is reviewed first, followed by a review of the literature on safety climate and error reporting.

Safety culture is a dimension or sub-component of organizational culture that is specifically related to patient safety (Cooper, 2000). There is evidence from the literature

that safety culture is positively associated with error reporting. A study by researchers in Israeli hospitals examined the association between its patient safety culture and the incidence of error reporting. It found that patient safety culture was postively associated with increased levels of error reporting (Kagan & Barnoy, 2013). Similarly, a large study that used data from hospitals across the U.S. to determine how safety culture affected error reporting found that dimensions of the safety culture (e.g., management support, teamwork across units, etc.) were positively associated with clinicians' perceptions about the frequency of error reporting on their patient care unit (Richter, McAlearney, & Pennell, 2014).

A study of pharmacists in the United Kingdom revealed that pharmacists were more willing to report errors when they believed that the hospitals valued and welcomed error reports as a way to learn and improve. Conversely, a negative safety culture was seen as a barrier to error reporting when the pharmacists believed that individuals were blamed for errors (Williams, Phipps, & Ashcroft, 2013). Similarly, a study that examined the perspectives of clinicians (i.e., nurses and physicians) regarding error reporting found that a significant barrier to reporting was a culture of blame for errors (Jeffe et al., 2004). Thus, past studies of safety culture suggest that cultures that hold systems rather than individuals accountable for errors increase error reporting markedly.

Like safety culture, safety climate is a sub-dimension of organizational climate that is specifically related to patient safety. Safety climate has not been studied extensively in relationship to error reporting, and certainly not to the same degree as safety culture. Safety climate is defined as the shared perceptions and experience of employees about the practices, policies, and procedures related to the safety of patients (Katz-Navon et al., 2005; Vogus et al., 2010).

Evidence from the literature suggests that work teams that perceive better safety climates exhibit better error reporting behaviors (Naveh et al., 2006) and commit fewer errors (Hoffman & Mark, 2006; Naveh, Katz-Nevon, & Stern, 2005). In a study of error reporting by clinicians in 44 units within three hospitals in Israel, the investigators found that certain aspects of the safety climate on the unit significantly predicted the clinicians' readiness to report medical treatment errors (Naveh et al., 2006). Specificially, the safety climate dimensions of safety procedures and safety information flow were positively linked with the total number of error reports submitted over the course of a year to the risk management system. Based on this past evidence, coupled with the knowledge that climate is ideal for studying the influence of the organizational context on individuals, the present study examines the effect of safety climate on error reporting.

Leader Inclusiveness

Research indicates that leadership behavior is important to error reporting. One study showed leadership behaviors of healthcare leaders (e.g., nurse managers, physicians, etc.) related to safety, not the verbal directives about safety, to be a far more important influence on error reporting by the staff they managed (Van Dyck et al., 2013). These findings are further supported by additional studies that have established the importance of team leadership behavior to error reporting (Ko & Yu, 2015; Pfeiffer, Briner, Wehner, & Manser, 2013). For example, Ko and Yu (2015) examined the relationships among nurses' perceptions of the patient safety culture, nurse leader coaching behaviors, and nurses' intent to report errors in five Korean hospitals. The findings of the study indicated that nurse leader coaching behaviors were positively related to nurses' intent to report errors. In a 2013 study, Pfeiffer and colleagues examined individual, organizational, and system-level influences on

clinicians' willingness to report errors. They found that managers' support for error reporting positively influenced clinicians' willingness to report errors. Thus, findings from past studies demonstrate that leadership behavior is significantly related to error reporting, but these studies have examined different leadership behaviors (i.e., leadership behaviors related to safety, nurse leader coaching, and management support for error reporting).

An operationalization of leadership behavior found in more recent organizational and team literature is that of leader inclusiveness. Leader inclusiveness is when leaders demonstrate availability, openness, and accessibility to team members by inviting input and offering appreciation for their employees' contributions (Hirak et al., 2012; Nembhard & Edmondson, 2006). Nembhard and Edmondson (2006) first introduced leader inclusiveness in a study that examined its effects with professional status on psychological safety, and the improvement efforts in health care teams working in neonatal intensive care units. The researchers of the study found that leader inclusiveness positively predicted team engagement with quality improvement work. Another study examined how leader inclusiveness promoted employee creativity in Research and Development teams of high-technology organizations and found that leader inclusiveness positively affected psychological safety among employees, which in turn increased employee creativity in the workplace (Carmeli, Reiter-Palmon, & Ziv, 2010). Hirak et al. (2012) examined the effects of leader inclusiveness and psychological safety on team learning and team performance among employees working in units of a large hospital in Israel. They found that leader inclusiveness was positively associated with team psychological safety, which in turn positively affected team learning from failure and ultimately resulted in better team performance. These studies thus demonstrate that leader inclusive behaviors in teams

promote improved team functioning by engaging members in quality improvement initiatives, workplace creativity, and team learning and performance.

Past study findings suggest that leader inclusiveness may be an important factor in promoting team learning behaviors related to error reporting. The study of leader inclusiveness is relatively new (Carmeli et al., 2010; Mitchell et al., 2016), so there is only a limited number of studies that have examined leader inclusiveness. Moreover, no previous studies have examined the relationship between leader inclusiveness and error reporting. Despite the lack of study in this area, research that ties leader behaviors to error reporting suggests that leader inclusiveness should also positively influence error-reporting behavior.

Psychological Safety

Psychological safety has been defined as

> individuals' perceptions about the consequences of interpersonal risks in their work environment. It consists of taken-for-granted beliefs about how others will respond when one puts oneself on the line, such as by asking a question, seeking feedback, reporting a mistake, or proposing a new idea. (Edmondson, 2004, p. 241)

The ideas represented by the concept of psychological safety are seen in much of the literature on error reporting. Specifically, much of the past research on error reporting indicates that fear is a significant barrier to error reporting, which could be interpreted as poor psychological safety.

Research on error reporting that has used qualitative methods indicates that fear can significantly inhibit error reporting by nurses and other clinicians (Lederman et al., 2013). Psychological safety conveys the extent to which team members feel safe to identify and speak up about problems they encounter in their work (Edmondson, 1999, 2004). Thus, it seems that fear related to error reporting is indicative of poor psychological safety on the part of clinicians, inhibiting them from reporting errors. For example, in a study of nurses and

physicians who were asked to evaluate a scenario that clearly portrayed the hospital as the source of error, not the individual, a theme emerged from the nurse focus groups of fear to speak up and report the error (Jeffe et al., 2004). Other studies have documented that nurses were particularly hesitant to report errors they observed physicians commit because they perceived physicians to be more powerful (Espin et al., 2006, 2010). As a result, nurses felt more comfortable informally reporting errors committed by physicians by verbally discussing the events with a peer or nurse manager, or by documenting the events in the clinical note of a patient's chart rather than formally submitting an error report through the voluntary error reporting system. In another study that examined error reporting by nurses working in pediatric units of hospitals (Stratton, Blegen, Pepper, & Vaughn, 2004), nurses indicated that fear related to reporting (e.g., fear of losing their nursing license, fear that colleagues would think they were incompetent) were primary reasons for not reporting errors.

In the healthcare literature, there is growing support for the role of psychological safety as an important positive influence on error reporting and the ability to speak up about safety concerns in healthcare (Leroy et al., 2012). A recent study conducted in the Veterans Health Administration (VHA) demonstrated a positive relationship between psychological safety and error reporting. Specifically, individuals working in hospitals with higher and more positive psychological safety scores indicated a greater willingness to report errors (Derickson et al., 2015).

Another study of healthcare professionals working in cancer hospitals in Sweden examined a broader but similar concept to error reporting, speaking up behavior, and found that healthcare professionals who did not feel psychologically safe were unlikely to speak up

about unsafe conditions they encountered (Schwappach & Gehring, 2015). Similarly, a study conducted on nursing units of a hospital examined the relationships among nurse managers' behavioral integrity for safety, team priority for safety, and team psychological safety, and the number of treatment errors reported by nurses (Leroy et al., 2012). The study findings indicated that more positive team psychological safety resulted in greater reporting of treatment errors by nurses.

Past research indicates that there is a significant relationship between psychological safety and error reporting (Derickson et al., 2015; Leroy et al., 2012). Therefore, this study used existing research indicating that psychological safety inhibits error reporting by including psychological safety in this study of error reporting.

Knowledge Gaps

A broad review of past organizational and error-reporting literature suggests that the variables of safety climate, leader inclusiveness, and psychological safety are important in the study of error reporting. Past research has also demonstrated that leadership behaviors significantly affect error reporting (Ko & Yu, 2015; Van Dyck et al., 2013), but these studies did not examine the specific behavior of leader inclusiveness, which the literature on teams suggests may affect error reporting. While the factors of safety climate (Naveh et al., 2006) and psychological safety (Derickson et al., 2015; Leroy et al., 2012) have been examined to some extent in past studies of error reporting, none of the identified studies of error reporting have assessed these factors and their relationship to error reporting within the context of related theory. Doing so would help to elucidate the relationships among variables and error reporting behaviors. This kind of evidence would be important information for those in healthcare leadership positions of hospitals as they work to improve error reporting in order

to gain better knowledge of how to improve the hospital system in order to prevent future errors from occurring. Therefore, this study of error reporting addresses significant gaps in the research by examining safety climate, psychological safety, and error reporting with the model of work-team learning.

Theoretical Foundation of the Study

The theoretical foundation for this study of error reporting is the model of work-team learning, which emphasizes team level factors that are believed to affect error reporting. This model reflects the work of Amy Edmondson (1999). In particular, there are three past studies conducted by Edmondson that are relevant to a discussion of the model of work-team learning. Each of these studies is reviewed in the following sections.

Group and Organizational Influences on Learning from Mistakes

In 1996, Edmondson explored how group and organizational factors affected learning from mistakes in hospitals. The study used both quantitative and qualitative methods to better understand whether some hospital work-teams were better than others at finding and correcting errors before serious harm occurred. The study also examined which teams were more capable of learning from the errors they identified, and thereby avoided similar mistakes in the future. In particular, the study sought to explain what accounted for the differences in performance between the teams. The quantitative component of the study examined 12 variables in five organizational categories: leadership behavior, organization context, unit characteristics, unit outcomes, and individual satisfaction. The results of the analyses showed that higher perceptions of unit performance, the quality of unit relationships, and nurse manager leadership behaviors were positively related to higher error rates (recorded through daily chart review, daily visits to the unit, and a confidential error

reporting system). Noting that she expected to find the opposite, Edmondson questioned whether her findings indicated that better nursing leadership led to higher error rates, or whether units with leaders who created a climate of openness to facilitate the discussion of errors encouraged employees to be more willing to report errors. Furthermore, the study demonstrated considerable variability in error reporting rates among the units, which led Edmondson to propose that there were at least two influences on detected error rates in hospital units: the number of actual errors that occur and the willingness of unit employees to report the actual errors made.

Qualitative data for the study were collected from clinicians (e.g., nurses, physicians, and pharmacists) and manager interviews on eight patient care units in two different hospitals, and provided further support for Edmondson's quantitative findings. These data were used to identify several factors that helped to explain the variation between units: the climate of the unit; the characteristics of the nurse manager as perceived by staff (i.e., openness, attire, and trustworthiness); perceived supportiveness among nurses of each other and of the nurse manager; and nurses' willingness to collaborate across disciplines (e.g., nurses with physicians). Thus, the qualitative findings of Edmondson's study supported the conclusions she reached about the quantitative results, suggesting that nurse managers' leadership behaviors were an important influence on clinicians' beliefs about discussing errors. Higher rates of error detection were found on units with more positive leadership characteristics.

Edmondson's study is relevant to the model of work-team learning for a number of reasons. First, this study established that two structural characteristics at the team level—the climate of the unit where clinicians worked and the leadership behavior of the nurse

manager—were important to clinicians' willingness to speak up about mistakes or problems in their unit and the ability of the team to then learn from the mistakes reported. This study emphasizes the importance of both the climate of the unit and leadership behavior as well as the effect of these two factors (climate and leadership behavior) on error-reporting rates. Second, the study highlights that the climate of the unit, the leadership behaviors of nurse managers, the error reporting rate, and team learning all varied widely between the units studied. Edmondson recommended continued study of errors and reporting from a team level in organizations. She found that team factors on these nursing units seemed to affect error identification and learning in teams. Finally, Edmondson recognized that employees must feel safe to speak up before they are willing to report mistakes and share information that might challenge the status quo, a concept that becomes more fully articulated in the model of work-team learning as psychological safety.

Learning Behavior in Work Teams

In 1999, Edmondson examined team learning in manufacturing organizations, using the model of work-team learning. This study again used quantitative and qualitative methods to explore how structural and interpersonal dynamics of the team influenced team learning and, in turn, whether team learning influenced team performance. The study also explored the concept of psychological safety in work teams, which was prompted by findings from her 1996 study. Prior to this study, psychological safety had been examined in the organizational literature of the 1960s, but research on psychological safety had mostly been abandoned until the 1990s when researchers like Edmondson began to study psychological safety within the context of organizational teams (Edmondson & Lei, 2014).

Edmondson explained the concept of psychological safety by noting that there is a natural proclivity on the part of all individuals to protect themselves from potentially embarrassing situations, something that most individuals accomplish by not challenging conventional practices, discussing problems, or reporting their own mistakes. However, this natural tendency, she noted, poses a threat to organizational learning because the very information individuals are apt to suppress (e.g., mistakes, problems, challenging conventionality) is essential for learning and enacting improvements in teams and organizations. She also noted that research has demonstrated that the tendency to withhold potentially embarrassing or uncomfortable information is counteracted, to some degree, by familiarity and comfort with the teams where individuals worked. She cited findings from her 1996 study in support of this assertion, noting that clinicians' willingness to report errors was associated with the climate of the unit and the leadership behaviors of the manager. Thus, the concept of psychological safety in teams was more purposefully explored in this study than in her previous work.

In this study of psychological safety and learning behavior in work teams, Edmondson introduced the model of work-team learning as the theoretical basis for the study. The model included the constructs of team structures (operationalized as context support and team leader coaching) and team beliefs (operationalized as team safety and team efficacy) on team behaviors (operationalized as team learning behavior) and team outcomes (operationalized as team performance). The model is more fully explained later in this chapter.

This study provided support for the important role of psychological safety to team learning behavior and the ultimate performance of the team. It also supports the use of the

model of work-team learning as a theoretical foundation for studying learning behaviors in teams. The study demonstrated that the team structures of context support and team leader coaching were important antecedents to psychological safety, and that psychological safety positively affected team learning behavior and ultimately team performance. The only portion of the model of work-team learning that was not supported by the study findings was the concept of team efficacy, which Edmondson had hypothesized was related to team learning behavior when controlling for the variable of psychological safety. She had also hypothesized that team efficacy acted as a mediator between team structures (team leader coaching and context support) and team learning behavior. Neither of these hypotheses were supported by the model, and in response Edmondson wrote, ". . . the theoretical premise that lies at the core of the team learning model does not appear to require the supplementary effects of team efficacy" (p. 376). Based on study findings, Edmondson suggested that team efficacy was not important in future studies using the model of work-team learning.

This 1999 study by Edmondson provided support for the concept of psychological safety and for the importance of this variable in studying learning behavior in teams. Furthermore, the study affirmed the utility of the model of work-team learning, with the exclusion of team efficacy as a theoretical foundation for the study of learning behavior in teams.

The Learning Process in Interdisciplinary Action Teams

In 2003, Edmondson returned to healthcare and conducted a study that examined interdisciplinary work teams in the operating room and how team structural factors (team leadership and organizational context) affected the learning processes (speaking up, practice

and reflection, boundary spanning), and the successful implementation of a new technology for cardiac surgery. This study was particularly focused on how team leader behaviors and the organizational context[2] affected the team learning process and the implementation success of the new technology. The study used multiple case comparison methods to gather both quantitative and qualitative data and was conducted with 16 teams and 150 individuals from hospitals across the U.S. in the process of implementing a new, minimally invasive cardiac surgery. This new technology was implemented in interdisciplinary action teams, and therefore provided a unique opportunity to study learning and change in a different type of team situation.

Results of the study showed that multiple factors were important to the successful implementation of the technology. Specifically, quantitative data demonstrated that team leader coaching, team preparation, the ease with which team members could speak up about problems, and the boundary spanning of team members (i.e., the ability to communicate and coordinate both within the team context and outside the team) were all related to the procedure's implementation success. The study findings emphasized the important role of team leadership behaviors in team members' willingness to speak up and ultimately to the successful implementation of the technology. In discussing the results, Edmondson noted that the study findings suggested that the team leadership behaviors of engaging team members and directing their behaviors to the goal or task were closely aligned with the leaders' invitations for team members to speak up. She noted that employing motivating

[2] In the original model of work-team learning, Edmondson (1999) uses *context support*. In this particular study of work-teams in the operating room (Edmondson, 2003), she uses the slightly different term of *organizational context*. However, both terms convey the same idea of tangible and intangible supports in place for the team. Thus, context support and organizational context are interpreted as equivalent concepts.

behaviors and promoting psychological safety by inviting input and downplaying power differentials enabled leaders to promote learning within the team. Of particular note, the study did not find a significant relationship between the organizational context and implementation success, suggesting that the importance of the organizational context to team outcomes may differ depending on the type of team and the nature of their work.

Interestingly, this study did not use the model of work-team learning as the theoretical basis, but instead used some of the model constructs, particularly the constructs of team leadership and organizational context. The findings of this study with respect to team leadership highlight the importance of the relational aspects of leadership (e.g., emotional and social factors) to the team members' willingness to speak up (e.g., psychological safety). The organizational context was therefore not important to the learning process or to the teams' successful implementation of the technology in this study. These findings demonstrate that teams vary in their goals and contexts in such a way that team factors that are important for success in one arena may not be essential in another.

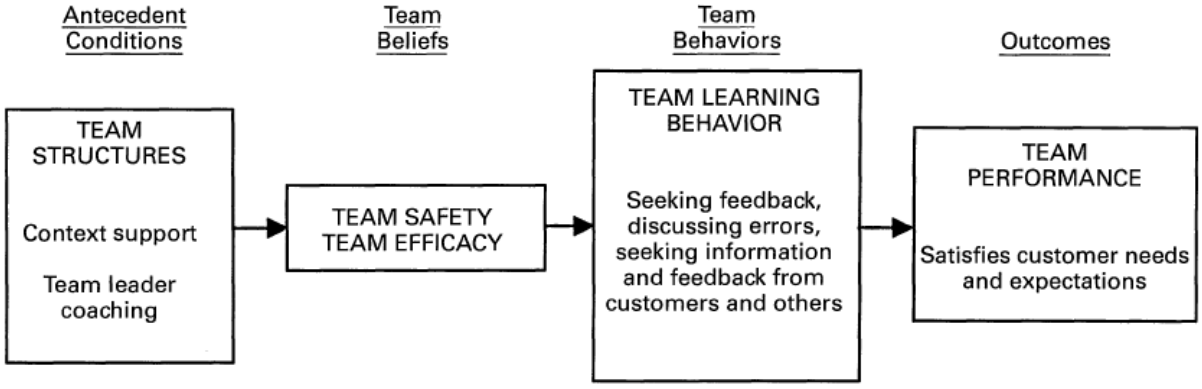
In summary, Edmondson's 2003 study contributes to our understanding of some constructs and concepts included in the model of work-team learning. In particular, this study emphasizes the importance of team leader behaviors to team members' perceptions of psychological safety. Furthermore, this study highlights that some team factors such as context support may be important in some team situations (e.g., teams in the manufacturing industry; Edmondson, 1999), but not in others (e.g., interdisciplinary action teams in the operating room of hospitals; Edmondson, 2003).

Summary of Key Studies by Edmondson

This review of relevant studies conducted by Amy Edmondson (1996, 1999, 2003) helps to explain the model of work-team learning from which this study's conceptual model was derived. In general, there is support for the use of the model of work-team learning to study learning behavior in teams. In particular, these studies are relevant to understanding the role of team structures in the team members' perceptions of psychological safety and team learning. In the section that follows, the model of work-team learning is described and explained by examining the constructs and concepts of the model.

The Model of Work-Team Learning

The model of work-team learning (Figure 1) demonstrates how structural and interpersonal dynamics of the team influence team learning and team performance (Edmondson, 1999). The model of work-team learning is a mid-range or intermediate theory that addresses the relationships between abstract and operational elements (Edmondson, 2003; Edmondson & McManus, 2007).



From "Psychological safety and learning behavior in work teams," by A. C. Edmondson, 1999, *Administrative Science Quarterly*, *44*(2), p. 357. Copyright 1999 by ASQ. Reprinted with permission.

Figure 1. A model of work-team learning (Edmondson, 1999, p. 357).

The model reflects the major constructs of antecedent conditions, team beliefs, team behaviors, and outcomes. Antecedent conditions are considered to be team structures while team beliefs are team safety and team efficacy, team behaviors are team learning behavior, and outcomes are team performance. These constructs, along with related concepts and variables, will be discussed below using Edmondson's three prior studies to describe the model of work-team learning (Edmondson 1996, 1999, 2003).

Antecedent Conditions: Team Structures

The first construct in Edmondson's model of work-team learning is antecedent conditions. This construct is manifested as the team structures, defined as properties of the team that inform team beliefs, team behaviors, and ultimately team outcomes (Edmondson, 1996, 1999). In the model of work-team learning, team structures are conceptualized as context support and team leader coaching (Edmondson, 1999). Context support refers to the shared beliefs among team members that they are supported in their work in tangible ways (i.e., informational needs are met) and intangible ways (i.e., rewards are given for hard work) (Edmondson, 1999). Team leader coaching refers to the way leaders behave, and whether they are perceived to be open to team members' ideas and supportive of the team as a whole (Edmondson, 1999). There is support from past research that context support and team leader coaching are important factors in creating an environment that team members believe is safe to share their ideas or admit mistakes (Edmondson, 1996, 1999).

Team Beliefs: Team Safety and Team Efficacy

The next construct in Edmondson's model of team learning is team beliefs, which are postulated as a manifestation of the antecedent conditions (context support and team leader coaching). These antecedent conditions were described as influencing the degree to which

team beliefs predicted team behaviors and outcomes (Edmondson, 1999). Team beliefs are defined as the shared group perspectives that arise from individuals' perceptions about a group (Knott, 2009), and include team safety and team efficacy.

