ABSTRACT

Title of Document: **THE MISSING LINK: AN EXAMINATION OF SAFETY CLIMATE AND PATIENT CLINICAL OUTCOMES IN A NATIONAL SAMPLE OF HOSPITALS**

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This dissertation examined the effect of safety climate on caregiver and patient safety outcomes in a national sample of hospitals. Hypotheses testing climate level and climate strength were not supported for caregiver injuries and postoperative patient outcomes. The main contribution of this dissertation was to test whether the system of care—as evidenced by the patterns of safety climate in multiple units—was related to patient harm.

The pattern of safety climate across units within hospitals predicted compliance with procedures for treating heart failure and pneumonia patients over and above the effect of safety climate elevation and variability. In addition, variability in safety climate between units in hospitals was related to lower compliance with procedures for treating heart attack patients. The sample consisted of caregiver survey data collected from 59 hospitals that belonged to a non-profit hospital system in the United States.

THE MISSING LINK: AN EXAMINATION OF SAFETY CLIMATE AND PATIENT CLINICAL OUTCOMES IN A NATIONAL SAMPLE OF HOSPITALS

By

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Chapter 1: Introduction

Medical errors can literally become a matter of life and death. The Institute of Medicine (IOM) recently reported that up to 98,000 deaths per year in the United States were due to medical error (Kohn, Corrigan, & Donaldson, 1999). In spite of these staggering numbers, organizational scientists have only recently begun studying medical error and safety in healthcare (Katz-Navon, Naveh, & Stern, 2005; Naveh, Katz-Navon, & Stern, 2005). Studies of clinical outcomes in hospitals have tended to focus on medical diagnoses rather than organizational diagnoses. One of the most promising ways to reduce error and increase safety appears to be through the development of a climate for safety. *Safety climate* is defined as shared perceptions that safe behavior is rewarded, supported, and expected in the unit. While research on safety climate in other industries, such as nuclear power plants (Carroll, 1998), manufacturing (Zohar, 2000; Cheyne, Cox, Oliver, & Tomás, 1998), industrial facilities (Zohar, 1980; Donald & Canter, 1994), construction (Dedobbeleer & Beland, 1991), road administration (Niskanen, 1994), railways (Clarke, 1998), and restaurants (Barling, Loughlin, & Kelloway, 2002) has received plenty of attention for the past twenty years or so, research on safety climate in healthcare has blossomed only with IOM's recent suggestion that healthcare organizations improve their safety cultures (Kohn et al., 1999). In fact, assessment of safety climate will be mandated for all hospitals in the United States starting in 2007 (JCAHO, 2005).

In order to give hospitals good recommendations on how to study and understand safety climate, several missing elements in the literature need to be addressed. In recent years, there has been considerable controversy over the predictive power of climate level (mean of climate perceptions in the unit) versus climate strength (sharedness of those perceptions, operationalized by the standard deviation) on outcomes. In research published in top journals, studies have found climate strength to have main effects (e.g., Colquitt, Noe, & Jackson, 2002), moderator effects for most outcomes (e.g., González-Romá, Peiró, & Tordera, 2002), moderator effects for few outcomes (e.g., Schneider, Salvaggio, & Subirats, 2002), and no effect once climate level is taken into account (Lindell & Brandt, 2000). Some of the debate over the efficacy of climate strength regards the appropriateness of climate strength as a construct separate from climate level and the possibility that moderation results could be statistical artifacts. In light of these concerns, one of the primary aims of this dissertation is to make a case for the importance of considering safety climate strength as a moderator of safety climate level on outcomes. In particular, this dissertation will examine the relationship between safety climate level and strength on employee injuries and accidents in intensive care units (ICUs).

Another missing element in the literature is the extent to which safety climate can predict the most important outcomes in hospitals: patient safety. Previous research on safety climate in healthcare has focused almost exclusively on showing that better safety climates are associated with fewer treatment errors (Katz-Navon et al., 2005). While this is an important contribution, doctors and hospital administrators are more interested in the factors that contribute to patient harm. Thus, an important contribution of this dissertation is the introduction of a new type of outcome variable in the climate literature: patient clinical outcomes. In effect, this is a study of the missing link in climate research. While previous research has connected climate to employee outcomes, this dissertation reaches one step beyond employee outcomes by examining patient outcomes. Previous climate studies in the organizational sciences have studied softer customer outcomes (such as customer satisfaction) but few to date have examined actual customer outcomes such as patient harm that is the direct result of the health care system. In this study, safety climate level and strength in operating rooms (ORs) is predicted to be correlated with postoperative hospital-acquired outcomes, that is, those that are the result of treatment by the hospital rather than the underlying condition of the patient.

Finally, another critical area that has been overlooked in climate research is an approach to studying the simultaneous effect of key units on organizational outcomes. Previous research has demonstrated that organizational climate is directly related to several organizational outcomes (e.g., Ostroff, 1992). However, in the hospital setting, many organizational outcomes are determined by a patient's interaction with many units within the hospital, with each of these units potentially having different safety climates. Thus, a study that examines the simultaneous effect of several units' safety climate on organizational outcomes is needed. In effect, this is a study of the system of care. To illustrate, with numerous patient conditions, patients are seen by many areas within the hospital. For example, take the case of a patient who arrives with a heart attack. This patient is typically admitted through the emergency room and then may be sent for testing by a cardiology unit. Then, the patient may spend a few days in the ICU or a step-down unit (i.e., one that monitors patients more closely than a nursing unit but not as intensely as an ICU). Hospitals have developed very specific guidelines of best practices in dealing with patients that have heart attacks and other common conditions, such as heart failure and pneumonia. Hospitals are now tracked on their compliance with these guidelines, and this metric is computed at the hospital level of analysis. Because these patients are seen by multiple units, it makes more sense to understand how the safety climate of those units contributes to overall compliance with the guidelines for treating these common conditions. However, current research on safety climate has little guidance for how to study this cross-level phenomenon. Typically, research has studied the effect of organizational level variables on unit or individual level outcomes. In this study, I propose to use a configurational approach to studying the patterns of safety climate across several units in order to predict hospital-level outcomes. This is an extension of previous climate research that uses the configurational approach because it studies safety climate across several units rather than several dimensions of climate within one type of unit.

In what follows, I review the literature on climate and make predictions of the effect of safety climate level and strength on caregiver injuries and accidents as well as patient clinical outcomes. I also describe the configurational approach for understanding the relationship between climate and outcomes at the organizational level of analysis.

Climate Etiology

While safety climate researchers have continued to debate the relative merits of using safety culture or safety climate as the measurement construct, most organizational scholars see the distinction between climate and culture as the difference between measuring shared attitudes during one slice of time (climate) and measuring the underlying determinants of these shared attitudes (culture) (Mearns, Flin, Fleming, & Gordon, 1997; Wiegmann, Zhang, & von Thaden, Sharma, & Gibbons, 2004) or alternatively, studying the what (climate) versus the why (culture) (Ostroff, Kinicki, & Tamkins, 2003). In a comprehensive review of the climate and culture literature, Ostroff et al. (2003) indicated that while climate can be captured by survey measures, culture is better understood through ethnographic studies of the artifacts (Schein, 1992; Trice & Beyer, 1993), values (Schwartz, 1992), and assumptions (Schein, 1990; 1992). Understanding organizational culture helps determine why a particular climate might have emerged, but it is less helpful in improving the outcomes linked to climate.

Theorists believe that climates develop through several processes: the structural features of the organization (Payne & Pugh, 1976), attraction-selection-attrition (ASA) processes (Schneider, 1987), and sense-making processes among individuals, which is referred to as the symbolic interactionist approach (Blumer, 1969; Schneider & Reichers, 1983). Each of these approaches contributes to the development of climates, however, it is important to realize that they are not mutually exclusive (Schneider & Reichers, 1983). The structuralist approach proposes that climates develop through objective features of the organization, such as size, degree of centralization, and hierarchy. Research has attempted to link these objective organizational features to employees' shared perceptions, with limited success. A second explanation for the development of climates within organization is ASA processes. This approach takes an individualistic perspective on the development of climates—because individuals who remain in organizations are similar in values and personalities, their perceptions of the organization are also likely to be shared. Originally, Schneider and Reichers believed that one limitation of the ASA approach is that it cannot account for differences in climates among work units within the same organization and functional group; however recent research has shown that ASA processes may account for these differences (Schneider, Smith, Taylor, & Fleenor, 1998). Schneider reconciled the interaction between ASA processes and the development of climate when he stated that ASA processes allow for similarities between employees that allow for liking (Festinger, 1954), which leads them to interact with each other and establish shared meanings of what is valued in the organization (Schneider, 1987).

This interaction to establish shared meanings is termed symbolic interactionism (Blumer, 1969), which leads to the idea that employees' interactions with each other contribute to the emergence of climates (Schneider & Reichers, 1983). This approach draws from research on socialization, in that new organizational members come to understand what the policies, practices, and procedures really mean in the day-to-day life of employees in the organization. They learn over time whether established policies in the organization are enforced or ignored. Though the environment is complex with signals about which behaviors will be reinforced, employees quickly learn through their interactions with coworkers to find patterns of priorities within the organization. These patterns of priorities give rise to employees within a workgroup having similar perceptions of what is rewarded, supported, and expected. In the next sections, I will describe the emergence of the climate construct, from its beginnings as a more generic term to its current place as a specific construct that predicts specific outcomes.

General Climate

Early in the development of the climate construct, researchers proposed that climate consisted of several dimensions that dealt with various aspects of the work itself, coworkers, rewards, and employee motivation (Ashforth, 1985; Newman, 1977). Generally speaking, these dimensions did not considerably overlap across studies. For example, Kopelman, Brief, and Guzzo (1990) included reward orientation and socioemotional support as some of the important dimensions of climate. In contrast, Ostroff and Schmitt (1993) believed that organizational climate in schools was composed of many dimensions, including parent involvement and openness of communication. In a study of hotels, organizational climate was composed of dimensions related to goal attainment, such as management support and working conditions (Ostroff, Kinicki, & Clark, 2002). One of the problems with this approach to general climates is that it is difficult to pinpoint which dimensions of climate are predictive of outcomes. Because each study has its own conceptualization of the dimensions of climate and its own organizational effectiveness measures, it is difficult to know whether the results of any one study will replicate with other dimensions or other settings.

Another approach to studying general climates is to use cluster analysis. Climates are aggregated by the consistency of employees' climate profiles with each other (termed "collective climates"; Joyce & Slocum, 1984). Often, the profiles that emerged were uncorrelated with membership in a particular department but were instead comprised of employees with no apparent ties (Jackofsky & Slocum, 1988). This approach has been criticized for being inconsistent with the symbolic interactionist explanation for the development of climates (Patterson, Payne, & West, 1996). The cluster analysis created groups of employees with similar climates even though these employees did not interact with each other. In other words, the similarities of their climate ratings appear to be due to random chance as opposed to a meaningful process by which shared climate perceptions emerge.

Despite the early focus on general climate, the research literature has recently emphasized a facet approach. The first to push for this approach, Schneider (1990a), argued that climate should represent a specific construct with a particular referent ("facet climate" or "molar climate") such that the construct should be a climate *for something*. The impetus for this approach is that facet climates should be able to predict facet outcomes. Thus, safety climate should be a better predictor of safety-related outcomes than a general climate measure, just as service climate is a better predictor of customer service than a general climate measure (Schneider, Bowen, Ehrhart, & Holcombe, 2000). Facet climates include a strategic focus on customer service (Schneider, 1990a), sexual harassment (Fitzgerald, Drasgow, Hulin, Gefland, & Magley, 1997), innovation (Klein & Sorra, 1996), justice (Naumann & Bennett, 2000), citizenship behavior (Schneider, Gunnarson & Niles-Jolly, 1994), ethics (Victor & Cullen, 1988), and safety (Zohar, 2000), to name a few. Each of these facet climates have predicted specific outcomes related to those domains, including customer satisfaction, sexual harassment, and injuries. Thus, there is considerable support that facet climates have predictive power with specific outcomes. After considerable debate in the organizational literature, facet specific climates are the norm.

In summary, a review of the organizational climate research has shown that it evolved from a focus on global climate to one more concerned with a facet approach. Following this trend, I focus on a specific climate facet in this dissertation: safety climate. I begin the next section with a definition of the safety climate construct and a description of safety climate level. Following that, I will describe the antecedents to safety climate level, followed by the consequences of safety climate level. Finally, I propose that safety climate level will be related to caregiver injuries and accidents within the ICU.

Safety Climate

Safety climate has been a key construct of study since the Chernobyl accident was attributed to poor safety climate (IAEA, 1986). Safety climate is defined as shared perceptions of policies, practices, and procedures related to safety (Reichers & Schneider, 1983). For purposes of this dissertation, s*afety climate* is defined as shared perceptions that patient safety is valued in the unit. This particular measure of safety climate is focused on ensuring patient safety—it does not include information about caregiver safety. Additionally, by referring to "this clinical area", the safety climate measure used in this dissertation is centered at the unit level of analysis—not the organizational level of analysis. While other literature on safety climate distinguishes between organizational safety climate and unit level safety climate by focusing on policies and practices versus supervisory behavior, the safety climate measure used in this research does not. For the purposes of this dissertation, safety climate is an overall evaluation that safety is valued in the unit.

Recently, scholars have argued that the higher-order factor of safety climate is based on the relative priority of safety versus production goals (Naveh et al., 2005; Zohar, 1980; Zohar, 2000). In the many clues that employees receive about their work from managers, coworkers, and organizational policies, practices, and procedures, they are able to discern patterns that emphasize getting the job done safely versus getting the job done quickly. Traditionally, climate researchers have studied the mean of facet climate perceptions, or the *level* of facet climate in the group or organization. In Chan's (1998) typology of composition models, climate level is referred to as a direct consensus model. A direct consensus model is one in which the perceptions of individuals within a unit need to show sufficient within group agreement in order to use the group mean as a meaningful representation of the group's perceptions. Climate level is an aggregation of the mean level of climate perceptions of the individuals in a particular unit. In direct consensus models, the higher level of analysis is of import—on their own, climate perceptions have little meaning. Aggregated climate perceptions represent the group's climate level.

Antecedents to safety climate level. Many studies have discussed the antecedents to safety climate level. The most influential researcher on safety climate level over the past 25 years is Dov Zohar. One focus of his research is explicating the antecedents to safety climate. For example, across numerous industrial and military settings, Zohar has shown that transformational leadership is positively correlated with safety climate (Zohar, 2002a; Zohar & Luria, 2003; Zohar & Luria, 2004). Also, he has shown that positive changes in supervisory safety practices are associated with positive changes in the safety climate and safety records of units within factories (Zohar, 2002b). Research has shown that other conceptualizations of leadership (e.g., leader-member exchange) are also related to safety climate (Hofmann & Morgeson, 1999; Hofmann & Morgeson, 2004; Hoffman, Morgeson, & Gerras, 2003). The actions and communications of the unit leader often play an important role in helping employees detect the patterns of safety versus production, as they tend to reward one priority consistently over the other (Dragoni, 2005). Employees are then able to determine whether safety or production is valued and under what circumstances.

Consequences of safety climate level. Likewise, numerous climate papers have detailed the importance of the mean level of climate in predicting the consequences of climate on the behavior of the employees. For example, Fitzgerald et al. (1997) showed that climate for sexual harassment strongly predicted incidences of sexual harassment. More germane to this dissertation, safety climate has been found to be related to many important employee outcomes, such as unsafe behaviors (Cooper & Phillips, 2004; Hofmann & Stetzer, 1996), injury rates (Barling et al., 2002; Zohar, 2002a; Zohar & Luria, 2004), safety-specific organizational citizenship behaviors (Hofmann et al., 2003), and accidents (Donald & Canter, 1994; Hofmann & Stetzer, 1996). Zohar (2000) has also found that safety climate perceptions are associated with safety behavior and employee injuries.

However, it is important to draw a distinction between the *perceived* consequences of safety climate level and the *objective* consequences of safety climate level. For example, Griffin and Neal (2000) showed that safety climate perceptions affected perceived safety performance. Other studies have shown that the relationship between climate level and outcomes holds for retrospective or archival accident data (Hofmann & Stetzer, 1996). Thus, one of the main criticisms of some safety climate research is the lack of a hard or objective criterion measure. Another limitation with the prior safety climate studies is that they are plagued by single source bias. This is true for self-reports of safety behavior (DeJoy, Murphy, & Gershon, 1995; Hofmann & Stetzer, 1996; Thompson et al., 1998), expert ratings of safety level (Zohar, 1980), and retrospective accident data (Brown & Holmes, 1986). More stringent tests of the link between safety climate and accidents or errors are relatively rare in the literature, though there are recent exceptions (e.g., Zohar, 2000, Hofmann & Mark, 2006). One of the contributions of this dissertation is the examination of objective measures of injuries and accidents that are free from single source bias.

Within the healthcare domain, safety climate has a direct and substantial influence on reported compliance with universal precautions (precautions that caregivers take to prevent injuries such as needle-sticks; DeJoy, Searcy, & Murphy, & Gershon 2000; Gershon, Karkashian, & Felknor, 1994; Grosh, Gershon, Murphy, & DeJoy, 1999; McGovern, Vesley, Kochevar, Gershon, Rhame, & Anderson, 2000). Compliance with universal precautions is important because needle-sticks could transmit serious viruses such as HIV. Lack of compliance with universal precautions is often cited as a potential source of errors in healthcare (Gershon et al., 1994; OSHA, 1991). According to a national survey, health care workers reportedly wore gloves only 43% of the time, (Hersey & Martin, 1994). Even at a nationally renowned hospital system such as Johns Hopkins University Medical Center, compliance with universal precautions was 44% (Kelen et al., 1990).

I mention universal precautions because it provides one justification for how safety climate can impact caregiver safety. One of the primary aims of this dissertation is to understand the impact of safety climate on the objective outcome of caregiver injuries and accidents. A unit that values safety would be expected to have lower rates of injuries and accidents for its caregivers (Hofmann & Mark, 2006). Again, a priority of safety over speed or efficiency means that caregivers should take their time when completing their duties and should be aware of safety hazards that might exist in the workplace (e.g., spills). Though the measures used in this study are based on patient safety, I predict that the measure will be useful in also predicting caregiver safety outcomes. In order to replicate the results that are found in other industries, I propose to examine the effects of safety climate on caregiver injuries and accidents.

Hypothesis 1: Safety climate level will be negatively related to objective measures of caregiver injuries (i.e., needle sticks, slips/falls, strains/sprains).

In summary, the current study tests the relationship between safety climate level and injuries in ICUs. In the next section, I will describe safety climate strength. Following a general review of the climate strength construct, I will describe the antecedents to safety climate strength, followed by the consequences of safety climate strength. Finally, I propose that safety climate level and strength will interact to predict caregiver injuries and accidents within the ICU.