The concept of team safety, measured by the variable of psychological safety, reflects team members' shared perceptions of trust and mutual respect that enable team members to take certain risks, such as reporting mistakes, asking questions, seeking feedback, and challenging the status quo (Edmondson, 1999, 2004). The concept of team efficacy is team members' shared perceptions of the work team's ability to accomplish team goals. Edmondson (1999) theorized that both team safety and team efficacy influenced team behaviors and in particular, team learning behavior. Findings from her study of team learning behavior in the manufacturing industry supported the relationship between team safety and team learning behavior, showing that beliefs about mutual respect in the team and the ability of team members to speak up about unsafe practices enabled learning behavior that ultimately influenced team performance (Edmondson, 1999). Additionally, psychological safety was supported as a mediator between team structures (context support and team leader coaching) and team learning behavior, with psychological safety explaining how team context support and team leadership coaching are related to team learning and performance. As previously discussed, Edmondson (1999) did not find support for her hypotheses about the role of team efficacy as either an influence on team learning behavior or as a mediator between team structures (context support and team leader coaching) and team learning behavior. Accordingly, she recognized that team efficacy did not appear necessary to team learning behavior.

Team Behaviors: Team Learning Behavior

The next construct in the model is team behaviors, which is conceptualized as the actions of the team that allow for improvement and learning (Edmondson, 1999; Knott, 2009). Team behaviors are conceptualized as team learning behavior and viewed as the learning process that occurs at the unit or team level of the organization (Edmondson, 1999, 2003). While some scholars of organizational learning have defined learning as an outcome, Edmondson (1999) views learning as an ongoing process that involves seeking feedback and information via team reflection, from clients, and from others relevant to team performance. Information sharing has long been recognized as an essential aspect of learning (Argyris, 1976; Levitt & March, 1988), and was included by Edmondson (1999) as part of the concept of team learning behavior. Her analysis of team learning behavior in manufacturing work units demonstrated that team learning behavior was positively related to team performance.

Outcomes

The final construct in Edmondson's model of work team learning is outcomes, operationalized as team performance and conceptualized as the result of team structures, team beliefs, and team behaviors (Edmondson, 1999). While team learning behavior is the overall process through which the team learns, the ultimate outcome is team performance (Edmondson, 1999). The achievements of the team might include outcomes such as customer satisfaction or successful team implementation of a new technology (Edmondson, 1999, 2003).

The Model of Work Team Learning Applied to This Study of Error Reporting

The model of work team learning was the theoretical basis of this study to examine the phenomenon of error reporting, and was used to develop the conceptual model used in

this study. Three of the four constructs from the model of work-team learning were used in the conceptual model: team structures, team beliefs, and team behaviors. Like Edmondson's model, these constructs are believed to be related to one another. Team structures inform team beliefs which in turn affect team behaviors.

The construct of outcome, conceptualized as team performance, was not examined in this study because the utility of the work-team learning model largely depends on the phenomenon of study, and in this study, the focus was on the team learning behavior of error reporting. Also, it is difficult to tease out the outcomes per se that might be associated with error reporting. For example, many studies of patient safety or quality use patient outcomes (e.g., length of stay, infection rates, mortality rates, etc.) or nurse outcomes (e.g., nurse satisfaction, nurse turnover, staffing mix, etc.) to reflect unit or team performance. However, there was no support found in the literature documenting a relationship between error reporting and any of these commonly studied outcomes. In fact, after a review of the literature, error reporting was not found to be clearly related to any patient or nurse outcomes, and this lack of support in the literature suggests that common outcome measures are not linked to error reporting, and argues against including these outcome variables in this study of error reporting. The relationship between team learning behavior and outcomes also has not been supported through prior research. This lack of support from prior research for a relationship between team learning behavior and outcomes of care can be explained by the fact that team learning with respect to error reporting instead likely leads to *organizational learning*, versus the outcomes of care typically studied in patient safety and quality.

The conceptual model for this study is presented in Figure 2. The section that follows provides a discussion of how the constructs and concepts from the model of work team

learning were applied to develop the conceptual model, and provides an explanation of how the concepts were operationally defined. The relationships in the conceptual model are then discussed with a presentation of the research questions of the study. Finally, the covariates believed to be important in the study of error reporting on patient care units are reviewed.

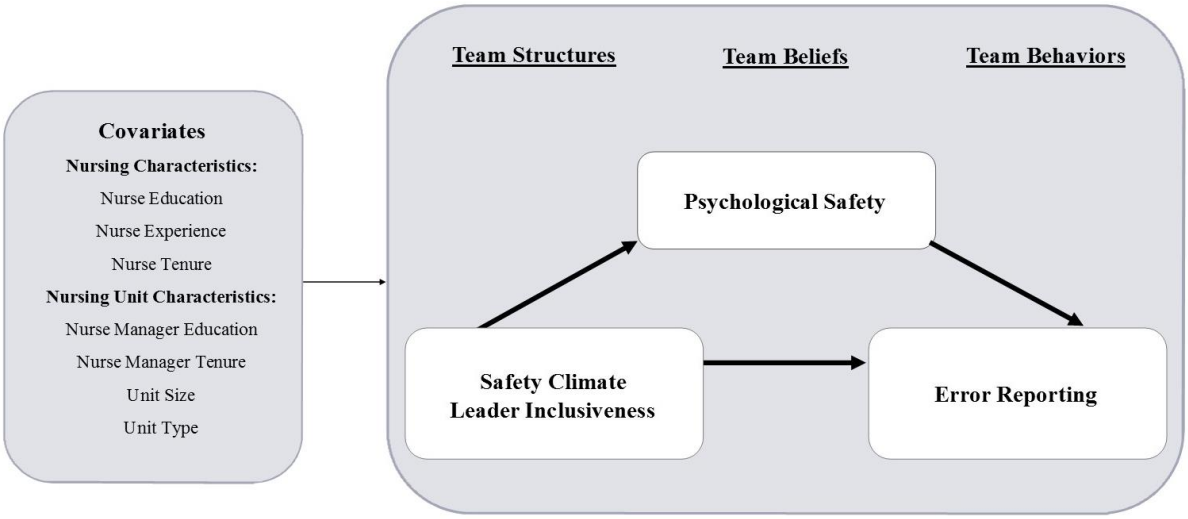


Figure 2. Conceptual model of error reporting, derived from Edmondson's model of work-team learning.

Team Structures

Similar to Edmonson (1999), team structures in this study were viewed as the antecedent conditions of the conceptual model. Past organizational research has supported this construct, suggesting that team structures are related to both team learning and team beliefs about safety (Bresman & Zellmer-Bruhn, 2013; Bunderson & Boumgarden, 2010; Edmondson, 1999). In a study of pharmaceutical research and development teams that in part examined the effect of team structure on team learning (Bresman & Zellmer-Bruhn, 2013), the researchers found that team structures were positively associated with team learning both internally between team members, and externally between the team and other groups in the organization. Similarly, Bunderson and Boumgarden (2010) examined teams

in high-technology firms of the Fortune 100 to determine how team structure influenced team learning. They found that team structure, by establishing psychological safety, positively influenced team learning.

Team structure is commonly examined in the research on teams, but there is no clear consensus among researchers and theorists on the best way to conceptualize team structure. In Edmondson's (1999) study of teams in manufacturing organizations, the study where she introduced and used the model of work-team learning, she conceptualized team structure as context support and team leader coaching. Other researchers have used the sociology and organizational literature to conceptualize team structure as specialization (e.g., roles and responsibilities of the team members or the vertical distribution of work), hierarchy (e.g., the vertical relationship between the team leader and the employees), and formalization (e.g., priorities and procedures that regulate and govern work). Like the model of work-team learning, this study conceptualizes team structures as context support and team leadership behavior. This conceptualization differs slightly from Edmondson (1999), by using team leadership behavior instead of team leader coaching.

Context support. The first element of team structure included in this conceptual model is context support, which Edmondson (1996, 1999, 2003) has described as team goals, team design, resources, information, and climate. The idea of context support can be explained as the structural elements present that influence team beliefs and team behaviors (Edmondson, 1996, 1999, 2003) or the norms and climate of the team (Bunderson & Boumgarden, 2010). In keeping with Edmondson's (1996) study of error reporting and learning in hospital teams, this study operationalizes context support as climate, and more specifically, as the safety climate of the nursing unit, also described earlier.

Team leadership behavior. The second element of team structure in this conceptual model is team leadership behavior. This concept differs slightly from Edmondson (1999) who instead used team leader coaching. Team leadership behavior was chosen for use in this study because it is a broader definition of team structure derived from earlier work by Edmondson (1996). In her 1996 study of learning from mistakes in hospital units, Edmondson used both qualitative and quantitative methods to understand the differences in teams that helped to explain why some teams identified and learned from errors better than others. Among her findings, she identified leadership behaviors by the unit managers (i.e., nurse managers) that positively affected error detection and learning. These positive behaviors included openness, accessibility, and engaging with staff, which she then seemed to both conceptualize and operationalize as "team leader coaching" (Edmondson, 1996, 1999). While Edmondson used the term "team leader coaching," the behaviors she described are not limited to merely coaching. This study describes "team leadership behavior" instead, which recognizes a wider array of leadership behaviors that can positively influence the team belief about safety and the learning behavior of teams. Therefore, the second element of team structure in this model is defined as team leadership behavior, which is conceptualized as leader inclusiveness and discussed earlier in the chapter.

Team Beliefs

Team beliefs begin with the individual but emerge and are observed in shared team attitudes, perceptions, experiences, and behaviors (Kozlowski & Klein, 2000). Team beliefs are comprised of both cognitive and social processes (Van den Bossche, Gijselaers, Segers, & Kirschner, 2006). Past research demonstrates that team structures influence team beliefs, which, in turn, influence team behaviors (Edmondson, 1999). A more recent study of nurses

and other health professionals working in nursing teams found that team beliefs influenced team behaviors, specifically team learning behavior (Ortega, Sanchez-Manzanares, Gil, & Rico, 2013). In this study of error reporting, team belief is conceptualized as team safety belief, which is in keeping with the work of past scholars (Edmondson, 1999; Ortega et al., 2013).

Team safety belief. The concept of team safety is a shared perception among team members of trust and mutual respect that empowers individuals in the team to take interpersonal risks like reporting mistakes, challenging the status quo, asking questions, and seeking feedback (Edmondson, 1999, 2004). In a study conducted in nursing units of hospitals, Edmondson (1996) used both qualitative and survey methods to examine the differences in medication errors detected between eight nursing work teams. Through qualitative interviews, she discovered that shared perceptions among team members about the consequences of making an error influenced the rate of error reporting. She identified this notion of willingness to speak up or willingness to discuss mistakes. In later research, Edmondson further refined this concept of willingness to speak up as team safety, and measured as psychological safety, noting that team safety influences both team learning behavior and team performance (Edmondson, 1999, 2003). She operationally defined team safety as psychological safety and developed a valid measure of this variable (Edmondson, 1999). Similarly, this study of error reporting conceptualizes team safety as psychological safety.

Team Behaviors

Team behaviors reflect the actions or conduct exhibited by teams, as a whole. Past research has examined team behaviors manifest in a multitude of ways, including unethical

behaviors (Pearsall & Ellis, 2011), involvement in quality improvement (Nembhard & Edmondson, 2006), and team learning behavior (Edmondson, 1999, 2003). In this study, similar to the model of work-team learning, team behavior is conceptualized as team learning behavior.

Team learning behavior. Team learning behavior is characterized by reflection and action by team members that result in improved performance in the team (Edmondson, 1999). There is some debate among organizational learning scholars over the nature of learning. Some have viewed learning as an ongoing process that organizations engage in while others have viewed learning as an outcome. Similar to Edmondson's (1999) conceptualization, this study views learning as reflection and subsequent action taken by team members. Specifically, this study examines how the antecedent conditions of team structures and team safety influence the team learning behavior of error reporting in hospitals.

Relationships of the Model

In this section, the relationships illustrated by the conceptual model and postulated in this study are examined in detail. The discussion begins with the relationships of context support and team leadership behavior to team learning behavior followed by an analysis of the relationship of team leadership behavior and context support with team safety belief. Next, the study looks at the relationship of team safety belief with team learning behavior. Finally, there is a discussion of the mediating role of team safety belief. Each relationship in the model is presented with related research questions.

Context support and team leadership behavior. Previous studies have demonstrated that both context support and team leadership are important to team beliefs and

learning behavior. Early work by Edmondson (1996) found that organizational characteristics of the unit, such as the climate, contributed to the detection of errors on the unit. Additionally, the same study found that leadership behaviors were strongly tied to the number of errors detected on the unit, with more positive leadership behaviors resulting in greater error detection. A 2006 study by Naveh and colleagues found that certain dimensions of the safety climate of nursing units positively affected clinicians' readiness to report errors so that more positive aspects of the safety climate were related to more error reports submitted by clinicians. Another study that examined the relationship between nurses' perceptions of the safety culture, nurse leader coaching behaviors, and nurses' intent to report errors found that both safety culture and nurse leader coaching behaviors were positively related to nurses' intent to report (Ko & Yu, 2015). Taken together, these studies (Edmondson, 1996; Ko & Yu, 2015; Naveh et al., 2006) provide support for the importance of context support and team leadership behaviors relative to team learning behavior (in this study, error reporting). Thus, Research Question 1 (RQ1) seeks to determine how team context support and leadership behavior influence team learning behavior by asking: *How do safety climate and leader inclusiveness affect error reporting?*

The study conducted by Edmondson (1999) in work teams of manufacturing organizations supports the relationship between context support and team safety belief. That study demonstrated that context support was positively related to the team safety belief of psychological safety. No identified past studies have examined the specific relationship of safety climate to psychological safety, but it seems logical to expect that an organizational environment that prioritizes safety is one where individuals would feel safe to speak out about unsafe conditions or error-related events they observe.

There is past research to support the relationship between team leadership behavior and team safety belief (operationalized as psychological safety). For example, a study that examined improvement efforts in health care teams working in neonatal intensive care units of hospitals first demonstrated a positive relationship between team leadership and psychological safety (Nembhard & Edmondson, 2006). Later research has further supported the notion that team leadership (measured as leader inclusiveness) is positively associated with the team safety belief of psychological safety (Carmeli et al., 2010; Hirak et al., 2012). A study by Carmeli and colleagues (2010) examined how leader inclusiveness and psychological safety promoted team creativity in the workplace. The study findings demonstrated that leader inclusiveness was positively related to psychological safety, which was then positively associated with employee creativity in the workplace. Another study conducted in nursing units of a large medical center in Israel found that leader inclusiveness positively affected psychological safety, which subsequently resulted in team learning from failure and the ultimate performance of the unit (Hirak et al., 2012). In Research Question 2 (RQ2), the relationships of context support and team leadership behavior with team safety belief are explored by asking: *How do safety climate and leader inclusiveness affect psychological safety?*

Team safety belief. Past studies have demonstrated a positive relationship between the team safety belief of psychological safety and team learning (Brueller & Carmeli, 2011; Edmondson, 1999; Kostopoulos & Bozionelos, 2011). Edmondson (1999) found that the team safety belief of psychological safety promoted team-learning behavior in work-teams within a manufacturing organization. Similarly, Brueller and Carmeli (2011) conducted a study of teams in eight large organizations in Israel to determine how high quality

relationships in the team affected team learning and team performance. They found that psychological safety was one of the significant predictors of both team learning and team performance. Another study examined teams in information technology companies and pharmaceutical organizations in three countries to determine the effect of psychological safety on different types of team learning and team performance (Kostopoulos & Bozionelos, 2011). The researchers found that psychological safety positively affected team learning activities or behaviors (measured as team exploratory learning and team exploitive learning), which resulted in improved team performance. These studies illustrate and support the role of team beliefs about safety, operationalized as psychological safety, on team learning behavior.

There is also growing support in the healthcare literature for the role of psychological safety as an important influence on error reporting, which is how team learning behavior is operationalized in this study (Leroy et al., 2012). A recent study conducted in the Veterans Health Administration (VHA) demonstrated a positive relationship between psychological safety and error reporting. Individuals working in hospitals with more positive psychological safety scores indicated greater willingness to report errors (Derickson et al., 2015). Another recent study of healthcare professionals working in cancer care hospitals in Sweden found that withholding patient safety concerns among healthcare professionals was negatively associated with psychological safety, and that individuals who did not feel psychologically safe were unlikely to speak up about safety concerns they encountered (Schwappach & Gehring, 2015). In other words, the study findings demonstrated that psychological safety is an important factor in whether individuals were willing to report error-related events. Based on the cumulative literature on psychological safety found both in the organizational and

psychology and healthcare literature, there is strong empirical support for the positive relationship between psychological safety and error reporting. Thus, Research Question 3 (RQ3) seeks to determine the effect of team safety belief on team learning behavior by asking: *How does psychological safety affect error reporting?*

Additional evidence from the literature suggests that psychological safety in teams often mediates different team factors that can affect team-learning behavior. For example, a study that examined the effect of emotional intelligence on learning behavior in work teams of different organizations found that psychological safety mediated the relationship between emotional intelligence and team learning behavior (Ghosh, Shuch, & Petrosko, 2012). Thus, psychological safety helped to explain how emotional intelligence affected learning behavior in teams. Similarly, a study of teams in 85 different organizations in China found that psychological safety was an important mediator between the relationship of the team leader's values (measured as leader's values of participation, people, and productivity) and team learning. Edmondson (1999) found that within work teams of a manufacturing company, psychological safety was an important mechanism through which the team structures of context support and leader coaching affected team learning and performance. In the context of that study, psychological safety mediated the relationship between context support and leader coaching with team learning behavior. Based on past research, this study seeks to determine whether psychological safety helps to explain how safety climate and leader inclusiveness affect error reporting. It may be that psychological safety is an important factor in explaining the effect of the safety climate and leadership on error reporting. Research Question 4 (RQ4) determines the mediating role of team safety belief by asking:

Do leader inclusiveness and safety climate indirectly affect error reporting through psychological safety?

Covariates

Covariates are often included in studies of organizations, particularly in studies of patient safety and outcomes in hospitals, as researchers seek to determine characteristics of employees (e.g., nurses) or the work unit that may explain variations in responses (de Cordova, Phibbs, Schmitt, & Stone, 2014; Needleman, Buerhaus, Pankratz, Leibson, & Stevens, 2011). The covariates included in this study are categorized as nurse characteristics (individual level) and nursing unit characteristics (unit level). The nurse characteristics included nurse education, nurse experience, and nurse tenure. The nursing unit characteristics included nurse manager education, nurse manager tenure, the size of the nursing unit, and the type of nursing unit. Each of these covariates are discussed in greater detail in the sections that follow.

Nursing characteristics. Nursing characteristics are individual characteristics of the nurse. In this study, nurse education, nurse experience, and nurse tenure are the nursing characteristics included as covariates. These covariates are briefly discussed from the literature with an explanation for their inclusion in this study.

Nurse education. In 2012, the IOM recommended increasing the total percentage of nurses with a baccalaureate degree to 80% by the year 2020. This group recognized that while there is inconclusive evidence in the literature to causally link nurse education (i.e., academic degree) with patient outcomes, there is considerable evidence to support the relationship between nurse education and patient outcomes such as mortality or failure to rescue (Aiken et al., 2011; Aiken, Clarke, Cheung, Sloane, & Silber, 2003). For example,

Aiken and colleagues (2003) examined the association between nurse education levels and the rate of mortality and failure to rescue in hospitals. Using data from acute care hospitals in Pennsylvania, they found that hospitals with a higher proportion of baccalaureate degree nurses had lower mortality and failure-to-rescue rates. Another study by Aiken and colleagues (2011) explored the effect of nurse staffing, nurse education, and nurse work environment on hospital mortality rates. The study further demonstrated this important relationship by showing that even in hospitals with poor work environments, increases in the percentage of nurses with a baccalaureate degree decreased patient mortality rates.

However, there is no evidence from past studies that nursing education is a significant predictor of error reporting by nurses (Chlang, Lin, Hsu, & Ma, 2010; Hung, Chu, Lee, & Hsiao , 2015; Throckmorton & Etchegaray, 2007; Vogus & Sutcliffe, 2007). Notwithstanding previous findings, nurse education level is included in this study because it is a common covariate in many studies of nursing and patient safety. One would anticipate that as nurses' educational levels increase, so too, does their knowledge of errors and the importance of reporting errors. Furthermore, this variable also provides important descriptive information of the study sample.

Nurse experience. There is evidence from past studies that the number of years an individual has worked as a nurse influences patient safety outcomes. Studies of medication errors suggest that as nurses gain nursing experience, the number and severity of errors decreases (Fasolino & Snyder, 2012; Westbrook, Rob, Woods, & Parry, 2011). Another study reported that nursing units with more experienced nurses had fewer medication errors and patient falls (Blegen, Vaughn, & Goode, 2001). The relationship of nurse experience to

medication errors suggests that the number of years an individual has worked as a nurse may be related to team learning behaviors (i.e., error reporting).

Researchers who have examined the relationship between nurses' experience and error reporting have reported mixed results. In a study of newly graduated nurses and experienced nurses, Unver, Tastan, and Akbayrak (2012) found that there was no statistically significant difference between newly graduated nurses' and experienced nurses' perceptions of error reporting. However, there was a significant difference in understanding between new and experienced nurses of what constitutes an error and what should be reported as an error. More experienced nurses were better aware of what constituted an error and should be reported. In contrast, another study found an inverse relationship between experience and willingness to report so that nurses with less experience were more willing to report errors and vice versa (Throckmorton & Etchegaray, 2007). The difference in these findings may be explained by different measures of error reporting (i.e., perceptions of reporting, willingness to report, or knowledge of what to report). Nonetheless past research suggests that nurse experience is important in error reporting and should be considered when examining nurse error reporting. Thus, this study included nurse experience as a covariate in the model.

Nurse tenure. Tenure, the length of time a nurse has worked on a particular nursing unit, is important because there are skills and knowledge that are acquired over time that are specific to a particular unit or team in which a nurse may work. Furthermore, the nature of nursing work is highly interdependent and the relationships between workers can influence communication and productivity practices. Therefore, nursing tenure is important, both from depth of knowledge as well as strength of relationship, a concept that has been described as human capital (Bartel, Beaulieu, Phibbs, & Stone, 2014). Specifically, a study investigating

the effects of human capital variables (i.e., nurse turnover and nurse education) on productivity (measured as patient length of stay) found that human capital had a significant influence on productivity (Bartel et al., 2014). Similarly, in studying error reporting, nurse tenure may be an important variable to include because of the potential relationship between nurses' unit tenure and their perceptions of nurse manager inclusiveness, safety climate, psychological safety, and error reporting. Nurses' perceptions of these team factors may change as they gain experience and exposure to the structural and interpersonal dynamics of the team.