Safety Climate Strength

In recent years, climate researchers have begun studying the sharedness of climate perceptions, using dispersion indices such as the standard deviation (Schneider et al., 2002). Climate strength refers to the overall consensus regarding a unit's climate among the members of the unit. In multilevel research, constructs might have differential meanings depending on the level of analysis used (Chan, 1998). The purpose of composition models is to specify how constructs differ in their lower level and higher level manifestations to avoid too many overlapping constructs with the same meaning. In Chan's typology of composition models, climate strength is considered a dispersion model. In a dispersion model, the within-group variance becomes the construct of interest. Climate strength is defined as the amount of variance in individuals' perceptions of climate within the unit. Large amounts of within-group variance reflect weak within-group consensus concerning the climate, while small amounts of within-group variance reflect strong within-group consensus. To be clear, the climate strength construct is focused on *agreement* (or lack thereof) regarding the mean climate. Low agreement is clearly differentiated from high disagreement in that low agreement regards a lack of consensus whereas high disagreement is likely the result of subgroups (Chan, 1998).

Antecedents of safety climate strength. Climate strength emerges through the same mechanisms as climate level: objective organizational characteristics, member perceptions, and socialization/symbolic interactionism (Dickson, Resick, & Hanges, 2006). "Stronger climates reflect less ambiguity of organizational norms and practices, leading to more uniform perceptions and expectations among members" (Dickson et al., 2006, p. 352). Consistent with this perspective, González-Romá et al. (2002) showed that leader behavior (Yukl & Van Fleet, 1992) was correlated with climate strength for three types of climate. In other words, the leader's behavior serves as an interpretive filter in the workplace and can determine the degree of consensus regarding climate there is in a group. Further, Rentsch (1990) supported this belief by showing that members of the same interaction groups made similar interpretations of organizational events. In her research, some groups had stronger climates than others as a function of the interaction among group members. Although Rentsch did not provide evidence of this finding, one reasonable hypothesis is that the greater the amount of interaction between group members, the more similar their climate perceptions should be. Consistent with this interpretation, González-Romá, Ramos, Peiró, Rodríguez, and Muñoz (1994) found that social interaction in health care teams was correlated with climate strength. González-Romá, Peiró, and Tordera (2002) confirmed these findings by showing that work group interaction was related to climate strength for two out of three types of climate. Finally, Zohar and Luria (2004) found that the more complex the leader's rationale and communications regarding the priority of safety, the more confusion among the employees, and the lower the consensus in their climate ratings. This suggests that group interaction is not the only factor that leads to greater climate strength; the clarity of leader communications also plays a role in creating strong climates.

Consequences of safety climate strength. With regard to the consequences of safety climate strength, it seems reasonable to expect that there will be more variability in outcomes when climates are weak than when they are strong because climate strength results from the consistency of messages. While a few studies have hypothesized a main effect for climate strength, there does not appear to be strong support for this effect. For example, Lindell and Brandt (2000) failed to find a main effect for procedural justice climate strength on any of their organizations outcomes. They explained this lack of support by demonstrating that there will be a relationship between climate level and climate strength on any bounded scale. For example, any within-group variability in procedural justice climate perceptions will move the procedural justice perceptions to the mid-point of the scale. Thus, the unique main effect of climate strength is somewhat captured by the climate level variable (Colquitt et al., 2002).

Following this logic, other studies have posited that the effect of climate level is moderated by climate strength (e.g., Schneider et al., 2002). In this line of inquiry, researchers postulate that the greater the sharedness of the climate, the stronger the relationship between climate level and outcomes. In their seminal article, Schneider et al. tested for this interaction between climate level and strength on customer satisfaction measures. As hypothesized, Schneider et al. found an interaction between service climate level and strength on customer satisfaction. The relationship between climate level and customer outcome was significantly weaker when the within-group consensus regarding climate was weaker. They explain that when service climates are negative but weak, some customers may be getting higher quality service, and so aggregate customer satisfaction is higher than if there is more consensus that service climate is negative. This interaction was found on only one of their four service climate sub-scales.

To date, the safety climate literature has not explored the moderating effect of climate strength on the climate level when looking at objective outcomes. Climate strength should affect the number of caregiver injuries that occur in a unit for reasons similar to the justification given by Schneider et al. (2002) with service climate. That is, in a stronger climate, caregivers will be more vigilant and coordinated in their actions regarding safety. This should hopefully have a spillover effect such that by focusing on patient safety, caregivers are also more likely to focus on their own safety. Though there is not a direct link between the items in the measure and caregiver safety, I predict that safety climate will be important in predicting caregiver safety outcomes. In particular, I propose that climate strength is a moderator of the relationship between climate level and caregiver injuries, such that in those units where climate is strong, the relationship between level and outcome is stronger (i.e., safety climate is positively related to injuries in strong climates) and this relationship diminishes in weaker safety climates.

Hypothesis 2: *Safety climate strength with interact with safety climate level to affect caregiver injuries. In units with higher safety climate level, stronger safety climates will lead to fewer caregiver injuries. In units with lower safety climate level, weaker safety climates will lead to fewer caregiver injuries.*

Climate and Patient Safety Outcomes

The missing link in safety climate research is the link between safety climate and patient safety outcomes. Previous research has documented that safety climate is important for predicting employee injuries and accidents, but few studies have examined the effect that safety climate has on patient safety outcomes. Preliminary research suggests that safety climate is related to clinical and operational outcomes such length of stay, medication error rates (Pronovost et al., 2005) wrong site surgeries (Defontes, 2003) and ventilator associated pneumonia (Sexton et al., 2006). One of the most relevant research studies published in the organizational literature shows that safety climate is linked to treatment errors within hospital units (Katz-Navon et al., 2005). However, their definition of treatment errors was multifaceted in that it covered everything from procedural errors to dosing errors to "generally inappropriate care" (p. 1080). Similarly, Hofmann and Mark (2006) found that safety climate is related to medication errors that resulted in patient harm. This dissertation extends prior research by going one step beyond treatment errors to examining the end result of safety climate—better patient safety outcomes. To my knowledge, a test of this missing link (patient safety) is rare in the organizational literature.

For this portion of my dissertation, I will examine operating rooms (ORs), another subset of the unit types in the dataset, because the patient safety outcomes are specific to patients who have just undergone an operation. Additionally, the outcomes are a result of treatment, not a result of the underlying condition of the patient.

<u>Hypothesis 3</u>: *Safety climate level will be negatively related to rates of patient safety outcomes in the OR (i.e., postoperative bleeding, postoperative infections).*

Safety climate strength is also likely to have an impact on patient safety outcomes in the OR. In one study that examines safety climate strength, Shteynberg, Lyon, and Sexton (2005) demonstrated that climate strength moderated the effect of climate level on outcomes. However, this moderation effect was only found when the patient outcomes were a function of multiple interdependent employee actions. More precisely, Shteynberg and his colleagues showed that climate strength predicted conditions that occur over time and that involve repeated interactions among caregivers in the ICU.[1] On the other hand, climate strength was not a moderator when the patient outcome was a function of a single event or the result of one caregiver's inattention (e.g., caregiver's lack of cleanliness). I believe that these differential moderation results make sense in that caregivers may have differing goals in treating patients as a function of inconsistent climate messages that they receive from the hospital. As a result, patient outcomes that are affected by employee coordination are more likely to vary in units with low climate strength. Low climate strength means that caregivers are less consistent in their dedication to patient safety in the unit, and thus patient safety may be compromised.

<u>Hypothesis 4</u>: *Safety climate strength will interact with safety climate level to affect the rates of patient safety outcomes in the OR (i.e., postoperative bleeding, postoperative infections). In ORs with higher safety climate level, stronger safety climates will lead to lower rates of patient safety outcomes. In ORs with lower safety climate level, weaker safety climates will lead to lower rates of patient safety outcomes.*

In summary, this dissertation extends previous research by examining the relationship between safety climate level and strength and patient safety outcomes with in the OR. Demonstrating this is important and interesting because previous research has only examined errors rather than the resulting patient harm. In the next section, I describe an approach to studying the effects of safety climate across units on organizational level patient safety outcomes.

Climate and Organizational Outcomes: A Configurational Approach

In the following section, I argue for a new approach in studying the effects of safety climate across the organization. In particular, I argue for a configurational approach in studying the effects of safety climate on patient safety. I propose to link the configurations of unit safety climate within each hospital to organizational-level patient safety outcomes across hospitals. I draw on the strategic human resources management (SHRM) literature as well as recent work by Ostroff and colleagues to make a case for this approach. However, it should be noted that my argument and the way that I utilize configurations in this dissertation are somewhat different than the ways that researchers from these two areas study configurations. Thus, after I describe the configurational approach used in the current literature, I will discuss and identify the differences in my approach. In the next section, I provide an introduction to configurational thinking, citing literature on the configurational approach in strategy and psychology, after which I describe the SHRM perspective on configurations.

Introduction to Configurational Thinking

Researchers have recently started to shy away from using simple linear models to capture the relationship between organizational characteristics and organizational performance. With the increasing sophistication of the measurement and research designs being employed, researchers have used the patterns or configurations of organizational characteristics in an attempt to capture the complexity of organizational life (Miller, 1981; Schneider, Smith, & Sipe, 2000). In an editorial, Rousseau and Fried (2001) describe why a configurational approach is important for contextualizing research: "A set of factors, when considered together, can sometimes yield a more interpretable and theoretically interesting pattern than any of the factors would show in isolation" (p. 4). Johns (2006) has likewise called for more research on contextualizing organizational behavior research. The impetus for the pattern or configurational approach comes from the hope that the gestalt of variables has interactive effects not evident when each variable is examined in isolation (Huselid, 1995).

Numerous scholarly areas have an interest in the configurational approach. Scholars of organizational strategy have often used a configurational approach to studying the many elements of organizations that could impact firm performance (for a review and meta-analysis see Ketchen et al., 1997 and Ketchen & Shook, 1996). Venkatraman (1989) details ways in which configurational research can fit theory to measurement. Psychology has a history of using the holistic or configurational approach in studying the effects of personality variables on achievement and performance (e.g., Magnusson & Törestad, 1993). In a study of leadership motives (i.e., need for power, need for affiliation, and activity orientation), McClelland and Boyatzis (1982) found that certain patterns of leadership motives were associated with managerial success. Similarly, Foti (in press) demonstrated that configurations of individual differences were associated with leadership emergence and leadership effectiveness. From the educational literature, configurations of sub dimensions of cognitive ability are predictive of children's academic performance (Watkins & Glutting, 2000).

Looking across literatures in organizational behavior, strategy, and psychology, there is a great interest in contextualizing variables and in using configurational approaches to understand outcomes. In the next section, I go into more depth with the configurational approach by reviewing the strategic human resources management (SHRM) literature. Following that review, I present some of the ways the climate literature has drawn on the SHRM approach to understand the interactive effects of climate.

SHRM as an Exemplar of the Configurational Approach

The strategic human resources management (SHRM) literature has a long tradition of using the configurational approach and this field has developed some guidelines for the use of this research approach to study the link between human resources (HR) practices and organizational performance. My purpose in reviewing this literature is to demonstrate the feasibility of the configurational approach in organizational research as well as highlight some of its limitations. SHRM researchers typically study the impact of HR practices on firm performance from one or more of four positions: a universalistic approach, which prescribes a set of best practices (e.g., Arthur, 1994; Huselid, 1995; Ichniowski, Shaw, & Prennushi, 1997); a contingency approach, which asserts that HR practices must be aligned with strategy (e.g., Koch & McGrath, 1996; MacDuffie, 1995; Wright, Smart, & McMahan, 1995; Youndt, Snell, Dean, & Lepak, 1996); a configural approach, which looks at the pattern of HR practices and assumes equifinality (e.g., Delaney & Huselid; 1996); and a contingent configurational approach, which looks at the alignment of bundles of HR practices with firm strategy (e.g., Delery & Doty, 1996). In their review of the link between HR practices and firm performance, Bowen and Ostroff (2004) organized these approaches into two perspectives: a strategic approach and a systems approach. In the next section, I describe the strategic approach and the systems approach, and describe one exemplary study from each perspective.

Strategic approach. In the strategic approach, the alignment of HR practices with each other (internal fit) or the alignment of HR practices with strategy (external fit) is hypothesized to lead to firm performance. A well-cited study that examines both internal fit and external fit is a study of high performance work practices (HPWP) and firm performance (Huselid, 1995). In this study, Huselid measured a set of internally consistent work practices (HPWP) across almost 1000 firms and found that HPWP affected firm performance. He did not find much support that either internal or external fit mattered in determining firm performance. However, this study provided the impetus for other researchers to find better measures of internal and external fit in order to show their importance in determining firm performance. Since then, other studies have shown some support for internal fit (Delery & Doty, 1996; MacDuffie, 1995) and external fit (Wright et al., 1995; Youndt et al., 1996). In most cases, research from the strategic approach has lacked theoretical justification for their results, despite being heavily cited.

Systems approach. In the systems approach, researchers predict that the pattern or configuration of HR practices leads to firm performance. In one exemplary study, Ichniowski et al. (1997) examined the interactive effects of various work practices (e.g., compensation, employment security, skills training) on very specific performance measures in steel finishing lines. They argued that developing clusters of work practices would be more meaningful than examining the practices in isolation, due to the interactive and enhancing effects of work practices on each other. They created four HR systems based on "the most common combinations of HR practices in these production lines" (p. 296). Then, they demonstrated that HR systems had effects on productivity, such that more innovative HR systems showed greater productivity gains. The benefit of this approach is that HR practices do not exist in isolation and it is the combination of these practices that influences performance. However, one drawback of this approach is the relative lack of theory supporting the clusters that were developed and the reasons why these practices in combination might yield greater performance.

To summarize, SHRM researchers have studied the interactive effects of human resources practices on firm performance. The results vary by study, but there is evidence that configurations of HR practices do affect firm performance. Part of the problem with the SHRM literature in general is the relative lack of theory in understanding and predicting which HR practices will result in performance. In contrast, the climate literature has a greater theoretical justification for why firm performance should result. In what follows, I describe recent research on the effect of climate configurations on performance.

Configurations of Climate

Within the climate literature, researchers have rarely used a configurational approach, except to create configurations of individual climate perceptions (González-Romá, Peiró, Lloret, & Zornoza, 1999; Joyce & Slocum, 1984), an approach which has been roundly criticized (Patterson et al., 1996; Payne, 1990). A relatively new approach to studying configurations of climate comes from research by Ostroff and her colleagues (Ostroff et al., 2003; Schulte, Ostroff, & Kinicki, 2004; Schulte, Ostroff, & Kinicki, in press). Configurational climate scholars have typically explored the interactive effects of several types of climates (Schulte, Ostroff, & Kinicki, in press; Schulte, Ostroff, Shmulyian, & Kinicki, 2006) on organizational outcomes. In this line of research, climate configurations are conceptualized at the unit level of analysis, using several climate dimensions (e.g., managerial support climate, rewards for service climate, communication climate).

In a recent paper, Schulte et al. (2006) presented three ways of conceptualizing climate patterns: elevation, variability, and shape. In the next section, I describe the predictions and results from this exemplary study of the climate configuration approach. I will describe each of these ways of conceptualizing climate, as these will have relevance to my own hypotheses below.

Profile elevation. Elevation refers to the mean level of climate across multiple climate dimensions. Schulte et al. (2006) found that the higher the average level of climate was associated with better employee attitudes. They argued that elevation reflects a general summary judgment of the good feeling in the organization. In other words, elevation captures the higher order latent factor of positive climate.

Profile variability. Variability is defined as the spread of the means across the climate dimensions. Schulte et al. (2006) did not find variability related to employee attitudes. They argue that variability is important to study because the higher the variability, the less consistency in enacting policies and procedures in the organization. The inconsistency of messages leads to confusion about what is valued, which leads to inconsistencies in employee behavior. However, they did not find support for this hypothesis in their study.

Profile shape. Finally, shape refers to the pattern of means across the climate dimensions. Schulte et al. (2006) found that climate patterns were related to customer satisfaction and firm performance. For example, they found that the supportive climate shape (e.g., high internal management support climates, low store orientation climates) had lower relationships with firm financial performance than strategic climate shape (e.g., moderate to high on employee-oriented climates, high on store orientation). They argue that shape is important for the same reasons that configurations of HR practices within the SHRM literature are related to firm performance (Arthur, 1994; MacDuffie, 1995). In particular, configurations are more meaningful than examining practices in isolation. This argument is extended to climate dimensions. Because climate is an aggregation of employee perceptions of the organizations policies, practices, and procedures, it follows that patterns of climate should also be predictive of firm performance. In fact, I would argue that the pattern of climate dimensions should be more predictive of firm outcomes than configurations of HRM practices.

To summarize, these researchers provide excellent examples of uses of this technique to understand the impact of organizational climate on performance. While promising, the Schulte et al. (2006) study highlights one of the difficulties in using this approach in the organizational literature. Specifically, it is extremely difficult to hypothesize in advance about which configurations will emerge in the cluster analysis. Organizational research has not yet advanced to formulating which configurations will be important a priori (Schulte et al., 2006). However, part of the attraction of this research is an increased understanding of how climate variables affect outcomes at a broader level. In previous research, climate patterns are related to organizational outcomes. In the next section, I describe how a different set of climate patterns can be related to organizational outcomes.

Configurational Approach in the Current Study

I draw on the configurational approach to study patterns of safety climate within hospitals. In doing so, I present a new approach to studying configuration. It is important that I distinguish my approach from that of the previous literature because this is one of the main contributions of this dissertation. In this section, I describe my approach to studying configurations of climate and show that it is not only unique, but also conceptually sound and theoretically meaningful. I use the terms elevation, variability, and shape to describe my hypotheses, but it is important to note that what I mean by elevation, variability, and shape differs from the meaning in previous climate research (e.g., Schulte et al., 2006) as well as psychological research (e.g., Watkins & Glutting, 2000).

In considering aggregate patient care within a hospital setting, patient treatment across several hospital units is likely to impact patient safety outcomes. Thus, my approach is distinct from the approach used by Ostroff and colleagues in that I examine one dimension of climate (i.e., safety climate) across multiple units. I create configurations of these unit-level safety climate scores to predict patient safety outcomes that are conceptualized and measured at the organizational level of analysis. Thus, I examine the configurations of safety climate across units within a hospital and then relate those hospital-level configurations to patient safety outcomes at the hospital level. Following Ostroff and colleagues, I present three general hypotheses for how safety climate configurations affect patient safety outcomes: elevation, variability, and shape

(Schulte et al., 2006). I will describe each of these predictions in turn and describe why they might be important in this setting.

Profile elevation. Profile elevation reflects the mean safety climate score across units within one hospital. This is important to study because patients are exposed to numerous units within the hospital. At every point, patients may be harmed if commitment to patient safety is not the overriding priority for caregivers. Thus, it is important that every unit that a patient comes into contact with has a high safety climate.

The general hypothesis is that the higher the elevation, the better the patient safety outcomes. This approach reflects an aggregation to the unit level, and a further aggregation to the hospital level. Because safety climate is conceptualized and measured at the unit level, this approach represents the best attempt to gauge the mean climate level across critical units in an entire hospital. A previous study found a positive relationship between profile elevation and collective attitudes (Schulte et al., 2006). The current study extends this link and contends that elevation will impact patient safety outcomes, rather than attitudes.