Among nursing characteristics typically included in studies of error reporting, nurse tenure is not included as often as others (i.e., nurse education). However, three studies have examined nurse tenure in relation to error reporting. Two studies found no significant relationship with tenure and error reporting (Chlang et al., 2010; Vogus & Sutcliffe, 2007), while another found that tenure was significantly associated with error reporting so that greater tenure was associated with less fear in speaking up about errors (Castel, Ginsburg, Zaheer, & Tamim, 2015). Based on these very limited but conflicting findings, further study of nurse tenure and its relationship to error reporting is warranted.

Nursing unit characteristics. The nursing unit characteristics examined in this study included nurse manager and unit specific characteristics that might help to explain error reporting on nursing units. Much of the past research on error reporting has not been conducted from a multilevel or unit perspective; thus, there are covariates included in this study that were not included in past studies. However, a rationale is provided to explain why these variables were included. The nursing unit characteristics included in this study were nurse manager education, nurse manager tenure, unit size, and type of unit.

Nurse manager education. There is a growing recognition in some hospitals across the U.S. that nurse managers should obtain advanced, graduate level degrees (e.g., Master of Science in Nursing, Master of Healthcare Administration, etc.) to effectively manage and lead in hospitals (Yoder-Wise, Scott, & Sullivan, 2013). However, there is a gap in the literature that ties nursing, patient, or hospital outcomes to the educational level of nurse managers (Thompson & Fairchild, 2013).

Because graduate level education often emphasizes system thinking, it is possible that nurse managers with at least a master's level education, when compared to an entry-level degree in nursing, have a deeper understanding of safety issues on the units they manage. In turn, error reporting may be emphasized to nurses who work on the unit as an essential component of improving the quality and safety of care delivered to patients. Thus, nurse manager education was included as a covariate in this study.

Nurse manager tenure. Nurse manager tenure, the amount of time the individual nurse manager has been in his or her position was included as a covariate because the length of time leading the unit is related to the depth and productivity of unit relationships. Also, the extent to which nurse managers influence nurse error reporting may be in some way associated with the amount of time they have been in the position. Almost all identified studies of error reporting did not control for unit manager characteristics. While there is no identified evidence from past studies for the inclusion of nurse manager tenure as a covariate, the economic concept of human capital supports nurse manager tenure and the knowledge and skills associated with tenure as a potentially important covariate to this of error reporting.

Unit size. There is known variability between nursing units in hospitals, so researchers examining outcomes in nursing units often control for a number of unit-level

variables (Needleman et al., 2011). One such variable is unit size, which has been included as a covariate in past studies conducted on nursing units (Bae, Kelly, Brewer, & Spencer, 2014; Shah, Mirea, Solimano, & Lee, 2015). One study examined how nurse-staffing characteristics affected the patient outcomes of pressure ulcer rates and patient falls (Bae et al., 2014). Researchers in the study indicated that *unit size* was one of the nursing unit variables for which they controlled. However, there is no information in the article about the significance of this control variable on the outcome measures. Shah and colleagues (2015) examined the effect of unit size, resource allocation, and occupancy in neonatal intensive care units in relationship to any associated morbidities of preterm infants cared for in the respective study units. Findings from the study indicated that larger unit size was significantly associated with an overall increase in morbidities for preterm infants. There is some evidence that unit size has influenced unit outcomes in past studies.

In studies of error reporting, unit size has been investigated in a limited capacity. Only one identified study included unit size as a covariate, and those researchers did not find a significant relationship between unit size and error reporting (Vogus & Sutcliffe, 2007). While there is limited past evidence to determine the effect of unit size on error reporting, it is possible that larger units with more staff generate more errors and therefore more error reports. In larger units with more staff, nurses may not feel as psychologically safe because there is less opportunity for interactions with the manager or with colleagues, which contributes to feelings of psychological safety. Because of these reasons, unit size was included as a covariate in this study.

Type of unit. The type of nursing unit is an important covariate that is frequently included in studies of nursing units within hospitals. For example, one study that examined

reported medication errors on nursing units found that emergency department units reported fewer medication errors, and intensive care units reported more medication errors. Interestingly, the number of medication errors reported by surgical units was not significant (Vogus & Sutcliffe, 2007). Another study that examined contributing factors to medication errors observed that medical units and intensive care units had the greatest percentage of medication errors over surgical units, emergency units, pediatric units, and other units (Tang, Sheu, Yu, Wei, & Chen, 2007). Thus, past evidence suggests that the type of unit is an important covariate to include in the study because the number of errors reported can vary depending on the type of nursing unit.

Summary of the Conceptual Model

The conceptual model for this study was derived from the model of work-team learning and uses the constructs of team structures, team belief, and team behavior. An illustration of how the study constructs were used to derive the concepts, variables, and measures of this study is provided in Figure 3. In addition, Table 1 provides definitions for the concepts and variables of the study.

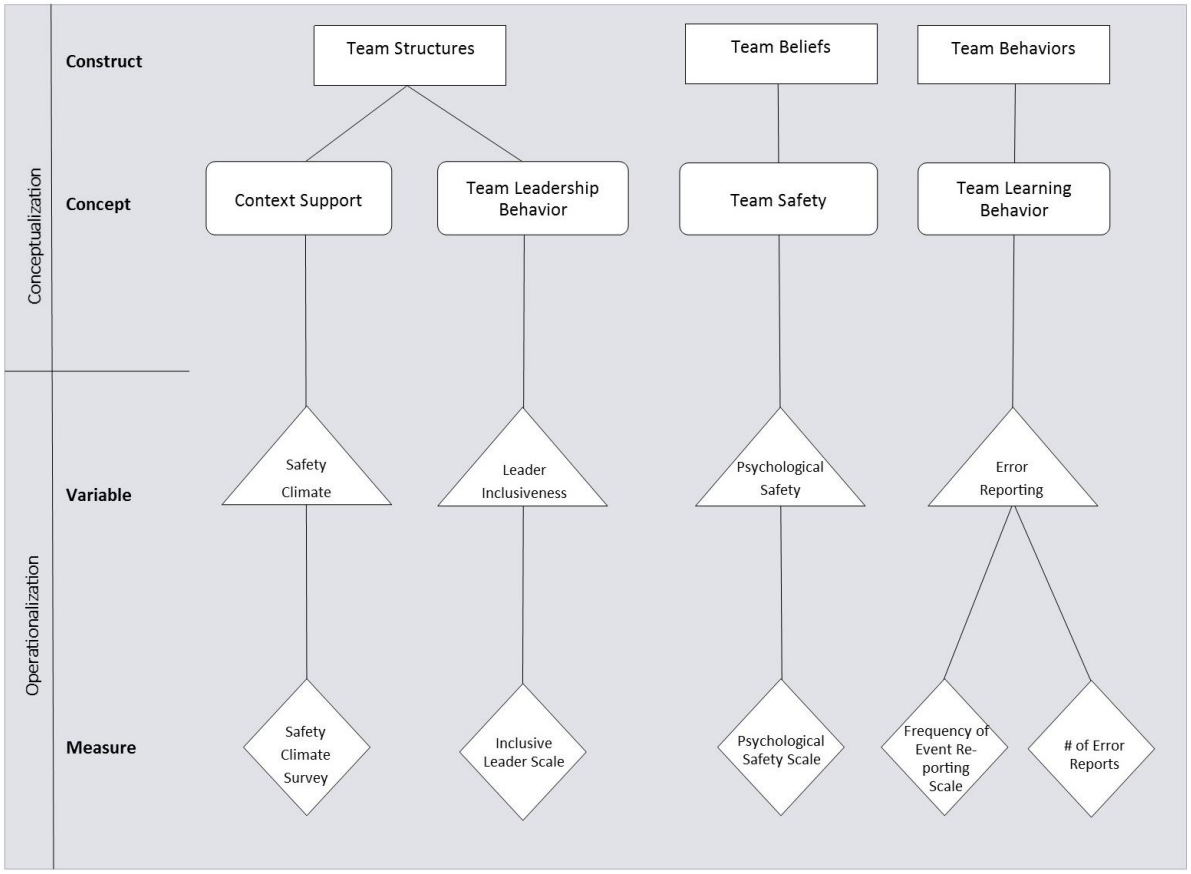


Figure 3. Illustration of the derivation of underlying conceptual components of this study of error reporting.

Table 1

Definitions of the Study Concepts and Variables Used in this Study of Error Reporting

Construct	Concept: Definition	Variable: Definition
TEAM STRUCTURES	**Context Support:** The elements that support the team to engage in learning behavior and also promote trust among team members by dispelling fear (Edmondson, 1996; Edmondson, 1999; Edmondson, 2003).	**Safety Climate:** The shared perceptions and experience of employees about the practices, policies, and procedures related to the safety of patients (Katz-Navon et al., 2005; Vogus et al., 2010)
	Team Leadership: The behaviors whereby the team leader conveys openness, accessibility, and approachability to team members thereby promoting trust within and between team members (Edmondson, 1996, 1999, 2003).	***Leader Inclusiveness:*** The behavior of leaders that demonstrates availability, openness, and accessibility to employees whereby they invite input and demonstrate an appreciation for the contribution of employees (Hirak et al., 2012; Nembhard & Edmondson, 2006).
TEAM BELIEF	**Team Safety:** The beliefs among team members of trust and mutual respect that empower them to take interpersonal risks like reporting mistakes, challenging the status quo, asking questions, and seeking feedback (Edmondson, 1999, 2004).	***Psychological Safety:*** The willingness of team members to speak up about concerns without fear of negative consequences (Edmondson, 1999, 2004).
TEAM BEHAVIORS	**Team Learning Behavior:** Reflection and action by team members that promote team learning (Edmondson, 1999)	***Error Reporting:*** The formal and primary way by which healthcare professionals document and communicate to unit managers and those at upper levels of healthcare administration the errors and near misses that occur during the provision of medical care to patients (Leape, 2002).

Chapter Summary

This chapter reviewed relevant literature on the independent variables of the study: safety climate, leader inclusiveness, and psychological safety. From the literature review there were two primary gaps identified. Leader inclusiveness has not been previously studied in relationship to error reporting, and more importantly, the majority of research on error reporting has not used a cohesive theoretical foundation to examine the factors related to error reporting. This research study addresses both of these gaps by integrating leader inclusiveness and by applying the model of work-team learning as the theoretical basis of the conceptual model to investigate team factors that affect error reporting.

A synopsis of key studies conducted by Amy Edmondson (1996, 1999, 2003) was then presented to facilitate the discussion of the model of work-team learning. The conceptual model of the study was discussed along with theoretical and research support for the relationships examined by the research questions of the study. This chapter concluded with a discussion of the covariates and a rationale for their inclusion in the study. Building on this review of literature and discussion of the conceptual model for the study, Chapter 3 presents an outline of the study methods and procedures that were used to examine the team factors related to error reporting.

CHAPTER 3

METHODOLOGY

The purpose of this study was to determine the effect of context support, team leadership behavior, and safety belief on team learning behavior. The theoretical foundation for this study was the model of work-team learning (Edmondson, 1999), which then was used to derive the conceptual model for examining error reporting by nurses. The study accomplishes its purpose by examining the effects of nurses' perceptions of safety climate, leader inclusiveness, and psychological safety on error reporting. The research questions of the study were answered by using methods for modeling correlated outcomes. Continuous outcomes were examined using linear mixed models with random effects, while count outcomes were examined using Poisson regression models and generalized estimating equations. This chapter presents research and methodological issues germane to the conduct of this study.

Study Design

This study used a cross-sectional, descriptive design to address the research questions. Data were collected from nurses and nurse managers through a self-administered survey available in paper or electronic format, depending on respondents' preferences. The following research questions were addressed in this study:

1. How do safety climate and leader inclusiveness affect error reporting (RQ1)?

2. How do safety climate and leader inclusiveness affect psychological safety (RQ2)?
3. How does psychological safety affect error reporting (RQ3)?
4. Do safety climate and leader inclusiveness indirectly affect error reporting through psychological safety (RQ4)?

Setting and Sample

The setting for this study was a large academic medical center in the southeastern U.S. with 805 licensed beds (American Hospital Association, 2013). The sample was a convenience sample of nurses and nurse managers who were employed by the hospital. *Nurses* included in the study were Registered Nurses (RNs; i.e., per diem, part-time, or fulltime) who spent the majority of their time providing direct care to patients. The nurse sample was recruited from 50 patient care units, including 38 inpatient areas as well as short-term or outpatient areas, including the operating room, emergency room, dialysis, procedural, and rehabilitation units. *Nurse managers* are the formal organizational administrators of nursing units providing inpatient care, as well as short-term or outpatient areas, including the operating room, emergency room, dialysis, procedural, and rehabilitation units.

Power Analysis

Power analyses were conducted using the approach of Hauck, Gilliss, Donner, and Gortner (1991) and were based on the effective sample size, that is, the equivalent number of independent observations. Prior to data collection, it was estimated that 49 nursing units would provide an average of 16 nurse responses per unit. For a small intra-unit correlation of .05, the effective sample size would be 448; for a large correlation of .125, the effective sample size would be 273. This latter, conservative effective sample size would be sufficient

to identify a very small R^2 of 2.8% for a bivariate regression analysis at 5% significance with 80% power and 3.9% for a multiple regression based on three predictors (Cohen, 1992). While nurses in 53 units responded to the survey, there were only usable data for nurses from 49 units. Actual sample sizes ranged from 736 to 814 due to missing data. Using the conservative value of 736, or about 15 nurses per unit, and the largest observed intra-unit correlation of .13, the effective sample size is 261. This provides 80% power at 5% significance for identifying a small effect size of 2.9% for a bivariate regression analysis and 4.0% for a multiple regression based on three predictors. With an intra-unit correlation of .05, the effective sample size increases to 448. Consequently, the study is very well powered for conducting the regression analyses for the first three steps of the Baron and Kenny (1986) approach to mediation analysis, possibly even allowing for an extra covariate. For the fourth step of the mediation analysis, the simulation results of Fritz and MacKinnon (2007) indicate that a sample size of n = 396 was needed for 80% power and 5% significance based on the slopes of the data for steps 2 and 3 of the mediation analysis using the bias-corrected bootstrap. Thus, tests for indirect effects may be underpowered for analyses involving larger intra-unit correlation but well powered for smaller ones.

Instrumentation

Variables and Their Measurement

The dependent variable in this study was error reporting, while the independent variables were safety climate, leader inclusiveness, and psychological safety. The covariates examined in this study were nursing characteristics and nursing unit characteristics. The nursing characteristics identified in the literature as being relevant to this study were: nurse education (Aiken et al., 2011, 2003), nurse experience (Throckmorton & Etchegaray, 2007),

and nurse tenure (Castel et al., 2015). The nursing unit characteristics also derived from the literature and relevant to this study included the following: nurse manager education, nurse manager tenure, unit size (Shah et al., 2015), and type of nursing unit (Tang et al., 2007; Vogus & Sutcliffe, 2007).

The quality of instruments used in a research study is essential to the accuracy of the data collected and the research study itself (DeVellis, 2003). When discussing instruments, there are two important and interrelated concepts: validity and reliability. *Validity* is concerned with the extent to which items in a scale accurately measure and reflect the underlying concept responsible for item co-variation (DeVellis, 2003; Vogt & Johnson, 2011). *Reliability* refers to the internal consistency or performance of the scale (Tavakol & Dennick, 2011). The reliability of the instruments used in this study was tested using Cronbach's alpha to determine the internal consistency of each instrument.

The section that follows provides a more detailed discussion of the study variables, their operational definition, and how they were measured.

Error Reporting

Error reporting was defined as nurses' perceptions of and engagement in error reporting on their nursing unit. Error reporting was measured in two ways. First, the frequency of error reporting on nursing units was measured with the 3-item subscale, the *Frequency of Event Reporting Scale,* from the Hospital Survey on Patient Safety Culture (HSPSC; Agency for Healthcare Research and Quality [AHRQ], n.d.). The HSPSC is a 46-item instrument with 12 subscales that was developed to measure patient safety culture in hospitals (Sorra & Dyer, 2010). Respondents provided answers to scale items via multiple choice responses with options specific to the item. Validity for the HSPSC was addressed by

its developers, who generated the items of the scale by conducting literature reviews and interviewing staff in hospitals (Pinkerton, 2005). The survey was then tested, piloted, and amended before it was widely administered in hospitals (Pinkerton, 2005). Through this process, the researchers developed a valid tool for measuring patient safety culture in hospitals. The psychometric properties of the scale have been evaluated by past researchers who found evidence that overall, the dimensions of the scale and the items are psychometrically sound (Blegen, Gearhart, O'Brien, Sehgal, & Alldredge, 2009; Sorra & Dyer, 2010). The subscale composites had reliability scores, assessed with Cronbach's alpha, that ranged from .62 to .85 (Sorra & Dyer, 2010). Other than one subscale dimension, the staffing composite, the overall Cronbach's alpha for each of the subscales was greater than or equal to .70, indicating good reliability (Sorra & Dyer, 2010).

The *Frequency of Event Reporting Scale* used in this study was originally developed as one of 12 subscales that comprise the HSPSC. This subscale of the HSPSC has three items that are scored with a 5-point unbalanced scale where 1 = *never* and 5 = *always*. The *Frequency of Event Reporting Scale* has been used as a standalone measure in two other identified studies of error reporting in hospitals (Hillen, Pfaff, & Hammer, 2015; Richter et al., 2014). The study by Hillen et al. (2015) examined how the transformational leadership of hospital directors in Germany influenced the frequency of event reporting by staff. The authors used the *Frequency of Evens Reporting Scale* and reported a Cronbach's α = .86. Another study (Richter et al., 2014) examined the effect of safety culture on error reporting and how those perceptions differed between managers and staff in hospitals across the U.S., and also used the *Frequency of Event Reporting Scale*; however, they did not report the psychometric properties for the scale in their study. Past studies that have examined the

HSPSC have used factor analysis and inter-item correlations to assess the validity and reliability of the scale. Those studies found that the *Frequency of Event Reporting Scale* had a one-factor solution with inter-item reliabilty ranging from .69 to .85 and an overall Cronbach's α = .85 (Blegen et al., 2009; Sorra & Dyer, 2010).

For use in this study, slight changes were made to the original items of the *Frequency of Event Reporting Scale* to improve clarity. These changes were made in consultation with experts in the fields of survey design, psychometrics, and organizational study who also reviewed the items for face validity. The original item wording and the changes to the items used in this study can be viewed in Appendix 1. Each item of the 3-item scale was scored on a 5-point unbalanced scale, with a score of 5 corresponding to greater frequency of error reporting on the unit. In this study, factor analysis confirmed a one-factor solution and the inter-item correlations for the *Frequency of Event Reporting Scale* ranged from .62 to .74. The reliability of the scale, using Cronbach's alpha, was .81.

The second measure of error reporting, the number of errors, was measured through a self-reported numerical estimate reported by individual nurse respondents in the 12 months prior to the survey administration. This numerical estimate of error reports submitted through the error reporting system was chosen as a second measure of error reporting because it assesses one aspect of error reporting that is distinct from nurses' perceptions about unit error reporting and it gets closer to the actual number of reports that nurses submitted. This measurement is also consistent with other studies that have examined actual error reports as a measure of error reporting (Milch et al., 2006; Naveh et al., 2006; Vogus & Sutcliffe, 2007). While the number of reports actually submitted through the error reporting system for each respondent would have been preferable to a self-report of errors reported, it

was impossible to obtain these data from the study hospital and its risk management department. Thus, the self-report measure of error reports was used instead, as it was believed to be the closest measure of the actual number of error reports submitted by nurses. A similar item is used in the AHRQ HSOPSC (n.d.), but provides numeric categories for participants from which to choose. In this survey, respondents were asked to "Estimate the number of error reports you have completed in the last 12 months." This allowed for a count rather than categorical variable for the response, which provided greater flexibility in data analysis.

Safety Climate

Safety Climate is the shared perceptions and experiences of employees about the practices, policies, and procedures related to the safety of patients (Katz-Navon et al., 2005; Vogus et al., 2010). The Safety Climate Survey used in this study is a 21-item scale designed to measure individual perceptions of the unit level safety climate (Thomas, Sexton, Neilands, Frankel, & Helmreich, 2005). Scale items were scored with a 5-point Likert scale, with 1 corresponding to *poor safety climate* and 5 corresponding to *a very positive or very strong safety climate*.

The survey has previously been used in over 251 clinical units in 52 hospitals (Thomas et al., 2005) and is recognized and endorsed by the Institute for Healthcare Improvement, an organization dedicated to the improvement of healthcare (Kho, Carbone, Lucas, & Cook, 2005). The authors of the Safety Climate Survey indicated that the survey was developed based on similar surveys from the aviation industry (Thomas et al., 2005). The authors of the scale conducted focus groups with healthcare workers, consulted with subject matter experts, and conducted field testing to address the validity of the measure

(Thomas et al., 2005). However, they neither reported any results from a factor analysis of the safety climate survey, nor did they provide details on the reliability of the survey. Other researchers, who did a study comparing different measures of the safety climate, reported that the reliability of the Safety Climate Survey in their study, using Cronbach's alpha, was .86 (Kho et al., 2005). No other psychometric properties of the scale were identified from the published literature.

Prior to survey administration, psychometric and subject matter experts reviewed the items of the scale for face validity. In consultation with these experts, some of the items in the scale were altered for clarity or changed from a single item into two separate items. For example, one of the items read, "The physician and nurse leaders in my areas listen to me and care about my concerns." Because this question referred to both physicians and nurse leaders it was modified to be two separate items that read "The physician leaders on my unit listen to me and care about my concerns" and "The nurse leaders on my unit listen to me and care about my concerns." The original scale items and the changes to the items made for this survey of error reporting are found in Appendix 2.

Prior to data analysis, Item 21 from the *Safety Climate Survey,* "The staff on my unit frequently disregards established rules or guidelines" was reverse-coded. In a search of published literature on the Safety Climate Survey, no studies were found that reported an analysis of the survey dimensions through factor analysis (Colla, Bracken, Kinney, & Weeks, 2005). Thus, after data collection, an exploratory factor analysis of the scale items was conducted using principal axis factoring with Oblimin rotation. Examination of the Scree plot suggested that this scale had four factors. The 2-, 3-, and 4-factor solutions were reviewed. The 3-item solution was immediately eliminated because the majority of the scale

items (17 items) loaded on the first factor. Only two items loaded on the second factor and two items on the third factor. The 2-factor and 4-factor solutions were then examined to determine which was the best factor solution. The 2-factor solution was chosen because it provided two conceptually distinct factors without a great deal of overlap. Further, the 2-factor solution demonstrated good reliability of at least $\alpha = .70$ in both factors. After choosing the 2-factor solution, two items from Factor 1 were eliminated from the scale because they did not meet the criteria for item retention, a factor loading of at least 0.40 (Netemeyer, Bearden, & Sharma, 2003). The items that were eliminated from the original scale are noted in Appendix 3.