> Hypothesis 5: *Elevation in safety climate across units is positively related to organizational-level patient safety outcomes.*

One potential problem with the profile elevation approach is the inclusion of less critical units in the averaging of climate scores from unit to hospital level. Including units that do not contribute meaningfully to patient outcomes can introduce systematic error into the measurement of the construct of organizational safety climate.

Profile variability. Profile variability reflects the deviation of unit level safety climate scores within one hospital. Inconsistencies in care are what drive this hypothesis.

Every caregiver needs to be operating with high attention to patient safety. One gap in that chain could have disastrous effects.

The general hypothesis is that the higher the variability, the lower the consistency in keeping patient safety a top priority, and the worse the patient safety outcomes. This approach reflects an aggregation to the unit level, then a further aggregation (by using the standard deviation) to the hospital level. Because safety climate is conceptualized and measured at the unit level, this approach represents an attempt to gauge the variability in safety climate across an entire hospital. Profile variability will be linked to patient safety outcomes at the hospital level of analysis.

<u>Hypothesis 6</u>: *Variability in safety climate across units is negatively related to organizational-level patient safety outcomes*.

One common criticism of the profile variability approach is the possibility that profile variability is a reflection of measurement error rather than a true construct. However, because profile variability in the current study is measured at the organizational level of analysis, as variation between unit-level safety climate scores across the hospital, justification of aggregation to the unit level should ameliorate some of these concerns. That is, with justification for aggregation and reliable group means, we should have increased confidence that any differences between units are more due to signal rather than noise. A bigger problem is the criticism that profile elevation and profile variability are correlated (Schulte et al., 2006; Dickson et al., 2006). In particular, the maximum amount of variability occurs with moderate climate scores, whereas minimum variability occurs with low or high climate scores. Schulte et al. controlled for elevation when studying variability, which is the approach I will use in this study.

Profile shape. Profile shape reflects the "overall pattern of 'ups' and 'downs'" (Schulte et al., 2006, p. 7) of unit-level climate scores across a hospital. Profile shape captures the gestalt of unit-level safety climate patterns within a hospital. In considering aggregate patient care within a hospital setting, patient treatment across several hospital units is likely to impact patient safety outcomes, but not necessarily in a simple additive way. For example, high safety climate is likely to have a greater impact on patient safety during patients' exposure to several key units (e.g., emergency room, intensive care unit) rather than peripheral units (e.g., cardiology laboratory, pharmacy). However, better care in the emergency room is unlikely to compensate for poor care in the intensive care unit, and a lack of attention to safety in peripheral units may also impact overall patient care. For this reason, I propose to develop several profile shapes using cluster analysis, and to relate those shapes to patient safety outcomes.

Hypothesis 7: Profile shape is related to organizational-level patient safety outcomes.

One of the problems with proposing that profile shapes affect outcomes is the difficulty in hypothesizing a priori which profiles will emerge from cluster analysis. Schulte et al. (2006) have argued that our theories are not advanced enough to specify which configurations will emerge from the data. In this way, identifying profile shapes is an empirically-driven approach and likely depends on the sample, industry, and other characteristics, therefore making any shapes that emerge idiosyncratic (Meyer, Tsui, Higgins, 1993). However, that does not preclude the predictive power of the profile shape approach. In fact, Schulte et al. (2006) were able to explain significant variance in firm financial performance using climate profiles.

Additionally, to test the configurational approach against more traditional approaches to analyze the data, I will also examine a regression based approach, entering the mean levels of safety climate for each of the units and all of the two- and three-way interactions. These additional analyses will hopefully illustrate the advantages and disadvantages of the configurational approach—and cluster analysis in particular.

To summarize, I propose to study the configurations of safety climate in several units within the hospitals to predict hospital-level patient safety outcomes. In this way, I am focusing on a specific facet of climate (safety) and the patterns that are exhibited by units.

Summary of Contributions

This dissertation is an important contribution to the I/O psychology literature because it tests the efficacy of safety climate level and strength on both caregiver injuries and patient safety outcomes. Additionally, this dissertation is unique in that it tests a configurational approach that examines the pattern of climate between-units visited by a customer. This technique is also important because it allows researchers to see how predictors from several types of units within a larger organization can impact organizational level outcomes.

Chapter 2: Method

Study Design and Sample

The relationship between safety climate level/strength and caregiver/patient safety outcomes was examined in this study. Unit scores for safety climate level were based on the mean safety climate score for the unit, and safety climate strength will be based on the standard deviation of the safety climate scores for the unit. I will analyze the data using structural equation modeling.

The sample consisted of caregiver survey data collected from 59 hospitals that belonged to a faith-based non-profit hospital system in the United States. The average number of units per hospital (with 5 or more caregivers) was 16 (SD = 11). The data were collected anonymously in 2004. Surveys were completed by all members of the hospital team (e.g., nurses, physicians, fellows, residents). The collection of safety climate and clinical outcome data was supervised by an on-site research nurse. Data were sent back to researchers at the Johns Hopkins University (JHU), who directed the study. The JHU Internal Review Board (IRB) approved this study, and the University of Maryland IRB has provided a waiver for this research. The data were part of a larger project, and the present data is a subsample.

Survey Measures

Within the 57 hospitals, several versions of the survey were distributed. The teamwork and safety climate surveys were distributed to 985 units (n = 23,274 respondents). Longer versions of the survey were also distributed to 67 operating rooms (n = 3,831 respondents) and 90 intensive care units (n = 2,688 respondents). Altogether, 29,793 respondents from 1,142 units responded to a version of the survey (Table 1).

Safety Climate

Safety climate was assessed using one of three safety climate measures: safety climate-general, safety climate-ICU, and safety climate-OR. These measures were adapted from the Safety Attitudes Questionnaire (SAQ; Sexton, et al., 2004), which is a revised version of the Intensive Care Unit Management Attitudes Questionnaire (ICUMAQ; Sexton, Thomas, & Helmreich, 2000; Thomas, Sexton, & Helmreich, 2003).

Safety climate-general. Safety climate-general was assessed using 6 items, using a unit referent (e.g., "in this clinical area") when appropriate. The following are sample items: "The culture in this clinical area makes it easy to learn from the errors of others," and "In this clinical area, there is widespread adherence to clinical guidelines and evidence based criteria regarding patient safety." All items are rated on a five-point scale (1 = disagree strongly to 5 = agree strongly). See Appendix A for the complete set of items.

Table 2 shows the aggregation statistics for this scale. Because analyses are computed based on the types of units, ICCs and average rwgs are reported by unit type. As can be seen, significant variance was accounted for by group membership; the average ICC(1) value was .10. In every case, ICC(2) was above the recommended value of .60 (Glick, 1985). Additionally, the average r_{wg} statistic, which is a measure of within-group agreement, was above the recommended value of .70 (James, 1982).

I also tested for the unidimensionality of this scale at the unit level by conducting a multi-level confirmatory factor analysis (MCFA). Figure 1 shows the model tested and the estimated factor loadings at the within and between level. The results confirmed a one factor solution at the group level of analysis (χ^2 = 190.33(18), CFI = .98, RMSEA = .03,

$SRMR_W$ = .02, $SRMR_B$ = .03). As can be seen in Figure 3, the average between factor loadings (average *r* = .84) was greater than the average within factor loadings (average *r* = .57). Thus, it is reasonable to conclude that a single factor exists at the unit level of analysis.

Safety climate-ICU. Safety climate-ICU was assessed using 5 items, using a unit referent (e.g., "in this ICU") when appropriate. All items are rated on a five-point scale (1 = disagree strongly to 5 = agree strongly). Table 2 shows the aggregation statistics for this scale. Significant variance was accounted for by group membership (ICC[1] = .08). The reliability of group means was acceptable (ICC[2] = .88), and the average r_{wg} statistic was .80.

I also tested for the unidimensionality of this scale at the unit level by conducting a multi-level confirmatory factor analysis (MCFA). Figure 2 shows the model tested and the estimated factor loadings at the within and between level. The results confirmed a one factor solution at the group level of analysis (χ^2 = 54.66(10), CFI = .98, RMSEA = .04, $SRMR_W$ = .04, $SRMR_B$ = .02). As can be seen in Figure 2, the average between factor loadings (average *r* = .92) was greater than the average within factor loadings (average *r* = .60). Thus, it is reasonable to conclude that a single factor exists at the unit level of analysis.

Safety climate-OR. Safety climate-OR was assessed using 4 items, using a unit referent (e.g., "in this clinical area") when appropriate. All items are rated on a five-point scale (1 = disagree strongly to 5 = agree strongly). Table 2 shows the aggregation statistics for this scale. Significant variance was accounted for by group membership

(ICC[1] = .07). The reliability of group means was acceptable (ICC[2] = .88), and the average r_{wg} statistic was .82.

I also tested for the unidimensionality of this scale at the unit level by conducting a multi-level confirmatory factor analysis (MCFA). Figure 3 shows the model tested and the estimated factor loadings at the within and between level. The results confirmed a one factor solution at the group level of analysis (χ^2 = 10.63(4), CFI = .99, RMSEA = .02, $SRMR_W$ = .01, $SRMR_B$ = .01). As can be seen in Figure 3, the average between factor loadings (average *r* = .97) was greater than the average within factor loadings (average *r* = .61). Thus, it is reasonable to conclude that a single factor exists at the unit level of analysis.