Factor 1 contained 15 items examining the support of unit leaders for safety, the degree to which errors were handled appropriately on the unit, the culture for learning from mistakes on the unit, and the degree to which respondents would feel safe being treated as a patient on the unit. These items all addressed elements of the safety climate that were specific to the environment of the nursing unit and were therefore titled *Safety Climate—Unit Environment*. This dimension of the safety climate survey was scored individually on a 5-point Likert scale, with 5 corresponding to *a very positive safety climate-unit environment*. Reliability of this dimension of the safety climate survey was assessed using Cronbach's alpha, which was .93, and the inter-item correlations ranged from .25 to .77. See Appendix 3 for the items included in the *Safety Climate—Unit Environment.*

Factor 2 had five items. These items assessed safety briefings on the unit that were generally attended by interdisciplinary team members and assessed the level of support provided by physician and pharmacy interdisciplinary staff. Because these items addressed the availability, interaction, and support of interdisciplinary staff on the unit, Factor 2 was

labeled *Safety Climate—Interprofessional Relationships*. Each item of the scale was scored on a 5-point Likert scale with 1 indicating poor interprofessional relationships on the unit and 5 indicating very positive interprofessional relationships on the unit. Cronbach's alpha was .77. The inter-item correlations ranged from .27 to .73. See Appendix 3 for the items included in the *Safety Climate Survey—Interprofessional Relationships.*

Leader Inclusiveness

Leader inclusiveness is defined as nurses' perceptions of the degree to which the words and actions of the unit nurse manager communicate an invitation of and appreciation for the contribution of the individual nurse (Nembhard & Edmondson, 2006). Leader inclusiveness was measured with the Inclusive Leadership Scale, a 9-item scale that was developed to measure individual worker perceptions of manager inclusiveness (Carmeli et al., 2010). Scale items were scored on a 5-point Likert scale, with 1 corresponding to *low degrees of leader inclusiveness* and 5 corresponding to *high degrees of leader inclusiveness* for the nurse manager of the unit.

Because the study was designed to assess team factors in nursing units, small changes were made to the original scale items to reflect the unit level of study. For example, the first item of the scale originally read, "The manager is open to hearing new ideas." This item was changed to read, "The manager on my unit is open to hearing new ideas." The original scale and the changes made to the items for this study are found in Appendix 4.

In creating the scale, the authors addressed the validity of the scale by first creating items that accurately reflected the three dimensions of leader inclusiveness: openness, availability, and accessibility (Carmeli et al., 2010). Next, they had 15 graduate students and 10 employees at the study site review the items in the scale and indicate the extent to which

each item reflected the construct it was designed to reflect. Any items that did not reflect the underlying construct or reflected more than one construct were removed from the scale. This process resulted in a 9-item scale with a one-factor solution.

To date, there are two identified published studies that have used the Inclusive Leadership Scale. Carmeli and colleagues (2010) developed the Inclusive Leadership Scale for a study of team engagement in creative tasks on the research and development units of eight high-tech firms. Cronbach's α for the scale in that study was .94. Hirak and others (2012) also used the Inclusive Leadership Scale to examine work team performance in 67 nursing units of a hospital (Hirak et al., 2012). They reported a Cronbach's α = .93 for the Inclusive Leadership scale.

The factor analysis conducted in this study affirmed a one-factor solution for this scale. The inter-item correlations ranged from .68 to .91. The high inter-item correlation suggests that the items in the scale are redundant, highlighting a weakness of this scale (Netemeyer et al., 2003). Internal consistency of the scale, using Cronbach's alpha, was .98.

Psychological Safety

Psychological Safety is the degree to which a nurse feels safe to speak up about issues or needs in the unit (Nembhard & Edmondson, 2006). The original psychological safety scale, developed by Edmondson (1999), included seven items, which were scored on a 7-point scale with 1 = "*very inaccurate*" to 7 = "*very accurate*." There are examples throughout the literature of researchers who have adapted the original 7-item scale to include four items (Nembhard & Edmondson, 2006), five items (Carmeli, Brueller, & Dutton, 2009; Carmeli et al., 2010), and six items (Baer & Frese, 2003; Kark & Carmeli, 2009; Lau & Murnighan, 2005). In previous published studies, the coefficient alpha for the psychological

safety measure has ranged from 0.67 to 0.82 (Baer & Frese, 2003; Carmeli et al., 2009; Edmondson, 1999; Kark & Carmeli, 2009; Lau & Murnighan, 2005; Leroy et al., 2012; Nembhard & Edmondson, 2006; Ortega et al., 2013). Specifically, α = .74 for the Carmeli et al. (2010) study, which used the same five items from the original 7-item scale used in this study.

In her development of the psychological safety scale, Edmondson (1999) addressed the validity of the scale by indicating that it was derived from theoretical constructs. Further, she used qualitative interviews to create the scale and then tested the scale through psychometric analysis. She indicated that discriminant validity was primarily addressed through factor analysis, which yielded a one-factor solution for psychological safety, thus supporting the validity of the scale to measure the concept of psychological safety. In the published study that described and tested the psychological safety scale, study results showed inter-item correlations that ranged from .28 to .48, with a Cronbach's α = .82.

Consistent with other studies (Carmeli et al., 2010), this study used five items from the original 7-item psychological safety scale (Edmondson, 1999). Prior to survey administration, some items were changed for clarity. For example, item 5 in the scale originally read, "No one on this team would deliberately act in a way that undermines my efforts." It was changed to read, "No one I work with would deliberately act in a way that undermines my efforts." The individual items of the scale were scored with a 5-item Likert scale with 1 corresponding to *low degrees of psychological safety* and 5 corresponding to *high degrees of psychological safety*.

Prior to data analysis in this study, Item 2 from the *Psychological Safety* scale, "People on my unit sometimes reject or ignore others for being different" was reverse coded.

Each item of the scale was scored on a 5-point Likert scale, with a score of 1 corresponding to low levels of psychological safety and a score of 5 corresponding to high levels of psychological safety. A factor analysis was performed, which confirmed a single factor scale. The mean inter-item correlation for the scale was poor at .30 and the inter-item correlations ranged from .06-.49. The Cronbach's alpha for the 5-item scale was .66. In particular, there was one item with poor inter-item correlation, and at least 2 study participants even commented in an open-ended section at the end of the survey that the item was confusing. The item read, "It is safe to take a risk on my unit." As a result, this item was dropped from the scale. The resulting Cronbach's alpha improved to .70, and the inter-item correlations ranged from .29 to .49 with a mean inter-item correlation of .39. See Appendix 5 for the original items from the *Psychological Safety Scale* and the items that were used in this study of error reporting.

Covariates

Nursing characteristics. Nursing characteristics are often included in studies of patient safety and outcomes as researchers try to determine characteristics of nurses that may significantly affect patient outcomes. A rationale was provided in Chapter 2 to explain why these nursing characteristics—nurse experience, nurse tenure, and nurse education—were included as covariates.

Nurse education. In this study, *nurse education* was defined as the highest level of nursing education possessed by nurses. This variable was measured as a categorical variable, and respondents were first asked to select their highest degree in nursing from the following choices: Diploma, associate degree in nursing (ADN), bachelor of science in nursing (BSN), master of science in nursing (MSN), or doctorate in nursing. Second, respondents were

asked to indicate their highest non-nursing degree from the following choices: no degree outside of nursing, diploma, associate degree, bachelor degree, master of business administration, master of health administration, master of public health, other master's degree, doctorate, or other. Nurses' responses were then assigned codes so that 1 = Diploma degree in nursing, 2 = ADN, 3 = BSN, and 4 = MSN or higher.

Nurse experience. *Nurse experience* was operationally defined as the length of time in years that an individual had practiced as a nurse. This variable was determined by asking nurses for the year of their original licensure to practice as a registered nurse and subtracting that date from the study year.

Nurse tenure. *Nurse tenure* was operationally defined as the length of time in years that an individual had been employed on the nursing unit where they currently worked. This variable was measured by asking respondents to provide the year they first began working on their current nursing unit and subtracting that date from the study year.

Nursing unit characteristics. The nursing unit characteristics examined in this study included nurse manager and unit specific characteristics that might help to explain error reporting on nursing units. A rationale was provided in Chapter 2 to explain why these covariates were included. The nursing unit characteristics included in this study were: nurse manager tenure, nurse manager education, unit size, and type of unit.

Nurse manager education. *Nurse manager education* was operationally defined as a nurse manager's highest level of education. This variable was measured in two different questions as a categorical variable. First, respondents were asked to select their highest degree in nursing from the following choices: Diploma, ADN, BSN, MSN, or Doctorate in Nursing. Second, respondents were asked to select their highest degree outside of nursing

from the following choices: No degree outside of nursing, diploma, associate degree, bachelor degree, master of business administration (MBA), master of health administration (MHA), master of public health (MPH), other master's degrees, or doctorate. Because all nurse managers had at least a BSN, and many had a master's degree outside of nursing, the data from these two questions was combined into the nurse manager education variable. The following dummy codes were assigned for data analysis: 1 = BSN and 2 = Master's degree or higher.

Nurse manager tenure. *Nurse manager tenure* was operationally defined as the length of time the nurse manager had served in his or her current position on the nursing unit. This variable was measured as the year a nurse manager started working in the role of manager on the unit. Nurse manager tenure was determined by taking the difference between this date and the study year.

Unit size. *Unit size* was operationally defined as the number of RN employees on the nursing unit. This variable was measured in two ways. First, as the number of RN employees (i.e., head count) on the unit, as reported by the nurse manager, and secondly, as the number of FTE RN employees on the unit, as reported by the nurse manager.

Type of nursing unit. The type of nursing unit was operationally defined as Medical/Surgical, Intensive Care Unit (ICU), Specialty, and Other. Each of the 49 patient care units represented in this study were assigned to these four catagories. After this initial assignment to *type of unit*, an expert in quality and safety who also works at the study hospital reviewed the assignment of units to catagories and made changes. Finally, an expert in organizaitonal research also reviewed the categories and unit assignments for agreement. The units were then coded so that each unit in the study was designated as a

Medical/Surgical (1 = yes; 0 = no), *ICU* (1 = yes; 0 = no), *Specialty* (1 = yes; 0 = no), or *Other* (1 = yes; 0 = no) type of unit.

Study Survey

The survey questionnaire for the study was comprised of four different instruments that measured the key study variables of error reporting, safety climate, leader inclusiveness, and psychological safety. The overall survey included a total of 46 items. Table 2 provides details on the study variables and covariates, and how they were collected.

Table 2

Study Variables, Level of the Variable, Type of Variable, and Source of the Variable

Variable	Individual	Unit	Categorical	Continuous	Nurse Survey	NM Survey
Error Reporting	X			X	X	
Safety Climate	X			X	X	
Leader Inclusiveness	X			X	X	
Psychological Safety	X			X	X	
Nurse Education	X		X		X	
Nurse Experience	X			X	X	
Nurse Tenure	X			X	X	
Nurse Manager Education		X	X			X
Nurse Manager Tenure		X		X		X
Unit Size		X		X		X
Unit Type	X	X	X		X	X

Note. NM Survey: Nurse Manager Survey.

Prior to survey administration, a panel of six experts reviewed the survey for clarity and in some cases made recommendations for wording changes to items in the survey. As a whole, the experts represented a knowledgeable panel with extensive experience in survey development and administration, psychometric analysis, quality and patient safety, and error reporting. In particular, one reviewer is a survey expert who teaches instrumentation and measurement and consults nationally and internationally as an expert on survey construction and instrumentation. Another reviewer consults throughout the university community and beyond on survey construction and administration. Two reviewers are experts from practice and are highly engaged in patient safety and quality as well as the measure of quality and safety in the hospital setting. Another reviewer is a statistician, and the final reviewer is an expert in the field of organizational study and the nursing workforce.

Human Subjects Protection

Approval to conduct this study was obtained from the Institutional Review Board (IRB) at the University of North Carolina at Chapel Hill as well as the nursing research council at the study site before beginning data collection. Consent to participate in the study was attached to both the online and paper surveys distributed to RNs (Appendix 6) and nurse managers (Appendix 7). Study participants indicated their consent to participate by choosing to advance to and submit the survey questions in the online survey or by completing and returning the paper survey. The study consent notified the study participants, both individual RN participants and nurse manager participants, that data collected were confidential. Further, the identities of the study hospital and nursing units were kept confidential. While nursing units were collapsed and labeled as broad specialty categories to be used for data analysis, they were not named.

Procedures

After receiving approval to conduct the study from the University of North Carolina at Chapel Hill IRB and the study site research council, the recruitment of participants and data collection began. A number of targeted approaches were used to maximize the response rate. These included the use of a study site coordinator, specific recruitment activities, and a survey implementation plan. These procedures are discussed in greater detail below.

Study Site Coordinator

A study site coordinator was identified in the study site hospital to facilitate sample recruitment and data collection. This individual was well connected in the study site, served as the chair of the organization's research council, and was a highly respected clinical nursing leader. The study site coordinator played an important role in recruitment and data collection by advising the researcher on the best ways to communicate with the organization's research council, staff hospital directors, nurse managers, and staff nurses in the hospital. This individual helped to troubleshoot any problems that arose, facilitated study communications by distributing recruitment fliers and paper surveys, and sent out all electronic communications to staff nurses and nurse managers.

Recruitment Activities

Study recruitment activities began on April 7, 2015, when the study investigator attended the Nurse Manager Forum Meeting, a monthly meeting of all nurse managers at the study site. At this meeting, the purpose of the study was explained by the study investigator to the nurse managers, who were provided time to ask questions about the study. The nurse managers were asked to make staff aware of the study and to encourage staff nurse participation. Nurse managers were also given a study packet for their individual unit, which

contained flyers to be posted on the nursing unit and in the staff break room. Paper surveys with stamped return envelopes addressed to the researcher were also provided for any staff nurses who preferred to complete a paper versus online survey. During this meeting, the nurse managers asked to be informed about their unit's response rates at regular intervals so that they could send out weekly email updates to staff members on all units. Thus, emails were sent to nurse managers during the recruitment period so they could communicate about the study with their staff and remind them of the opportunity to participate in the study. In addition to asking nurse managers to encourage staff nurses' participation in the study, the nurse managers themselves were also asked to participate in the study by completing the nurse manager survey.

Data Collection

There is anecdotal and research evidence suggesting that different groups of nurses show preference for different modes of electronic versus paper survey administration (VanGeest & Johnson, 2011). To account for this preference, both the staff nurse and nurse manager surveys were made available to prospective participants in paper and electronic format. Data collection for both paper and electronic surveys began on April 7, 2015 and ended on June 12, 2015.

Nurses who chose to complete the paper surveys were instructed to return their surveys via the United States Postal Service directly to the researcher. Nurse managers who chose to complete a paper survey were also instructed to return their surveys directly to the researcher or to the study site coordinator, who then forwarded the surveys to the researcher.

Electronic surveys for both the nurse and nurse manager surveys were developed to follow the flow of the paper surveys (including all skips and other patterns), and formatted

using Qualtrics, an online survey tool. Electronic responses for both nurses and nurse managers who completed their respective online surveys were captured via separate Qualtrics databases.

Survey Implementation

Nurse surveys. The paper surveys for the nurses at the study site were distributed through the nurse managers, who were asked to place the paper surveys along with attached stamped, addressed envelopes in the break room of the nursing unit. The researcher neither had face-to-face interaction with potential respondents, nor addresses with which to contact the respondents, either to distribute the paper surveys or to send paper reminders about the survey. As a result, the implementation of the paper survey was done in conjunction with the electronic version of the survey so that all reminders were sent through email to notify participants of the opportunity to participate in the study by either paper or electronic means. This methodology was chosen because the study site hospital routinely used email to communicate with all of their employees. Thus, every employee had access to a personal email account, and there were computers on all patient care units that allowed them to access their email. Further, the hospital predominantly used electronic means to communicate with the staff so that using only electronic communications for survey implementation was not perceived as problematic. Further details on the implementation of the nurse survey are provided in Table 3.

The original intent of the study investigator was to use a four-contact method of survey implementation so that as nurse managers posted fliers and paper surveys on the units, potential participants would also receive the first recruitment email (Dillman, Smyth, & Christian, 2009). However, unanticipated challenges in obtaining email addresses from the

hospital's Human Resources (HR) department for all nurses at the study site delayed the distribution of initial contact emails to nurses. There was a delay of almost two weeks from the distribution of the study fliers and paper surveys to receipt of the email of the initial contact emails. Ultimately, the study site coordinator was able to work with the HR department to obtain the email addresses for the staff nurses employed on study units of interest. There were also further difficulties in obtaining the email addresses, specifically for nurses working in the operating room (OR), delaying initial contact by an additional 1 to 1.5 weeks. These delays are reflected in the timeline shown in Table 3.

Table 3

Details on the Implementation of the Nurse Survey

Contact Date	Survey Implementation
April 7, 2015	**Contact 1:**[a] Paper versions of the nurse survey were given to NMs, who were asked to distribute them to nurses employed on the unit by making the survey packets available in their unit's break room.
April 21, 2015[b]	**Contact 2:** Initial recruitment email was sent to nurses at the study site, by the study site coordinator. The recruitment email included information on study participation and an electronic link to the survey, as well as information on the availability of paper surveys on the unit.
April 28, 2015[c]	**Contact 3:** First reminder email was sent to nurses at the study site by the study site coordinator and included information on study participation and an electronic link to the survey.
May 5, 2015[d]	**Contact 4:** Second reminder email was sent to nurses at the study site by the study site coordinator and included information on study participation and an electronic link to the survey.
May 13, 2015[e]	**Contact 5:** Third and final reminder email was sent to nurses at the study site by the study site coordinator and included information on study participation and an electronic link to the survey.

Note. [a] Ideally, Contact 1 and 2 should have occurred simultaneously rather than at separate times, but unanticipated events resulted in separate contacts; [b] April 29, 2015, was Contact 2 for nurses working in the OR; [c] May 5, 2015, was Contact 3 for nurses working in the OR; [d] May 13, 2015, was Contact 4 for nurses working in OR; [e] May 20, 2015, was Contact 5 for nurses working in the OR.

Nurse manager surveys. Paper surveys were distributed to nurse managers present at Nurse Manager Forum meetings in April and May 2015. The study investigator sent an electronic invitation to participate in the nurse manager survey to any nurse managers who did not submit a paper survey at the Nurse Manager Forum meeting in April 2015. Additional information on the timing of the nurse manager survey is provided in Table 4.

Table 4

Details for the Implementation of the Nurse Manager Survey

Contact Date	Paper Survey	Electronic Survey
April 7, 2015	**Contact 1:** Paper surveys were distributed at the nurse manager (NM) forum meeting, and completed surveys were collected.	
April 10, 2015		**Contact 1:** Initial recruitment email was sent to NMs by the study investigator and included information on study participation and an electronic link to the survey.
April 20, 2015		**Contact 2:** First reminder email sent to NMs by the study investigator reminding them of the study and included an electronic link to the survey.
April 27, 2015		**Contact 3:** Second reminder email sent to NMs by the study investigator reminding them of the study and included an electronic link to the survey.
May 4, 2015		**Contact 4:** Third and final reminder email sent to NMs by the study investigator reminding them of the study and included an electronic link to the survey.

Table 4

Cont.

Contact Date	Paper Survey	Electronic Survey
May 5, 2015	**Contact 2:** Paper surveys were distributed at the NM forum meeting by the study site coordinator, and completed surveys were collected and returned to the researcher.	

Note. NM: Nurse Manager.

Data Management and Analysis

Qualtrics, an online survey tool, was used for electronic survey data collection. Nurses and nurse managers who followed the electronic link provided to them via email completed the electronic survey. Paper surveys from both nurse managers and nurses were entered into Qualtrics by the researcher and then responses were double-checked against the paper version of the survey. After the paper surveys were entered into Qualtrics and double-checked, they were destroyed by shredding.

At the end of the data collection period, data were first downloaded into Excel spreadsheets and then imported into a SAS® dataset. Data from both the nurse and nurse manager surveys were cleaned, recoded as needed, and then merged into a single data file for analysis. The data analysis for this study was conducted using SAS® software, Version 9.4 (TS1M1) of the SAS System for Windows 8 [Copyright © 2002-2012 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA].

Descriptive statistics and correlations were conducted. The outcome variable for the study, error reporting, was defined and measured in two ways that necessitated the use of

different methods of analysis to answer the research questions. The first measure of error reporting was *nurses' perceptions of error-reporting frequency on the unit*, measured with the frequency of event reporting scale that yielded a mean score. The second measure of error reporting was *nurses' reporting of errors on the unit*, measured as nurses' estimates of the number of error reports submitted over the last 12 months. A discussion of how the data were analyzed is organized by the research questions of the study and these two different measurements of the outcome variable, error reporting.

How Do Safety Climate and Leader Inclusiveness Affect Error Reporting?

Research question 1 was first answered by using linear mixed models with random effects. Linear mixed modeling with random effects was chosen over ordinary least squares (OLS) linear regression because an underlying assumption of OLS regression is that observations are statistically independent, or mutually exclusive (Cohen, Cohen, West, & Aiken, 2003). However, because individual nurses work on nursing units in hospitals, and the data collected from nurses is clustered or correlated due to this organizational structure, an assumption of independence cannot be made (Liang & Zeger, 1993). Therefore, to account for any intra-unit correlation, linear mixed models with random effects representing the intra-unit correlation were used to analyze the data for this question.

After analyses for RQ1 were completed for nurses' perceptions of error reporting on their unit, an analysis of the covariates was conducted, again using linear mixed methods. Any covariates that significantly predicted nurses' perceptions of error reporting on their unit were then included in the linear mixed models to answer RQ1 with the addition of significant covariates.

Next, Poisson regression models with generalized estimating equations (GEE) were used to regress the number of error reports submitted by nurses in the last 12 months on safety climate-unit environment, safety climate-interprofessional relationships, and leader inclusiveness. Poisson regression was chosen for these analyses because the estimate of error reports submitted in the last 12 months was a count variable (Cohen et al., 2003), and GEE was used to address the correlated nature of the data (Der & Everitt, 2006).

After analyses for RQ1 were completed for the number of error reports submitted by nurses in the last 12 months, an analysis of the covariates was conducted using Poisson regression with GEE. Any covariates that significantly predicted this measure of error reporting were then included in the Poisson regression models to answer RQ1 with the addition of significant covariates.

How Do Safety Climate and Leader Inclusiveness Affect Psychological Safety?

Research question 2 was answered by using linear mixed models to regress the mean score for psychological safety on safety climate-unit environment, safety climate-interprofessional relationships, and leader inclusiveness. Next, an analysis of covariates was performed to determine if any covariates significantly predicted psychological safety. Since none of the study covariates significantly predicted psychological safety, no further analyses were conducted to address RQ2.

How Does Psychological Safety Affect Error Reporting?

Research question 3 was first answered using linear mixed models to regress the mean score for nurses' perceptions of frequency of error reporting on psychological safety. Next, any significant covariates were added to the models. Research question 3 was then answered a second time with Poisson regression models with GEE to regress the number of

error reports submitted by nurses in the last 12 months on psychological safety. Afterward, any significant covariates were added to the Poisson regression models with GEE.

Do Safety Climate and Leader Inclusiveness Indirectly Affect Error Reporting Through Psychological Safety?

Research question 4 addressed the mediating effect of psychological safety on the relationship between safety climate-unit environment and error reporting; safety climate-interprofessional relationships and error reporting; and leader inclusiveness and error reporting. For both measures of error reporting, nurses' perceptions of error reporting on the unit, and the number of error reports submitted by nurses in the last 12 months, the same basic steps were used to answer RQ4. However, the models used differed so that linear mixed models were used for nurses' perceptions of error reporting, and Poisson regression models with GEE were used for the number of error reports submitted by nurses.

There were four steps to the mediation analysis, the four steps of the causal steps approach of Baron and Kenny (1986) for addressing mediation. Step 1 assessed the total effect of the individual predictor variables (safety climate-unit environment, safety climate-interprofessional relationships, and leader inclusiveness) on the outcome variable (error reporting). In order to establish a mediating effect, Step 1 of the mediation analysis does not have to be significant, but the remaining steps (Step 2, Step 3, and Step 4) must all be significant (Kraemer, Kiernan, Essex, & Kupfer, 2008). Step 2 assessed the effect of the individual predictor variables (safety climate-unit environment, safety climate-interprofessional relationships, and leader inclusiveness) on the mediator variable, psychological safety. Step 3 assessed the direct effect of the individual predictor variables (safety climate-unit environment, safety climate-interprofessional relationships, and leader

inclusiveness) controlling for the mediator variable (psychological safety) on the outcome variable, nurse perceptions of error reporting. Finally, Step 4 assessed the indirect effects of the predictor variables (safety climate-unit environment, safety climate-interprofessional relationships, and leader inclusiveness) on the outcome variable (error reporting) through the mediator (psychological safety).

For the outcome variable of nurses' perceptions of frequency of error reporting on the unit, linear mixed models were used to address Steps 1, 2, and 3 of the mediation analysis. Step 4 was addressed by using bootstrap confidence intervals, with bias correction, to account for the change in slope (MacKinnon, Lockwood, & Williams, 2004; Preacher & Hayes, 2004; Shrout & Bolger, 2002). Simplified, the bootstrapping method is a process that samples one observation from the total number of complete observations in the dataset (n = 779), and then replaces the observation in the dataset before sampling another single observation. This process is then repeated until a resample with the same sample size as the original sample is obtained. In this study the resampling generated 1000 bootstrap samples, which were used with bias correction to compute confidences intervals for the indirect effect of psychological safety. An advantage to using the bootstrapping method is that a mediation analysis can be conducted with a smaller sample size (Shrout & Bolger, 2002). These computations were performed using macros available at http://www.unc.edu/~gknafl/ software.html from Dr. George Knafl (gknafl@unc.edu, Chapel Hill, NC, USA). Once all four steps of the mediation analysis were completed for nurses' perceptions of frequency of error reporting, the significant covariates were added to the models and Steps 1-4 were repeated.

The same 4-step mediation analysis was used for the error-reporting measure of the number of error reports submitted in a 12-month period. Steps 1-3 of the mediation analysis were conducted using Poisson regression models, because of the count outcome variable, with GEE, to account for intra-unit correlations. Step 4 of the mediation analysis was again conducted using bootstrap confidence intervals, with bias correction, to account for the change in slope using macros available at http://www.unc.edu/~gknafl/software.html from Dr. George Knafl (gknafl@unc.edu, Chapel Hill, NC, USA). Once the 4-step mediation analysis was completed for the number of error reports submitted by nurses, the significant covariates were added to the models and the 4-step mediation analysis was repeated.

Summary

This chapter provided a review of the study methodology. The research study used a cross-sectional, descriptive design to examine the effect of safety climate, leader inclusiveness, and psychological safety on error reporting. The study was conducted in a single academic medical center in the southeastern U.S. with a convenience sample of nurses and nurse managers working predominantly in the inpatient setting. Data were collected with a survey that was available to potential participants in either paper or electronic format, using four scales to measure the dependent and independent variables of the study. Error reporting was defined in two ways, as nurses' perceptions about the frequency of error reporting on the unit and as the number of error reports submitted by nurses; separate analyses were therefore used to answer the research questions of the study. Altogether, the research questions were answered using linear mixed models, Poisson regression with GEE, and bootstrapping confidence intervals with bias correction. The results of the data analyses of the study are discussed in Chapter 4.

CHAPTER 4

FINDINGS

This chapter presents the findings from this study that examined the effect of nursing unit factors—safety climate, leader inclusiveness, and psychological safety—on error reporting by nurses. The chapter begins with a description of the study sample followed by a description of the study variables. Next, the results of the analyses are presented for each of the study research questions. The chapter ends with a summary of the major study findings.

Description of the Sample

Response Rate and Sample Size

There were 1,922 RNs employed on 50 nursing units at the study site who were recruited to participate in this study. Of those nurses, 924 responded to the survey, for a response rate of 48.1%. Of the nurses who responded to the survey, 96.5% completed the web-based version of the survey and the remaining 3.5% completed the paper version. Nurses representing 53 units at the study hospital responded to the survey by following the web-based link that was posted on recruitment flyers, but data were only usable from nurses in 49 units. The sample sizes reported in analyses ranged from 687 to 924, depending on missing data and the relationships being examined.

The 50 nursing units at the study site, which were the focus of recruitment efforts, had one nurse manager with administrative responsibilities for overseeing patient care delivery on each unit. Of the nurse managers on the 50 units, 43 responded to the survey,

which represents a response rate of 86%. Most of the nurse manager respondents (72.1%) completed the paper version of the survey, while the remainder (27.9%) completed the web-based version of the survey.

Missing Item Values

There were missing responses for all of the scales used in this study. Consistent with other studies, values were imputed for individuals who had no more than 30% missing items for any given scale (Hillen et al., 2015; Roth, Switzer, & Switzer, 1999). A number of methods for imputing missing items exist. In this study, the individual mean approach was used for missing items so that an individual's mean score for the scale was used to replace no more than 30% of missing item values from a single scale. This approach is considered superior to other methods (e.g., single imputation, where the total mean score on the scale for all participants is used to impute missing values) because the individual's mean score likely best represents their views on a phenomenon, rather than the mean value for all participants (Newman, 2014; Peyre, Leplege, & Coste, 2011; Roth et al., 1999).

In total, values for 91 observations (2.2%) were imputed due to missing data for each of the scales in the study. Specifically values for 5 out of 876 observations (0.6%) were imputed in the frequency of event reporting scale (i.e. *nurses' perceptions of error reporting frequency on the unit*); 50 out of 824 observations (6.1%) were imputed for the safety climate-unit environment (i.e., *safety climate*); 9 out of 822 observations (1.1%) were imputed for the safety climate-interprofessional relationships (i.e., *safety climate*); 20 out of 847 observations (2.4%) were imputed for the inclusive leadership scale (i.e. leader inclusiveness); and 7 out of 842 observations (0.8%) were imputed for the psychological safety scale (i.e., psychological safety).

Description of the Variables

Sample Characteristics

The characteristics of the nurses in the study sample and the units on which they worked are displayed in Appendix 8. The nurses who participated in the study had an average of 11.7 years of experience as a nurse and were employed on their current unit for an average of 6.1 years. The majority of nurses in the sample had a bachelor of science in nursing (BSN) degree (68.4%). Because there were so few nurses with an earned doctorate (n = 3) and the number was too small to generate meaningful results, doctorally-prepared nurses were combined with MSN-prepared nurses (n = 48) in subsequent analyses.

For nurse manager participants, the average tenure as the nurse manager on their current unit was 5.3 years, but their tenure ranged from less than one year to a maximum of 26 years. The educational preparation of nurse managers was almost evenly split with 54.4% of nurse managers prepared with the highest degree of BSN and 43.5% of nurse managers prepared with a master's degree. Similar to the nurses in the study, the number of nurse managers with a doctorate (n = 1) was so small that it was combined in the category of nurse managers with a master's degree in subsequent analyses (n = 20).

Descriptive Statistics of Study Variables

The means, standard deviations (*SD*), and minimum and maximum values for the study variables are presented in Appendix 9. The mean score for nurses' perceptions of error reporting on their unit was 3.4 (*SD* = 0.9). Overall, nurses perceived that error reporting "sometimes" occurred on their unit. The number of error reports submitted by each nurse during a 12-month period was reported to be approximately two error reports per year (*SD* = 3.5), but the range in the number of error reports reported by nurses was great, from zero to

40 reports per year. The mean score for the safety climate-unit environment was 3.9 (*SD* = 0.7) while the safety climate-interprofessional relationships had a mean score of 3.7 (*SD* = 0.8), which means that overall the nurses on the units perceived that the unit environment and interprofessional relationships on their unit were good. The mean score for leader inclusiveness was 4.0 (*SD* = 1.0), which means that nurses working units at the study site perceived their managers to be inclusive leaders. Finally, the mean score for nurses' perceptions of psychological safety was 3.9 (*SD* = 0.7), meaning that nurses who participated in the survey felt positive psychological safety on their units. All in all, the nurses who responded to the survey perceived that in their units there was positive safety climate, positive leader inclusiveness, and positive psychological safety.

Relationships between Study Variables

The Pearson correlation coefficients for the relationships between the continuous dependent variables, independent variables, and covariates of the study are found in Appendix 10. Nurses' perceptions of error-reporting frequency on the unit were positively associated with the study variables of safety climate-unit environment, safety climate-interprofessional relationships, leader inclusiveness, and psychological safety. Safety climate-unit environment was positively associated with safety climate-interprofessional relationships, leader inclusiveness, and psychological safety but negatively associated with nurse manager tenure and unit size. Safety climate-interprofessional relationships was positively associated with leader inclusiveness and psychological safety but not with any of the nursing characteristics or nursing unit characteristics. Leader inclusiveness was positively related to psychological safety, nurse experience, and nurse tenure but negatively related to nurse manager tenure and unit size. Psychological safety was negatively associated

with nurse manager tenure and unit size. Nurse experience was positively related to nurse tenure. While tenure of nurses on the nursing unit was positively related to nurse manager tenure, it was negatively related to the size of the nursing unit (number of RN employees and number for RN FTEs).

The correlations for nurse manager tenure and unit size were analyzed separately because both nurse manager tenure and unit size represent nursing unit characteristics measured at the nursing unit level (Appendix 11). Nurse manager tenure was not significantly associated with either measure of unit size (number of RN employees and number of RN FTEs). The two measures of unit size were also positively related.

Covariate Selection

The covariates included in this study were nurse education, nurse experience, nurse tenure, nurse manager education, nurse manager tenure, unit size, and type of unit. Covariates were examined to select the covariates that would be used in the examination of dependent variables for the research questions of the study. Specifically, covariates were examined for the dependent variables of psychological safety, error reporting measured as nurses' perceptions of error reporting frequency on the unit, and error reporting measured as the number of error reports submitted by nurses in the past 12 months. The process used to examine covariates is described next.

Covariate analysis for psychological safety. A standard *t*-test was used to assess whether nurse education significantly influenced nurses' perceptions of psychological safety. Specifically, the four types of academic degrees (diploma, ADN, BSN, and MSN or higher) were examined individually to determine if any type of degree had a significant effect on psychological safety. Because of the continuous nature of the variables of nurse experience

and tenure, and since both of these variables were measured at the individual level, Pearson correlation coefficients were used to determine if these two covariates were significantly related to nurses' perceptions of psychological safety.

The remaining unit-level covariates (nurse manager education, nurse manager tenure, unit size, and type of unit) were examined using linear mixed models with random effects to account for within unit correlation and to assess the influence of these covariates on nurses' perceptions of psychological safety. The types of nurse manager education (BSN or master's degree or higher) and the four types of nursing units (medical/surgical, ICU, specialty, or other) were each assessed individually to determine whether type of nurse manager degree and type of nursing unit individually predicted nurses' psychological safety. None of the covariates significantly predicted nurses' psychological safety (Appendix 12).

Covariate analysis for error reporting (nurses' perceptions). For the covariate of nurse education, again, a standard *t*-test was used to assess the influence of each type of academic degree (diploma, ADN, BSN, MSN or higher) on nurses' perceptions of error reporting. Pearson correlation coefficients were used to assess the covariates of nurse experience and nurse tenure. The unit level covariates of nurse manager education, nurse manager tenure, unit size, and type of unit were assessed using linear mixed models with random effects to account for within unit correlations. For the categorical variables of nurse manager education and type of unit, separate models were created for each of the categories of the variables.

The results of the covariate analyses conducted for nurses' perceptions of error-reporting frequency on the unit are included in Appendix 13. There were a number of significant covariates for error reporting. A diploma degree in nursing was positively related

to nurses' perceptions of error reporting, but no other nursing degrees had a significant effect on nurses' perceptions of error reporting. Nurse manager education, specifically at the BSN and at the master's degree or higher levels, had a significant effect on nurses' perceptions of error reporting. However, on units led by BSN-prepared nurse managers, there was a negative relationship between nurse manager education and nurses' perceptions of error reporting, such that nurses working on units with a BSN-prepared manager perceived that fewer errors were reported. On units led by nurse managers with a master's degree, there was a positive relationship between nurse manager education and nurses' perceptions of error reporting, with nurses on these units perceiving that more errors were reported.

Covariate selection for error reporting (number of reports submitted). Because the second measure of error reporting—number of error reports submitted by nurses in the last 12 months—was a count variable, Poisson regression models were used to regress error reporting on the covariates. For unit level variables, GEE was used to account for within unit correlations. For categorical variables (i.e., nurse education, nurse manager education, and type of nursing unit), separate models were estimated for each variable. Results for these covariate analyses are reported in Appendix 14. Possessing a master's degree or higher was positively related to the number of error reports that nurses reported submitting. Nurse tenure was also positively related to the number of error reports submitted by nurses, so that the longer nurses worked on a specific unit, the fewer errors they reported submitting. Nurse manager education was both positively and negatively related to the number of error reports submitted by nurses. Nurses working on units with BSN-prepared managers submitted fewer error reports, while those who worked on units with a nurse manager prepared at the master's degree or higher level submitted greater numbers of error reports. Finally, working on *other*

types of nursing units (e.g., procedural units or clinics) negatively predicted the number of error reports submitted by nurses, such that nurses working on these types of units submitted fewer error reports.

Major Study Findings

The major findings of the study are organized by the four research questions that were addressed in this study. Analyses were first conducted without model covariates to maximize the sample size; the results of those analyses are reported first. Next, the significant covariates for the corresponding outcome variables (Appendix 13 and Appendix 14) were added to models one at a time. All remaining significant covariates were added to the models with the respective predictor and outcome variables. If any covariates were no longer significant, they were removed from the model so that only significant covariates remained with the predictor and outcome variables. Where significant, the results of the analyses with covariates included are reported below. The conceptual model for the study, which illustrates the relationships examined by the research questions, is presented at the variable level in Figure 4.

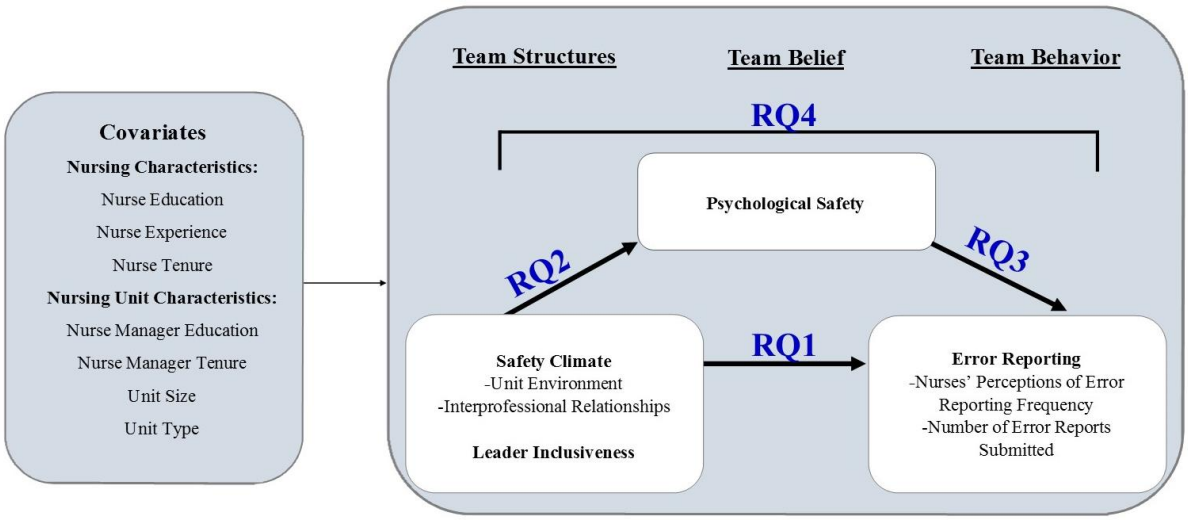


Figure 4. Conceptual model for the study with identified research questions.

Research Question 1: How Do Safety Climate and Leader Inclusiveness Affect Error Reporting?

This question was first examined using linear mixed models with random effects to account for within unit correlations. The results of the analyses, shown in Table 5, were all statistically significant and demonstrated that nurses' perceptions of safety climate, both the unit environment and interprofessional relationships, positively affected nurses' perceptions of error-reporting frequency on their unit. Further, the results showed that nurses' perceptions of the inclusiveness of their nurse managers also positively affected their perceptions of error-reporting frequency on the nursing unit where they worked.

Table 5

The Effect of Safety Climate and Leader Inclusiveness on Perceptions of Error Reporting

	n	*df*	Estimated Slope	*t* value	*p* value
Model 1					
Safety Climate-Unit Environment	788	738	0.59	12.45	< .01
Model 1 with Covariates					
Safety Climate-Unit Environment	788	738	0.59	12.59	< .01
Nurse manager education: BSN		47	–0.30	–3.59	< .01
Model 2					
Safety Climate-Interprofessional Relationships	787	737	0.45	10.76	< .01
Model 2 with Covariates					
Safety Climate-Interprofessional Relationships	787	737	0.44	10.89	< .01
Nurse manager education: BSN		47	–0.26	–3.41	< .01
Model 3					
Leader Inclusiveness	811	761	0.24	7.20	< .01
Model 3 with Covariate					
Leader Inclusiveness	811	761	0.25	7.39	< .01
Nurse manager education: BSN		47	–0.27	–3.21	< .01

Note. *df* = Degrees of Freedom; BSN: Bachelor of Science in Nursing.

Research question 1 was also examined using nurses' estimates of the number of error reports submitted in a year. Because this was a count variable, Poisson regression analyses with GEE was used to account for within unit correlations. The results of the analyses are presented in Table 6 and indicated that safety climate, both the unit environment and the interprofessional relationships, negatively predicted the number of error reports submitted by nurses so that the more positively nurses perceived the safety climate-unit environment and the safety climate interprofessional-relationships, the fewer error reports they submitted. The results also demonstrated that nurses' perceptions of the inclusiveness of the nurse manager on their unit negatively predicted the number of error reports submitted. Nurses working on units with higher levels of leader inclusiveness reported submitting fewer error reports than those working on units with lower levels of leader inclusiveness.

Next, the analyses were repeated with the addition of significant covariates (Appendix 14). The results presented in Table 6 demonstrated that safety climate-unit environment negatively predicted the number of error reports submitted when controlling for nurses' tenure on the unit and nurse managers' education (master's degree or higher). In addition, the results demonstrated that safety climate-interprofessional relationships negatively predicted the number of error reports submitted by nurses when controlling for the tenure of nurses on the unit where they worked and nurse manager education (i.e., master's degree or higher). Finally, leader inclusiveness negatively affected the number of error reports submitted by nurses when controlling for nurse managers' education (master's degree or higher).

Table 6

The Effect of Safety Climate and Leader Inclusiveness on the Number of Error Reports

	n	Estimated Slope	SE	Z score	95% CI		*p* value
					LL	UL	
Model 1							
Safety Climate-Unit Environment	792	-0.22	.08	-2.60	-0.38	-0.05	<.01
Model 1 with Covariates							
Safety Climate-Unit Environment	742	-0.22	.09	-2.62	-0.39	-0.06	.01
Tenure		-0.02	.01	-2.23	-0.04	-0.002	.03
Nurse Manager Education: Master's degree or higher		0.83	.20	4.11	0.44	1.23	<.01
Model 2							
Safety Climate-Interprofessional Relationships	791	-0.33	.11	-3.18	-0.54	-0.13	<.01
Model 2 with Covariates							
Safety Climate-Interprofessional Relationships	742	-0.33	.08	-4.12	-0.49	-0.17	<.01
Tenure		-0.02	.01	-2.47	-0.03	-0.004	.01
Nurse Manager Education: Master's degree or higher		0.86	.21	4.13	0.45	1.27	<.01
Model 3							
Leader Inclusiveness	814	-0.18	.07	-2.58	-0.31	-0.04	<.01
Model 3 with Covariates							
Leader Inclusiveness	814	-0.17	.06	-2.82	-0.29	-0.05	<.01
Nurse Manager Education: Master's degree or higher		0.81	.20	4.11	0.42	1.19	<.01

Note. SE: standard error; CI = confidence interval; LL = lower limit, UL = upper limit.

Research Question 2: How Do Safety Climate and Leader Inclusiveness Affect Psychological Safety?

Research Question 2 was answered using linear mixed models with random effects to model within-unit correlation and fixed effects to model psychological safety, safety climate-unit environment, safety climate-interprofessional relationships, and leader inclusiveness. The results, displayed in Table 7, show that nurses' perceptions of the safety climate of their

unit, both the unit environment and the interprofessional relationships, predicted their feelings of psychological safety. Additionally, nurses' perceptions about leader inclusiveness positively affected their feelings of psychological safety.