Caregiver Injury Outcomes

ICU claims for the period of July 2002 through June 2005 were reported by the healthcare system. Caregiver injuries in these reports included sprains, strains, punctures, slips, contusions, and the like. The dependent variable is the cost of these injuries incurred by the healthcare system, as the cost contains a lot of other information (i.e., nature of the injury, severity of the injury). A total of 382 claims were made during this period. Two hundred thirty six claims could be linked to safety climate scores from the unit. The injury data was collected prior to the collection of safety climate data, which was also prior to major interventions to improve safety climate.

Patient Safety Outcomes

Patient safety outcomes are reported at the hospital level of analysis. Many of the patient safety outcomes are from the Agency for Healthcare Research and Quality's (AHRQ) Patient Safety Indicators (PSIs). The PSIs "screen for problems that patients experience as a result of exposure to the healthcare system, and that are likely amenable to prevention by changes at the system or provider level" (AHRQ, 2005, p. 8). AHRQ screened potential quality indicators for the following characteristics: face validity, precision, minimum bias, construct validity, application, and relevance to quality improvement (AHRQ, 2005, p. 10). Each of the AHRQ patient safety outcomes are rates per thousand discharges. The numerator in the equation is the complication, and the denominator is the specific population (AHRQ, 2005). The PSIs in this study are "risk-adjusted" and have been aggregated by researchers from the metrics group of the hospital system.

Postoperative Outcomes

Two patient safety outcomes were used as outcome variables related to OR procedures. Many PSIs are related to surgical procedures because surgical populations are more homogeneous than medical populations (AHRQ, 2005). It is also easier to attribute surgical complications to surgery, whereas medical conditions could also be attributed to the patients' initial conditions (AHRQ, 2005). Each PSI is described briefly below, and more detail is provided in Appendix G from the PSI manual (AHRQ, 2006).

Postoperative bleeding. A principal components factor analysis revealed that the two PSIs loaded on a single factor. I labeled this factor postoperative bleeding. The two components include 1) postoperative hemorrhage and hematoma and 2) postoperative pulmonary embolism and deep vein thrombosis. A hemorrhage is internal bleeding (Stedmans, 2001) and a hematoma is a collection of blood that results from a hemorrhage (Stedmans, 2001). ARHQ (2006) reports this PSI as the number of "cases of hematoma or hemorrhage requiring a procedure per 1,000 surgical discharges with an operating room procedure" (p. 42). A pulmonary embolism is when a blood clot dislodges and travels through the bloodstream to the blood supply for one of the lungs, resulting in difficulty breathing (Stedmans, 2001). AHRQ (2006) reports this PSI as the number of "cases of deep vein thrombosis (DVT) or pulmonary embolism (PE) per 1,000 surgical discharges with an operating room procedure" (p. 49).

Postoperative infections. A principal components factor analysis revealed that the two PSIs loaded on a single factor which I labeled postoperative infections. This outcome includes both general infections as well as sepsis, which is a serious infection that is a leading cause of death (CDC, 2000; Stedmans, 2001).

Organizational Outcomes ("Core Measures")

The "Core Measures" are a set of indicators developed by the Centers of Medicare and Medicaid Services (CMS), the Hospital Quality Alliance (HQA), and U.S. hospitals to represent quality of care for several common conditions (HHS, 2005). These groups developed a set of best practices for providing care for four common conditions (heart attack, heart failure, pneumonia, and surgical infection prevention). The outcome data reflect the percent compliance with these recommended practices, with one hundred percent compliance as the goal. It is important to note that these data are reported at the hospital level of analysis; that is, they are not reported for individual patients. Hospitals volunteer to participate in data collection, and data are made public. Hospitals can receive incentive payment for their participation in data collection and public reporting (HHS, 2005). For the current study, I received the core measures data directly from the healthcare system sponsoring this dissertation. This hospital system collects data on three of these conditions: heart attack, heart failure, and pneumonia. According to one data specialist working for the healthcare system sponsoring this project, the core measures are the "hardest" (i.e., most objective) indicators that the system collects (Sakee, 2006 personal communication).

Heart Failure. Heart failure is a chronic condition. This organizational-level measure for heart failure is the percent compliance (at the hospital level) with the following procedures for treating heart failure patients: (1) assessment of left ventricular function (LVF), (2) ACE inhibitor or ARB for left ventricular systolic dysfunction, (3) discharge instructions, and (4) smoking cessation advice/counseling (HHS, 2005).

Heart Attack. Heart attack is an acute condition. This organizational-level measure for heart attack is the percent compliance (at the hospital level) with the following procedures for treating heart attack patients, which include: (1) aspirin at arrival, (2) aspirin at discharge, (3) ACE inhibitor or ARB for left ventricular systolic dysfunction, (4) beta blocker at arrival, (5) beta blocker at discharge, (6) thrombolytic agent received within 30 minutes of hospital arrival, (7) PCI received within 120 minutes of hospital arrival, and (8) smoking cessation advice/counseling (HHS, 2005).

Pneumonia. This organizational-level measure for heart failure is the percent compliance (at the hospital level) with the following procedures for treating pneumonia patients: (1) initial antibiotic timing, (2) pneumococcal vaccination status, (3) oxygenation assessment, (4) blood culture performed prior to first antibiotic received in hospital, (5) smoking cessation advice/counseling, and (6) appropriate initial antibiotic selection (HHS, 2005).

It is important to make one caveat about the organizational patient safety outcomes and the units used in the analyses. In this dissertation, I examine the configurations of safety climate across units that have been a likely destination for heart attack, heart failure, and pneumonia patients. The outcome of interest is compliance (at the hospital level) with prescribed procedures for treating these three common conditions. Patients with these conditions are treated by multiple units. Because each of these conditions requires treatment by a different set of units, the units included in the analyses will differ by condition.

Chapter 3: Results

Correlation tables are presented in Tables 3 (ICU), 4 (OR), and 5 (Hospital).

Safety Climate Level and Strength on Employee Outcomes at Unit Level

The first two hypotheses were tested using the ICU data, for which employee injury rates were provided by the hospital system. Hypothesis 1 stated that safety climate level will be negatively related to caregiver injury rates. Hierarchical linear modeling was used to account for the nesting of intensive care units within hospitals. As can be seen in Table 6, safety climate level was not related to days lost ($t(45) = .78$, $p > .05$) or cost to the hospital ($t(45) = -.54$, $p > .05$). Thus, Hypothesis 1 was not supported.

Hypothesis 2 tested the interaction between safety climate level and strength on caregiver injuries. The hypothesis was that in units with higher safety climate level, stronger safety climates will lead to fewer caregiver injuries. In units with lower safety climate level, weaker safety climates will lead to fewer caregiver injuries.
Hierarchical linear modeling was used to account for the nesting of intensive care units within hospitals. As can be seen in Table 6, the interaction between safety climate level and strength was related to days lost ($t(45) = -2.50$, $p < .05$) but not to cost to the hospital ($t(45) = -.90$, $p > .05$). However, the nature of the interaction was contrary to expectations (see Figure 4). Thus, Hypothesis 2 was not supported.

Safety Climate Level and Strength on Patient Outcomes at Unit Level

Hypothesis 3 stated that safety climate level will be negatively related to rates of postoperative outcomes. As discussed previously, this hypothesis was tested using the OR data because it was the only database with postoperative patient safety outcomes. The results of this analysis are shown in Table 7. As can be seen from this table, safety climate level was not related to postoperative bleeding ($B = .16$, $p > .05$) or postoperative infections ($B = .03$, $p > .05$). Thus, Hypothesis 3 was not supported.

Hypothesis 4 predicted an interaction between safety climate level and strength on postoperative outcomes such that in ORs with higher safety climate level, stronger safety climates will lead to lower rates of postoperative outcomes, whereas in ORs with lower safety climate level, weaker safety climates will lead to lower rates of postoperative outcomes. The interaction of safety climate level and strength was significant above and beyond level and strength alone for postoperative infections ($B = -4.26$, $p < .01$). As can be seen from Figure 5, the interaction was in the opposite direction of the prediction. In ORs with higher safety climate level, stronger safety climates led to higher rates of postoperative sepsis; in ORs with lower safety climate level, weaker safety climates led to higher rates of postoperative sepsis. The interaction was not significant for postoperative bleeding ($B = -1.77$, $p > .05$). Thus, Hypothesis 4 was not supported.

Configurations of Safety Climate on Patient Outcomes at Hospital Level

The configurational hypotheses were tested using much smaller sample sizes. Each hospital had to have a score for each of the included units in order to be included in the cluster analysis. Because of missing data, only 33 hospitals were used for the heart outcomes and 18 for the pneumonia outcomes.

Hypothesis 5 predicted that elevation in safety climate across units would be positively related to organizational-level patient safety outcomes. To test this hypothesis, the elevation variable was calculated by taking the mean of unit level safety climates scores for relevant units (i.e., for heart outcomes: emergency room, ICU, and medical/surgical were used; for pneumonia: emergency room, medical/surgical, and respiratory were used[1]). Next, elevation was regressed onto the three patient outcomes: compliance with core measures for heart failure, heart attack, and pneumonia. The results of this analysis are shown in Tables 8 and 9. Elevation was significantly related to compliance with the core measures for heart failure (β = -.37, $p < .05$) and for pneumonia (β = -.47, $p < .05$), but elevation was not significantly related to compliance with the core measures for heart attack (β = -.13, $p > .05$). Surprisingly, elevation was significantly related to heart failure and pneumonia in the opposite direction as predicted: as elevation increases, compliance with the core measures for heart failure and pneumonia decreased. Thus, Hypothesis 5 was not supported.