Table 7

The Effect of Leader Inclusiveness and Safety Climate on Psychological Safety

	n	*df*	Estimated Slope	*t* value	*p* value
Model 1 Safety Climate-Unit Environment	789	739	0.68	20.7	< .01
Model 2 Safety Climate-Interprofessional Relationships	788	738	0.36	10.8	< .01
Model 3 Leader Inclusiveness	809	759	0.27	10.4	< .01

Note. *df* = Degrees of Freedom

Research Question 3: How Does Psychological Safety Affect Error Reporting?

Research question 3 assessed the effect of psychological safety on error reporting; thus, data was analyzed in two ways to determine the effect of psychological safety on nurses' perceptions of error reporting frequency as well as the effect of psychological safety on the number of error reports submitted by nurses. First, linear mixed models with random effects were used to assess the effect of psychological safety on nurses' perceptions of error reporting. The results of the analysis, presented in Table 8, indicated that the psychological safety of nurses positively affected their perceptions of error reporting on the unit. Next, the analysis was repeated with the addition of significant covariates (Appendix 13). The results showed that psychological safety positively affected nurses' perceptions of error reporting when controlling for nurse managers' education (BSN). In other words, holding the effect of nurse managers' education constant (BSN), more positive levels of psychological safety by

nurses was associated with nurses' perceptions of greater frequency of error reporting on the unit.

Table 8

The Effect of Psychological Safety on Nurses' Perceptions of Error Reporting

	n	*df*	Estimated Slope	*t* value	*p* value
Model 1					
Psychological Safety	805	755	0.28	6.56	<.01
Model 1 with Covariate					
Psychological Safety	805	759	0.29	6.51	<.01
Nurse Manager Education: BSN		47	-0.24	-2.95	<.01

Note. *df* = Degrees of Freedom; BSN: Bachelor of Science in Nursing.

Poisson regression models with GEE were then used to determine the effect of psychological safety on the number of error reports nurses reported submitting during a 12-month period. These results indicated that the psychological safety of nurses negatively affected the number of error reports they submitted. In particular, the more psychologically safe nurses felt, the fewer error reports they indicated submitting in the past year. Next, the analysis was repeated with the addition of significant covariates (Appendix 14). The results of these analyses, shown in Table 9, demonstrate that psychological safety negatively affected the number of error reports submitted by nurses when controlling for nurse tenure and nurse manager education (master's degree or higher). In other words, more positive levels of psychological safety by nurses was associated with fewer numbers of error reports by nurses when controlling for the length of time nurses worked on the unit and for the nurse managers' education (master's degree or higher).

Table 9

The Effect of Psychological Safety on Number of Error Reports Submitted

	n	Estimated Slope	SE	Z score	95% CI		*p* value
					LL	UL	
Model 1							
Psychological Safety	809	-0.19	.09	-2.04	-0.37	-0.01	.04
Model 1 with Covariates							
Psychological Safety	742	-0.22	.10	-2.34	-0.41	-0.04	.02
Nurse Tenure		-0.02	.01	-2.34	-0.04	-0.003	.02
Nurse Manager Education: Master's degree or higher		0.87	.20	4.24	0.46	1.26	<.01

Note. SE: standard error; CI = confidence interval; LL = lower limit, UL = upper limit.

Research Question 4: Do Safety Climate and Leader Inclusiveness Indirectly Affect Error Reporting Through Psychological Safety?

To address Research Question 4, mediation testing was first used to determine whether psychological safety mediated the relationship between the safety climate, both unit environment and interprofessional relationships, and nurse perceptions of error reporting, as well as the relationship between leader inclusiveness and nurses' perceptions of error reporting frequency on the unit. There were four steps used in this mediation analysis. Briefly, and as described in Chapter 3, Step 1 assessed the total effect of the individual predictor variables (safety climate-unit environment, safety climate-interprofessional relationships, and leader inclusiveness) on the outcome variable, nurses' perceptions of error reporting. Step 2 assessed the effect of individual predictor variables (safety climate-unit environment, safety climate-interprofessional relationships, and leader inclusiveness) on the

mediator variable, psychological safety. Step 3 assessed the direct effect of the individual predictor variables (safety climate-unit environment, safety climate-interprofessional relationships, and leader inclusiveness) and the mediator variable (psychological safety) on the outcome variable, nurse perceptions of error reporting. Finally, Step 4 assessed the indirect effects of the predictor variables (safety climate-unit environment, safety climate-interprofessional relationships, and leader inclusiveness) on the outcome variable (nurse perceptions of error reporting) through the mediator (psychological safety).

Steps 1, 2, and 3 were conducted using linear mixed models with random effects to account for any within unit correlation. Step 4 of the mediation analysis was conducted using bootstrap confidence intervals with bias correction and 1000 resamples on the change in slope (MacKinnon et al., 2004; Preacher & Hayes, 2004; Shrout & Bolger, 2002; Knafl, personal correspondence, http://www.unc.edu/~gknafl/software.html). In the mediation analysis, only observations with no missing data were used to maintain consistent sample sizes for all of the mediation models. Doing so reduced the sample size for all steps of the mediation analysis (n = 779). The findings from the mediation analysis for Steps 1, 2, and 3 are found in Table 10, and Step 4 is found in Table 11. Taken together, these findings indicated the following: (a) psychological safety mediated the relationship between safety climate-interprofessional relationships and nurses' perceptions of error reporting, (b) psychological safety did not mediate the relationship between safety climate-unit environment and nurses' perceptions of error reporting, and (c) psychological safety mediated the relationship between leader inclusiveness and nurses' perceptions of error reporting.

Table 10

Steps 1-3 of the Mediation Analysis for Psychological Safety

Mediation Analysis	*n*	*df*	Estimated Slope	*t* value	*p* value
Step 1					
Safety Climate-Unit Environment	779	729	0.59	12.3	< .01
Safety Climate-Interprofessional Relationships	779	729	0.45	10.7	< .01
Leader Inclusiveness	779	729	0.03	7.02	< .01
Step 2					
Safety Climate-Unit Environment	779	729	0.68	20.7	< .01
Safety Climate-Interprofessional Relationships	779	729	0.37	10.9	< .01
Leader Inclusiveness	779	729	0.27	10.5	< .01
Step 3					
Safety Climate-Unit Environment	779	728	0.61	10.3	< .01
Psychological Safety	779	728	-0.04	-0.69	.49
Safety Climate-Interprofessional Relationships	779	728	0.40	8.94	< .01
Psychological Safety	779	728	0.14	3.03	< .01
Leader Inclusiveness	779	728	0.19	5.17	< .01
Psychological Safety	779	728	0.20	4.22	< .01

Note. *df* = Degrees of Freedom.

Table 11

Step 4 of the Mediation Analysis for Psychological Safety

Mediation Analysis[a]	95% Lower Bound	Mid-Value	95% Upper Bound
Step 4			
Leader Inclusiveness	0.03	0.05	0.08
Safety Climate—Interprofessional Relationship	0.02	0.05	0.08

Note. [a]Bootstrap confidence intervals with bias correction and 1000 resamples were used for the analysis.

Next, the four-step mediation analysis was repeated with the addition of significant covariates. The results of this analysis with significant covariates for each step of the analysis are displayed in Tables 12 and 13. Despite the addition of covariates to the mediation analysis, the effect of psychological safety on the relationship between safety climate-unit environment and nurses' perceptions of error reporting was not significant. Thus, even after the addition of significant covariates, there was no evidence to support psychological safety as a mediator between safety climate-unit environment and nurses' perceptions of error reporting.

Another mediation analysis was conducted to determine whether psychological safety mediated the relationship between safety climate and leader inclusiveness and the number of error reports submitted by nurses. The results of this analysis did not support the role of psychological safety as a mediator (Appendix 15). Next, the mediation analysis was repeated with the addition of significant covariates. Again, no support was found for psychological safety as a mediator of the relationship between safety climate-unit environment or interprofessional relationships and the number of error reports submitted by nurses, or of the relationship between leader inclusiveness and the number of error reports submitted by nurses (Appendix 16).

Table 12

Steps 1-3 of the Mediation Analysis for Psychological Safety with Significant Covariates

Mediation Analysis	*n*	*df*	Estimated Slope	*t* value	*p* value
Step 1					
Safety Climate-Unit Environment	779	729	0.59	12.5	< .01
-Nurse Manager Education (BSN)		47	-0.29	-3.47	< .01
Safety Climate-Interprofessional Relationships	779	729	0.45	10.8	< .01
-Nurse Manager Education (BSN)		47	-0.25	-3.20	< .01
Leader Inclusiveness	779	729	0.24	7.21	< .01
-Nurse Manager Education (BSN)		47	-0.28	-3.34	< .01
Step 2					
Safety Climate-Unit Environment	779	729	0.68	20.7	< .01
Safety Climate-Interprofessional Relationships	779	729	0.37	10.9	< .01
Leader Inclusiveness	779	729	0.27	10.5	< .01
Step 3					
Safety Climate-Unit Environment	779	728	0.61	10.4	< .01
Psychological Safety		728	-0.04	-0.75	.45
-Nurse Manager Education (BSN)		47	-0.29	-3.49	< .01
Safety Climate-Interprofessional Relationships	779	728	0.40	9.05	< .01
Psychological Safety		728	0.14	3.08	< .01
-Nurse Manager Education (BSN)		47	-0.25	-3.24	< .01
Leader Inclusiveness	779	728	0.19	5.33	< .01
Psychological Safety		728	0.19	4.18	< .01
-Nurse Manager Education (BSN)		47	-0.28	-3.25	< .01

Note. *df* = Degrees of Freedom; Bachelor of Science in Nursing

Table 13

Step 4 of the Mediation Analysis for Psychological Safety with Significant Covariate

Mediation Analysis [a]	95% Lower Bound	Mid-Value	95% Upper Bound
Step 4			
Safety Climate-Interprofessional Relationships -Nurse Manager Education (BSN)	0.02	0.05	0.07
Leader Inclusiveness -Nurse Manager Education (BSN)	0.03	0.05	0.08

Note. BSN: Bachelor of Science in Nursing; [a]Bootstrap confidence intervals with bias correction and 1000 resamples were used for the analysis.

Additional Analyses

Because there were two measures for the outcome variable of error reporting in this study, and because the results for those two measures demonstrated seemingly conflicting results, an additional analysis was conducted to determine whether nurses' perceptions of error reporting predicted the number of error reports they submitted over a year (Appendix 17). Poisson regression models were used with GEE to model the within unit correlations. The results of the analyses were not statistically significant. Next, the model was repeated with the addition of significant covariates (Appendix 14). These results also indicated that, even after controlling for significant covariates, nurses' perceptions of error reporting did not predict the number of error reports they submitted (Appendix 17).

Summary of Study Results

The major findings of this study suggested that nurses' perceptions of safety climate-unit environment, safety climate-interprofessional relationships, and leader inclusiveness positively affected nurses' perceptions of error reporting frequency on the unit when

controlling for nurse manager degree (BSN). In contrast, safety climate-unit environment, after controlling for nurse tenure and nurse managers' education (master's degree or higher), negatively predicted the number of error reports submitted by nurses. Safety climate-interprofessional relationships, after controlling nurse managers' education (master's degree or higher), negatively predicted the number of error reports submitted by nurses. Also, leader inclusiveness, after controlling for nurse managers' education (master's degree or higher), negatively affected the number of error reports nurses submitted during the previous 12-month period. Thus, while safety climate and leader inclusiveness positively affected *nurses' perceptions of error reporting frequency on the unit*, those same variables negatively affected the *number of error reports that individual nurses reported submitting* over a 12-month period.

Study findings also demonstrated that the psychological safety of nurses was positively affected by their perceptions of the safety climate-unit environment, their perceptions of the safety climate-interprofessional relationships, and their perceptions of the inclusiveness of their nurse manager. Further, nurses' perceptions of psychological safety positively affected their perception of error reporting on the unit when controlling for nurse managers' education (BSN), but negatively affected the number of error reports they submitted when controlling for nurse tenure on the unit and nurse managers' education (master's degree or higher).

The mediation analyses showed that psychological safety mediated the relationship between safety climate-interprofessional relationships and nurses' perceptions of error reporting on the unit when controlling for nurse managers' education (BSN). Psychological

safety also mediated the relationship between leader inclusiveness and nurses' perceptions of error reporting when controlling for nurse managers' education (BSN).

Finally, additional analyses were performed to determine whether there was a relationship between the two measures of error reporting in this study, nurses' perceptions of error reporting and the number of error reports submitted by nurses over a 12-month period. The results of those analyses, even after controlling for significant covariates, indicate there was no relationship between these two measures of error reporting.

Chapter Summary

This chapter presented the results of analyses examining the relationship between nursing unit or team factors (safety climate, leader inclusiveness, and psychological safety) and error reporting. With few exceptions, the regression models predicted that safety climate, both unit environment and interprofessional relationships, leader inclusiveness, and psychological safety positively affected nurses' perceptions of error-reporting frequency on the unit and negatively affected the number of error reports submitted by nurses on the unit. Further, the mediation analyses indicated that psychological safety is an important mediator between safety climate-interprofessional relationships and nurses' perceptions of error reporting frequency on the unit and also between leader inclusiveness and nurses' perceptions of error reporting. The models allowed the most important variables affecting nurses' error reporting behaviors to be identified and allowed research questions to be tested.

Chapter 5 will discuss major study findings, including possible explanations of the findings in light of current trends in nursing and health care. Specific recommendations will be made regarding practice and policy-making, future research and data collection efforts to

improve our understanding of nurses' error reporting behaviors, and foster better reporting of errors among health care professionals.

CHAPTER 5

DISCUSSION

Knowledge of and about error reporting is essential for nursing and healthcare leaders. This study was conducted to add to the existing body of knowledge by investigating factors associated with and impacting nurses' error reporting. The model of work-team learning guided the selection of salient variables for study (Edmondson, 1999). Study questions aimed to identify whether the nursing team factors of safety climate, leader inclusiveness, and psychological safety influenced nurses' error-reporting behaviors.

This chapter presents a discussion of major study findings. The first section contains a summary of research findings and general conclusions drawn from these findings relative to error reporting. The chapter is organized by the relationships examined in the study, followed by a discussion of the significant covariates to error reporting, and additional analyses that were completed. Next, study limitations are explored followed by an examination of the implication of study findings for future theory, research, practice, and policy.

Before proceeding, it should be noted that almost all of the major findings in this study were statistically significant. However, because there was a large sample size for the study, care should be used in interpreting these findings when the reported correlation is less than .30. Thus, there are some findings that are statistically significant, but the practical

value of the findings should be interpreted with caution when only a small amount of variance is explained by the independent variable.

Summary and Interpretation of Major Study Findings

The Effect of Safety Climate and Leader Inclusiveness on Error Reporting

The findings from this study demonstrated that nurses' perceptions of the safety climate on their unit (as unit environment and interprofessional relationships) and the leader inclusiveness of their nurse manager positively predicted perceptions of the frequency of error reporting on their unit. These findings are consistent with the model of work-team learning, which posits that context support (i.e., safety climate in this study) and team leadership (i.e., leader inclusiveness in this study) affect team learning behavior (i.e., error reporting in this study). This finding is also consistent with prior research that demonstrates a positive relationship between unit-level climate and nurse manager leadership with error reporting by clinicians (Edmondson, 1999; Richter et al., 2014). Thus, if the nursing unit is perceived to have a strong safety climate and nurse managers are perceived to be inclusive leaders, nurses believe that the error-reporting practices on their unit are such that more errors and near misses are reported.

The study also demonstrated that both dimensions of safety climate and leader inclusiveness negatively predicted the number of error reports that nurses acknowledged submitting. Findings suggest that a stronger safety climate and positive leader inclusiveness result in fewer error reports submitted by nurses. This is a surprising finding, given that these same factors positively predicted nurses' *perceptions* of error reporting.

One possible explanation for this finding comes from qualitative studies that have identified alternate reporting methods that sometimes replace the submission of formal error

reports by nurses. Espin and colleagues (2007) reported that nurses engaged in both formal error reporting (i.e., error reports submitted through a hospital's error-reporting system) and informal error reporting (i.e., verbally discussing errors with team colleagues or manager). They noted that when nurses chose to informally report errors across professions (e.g., to a physician) that the behavior depended on the degree of confidence they felt in their relationships with team colleagues. These same mechanisms may be at work on nursing units with strong team safety climates and leadership. When nurses feel supported by the team structures in place, they feel free to discuss errors that occur with their team colleagues and nurse managers in a way that fulfills their obligation to formally report errors. In contrast, nurses who work in less supportive environments, characterized by nurses' perceptions of a weaker safety climate and lower levels of leader inclusiveness by the nurse manager, may submit more error reports because the available reporting option allows them the security of anonymity and confidentiality.

An alternate explanation for the findings is that nurses' perceptions of positive safety climates and leader inclusiveness on nursing units lead to safer care. Thus, there are fewer error reports on these nursing units because there are actually fewer errors. There is some evidence from the literature that this may be the case. For example, Hofmann and Mark (2006) reported that safety climate on nursing units was negatively associated with the actual number of medication errors, which the researchers measured as the number of errors reported that resulted in "harm" to patients. Vogus and Sutcliffe (2007) also observed that more positive team leadership and safety organizing on the nursing unit resulted in fewer reported medication errors. However, error detection has been described as a confluence of the number of actual errors that occur as well as the willingness of clinicians to report. Thus,

the explanation of why more positive safety climates and inclusive leadership behaviors in nursing units predicted fewer numbers of error reports in this study is likely more complex than just differing reporting methods or altogether safer care.

Another explanation of the difference in findings may be due to the fact that the two measures of error reporting had a different focus. The measure of nurses' perceptions of error reporting was worded such that nurses were responding to their perceptions of error reporting on their unit. In contrast, the number of error reports submitted by nurses was worded in such a way that the item reflected individuals' behaviors. So it could be that the differences in findings are attributable to how the items were measured because nurses' perceptions of reporting on the unit differed from their own, individual reporting behavior. Ultimately, the study findings emphasize the need for better measures of error reporting and more sophisticated research methods that can uncover and better explain how team factors affect error reporting.

The Effect of Safety Climate and Leader Inclusiveness on Psychological Safety

The findings from this study indicate that both safety climate and leader inclusiveness positively affected psychological safety; that is, nurses who worked in teams with a strong safety climate and for inclusive nurse managers reported higher levels of psychological safety. These findings provide support for the model of work-team learning and also demonstrate that safety climate, an area of context support, and leader inclusiveness, a type of team leadership behavior, are important elements of team structure that influence team safety beliefs and the psychological safety of the team (Edmondson, 1999). Therefore, safety climates in units and leader inclusiveness of nurse managers are both important influences on nurses' perceptions of psychological safety.

The Effect of Psychological Safety on Error Reporting

This study's findings indicated that psychological safety positively affected nurses' perceptions of error reporting on the unit, so that higher levels of psychological safety were associated with higher levels of nurses' perceptions of the frequency of error reporting on their unit. These findings demonstrate that psychological safety is important in determining how nurses perceive the reporting practices on their unit. When nurses experience greater psychological safety, they perceive that there is more error reporting occurring on their unit. These findings, in fact, support and are consistent with the model of work-team learning.

The study findings also indicated that psychological safety negatively affected the number of error reports that nurses recall submitting during the past year, so that higher levels of psychological safety was associated with nurses submitting fewer error reports. This finding may be explained by the fact that, as nurses feel safer, they also engage in more informal reporting such as discussing errors face-to-face with managers and peers. This informal error reporting, in turn, is believed to take the place of error reporting through a hospital's formal reporting systems.

However, this explanation does not help to put into context the results that lower levels of psychological safety were associated with nurses submitting a higher number of error reports. These findings are difficult to explain in light of research suggesting that psychological safety is a shared team belief stemming from team members feeling safe talking about errors and raising concerns encountered in the work environment (Edmondson, 1996, 1999). In this context, one would expect that when psychological safety is poor, nurses would shy away from speaking up about errors. Perhaps these findings demonstrate that nurses who work in unhealthy work environments, characterized by a manager whose

behaviors do not convey the inclusive leadership behaviors of openness and accessibility to staff and a climate in which safety is not prioritized, submit more error reports because the error reporting systems provides them a confidential and anonymous option for reporting errors. In other words, nurses working in settings where they do not feel psychologically safe may choose to report errors through confidential and anonymous error reporting systems because they feel more psychologically safe doing so. This explanation is supported by past research demonstrating that nurses sometimes use error reporting as a defensive tool to protect themselves from the possibility of perceived future threats (Lederman et al., 2013). It may be inferred that in circumstances where nurses do not feel safe speaking directly with their managers or peers about unsafe practices, they submit a greater number of anonymous error reports through the error-reporting system because they view this as a "safe" way to document problems and put them in the hands of others who can address problems they observe in patient care and, at the same time, fulfill their fiduciary responsibility of reporting the error and protecting themselves from negative repercussions.

The findings that psychological safety positively predicted nurses' perceptions of error reporting and negatively predicted the number of error reports submitted by nurses are confusing. The difference in results is likely due to differences in the measurement of error reporting. These seemingly opposing findings highlight the need for better measures of error reporting.

The Mediating Effect of Psychological Safety

This study's results indicated that psychological safety mediated two relationships in the model. First, the findings demonstrated that psychological safety mediated the relationship between one dimension of the safety climate, interprofessional relationships, and

nurses' perceptions of error reporting. This is interesting because psychological safety only mediated one aspect of safety climate (interprofessional relationships) and because the dimension it mediated relates to relationships with and availability on the unit of physicians and other clinicians (i.e., pharmacists). Thus, this finding emphasizes the importance of psychological safety in explaining the relationship of interpersonal aspects of safety climate and error reporting. Past studies examining nurses' use of formal and informal reporting practices also reported that many nurses feared speaking up about errors they observed, especially when the error related to someone with higher levels of authority and scope of practice (e.g., physicians), which points to the power differential that nurses often feel when interacting with physicians (Espin et al., 2007, 2010). The findings from this study suggest that psychological safety helps to explain how the interprofessional aspects of safety climate affect nurses' perceptions about error reporting.

Second, psychological safety mediated the relationship between leader inclusiveness and nurses' perceptions of error reporting frequency. In other words, leader inclusiveness indirectly affected nurses' perceptions of error reporting through psychological safety. Notably, the study did not find support for psychological safety as a mediator between either dimension of safety climate and the number of error reports submitted by nurses or the relationship between leader inclusiveness and the number of error reports submitted by nurses. Past studies have not examined the mediating role of psychological safety between team factors and error reporting. This study suggests that in some cases, psychological safety helps to explain how team factors affect error reporting. Thus, there is a need for more study to help us better understand the situations and contexts in which psychological safety helps to explain the relationships between team factors and error reporting.

Study Covariates

Nurse characteristics. Several individual-level nurse characteristics were examined in this study based on past research: nurse education, nurse experience, and nurse tenure. Only one of these characteristics, nurse education, was predictive of nurses' perceptions of error-reporting frequency on the unit. Specifically, nurses with a diploma degree perceived that when errors occurred on their unit, they were reported with greater frequency than did nurses with different educational preparations. Based on this study and existing research on error reporting, it is difficult to draw meaningful conclusions about this finding. However, it may be that nurses with a diploma degree hold more positive attitudes about the work environment than nurses from other educational backgrounds, and/or are more aware of how and when to report errors through their educational and practice experiences and assume that others on their unit behave similarly.

Two nurse characteristics, nurse education and nurse tenure, were predictive of the number of error reports submitted by nurses. First, nurses with a master's degree or higher reported submitting the highest number of error reports. This finding may partially be explained because nurses, through master's and doctoral programs, become more aware of and knowledgeable about the importance of error reports in organizations, and in turn report more errors. It could also mean that nurses with higher levels of education are more vigilant in reporting errors to protect themselves and their organization from risk.

The second significant covariate for the number of error reports submitted by nurses was nurse tenure: there was an inverse relationship between tenure and the number of error reports nurses recalled submitting on their units. In other words, nurses employed on their units for a longer period of time recalled submitting fewer error reports. This finding may

indicate that nurses who have been employed on a unit for a longer period of time have a better understanding of what constitutes an error and report errors more appropriately. The finding may also mean that nurses with greater unit tenure overlook many errors that occur on the unit, prioritize the reporting of errors based on the impact to patients, or feel less inclined to report errors to protect themselves or their unit colleagues. For these reasons, it is difficult to draw conclusions about this finding, but further examination of nurses' unit tenure and error reporting is warranted.

Nursing unit characteristics. Several nursing unit characteristics were also included as covariates in the study: nurse manager education, nurse manager tenure, unit size, and type of unit. One of these, nurse manager education, predicted nurses' perceptions of frequency of error reporting on the unit. Specifically, nurses who worked on a unit where the nurse manager had a bachelor's degree in nursing as their highest degree perceived a lower frequency of error reporting on their unit, while nurses who worked on a unit where the nurse manager held a master's degree or higher perceived a higher frequency of error reporting. Similarly, nurse managers' education levels significantly predicted the number of error reports submitted by nurses on the unit. Nurses who worked on a unit led by a nurse manager with a bachelor's degree reported submitting fewer error reports, while nurses who worked on a unit with a nurse manager prepared with a master's degree or higher reported submitting more error reports.

One explanation for these findings is that nurse managers who are prepared with a graduate degree may have a greater understanding of error reports and foster learning from errors throughout the unit. Thus, nurses who work on these units value error reporting in a way that nurses working on units with managers prepared with bachelor's degrees do not.

Another possibility is that nurses working on units with managers prepared with master's degrees are led in a way that is different than those who work on units led by nurse managers with a bachelor's degree. This fundamental difference in unit leadership may result in different reporting behaviors by nurses. For example, nurses working on units led by master's prepared nurse managers may perceive they are empowered to participate in decision-making regarding error reporting and the frequency of error reporting, which fosters increased reporting of errors. Interestingly, nurse manager education was the only variable where both measures of error reporting (nurses' perceptions of error-reporting frequency on the unit and the number of error reports nurses recalled submitting in a year) responded in the same way (i.e., positively) to an independent variable.

The other significant nursing unit level covariate in the study was the type of nursing unit on which nurses worked. There were four types of nursing units identified in the study: medical/surgical, ICU, specialty, and other. The only type of unit that had a significant effect on the number of error reports submitted by nurses was the unit categorized as *Other*. The *Other* type of units included procedural units and outpatient clinics, as well as other types of non-ICUs that were neither medical-surgical nor specialty care units. Specifically, working on an *Other* unit negatively predicted the number of error reports submitted by nurses. There are many possible reasons that nurses working in these types of units acknowledged reporting fewer errors. For example, it is possible that these types of units have fewer errors because of the nature of the care delivered on these units. Or perhaps the patient populations, such as outpatient clinics where fewer activities like medication administration occur, might create fewer opportunities for errors to actually occur. It is also possible that the teams on these types of units function differently so that the teams communicate more face-to-face or

through other informal reporting practices than through the formal error-reporting system. Ultimately, there is not enough information in the data to clearly determine why these types of units submitted fewer error reports. However, this finding does suggest that further research is needed to help explain the differences in error reporting between types of units.

The Relationships between the Two Measures of Error Reporting

In seeking to make sense of the study findings, further statistical analyses were conducted to determine the relationship between nurses' perceptions of the frequency of error reporting on the unit and the number of error reports nurses acknowledged submitting during the 12-month period preceding the survey. These analyses did not reveal a significant relationship between the two measures of error reporting, even after controlling for covariates. On the surface, this suggests that there is a disconnect between nurses' perceptions of error reporting frequency on the nursing unit and their actual reporting behavior, to the extent that actual behaviors can be determined via the use of a self-report measure of error reporting. It may also be that because nurses' perceptions of error reporting focused on unit level reporting behaviors, and the estimate of the number of error reports focused on the individual level of error reporting behavior, nurses viewed these two measures of error reporting differently.

Thus, measurement issues may explain the difference in findings. Interestingly, AHRQ (2015) recently released a statement indicating they removed several items from the newest version 2.0 of the HSOPSC. Two of the items that were changed or removed from the survey were from the *Frequency of Event Reporting Scale* (AHRQ, n.d.), used in this study to measure nurses' perceptions of error reporting frequency on their unit. This suggests that there may have been measurement issues related to these two items that

prompted AHRQ to remove them from future versions of the survey. Altogether, the differences in findings between the two measures of error reporting in this study are puzzling and highlight the need for deeper study of error reporting.

Summary of Major Findings

In summary, this study's findings demonstrated that safety climate and leader inclusiveness on unit-level teams positively predicted nurses' perceptions of error reporting. Further, the study demonstrated that those same team factors of safety climate and leader inclusiveness positively affected psychological safety, which in turn positively predicted nurses' perceptions of error reporting. Finally, psychological safety mediated the relationship between the interprofessional relationships dimension of safety climate and nurses' perceptions of error-reporting frequency on the unit, as well as the relationship between leader inclusiveness and nurses' perceptions of error-reporting frequency on the unit. Thus, psychological safety helped to explain how these two variables that reflect team relationships, safety climate-interprofessional relationships, and leader inclusiveness affected nurses' perceptions of error-reporting frequency on nursing units in hospitals.

The study findings also demonstrated that the team factors of safety climate, leader inclusiveness, and psychological safety all negatively predicted the number of error reports that nurses submitted through error-reporting systems. These findings were surprising because they do not support the model of work-team learning, which would lead us to believe that these team factors should positively, not negatively, predict the number of error reports submitted by nurses. Thus, alternate explanations for the findings were explored. First, there is the possibility that nurses who work on nursing units with more positive team factors of leader inclusiveness, safety climate, and psychological safety may choose more informal

error reporting methods over submitting error reports through the formal error-reporting system. Another explanation might be that nursing units with more positive team factors actually make fewer errors, and therefore they submit fewer error reports because there are fewer errors that actually occur. Ultimately, the study findings reinforce the complex nature of error reporting in hospitals that have been reported by others (Lederman et al., 2013). Altogether, this study's findings raise important implications for future research.

Limitations

There are a number of limitations in this study that must be addressed. First, the study used a cross-sectional design to answer the study's research questions, which means that the findings reported represent one snapshot in time. This limitation is especially important to highlight relative to the team factors examined in this study: safety climate, leader inclusiveness, and psychological safety. It may be that the perceptions and beliefs held by team members about the nursing team factors examined in the study actually change over time and their relationship to error reporting could change as well. Thus, there is a need for future study that investigates team factors over time to establish whether some of the findings observed in this study remain. Further, the use of mediation analysis implies causality that cannot be fully supported with cross-sectional, non-experimental data (MacKinnon & Fairchild, 2009; Wong & Laschinger, 2015). At best, any conclusions about causality from this study should be viewed cautiously and causation can only be suggested from the theoretical framework, in combination with the study's findings (Wong & Laschinger, 2015). Instead, this study can be used to provide support for and further elucidate aspects of the underlying theoretical framework and to lay the groundwork for future study.

Second, the study was conducted in a single hospital. As a result, the study findings are not widely generalizable and should be interpreted cautiously. However, the findings demonstrate that the nursing unit factors included in this study exert an important effect on error reporting, and that further study is needed to better tease apart how those factors work together to influence error reporting. This study provides important information that can inform the conduct of future study, which will be discussed in the next section.

Third, there were limitations related to measurement of study variables. At the outset of the study, the intent was to have a perceptual measure of error reporting (i.e., nurses' perceptions of error-reporting frequency on the unit) and an objective measure of error reporting (i.e., the actual number of error reports submitted to the error-reporting system at the study site). However, the study investigator was unable to obtain permission from the study site hospital to use the actual number of error reports submitted to the error-reporting system. As a result, the second measure of error reporting was a self-report measure from study participants, which posed a risk for recall bias because participants were asked to estimate the number of error reports they submitted over the last year. In addition, the two measures of error reporting used in the study produced significant but different findings. Further statistical analysis revealed that the two measures were not related.

There were also problems with other scales in the study. For example, there was no identified evidence from the literature that the safety climate survey had ever been factor analyzed. When a factor analysis was performed in this study, there was support for at least a 2-factor solution. In addition, the 5-item psychological safety scale used in this study had poor reliability with an initial $\alpha = .66$. When a single item was removed because study participants found it confusing and because it had poor inter-item correlation, the Cronbach's

alpha improved to .70. Finally, the leader inclusiveness scale demonstrated high inter-item correlations suggesting that scale items were redundant. Every scale used in this study was problematic, which may have affected the study findings and highlights the need for more valid and reliable measures of the variables of interest.

There were also a number of limitations related to the use of a survey questionnaire for data collection. Because a survey questionnaire was used to collect data for the study, there was no opportunity to explore, in particular, why the two measures of error reporting generated such different results. While the survey included an open-ended question at the end of the questionnaire that allowed study participants to provide additional information they wanted the investigator to be aware of, this question did not provide the level of detail needed to understand the stark difference in results between the two measures of error reporting. This suggests that qualitative or mixed methods studies would better enable researchers to understand and explain how team factors influenced error reporting by nurses and why nurses' perceptions of error reporting on the unit differ from the number of error reports they submit.

The questionnaire was offered to participants in paper form or as a web-based survey. Web-based surveys are an efficient and cost-effective way to collect data, but in order to ensure anonymity, there was no way to prevent respondents from participating in the survey multiple times or to ensure that they completed the survey before submission (Heiervang & Goodman, 2011). As a result, there were a number of surveys in this study that only had partial responses or missing data. This limitation was addressed in the data analysis by only using complete responses for the statistical modeling.

A final limitation of this study is common method bias, defined as variance from the method of measurement rather than from the variables themselves (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). The greatest risk for common method bias arises from the use of perceptual measures for both the independent and dependent variables of the study. The three major independent variables used in the study and one measure of the dependent variable, nurses' perceptions of frequency of error reporting on the unit, all used perceptual measures and all gathered data from the same source, nurses in a single hospital. As a result, there is a risk of common method bias that represents a threat to validity (Craighead, Ketchen, Dunn, & Hult, 2011). A number of methods were used to address the risk for common method bias. First, the survey was anonymous, and participants were encouraged to answer as honestly as possible. Second, study participants were told that their participation was voluntary, and they could leave any questions they did not want to answer blank or could stop the survey at any time. These tactics were used to address the apprehension that individuals may feel related to participating in the study and to minimize any perceived need to answer questions in a socially desirable way (Chang, van Witteloostuijn, & Eden, 2010). Third, there were different measures of the dependent variable for the study, even though responses from these measures did not come from different sources. By using different types of measures, participants may not answer in a mindless way, but instead they have to adjust their response to a different type of question, which may help to address common method bias (Chang et al., 2010). Finally, more complicated regression models were used, with some models testing for mediation. The more complex the regression models, the more unlikely that common method bias is a threat because the relationships examined are outside what participants would anticipate on their own (Chang et al., 2010).

Implications for Practice and Policy

The study findings have important implications for practice as well as policy. First, the study findings indicated that when safety climate, leader inclusiveness, and psychological safety were more positive, nurses reported fewer errors, but when those same team factors were more negative, nurses reported more errors. These findings raise important questions about how error reports are viewed and utilized by leaders in healthcare organizations. That is, do hospital administrators view error reports as a way to learn, understand, and improve processes and outcomes of care? Or do they single out individuals who are involved in errors? Or do they use error reporting as a way to manage associated risks?

Hospital leaders are encouraged to embrace error reports as a way to improve the quality and safety of care delivered, which was also advocated over a decade ago by the IOM (2000). Leaders can do this by communicating with staff about the tangible ways that error reports are used to improve safety in hospitals so that clinicians understand the value of error reporting for creating safer healthcare systems and improving care to patients. When clinicians understand how error reporting improves the safety of care for patients, they are much more likely to engage in this activity. Hospital leaders should also assess the degree to which error reporting in their facility is currently used for learning and improvement. It may be that hospitals need better methods for reviewing errors and implementing changes within the system to prevent future errors from occurring. Thus, leaders should explore how error reports are currently used in their hospital and the extent to which this information can better be used and applied to quality improvement efforts.

Second, it is possible that known barriers to error reporting (e.g., the time-consuming nature of reporting, knowledge deficits about what constitutes a reportable event) frequently

cited by researchers (Hartnell et al., 2012; Jeffe et al., 2004; Kaldjian et al., 2008; Mayo & Duncan, 2004; Taylor et al., 2004) may help to explain why more positive team factors resulted in fewer error reports by nurses in this study. Organizations should work to address known barriers to error reporting while remembering that the goal is not necessarily to increase the number of formal error reports per se, but rather to foster the appropriate reporting of errors so that organizational learning and improvement can occur. Thus, hospital leaders might consider alternate methods of error reporting that work in combination with existing error reporting systems to provide clinicians with a way to report errors that is less time consuming and more compatible with their primary focus of patient care. In addition to existing error reporting systems, some hospitals have successfully implemented phone error-reporting systems that allow clinicians to call a secure phone number within the organization and report errors (Jeffe et al., 2004; Kaprielian, Østbye, Warburton, Sangvai, & Michener, 2008). Quality improvement specialists then review and route the error reports for further review and analysis by groups within the organization who can create action plans to improve the system in a way that works to prevent similar errors from reoccurring (Kaprielian et al., 2008).

Third, this study's findings raise important questions about the education level of nurse managers. Specifically, nurses who worked on units where the nurse manager had a master's degree or higher acknowledged submitting more error reports. One explanation for this finding is that nurses who worked for nurse managers with a graduate degree were exposed to ideas and activities that contributed to their broader understanding of the importance of error reporting to improving patient care, which translated to greater perceptions of and engagement in error reporting by these nurses. More research is needed to

determine if this is the case, but as organizations look to establish policies that target ways they can improve the quality and safety of care delivered to patients, considering the effect of the education level of nurse managers on their nurses may be important in developing strategies for enhancing safety behaviors on and improving the safety climate of the teams they lead.

Implications for Future Research

The relationship between the team factors in this study and error reporting are not well-explained in the current literature, and the findings of this study highlight the difficulty in explaining exactly how safety climate, leader inclusiveness, and psychological safety affect error reporting. In part, the inability to explain these relationships is due to the research design used in the study—a non-experimental, cross-sectional survey design. Future studies of error reporting should use different designs, such as mixed methods, that allow researchers to explore and explain how these team factors influence error reporting. Further, there is a need for studies that use a longitudinal design. By collecting data over time, studies could minimize the risk of common method bias and help researchers determine whether the identified effects of the team factors examined in this study are consistent over time, especially with respect to error reporting. Longitudinal or repeated measures would also enable mediation testing that allows researchers to better infer causality, which is beyond the scope of a cross-sectional study.

A second implication for future research is the need for valid and reliable measures for studying error reporting in hospitals. There were numerous issues identified in the limitations section that pertain to the measurement scales used in this study. These problems highlight the need for reliable and theoretically sound measures that accurately reflect error

reporting, as well as team factors such as safety climate, leader inclusiveness, and psychological safety. Without sound methods of measurement, the findings from studies and the ability of researchers to accurately draw conclusions are seriously threatened. Future research should thus focus on meeting this need by developing theoretically based and psychometrically robust measures for studying error reporting.

Another important implication for research is the need for greater clarity in how errors and error reports are used and interpreted by researchers, which is closely tied to how errors are measured. There is great diversity in how errors are measured. Some studies measure errors as clinicians' perceptions about error reporting frequency (Hillen et al., 2015; Richter et al., 2014) or the number of error reports submitted to a hospital's error-reporting system (Katz-Navon et al., 2005; Vogus & Sutcliffe, 2007), and still others use a combination of methods to measure errors, such as chart reviews and hospital error reporting systems (Edmondson, 1996). The findings of this study suggest that nurses' perceptions of error reporting are distinct from the number of error reports they submit. Thus, future researchers should use caution when using and interpreting perceptions of error reporting. When more robust measures are used (i.e., multiple ways of measuring errors as advocated by Edmondson, 1996), then stronger conclusions can be drawn that support and expand our understanding of error reporting as well as safety in hospitals.

This study provides evidence that the nursing team factors of safety climate, leader inclusiveness, and psychological safety are important to error reporting. However, the exact relationships of these factors to error reporting are not fully understood based on this study's findings. Future research is therefore needed that builds on the findings of this study to

include both quantitative and qualitative methodologies, which might better explain how team factors interact to affect error reporting.

Finally, studies are needed to determine the effects of error reports on organizational learning and ultimately outcomes of care. While this level of examination was beyond the scope of the current study, there is evidence to suggest that errors are underreported in hospitals (Levinson 2012; Sari et al., 2006; Taylor et al., 2004), yet remain essential to organizational learning in hospitals (Edmondson, 2004; IOM, 2000). Until organizational researchers can demonstrate that error reports are a vehicle through which organizational leaders can learn from errors to improve systems of care in a way that future errors are prevented, there may be little emphasis on using error reporting as a way to learn from mistakes and provide safer care. Thus, research is needed that establishes a link between error reports, learning at the team and organizational levels, and important outcomes of care related to safety and quality.

In summary, this study provides several implications for future research. First, there is a need for diverse methods of research in hospitals that do not solely rely on survey data and staff perceptions when studying organizational phenomena. Second, the validity of measures used in this and other studies of healthcare organizational phenomena indicate a strong need for more accurate and precise measures of complex variables. Third, this study's findings challenge researchers to use more robust measures of error reporting in order to further the science and our collective understanding about error reporting and patient safety in hospitals. Fourth, this study's findings emphasize the importance of further investigations of the team factors of safety climate, leader inclusiveness, and psychological safety in relation to error reporting and suggests that different study methodologies that incorporate

both quantitative and qualitative data might help to better explain how team factors in hospitals affect error reporting. Finally, research is needed that establishes a link between error reports, learning at the team and/or organizational level, and outcomes of care.

Implications of the Findings to Theory

This study's findings suggest that the team factors investigated in this study, rooted in the model of work-team learning, are important to the phenomenon of error reporting. The study findings partially support the model of work-team learning by demonstrating that there is a positive relationship between safety climate, leader inclusiveness, and psychological safety. These relationships are important because to the investigator's knowledge, this is the first time that the model of work-team learning has been applied to studying nursing teams in hospitals. The findings of this study reinforce the supposition that team context support and team leadership behavior are important to the team beliefs about safety purported by the theoretical model. In addition, the results of the study further support the model by demonstrating that psychological safety mediates the relationships between one aspect of safety climate, interprofessional relationships, and nurses' perceptions of error reporting, as well as the relationship between leader inclusiveness and nurses' perceptions of error reporting.

However, the difference in findings between the two measures of error reporting (i.e., perceptions about frequency of error reporting and number of error reports) raises important questions about the use of the model of work-team learning in studying error reporting. Based on the study findings, it may be that error reporting is a precursor to team learning behavior, such that error reporting informs organizations to learn. Future research is needed to more fully explore the role of error reporting in teams and how teams learn from error

reporting. The model of work-team learning introduces important constructs and concepts for studying error reporting. Future research is needed to more fully understand how those constructs and concepts relate to error reporting and team learning in nursing units.

Summary and Conclusions

This study demonstrates that the team dynamics of safety climate, leader inclusiveness, and psychological safety are important to error reporting. This knowledge is important for nurse and health care leaders and researchers, who can use this study's findings as a basis for developing and evaluating improved methods for error reporting and in turn delivering safe, high-quality, patient care. Error reporting in hospitals is a complex phenomenon that warrants additional study. Only when the importance of error reporting to organizational learning is thoroughly examined and better understood will future improvements in care delivery be achieved. Insights gained from this and future studies can be used by healthcare leaders to design and implement more effective systems for delivering safe, high-quality care to patients in hospitals. As continued emphasis is placed on improving quality and patient safety in hospitals, understanding how to enhance error reporting is necessary for the purpose of preventing errors and significantly improving the systems of healthcare delivery.

APPENDIX 1: FREQUENCY OF EVENT REPORTING SCALE

Frequency of Event Reporting (AHRQ, n.d.)	
Items from the Original Scale	*Items as Used in the Survey for this Study*
1. When a mistake is made, but is caught and corrected before affecting the patient, how often is this reported?	1. When an error is made on this unit, but is caught and corrected before affecting the patient, how often is it reported?
2. When a mistake is made, but has no potential to harm the patient, how often is this reported?	2. When an error is made on this unit, but has no potential to harm the patient, how often is it reported?
3. When a mistake is made that could harm the patient, but does not, how often is this reported?	3. When an error is made on this unit that could harm the patient, but does not, how often is it reported?