Hypothesis 6 predicted the variability in safety climate across units would be negatively related to organizational-level patient safety outcomes, after controlling for elevation. To test this hypothesis, variability was calculated by taking the standard deviation of the unit level safety climate score for the relevant units. Next, elevation was entered in step 1 of a regression, and variability was entered in step 2 of a regression on three patient outcomes: compliance with core measures for heart failure, heart attack, and pneumonia. The results of this analysis are shown in Tables 8 and 9. Variability was significantly related to compliance with the core measures for heart attack (β = -.43, $p < .05$), but variability was not significantly related to compliance with the core measures for heart failure (β = .02, $p > .05$) or for pneumonia (β = .21, $p > .05$). The greater the

[1] These units were chosen as likely destinations for heart attack, heart failure, and pneumonia patients. Additionally, the most complete data was available for these units, thus preserving degrees of freedom in the analysis. I would have liked to include other units that were likely destinations for these patients (e.g., cardiology, step-down) or were supporting these patients (e.g., pharmacy), but sample size restrictions prevented the inclusion of these units.

variability in safety climate across units, the lower the compliance with the core measure for heart failure. Thus, Hypothesis 6 was partially supported.

Hypothesis 7 predicted that profile shape would be related to organizational-level patient safety outcomes. To test this hypothesis, profile shapes were created using Ward's hierarchical cluster analysis procedure. Cluster analysis was used to create climate configurations. Ward's method of cluster analysis was chosen for three reasons. First, this method results in approximately equal numbers of observations per cluster (SAS Institute, 1990). Second, it tends to produce cluster in which the within group variance is the smallest (i.e., the cleanest clusters). Finally, this method tends to identify clusters that do not to contain outliers (Ketchen & Shook, 1996; Milligan, 1980). Standardization of the variables before conducting the cluster analysis was unnecessary because all units were measured on the same scale (Ketchen & Shook, 1996).

In this analysis, hospitals were clustered based upon their profile of unit level safety climate for relevant units. Results are separated for the heart outcomes and pneumonia. For heart failure and heart attack, the unit-level safety climate scores entered into cluster analysis were for emergency room, ICU, and medical/surgical units. Examination of the scree plot and dendogram suggested seven clusters. The seven clusters are labeled and described in Table 10. Additionally, Table 10 lists the number of hospitals within each cluster. The seven shapes are shown in Figure 6. For pneumonia, the unit-level safety climate scores entered into cluster analysis were for emergency room, medical/surgical units, and respiratory. Examination of the scree plot and dendogram suggested four clusters. The four clusters are labeled and described in Table

11. Additionally, Table 11 lists the number of hospitals within each cluster. The four shapes are shown in Figure 7.

Hypothesis 7 was tested by using hierarchical regression. For heart attack and heart failure, elevation was entered in step 1, variability was entered in step 2, and six effects coded variables for shape were entered in step 3. For pneumonia, elevation was entered in step 1, variability was entered in step 2, and three effects coded variables for shape were entered in step 3. The prediction was that shape will predict patient safety outcomes above and beyond elevation and variability. The results of these analyses are shown in Tables 8 and 9.

Heart failure. Shape added significant variance to the prediction of compliance with the core measures for heart failure ($\Delta R^2 = 0.32$, $p < .01$) after controlling for elevation and variability. Examining the individual regression coefficients revealed several shapes that were associated with greater or lower compliance with the procedures for treating heart failure patients. First, Shape 5, or equal safety climate shape, was associated with greater compliance with heart failure procedures ($\beta = .91$, $p < .01$). Additionally, Shape 2, or high ER safety climate shape, was associated with greater compliance with heart failure procedures ($\beta = .40$, $p < .10$). Finally, Shape 1, or low ICU, high elevation safety climate shape, was associated with less compliance with heart failure procedures ($\beta = -1.12$, $p < .01$).

Heart attack. Shape did not significantly add to the prediction of compliance with the core measures for heart attack ($\Delta R^2 = 0.14$, $p > .05$) after controlling for elevation and variability.

Pneumonia. Shape was significantly related to compliance with the core measures for pneumonia ($\Delta R^2 = 0.33$, $p < .05$). Examining the individual regression coefficients revealed that Shape 1, diminishing safety climate shape, had higher compliance with the pneumonia procedures ($\beta = 1.11$, $p < .01$). Shape 2, increasing safety climate shape, had lower compliance with the pneumonia procedures ($\beta = -.65$, $p < .05$). Finally, Shape 4, high ER safety climate shape, was associated with lower compliance with the pneumonia procedures ($\beta = -.89$, $p < .10$).

I conducted some additional analyses to examine whether a regression-based approach with interaction terms would provide essentially the same information as the configurational approach. A hierarchical regression, with the three unit means entered in the first step and all two-way and three-way interactions entered in the next step, found only some effects for the mean levels—no two-way or three-way interactions were significant (see Table 12). For heart failure and heart attack, lower safety climate in the medical/surgical units was associated with greater compliance for treating those conditions ($\beta = -.64$, $p < .05$; $\beta = -.65$, $p < .05$). For pneumonia, lower safety climate in the respiratory unit was associated with greater compliance ($\beta = -.59$, $p < .05$).

To summarize, shape was associated with compliance with procedures for treating heart failure and pneumonia, but not with heart attack. Thus, Hypothesis 7 was partially supported. Overall, elevation, variability, and shape predict different patient safety outcomes. Shape best predicts compliance with the core measures for heart failure and pneumonia, and variability best predicts compliance with the core measures for heart attack.

Chapter 4: Discussion

The purpose of this dissertation was to examine the effect of safety climate on caregiver and patient safety outcomes in a national sample of hospitals. After testing the effect of safety climate on outcomes in a traditional fashion--that is, by examining the effect of safety climate level and strength on outcomes within a particular type of unit--this study examined the effect of the patterns or shapes of safety climate across units on patient safety outcomes. The main contribution of this dissertation was to test whether the system of care--as evidenced by the patterns of safety climate in multiple units--was related to patient harm.

Overall, hypotheses testing traditional relationships were not supported. Safety climate level and strength in ICUs was related to caregiver injuries, but not in the direction predicted. The most days were lost to caregiver injuries when safety climate level was high and strength was weak. This is contrary to my prediction that safety climate that is high and strong would lead to the fewest days lost to injury. The interaction between safety climate level and strength on cost of the injuries to the hospital was not significant.

Safety climate level and strength in ORs was also not related to patient safety in predicted ways. The hypothesis testing the interaction of safety climate level and strength on postoperative outcomes were in the opposite direction as predicted. For example, when safety climate level was low and strong, there were fewer instances of postoperative infections. Additionally, when safety climate level was high and weak, there were fewer instances of postoperative infections. Based on previous literature, one would expect that this reduction in postoperative infections would be associated with strong safety climate (i.e., high level and strong strength). This result was wholly unexpected.

While the traditional safety climate hypotheses received little support, the hypotheses regarding the system of care received greater support. In these cases, I examined the pattern of safety climate across three units within each hospital and tested whether the pattern predicted patient safety outcomes over and above the effect of safety climate elevation and variability. In these cases, the outcomes were hospital-level compliance with procedures for treating three conditions: heart failure, heart attack, and pneumonia. Each hospital is rated on how well they comply with established guidelines for treating these conditions. For heart failure and pneumonia, the pattern or shape of safety climate predicted over and above the effect of elevation and variability. Below, I will examine each of the outcomes in turn and speculate on why the patterns are related to patient outcomes. Overall, the results show support for this new interpretation of safety climate--and the notion that organizations should examine the pattern of climate across units in understanding outcomes.

Heart Attack

Heart attack is an acute condition--it happens quickly and care must be delivered quickly in order to save patient lives. In this research, the variability of safety climate across the emergency room, ICU, and patient care units (i.e., medical/surgical units) predicted compliance with the procedures for treating heart attack patients. This result supports the idea that inconsistent care can have negative consequences for patients. At all links in the chain, care must be consistent to ensure that patients with heart attack are treated correctly. In this case, the shapes of safety climate across these units did not matter--it was the variability in whether patient safety was valued that really mattered.

Heart Failure

Above and beyond elevation and variability, the shape of safety climate across the emergency room, ICU, and patient care units predicted compliance with the procedures for treating heart failure patients. Three shapes out of seven were related to patient care. First, a flat shape--one that had relatively equal safety climate across the three groups--was associated with better patient outcomes. This shape suggests that having consistent levels of care--or consistent levels of the value of patient safety--was associated with better care. The second shape, one in which the emergency room safety climate is higher than the other two units, was also associated with better care. This suggests that the initial care received when patients enter the hospital is more important than having high safety climate of the other units. Finally, the low ICU, high elevation shape, in which ICU was lower than the other two units, but overall elevation was relatively high was associated with lower compliance with procedures for treating heart failure patients. This shape suggests that ICUs cannot have much lower safety climates than the other units if patient care is to be ensured.

One remaining question with the profile shape approach is why did other shapes not predict outcomes? For the heart failure outcome, only three out of a possible seven shapes predicted compliance with procedures for treating heart failure. Perhaps there are other unmeasured factors that are contributing to better patient care in these cases. There could be unmeasured third variables that are correlated with the shapes and also with the patient outcomes that are driving this relationship. Additionally, perhaps there are some shapes that, while they do not assist with patient care, they also do not cause any patient harm. Perhaps the other shapes create conditions that do not really affect patients. For example, patients may be getting reasonable (if not exemplary) care when ER and medical/surgical units are at a reasonable level. Perhaps there is an unmeasured third variable that allows the v-shape to be toxic in some situations (as seen with Shape 1), but not in other situations (as seen with Shape 4 and 7). Future research is needed to identify and measure these possible third variables as well as to establish which units should be targeted for examination of shape.