APPENDIX 2: SAFETY CLIMATE SURVEY

Safety Climate Survey (Thomas et al., 2005)	
Items from the Original Scale	*Items as Used in the Survey for this Study*
1. The culture of this clinical area makes it easy to learn from the mistakes of others.	1. The culture on my unit makes it easy to learn from the mistakes of others.
2. Medical errors are handled appropriately in this clinical area.	2. When an error occurs on my unit, it is handled appropriately.
3. The senior leaders in my hospital listen to me and care about my concerns.	3. My unit management listens to me and cares about my concerns.
4. The physician and nurse leaders in my areas listen to me and care about my concerns.[1]	4. The physician leaders on my unit listen to me and care about my concerns.
	5. The nurse leaders on my unit listen to me and care about my concerns.
5. Leadership is driving us to be a safety-centered institution.	6. Leadership on my unit is driving us to be a safety-centered unit.
6. My suggestions about safety would be acted upon if I expressed them to management.[2]	
7. Management/leadership does not knowingly compromise safety concerns for productivity.	7. Management/Leadership on my unit does not knowingly compromise safety concerns for productivity.
8. I am encouraged by my colleagues to report any safety concerns I may have.	8. I am encouraged by my colleagues to report any patient safety concerns I may have.
9. I know the proper channels to direct questions regarding patient safety.	9. I know the proper channels to direct questions regarding patient safety I may have on my unit.
10. I receive appropriate feedback about my performance.	10. I receive appropriate feedback from colleagues about my performance.
11. I would feel safe being treated here as a patient.	11. I would feel safe being treated as a patient here on my unit.
12. Briefing personnel before the start of a shift (i.e., to plan for possible contingencies) is an important part of safety.	12. Briefing staff before the start of a shift to plan for possible contingencies is an important part of patient safety here.
13. Briefings are common here.	13. Briefings are common on my unit.

Safety Climate Survey (Thomas et al., 2005)	
14. I am satisfied with the availability of clinical leadership (Physician)	14. I am satisfied with the availability of physician clinical leadership on my unit.
15. I am satisfied with the availability of clinical leadership (Nursing)	15. I am satisfied with the availability of nursing clinical leadership on my unit.
16. I am satisfied with the availability of clinical leadership (Pharmacy)	16. I am satisfied with the availability of pharmacy clinical leadership on my unit.
17. This institution is doing more for patient safety now, than it did one year ago.	17. My unit is doing more for patient safety now than it did one year ago.
18. I believe that most adverse events occur as a result of multiple system failures, and are not attributable to one individual's actions.[1]	18. A commonly held belief on this unit is that most errors occur as a result of multiple hospital failures.[3]
	19. When errors occur on my unit, they are generally not attributable to one individual's actions.
19. The personnel in this clinical area take responsibility for patient safety.	20. The staff on my unit takes responsibility for patient safety.
20. Personnel frequently disregard rules or guidelines that are established for this clinical area.	21. The staff on my unit frequently disregards established rules or guidelines.[3]
21. Patient safety is constantly reinforced as the priority in this clinical area.	22. Patient safety is constantly reinforced as the priority on this unit.

Note. [1] This item was changed from 1 item to 2 separate items. [2] When the paper version of the survey was created, this item was inadvertently eliminated from the survey. The online survey was then created from the paper version so no data were collected on this item. [3] These items were eliminated from the 2-factor solution of the survey because they did not meet the requirement of at least .40 factor loadings.

APPENDIX 3: DIMENSIONS AND ITEMS OF THE SAFETY CLIMATE SURVEY

Safety Climate Survey	
Safety Climate Survey: Unit Environment	*Safety Climate Survey: Interprofessional Environment*
1. Leadership on my unit is driving us to be a safety-centered unit.	1. I am satisfied with the availability of physician clinical leadership on my unit.
2. The nurse leaders on my unit listen to me and care about my concerns.	2. I am satisfied with the availability of pharmacy clinical leadership on my unit.
3. My unit management listens to me and cares about my concerns.	3. Briefings are common on my unit.
4. When an error occurs on my unit, it is handled appropriately.	4. Briefing staff before the start of a shift to plan for possible contingencies is an important part of patient safety here.
5. I am satisfied with the availability of nursing clinical leadership on my unit.	5. The physician leaders on my unit listen to me and care about my concerns.
6. The culture on my unit makes it easy to learn from the mistakes of others.	
7. I would feel safe being treated as a patient here on my unit.	
8. Management/Leadership on my unit does not knowingly compromise safety concerns for productivity.	
9. Patient safety is constantly reinforced as the priority on this unit.	
10. The staff on my unit take responsibility for patient safety.	
11. I am encouraged by my colleagues to report any patient safety concerns I may have.	
12. I receive appropriate feedback from colleagues about my performance.	
13. I know the proper channels to direct questions regarding patient safety I may have on my unit	

Safety Climate Survey	
14. My unit is doing more for patient safety now than it did one year ago.	
15. When errors occur on my unit, they are generally not attributable to one individual's actions.	

APPENDIX 4: INCLUSIVE LEADERSHIP SCALE

Inclusive Leadership (Carmeli et al., 2010)	
Items from the Original Scale	*Items as Used in the Survey for this Study*
1. The manager is open to hearing new ideas.	1. The manager on my unit is open to hearing new ideas.
2. The manager is attentive to new opportunities to improve work processes.	2. The manager on my unit is attentive to new opportunities to improve work processes.
3. The manager is open to discuss the desired goals and new ways to achieve them.	3. The manager on my unit is open to discuss desired goals and new ways to achieve them.
4. The manager is available for consultation on problems.	4. The manager on my unit is available for consultation on problems.
5. The manager is an ongoing 'presence' in this team—someone who is readily available.	5. The manager is an ongoing presence on my unit—someone who is readily available.
6. The manager is available for professional questions I would like to consult with him/her.	6. The manager on my unit is available to discuss professional questions on which I would like to consult with him/her on.
7. The manager is ready to listen to my requests.	7. The manager on my unit is ready to listen to my requests.
8. The manager encourages me to access him/her on emerging issues.	8. The manager on my unit encourages me to access him/her on emerging issues.
9. The manager is accessible for discussing emerging problems.	9. The manager on my unit is accessible for discussing emerging problems.

APPENDIX 5: PSYCHOLOGICAL SAFETY SCALE

Psychological Safety (Edmondson, 1999)	
Items from the Original Scale	*Items as Used in the Survey for this Study*
1. Members of this team are able to bring up problems and tough issues.	1. I am able to bring up problems and discuss tough issues with others on my unit.
2. People on this team sometimes reject others for being different.	2. People on my unit sometimes reject or ignore others for being different.
3. It is safe to take a risk on this team.	3. It is safe to take a risk on my unit.[1]
4. It is difficult to ask other members of this team for help.	4. It is easy for me to ask other members on my unit for help.
5. No one on this team would deliberately act in a way that undermines my efforts.	5. No one I work with would deliberately act in a way that undermines my efforts.
6. If you make a mistake on this team, it is often held against you	
7. Working with members of this team, my unique skills and talents are valued and utilized.	

Note. [1] After data collection, this item was removed because of comments from study participants that they found this item confusing. Further, the item had poor inter-item correlation with other items in the scale.

APPENDIX 6: NURSE CONSENT TO PARTICIPATE

This research study invites registered nurses working on patient care units at [redacted] to help us understand the ways the nursing work environment and other factors influence error reporting. You are one of almost 3,000 nurses invited to complete the survey, which forms the basis of my doctoral dissertation at the UNC-Chapel Hill School of Nursing.

There are no known risks, benefits, or costs to you for participating in this study. Taking part in this research is not a part of your University duties, and refusing will not affect your job. You will not be offered or receive any special job-related consideration if you take part in this research. Your responses will be confidential; no one will be able to identify you or your answers, and no one will know whether or not you participated. Data will be reported only in aggregate. The information you and other nurses provide will help us understand the factors that influence nurse error reporting, as well as quality and safety in hospitals.

The survey takes most people about 10 minutes to complete. Your participation is completely voluntary and you can skip any question you choose not to answer. The completion of the survey indicates your consent to participate.

Thank you for your participation. If you have any questions about the study, please contact me by email at Lindsay.Thompson@unc.edu or my dissertation chair, Dr. Cheryl Jones, at cabjones@email.unc.edu.

If you have any questions about your rights as a research participant, you may contact the University of North Carolina Institutional Review Board at irb_questions@unc.edu and mention study number 15-0229.

APPENDIX 7: NURSE MANAGER CONSENT TO PARTICIPATE

This research study invites all nurse managers of patient care units at [redacted] to participate in a study examining how the nursing work environment and other factors influence error reporting. You are one of almost 50 nurse managers invited to complete the survey, which forms the basis of my doctoral dissertation at the UNC-Chapel Hill School of Nursing.

There are no known risks, benefits, or costs to you for participating in this study. Taking part in this research is not a part of your University duties, and refusing will not affect your job. You will not be offered or receive any special job-related consideration if you take part in this research. Your responses are confidential. Data will be reported only in aggregate, no individual nurse managers or patient care units will be identified. The information you provide will help us understand how nursing work force factors may influence nurse error reporting, as well as quality and safety in hospitals.

The survey takes most people about 5 minutes to complete. Your participation is completely voluntary and you can skip any question you choose not to answer. The completion of the survey indicates your consent to participate.

Thank you for your participation. If you have any questions about the study, please contact me by email at Lindsay.Thompson@unc.edu or my dissertation chair, Dr. Cheryl Jones, at cabjones@email.unc.edu.

If you have any questions about your rights as a research participant, you may contact the University of North Carolina Institutional Review Board at irb_questions@unc.edu and mention study number 15-0229.

APPENDIX 8: SAMPLE CHARACTERISTICS

Variables	*n*	*M (SD)*	%	Minimum	Maximum
Nurse Characteristics					
Highest Nursing Education					
Diploma	24		3.0%		
ADN	179		22.3%		
BSN	549		68.4%		
MSN	48		6.0%		
Doctorate	3		0.4%		
Nurse Experience (years)	786	11.7 (10)		<1	51
Nurse Tenure (years)	777	6.1 (6.3)		<1	39
Nursing Unit Characteristics					
Highest Nurse Manager Education					
BSN	25		54.4%		
Any master's degree	20		43.5%		
Doctorate	1		2.2%		
Nurse Manager Tenure (years)	43	5.3 (4.8)		<1	26
Unit Size					
Number of RN Employees	49	39.9 (28.7)		9	162
Number of RN FTEs	43	36.0 (25.5)		6.8	137
Type of Unit					
Medical/Surgical	13		26.5%		
ICU	6		12.2%		
Specialty	18		36.7%		
Other	12		24.5%		

Note. ADN: Associate Degree in Nursing; BSN: Bachelor of Science in Nursing; MSN: Master of Science in Nursing; RN: Registered Nurse; FTEs: Full Time Equivalents; ICU: Intensive Care Units

APPENDIX 9: DESCRIPTIVE STATISTICS FOR VARIABLES IN THE STUDY

Variables	*n*	*M (SD)*	Minimum	Maximum
Dependent Variables				
Error reporting (perceived)	876	3.4 (0.9)	1	5
Error reporting (# of reports submitted)	924	1.9 (3.5)	0	40
Independent Variables				
Safety Climate-				
Unit Environment	824	3.9 (0.7)	1.6	5
Interprofessional Relationships	822	3.7 (0.8)	1	5
Leader Inclusiveness	847	4.0 (1.0)	1	5
Psychological Safety	842	3.9 (0.7)	1.3	5

APPENDIX 10: PEARSON CORRELATION COEFFICIENTS FOR CONTINUOUS STUDY VARIABLES AND COVARIATES[1]

	Variables	1	2	3	4	5	6	7	8	9	10
1	Error Reports	—									
2	Safety Climate - Unit Environment	.39*	—								
3	- Interprofessional Relationships	.37*	.58*	—							
4	Leader Inclusiveness	.23*	.76*	.43*	—						
5	Psychological Safety	.24*	.61*	.36*	.39*	—					
6	Nurse Experience	–.07	.04	.004	.11*	.04	—				
7	Nurse Tenure	.003	.06	.01	.16*	–.04	.65*	—			
8	Nurse Manager Tenure	.02	–.08*	.06	–.11*	–.08*	.01	.08*	—		
9	Unit Size (#RN employees)	–.02	–.19*	–.07	–.15*	–.10*	–.07	–.22*	—	—	
10	Unit Size (#RN FTEs)	.01	–.21*	–.07	–.20*	–.12*	–.07	–.23*	—	—	—

Note. RN: Registered Nurse, FTE: Full Time Equivalents; [1] Sample population represents nurse responses and ranged from 671 to 859; $^{*}p < .05$.

APPENDIX 11: PEARSON CORRELATION COEFFICIENTS FOR NURSING UNIT LEVEL COVARIATES[1]

Variables	1	2	3
1. Nurse Manager Tenure	—		
2. Unit Size (# RN Employees)	–.22	—	
3. Unit Size (# RN FTEs)	–.21	.96*	—

Note. RN: Registered Nurse, FTE: Full Time Equivalents; [1] Sample population represents nursing unit level responses, N = 43; *$p < .05$.

APPENDIX 12: COVARIATE ANALYSIS FOR PSYCHOLOGICAL SAFETY

Covariate	*n*	*r*	*df*	Estimated Slope	*t* value	*p* value
Nurse Education[a]						
- Diploma	842		840	0.01	0.08	.94
- ADN	842		840	-0.04	-0.65	.52
- BSN	842		840	0.04	0.81	.42
- MSN or higher degree	842		840	0.05	0.49	.63
Nurse Experience[b]	779	.04				.27
Nurse Tenure[b]	770	-.04				.30
Nurse Manager Education[c]						
- BSN	811		47	0.04	0.49	.62
- Master's or higher	811		47	-0.01	-0.11	.91
Nurse Manager Tenure[c]	687		38	-0.01	-0.71	.48
Size[c]						
-Number of RNs	781		44	-0.002	-1.23	.23
-Number of FTEs	687		38	-0.003	-1.73	.09
Type of Unit[c]						
- Medical/Surgical	811		47	-0.02	-0.25	.80
- ICU	811		47	-0.04	-0.32	.75
- Specialty	811		47	-0.04	-0.47	.64
- Other	811		47	0.11	1.08	.29

Note. *df* = degrees of freedom; ADN: Associate Degree in Nursing; BSN: Bachelor of Science in Nursing; MSN: Master of Science in Nursing; RN: Registered Nurse; FTEs: Full Time Equivalents; ICU: Intensive Care Unit; [a] Standard t test for each covariate value one at a time; [b] Standard Pearson Correlation Coefficient for each of the covariates; [c] Linear mixed models with random effects models to account for within unit correlation used to assess each covariate value one at a time.

APPENDIX 13: COVARIATE ANALYSIS FOR NURSE PERCEPTIONS OF ERROR REPORTING

Covariate	*n*	*r*	*df*	Estimated Slope	*t* value	*p* value
Nurse education[a]						
- Diploma	876		874	0.37	1.97	.049
- ADN	876		874	0.12	1.51	.13
- BSN	876		874	-0.10	-1.52	.13
- MSN or higher degree	876		874	0.04	0.31	.76
Nurse experience[b]	779	-.07				.05
Nurse tenure[b]	770	.003				.93
Nurse manager education[c]						
- BSN	845		47	-0.22	-2.62	< .01
- Master's or higher	845		47	0.20	2.24	.03
Nurse manager tenure[c]	715		38	0.01	0.55	.58
Size[c]						
-Number of RNs	814		44	-0.001	-1.01	.32
-Number of FTEs	715		38	-0.001	-0.71	.49
Type of unit[c]						
- Medical/Surgical	845		47	-0.12	-1.23	.23
- ICU	845		47	-0.20	-1.73	.09
- Specialty	845		47	0.06	0.62	.54
- Other	845		47	0.22	2.22	.31

Note. df = degrees of freedom; ADN: Associate Degree in Nursing; BSN: Bachelor of Science in Nursing; MSN: Master of Science in Nursing; RN: Registered Nurse; FTEs: Full Time Equivalents; ICU: Intensive Care Unit; [a] Standard t test for each covariate value one at a time; [b] Standard Pearson Correlation Coefficient for each of the covariates; [c] Linear mixed models with random effects models to account for within unit correlation used to assess each covariate value one at a time.

APPENDIX 14: COVARIATE ANALYSIS FOR THE NUMBER OF ERROR REPORTS SUBMITTED BY NURSES

Covariates	*n*	*df*	Estimated Slope	SE	Z Score	95% CI LL	95% CI UL	*p* value
Nurse education[a]								
- Diploma	924	1	-0.21	.17	1.64	-0.54	0.11	.20
- ADN	924	1	-0.01	.06	0.05	-0.13	0.11	.82
- BSN	924	1	-0.003	.05	0.00	-0.10	0.10	.95
- MSN or higher	924	1	0.44	.09	26.0	0.27	0.61	<.01
Nurse experience[a]	784	1	0.01	.003	3.56	-0.0002	0.01	.07
Nurse tenure[a]	775	1	-0.02	.004	27.9	-0.03	-0.01	<.01
Nurse manager[b] Education								
- BSN	891		-0.59	.22	-2.71	-1.02	-0.16	<.01
- Master's or higher	891		0.87	.21	4.13	0.45	1.28	<.01
Nurse manager tenure[b]	755		-0.003	.02	-0.11	-0.05	0.04	.91
Size[b]								
- Number of RNs	859		0.002	.003	0.67	-0.004	0.01	.50
- Number of FTEs	755		0.01	.01	0.90	-0.01	0.01	.37
Type of unit[b]								
- Medical/Surgical	891		-0.31	.27	-1.46	-0.72	0.11	.14
- ICU	891		0.11	.29	0.38	-0.45	0.67	.71
- Specialty	891		0.50	.25	1.95	-0.002	0.99	.05
- Other	891		-0.49	.22	-2.23	-1.07	-0.06	.03

Note. *df* = degrees of freedom; SE = standard error; CI = confidence interval; LL = lower limit, UL = upper limit; ADN = Associate Degree in Nursing; BSN = Bachelor of Science in Nursing; MSN = Master of Science in Nursing; RN = Registered Nurse; FTEs = Full Time Equivalents; [a] Poisson Regression used to assess each covariate value one at a time; [b] Poisson Regression with GEE models to account for within unit correlation used to assess each covariate values one at a time.

APPENDIX 15: THE INDIRECT EFFECT OF SAFETY CLIMATE AND LEADER INCLUSIVENESS ON ERROR REPORTING[1] THROUGH PSYCHOLOGICAL SAFETY

Mediation Analysis	*n*	Estimated Slope	SE	Z score	95% CI		*p* value
					LL	UL	
Step 1							
Safety Climate-Unit Environment	784	-0.22	.08	-2.59	-0.38	-0.05	<.01
Safety Climate-Interprofessional Environment	784	-0.34	.11	-3.20	-0.54	-0.13	<.01
Leader Inclusiveness	784	-0.18	.07	-2.55	-0.32	-0.04	.01
Step 2							
Safety Climate-Unit Environment	784	0.68	.03	20.78	—	—	<.01
Safety Climate-Interprofessional Environment	784	0.36	.03	10.90	—	—	<.01
Leader Inclusiveness	784	0.27	.03	10.53	—	—	<.01
Step 3							
Safety Climate-Unit Environment	784	-0.14	.09	-1.63	-0.31	0.03	.11
Psychological Safety		-0.11	.10	-1.07	-0.31	0.09	.28
Safety Climate-Interprofessional Environment	784	-0.31	.11	-2.76	-0.54	-0.09	<.01
Psychological Safety		-0.07	.10	-0.68	-0.25	0.12	.50
Leader Inclusiveness	784	-0.15	.07	-2.11	-0.30	-0.01	.03
Psychological Safety		-0.11	.09	-1.24	-0.29	0.07	.21

Note. [1]Error reporting: The number of error reports submitted by nurses over a 12-month period.
SE = standard error; CI = confidence interval; LL = lower limit, UL = upper limit.

APPENDIX 16: THE INDIRECT EFFECT OF SAFETY CLIMATE AND LEADER INCLUSIVENESS ON ERROR REPORTING[1] THROUGH PSYCHOLOGICAL SAFETY WITH SIGNIFICANT COVARIATES

Mediation Analysis	*n*	Estimate	SE	Z score	95% CI		*p* value
					LL	UL	
Step 1							
Safety Climate-Unit Environment	736	-0.22	.09	-2.60	-0.39	-0.05	<.01
-Tenure	736	-0.02	.01	-2.24	-0.03	-0.002	<.03
-Nurse Manager Education (master's degree or above)	736	0.84	.20	4.14	0.44	1.23	<.01
Safety Climate-Interprofessional Environment	736	-0.34	.08	-4.16	-0.49	-0.18	<.01
-Tenure	736	-0.02	.01	-2.40	-0.03	-0.003	.01
-Nurse Manager Education (master's degree or above)	736	0.87	.21	4.16	0.46	1.28	
Leader Inclusiveness	736	-0.20	.06	–3.34	-0.32	-0.08	<.01
-Nurse Manager Education (master's degree or above)	736	0.89	.20	4.24	0.47	1.27	<.01
Step 2							
Safety Climate-Unit Environment	736	0.69	.03	20.28	—	—	<.01
Safety Climate-Interprofessional Relationships	736	0.36	.03	10.53	—	—	<.01
Leader Inclusiveness	736	0.29	.11	10.79	—	—	<.01
Step 3							
Safety Climate-Unit Environment	736	-0.12	.08	-1.45	-0.28	0.04	.15
Psychological Safety	736	-0.14	.11	-1.36	-0.35	0.06	.17
-Tenure	736	-0.02	.01	-2.25	-0.04	-0.003	.03
-Nurse Manager Education (master's degree or above)	736	.85	.21	4.13	.45	1.26	<.01
Safety Climate-Interprofessional Relationships	736	-0.30	.08	-3.74	-0.46	-0.14	<.01
Psychological Safety	736	-0.09	.09	-0.95	-0.27	0.10	.34
-Tenure	736	-0.02	.01	-2.43	-0.03	-0.004	.02

Mediation Analysis	*n*	Estimate	SE	Z score	95% CI		*p* value
					LL	UL	
-Nurse Manager Education (master's degree or above)	736	0.87	.21	4.18	0.46	1.28	<.01
Leader Inclusiveness	736	-0.17	.06	-2.65	-0.28	-0.05	<.01
Psychological Safety	736	-0.12	.09	-1.27	-0.30	0.07	.21
-Nurse Manager Education (master's degree or above)	736	0.87	.20	4.27	0.47	1.26	<.01

Note. [1]Error reporting: The number of error reports submitted by nurses over a 12-month period. SE = standard error; CI = confidence interval; LL = lower limit, UL = upper limit.

APPENDIX 17: THE EFFECT OF NURSES' PERCEPTIONS OF ERROR REPORTING ON THE NUMBER OF ERROR REPORTS SUBMITTED

	n	Estimated Slope	SE	Z score	95% CI		*p* value
					LL	UL	
Model 1							
Error Reporting (Perceptions)	842	-0.07	.06	-1.19	-0.19	0.05	.23
Model 1 with Covariates							
Error Reporting (Perceptions)	742	-0.12	.06	-1.89	-0.25	0.004	.06
Tenure		-0.02	.01	-2.21	-0.04	-0.002	.03
Nurse Manager Education: Master's degree or higher		0.90	.20	4.45	0.50	1.20	<.01

Note. SE = standard error; CI = confidence interval; LL = lower limit, UL = upper limit.

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