Pneumonia

Above and beyond elevation and variability, the shape of safety climate across the emergency room, patient care units, and respiratory unit predicted compliance with procedures for treating pneumonia patients. Three shapes out of four were related to patient care. First, a diminishing shape, where ER had the highest safety climate and respiratory the lowest, was associated with better patient outcomes. This suggests that initial care is critically important in ensuring patient care. The second shape is the opposite of the first with lowest ER safety climate and highest respiratory safety climate. This shape was associated with less compliance in treating pneumonia patients. This suggests that the respiratory unit is less important than the ER in ensuring patient safety. Finally, a high ER shape, in which the other units had relatively similar (and lower) safety climates, was related to less compliance with the procedures for treating pneumonia patients.

The consequences of this third (high ER) shape at first may seem contradictory with the first (diminishing) shape. Both the first and the third shapes had high levels of safety climate for the ER units. However, it should be noted that there are two key differences between these shapes. First, respiratory and patient care units have relatively similar safety climates in the third (high ER) shape. Perhaps the safety climate for the patient care unit safety climate needs to be higher than the respiratory unit to achieve positive outcomes with respect to pneumonia. Secondly, the overall elevation of the third (high ER) shape is high--and elevation in this case is related to lower compliance with the procedures for treating pneumonia patients. Thus, this result highlights the importance of comparing the shape of the safety climate across units. If one just focuses on one unit (e.g., ER), one would never have been able to distinguish between these two dramatically different outcomes.

Why would the relatively high elevation of safety climate across units seen in the third (high ER) shape be negatively associated with compliance in treating these conditions? Perhaps caregivers have a false sense of security when they perceive safety to be highly valued. Perhaps high safety climate makes the caregivers less vigilant in ensuring that each patient is treated properly because they start to inappropriately rely on their co-workers to have done their job. In other words, it is possible that social loafing might actually be taking place in units with a high safety climate. Social loafing occurs when people exert less effort when working in groups than they would working individually and has been supported in numerous studies (see Karau & Williams, 1993 for a meta-analysis). Clearly, the current study does not provide any answers with regard to these potential explanations. More research is needed to tease out the reason for these results.

One surprise was the result that overall elevation was negatively related to compliance with procedures for treating heart failure and pneumonia. The exact opposite effect was hypothesized. In this case, perhaps there are two explanations. First, elevation is an aggregation of safety climate across units. In this way, it is neither unit-level safety climate nor hospital-level safety climate. Elevation in previous research has examined many different types of climate and combined them into an overall rating, rather than examining the same variable across different unit types (Schulte et al., 2006). Perhaps this conceptualization and operationalization of elevation needs to be reconsidered in subsequent research on climate. A second explanation for why elevation had the opposite predicted effect could be that elevation is less important than understanding shape--and in both of these cases, shape predicted over and above the effect of elevation and variability.

Overall Summary of Configural Results

The results from the profile shapes suggest that there is not one best way to ensure compliance with procedures for treating common conditions in the hospital. The fact that three shapes for heart failure and pneumonia were associated with patient outcomes suggests that equifinality in safety climate patterns exist. There may be some shapes that achieve synergy--and ensure patient safety--as well as some shapes that can be disastrous for patients. This research indicates that examining the pattern of safety climate across units in the hospital that contribute to patient care is as important as ensuring that the more high cost units (e.g., ICUs) have high safety climate.

In looking at the exploratory regression results, which included the mean levels of safety climate for each of the units and the two- and three-way interactions, no additional insights resulted. None of the two- and three-way interactions were significant. While there was a main effect for medical/surgical units for the heart outcomes, and respiratory units for the pneumonia outcome, these were hardly as interesting as the configurational results.

However, it should be reiterated that the present study is the first attempt to test the consequences of between-unit configurational patterns in safety climate. Replication of the predictive power of these patterns with other samples and/or in other populations is needed. If that future research supports the present study by finding useful patterns then systematic exploration of what causes multiple patterns to have the same or different outcomes is necessary.

Limitations, Future Research Directions, and Practical Implications

As with any study, this dissertation had a series of limitations that restrict both the conclusions and generalizability of the results. First, it was surprising that some of the findings in the safety climate literature could not be replicated. In particular, the findings within the ICU and OR were contrary to the hypotheses for both caregiver injuries and patient outcomes. The difference between the previous studies and this present one is that the prior studies tested the predictive power of a patient safety climate scale on patient safety. In the present study, I used a patient safety climate scale and examined its predictive power for caregiver injuries. Perhaps, caregiver injuries are not predicted easily by a safety climate measure focused on patient safety. Thus, a critical issue for these hypotheses was the construct validity of the measure. A measure specifically addressing caregiver safety might be more predictive. Further, in other hospital units in which team work plays such an important role (e.g., OR unit) other kinds of climate (e.g., teamwork climate) may be more important. Future research should investigate whether operating room safety climate is the most important variable to examine when trying to understand postoperative patient outcomes. Additionally, because operating room teams are so large, several subclimates may exist within them. It may be important to investigate whether subclimates exist, and which subclimates predict outcomes.

Another limitation of the study was the inability to draw on the large dataset for some of the analyses. Though the study was comprised of data from over 30,000 caregivers, most of the analyses were conducted at the hospital level of analysis, severely cutting down on degrees of freedom. One disappointment of the study was the inability to garner enough units that are similar across hospitals to analyze other configurations. The three units chosen in each of the configural hypotheses were ones that made both conceptual sense and were able to maximize the greatest degrees of freedom. In trying to add even a fourth unit to my analyses resulted in a substantial decrease in the number of units that could be used. Future research should investigate a related issue in order to minimize this problem. In what ways are the types of units that treat patients with these conditions different depending on the size and orientation of the hospital? For example, in large, regional hospitals, heart attack patients can be expected to visit several specialized units: a cardiodology unit, to run heart tests, an ICU specific for cardiac patients, and a cardiac patient care unit. For other types of hospitals, perhaps the pattern of care for this condition flows through different unit types. Not having more general information on the hospitals used in this study limited the types of additional analyses that were possible. In addition, analyzing data from different units depending on the hospital type changes the nature of the configural approach. Future research should investigate the feasibility of this investigation.

Another limitation in this study was that patient data was presented in the aggregate. Individual patients could not be tracked through the hospital and the units that they visited. This created two problems. First, several assumptions had to be made about which units patients were likely to visit during their stay. Second, data could only be analyzed at the hospital level of analysis, severely cutting down on the sample size to analyze the data. Future research should try to obtain individual patient data--including quality of care and perceptions of service--in order to investigate numerous cross-level and multi-level hypotheses regarding climate and other variables.

One final limitation is also a strength: the use of hard patient outcomes. May of the outcomes were coded from patient records, which reduced the amount of reporting bias inherent when asking caregivers from the unit to report negative outcomes. Additionally, many of the outcomes were metrics judged to be important both to hospital administrators interested in improving the overall quality of care and to patients choosing a hospital to attend. That this data is public and searchable is a great boon to the patient and provides good incentives for the hospital to ensure that it meets standards. However, though these outcomes may be “objective”, they are also subject to the same reporting biases as other measures as well as construct validity issues.

Future Directions

In general, the technique for examining the patterns of climate across units can be used broadly in other research. For example, it would be interesting to investigate the patterns of various dimensions of climate across units to have a multidimensional view of hospital life. To extend beyond hospitals, research could investigate the patterns of factors across units within organizations to understand what is related to outcomes that are multiply determined. Are there breaks in the chain that could be fixed? Are there certain patterns that are extremely successful or extremely detrimental to success? This approach has infinite possibilities in understanding complex phenomena in a system.

The configural approach could also be beneficial at other levels of analysis. Within the hospital arena, the pattern of perceptions by different types of caregivers (e.g., nurses, doctors, respiratory therapists) could predict outcomes within specific units. It could be the case that the safety climate perceptions of a certain subset of caregivers is important in ensuring patient safety. Alternatively, certain patterns of safety climate as perceived by different caregiver types might also be related to patient safety and other outcomes in the work unit (e.g., caregiver job satisfaction). Finally, understanding the antecedents to these climate patterns might also help in understanding why certain patterns are associated with certain outcomes as well as how to fix toxic patterns.

Conclusions

In conclusion, a large purpose of this dissertation was to examine whether patterns of safety climate throughout hospitals was related to hard, patient safety outcomes. Largely, the answer to that question is yes. The system of care within a hospital does have implications for the quality of care received.

Tables

Table 1.

Sample Size

	N Units	N Hospitals with These Unit Types	Participants	Average N of Participants per Unit
Operating Room	54	54	3831	70.94
Intensive Care Unit	45	30	2670	31.41
Emergency Medicine	59	54	2202	37.39
Medical/Surgical units	128	56	4222	32.98
Respiratory	36	33	823	24.94

Table 2

Aggregation Statistics

Unit Type	ICC(1)	ICC(2)	Average rwg
Operating Room	0.07	0.88	0.82
Intensive Care Unit	0.08	0.81	0.80
Emergency Room	0.08	0.80	0.81
Medical/Surgical units	0.08	0.78	0.80
Respiratory	0.07	0.70	0.81

Table 3

Correlations with ICUs

	M	SD	1	2	3	4
1. Safety climate level	3.92	0.27	1.00			
2. Safety climate strength	0.70	0.16	-0.57**	1.00		
3. Days lost to injury	16.63	41.79	0.07	-0.16**	1.00	
4. Cost of injury to the hospital	8149.63	28039.70	-0.12	-0.05	0.66**	1.00

Table 4

Correlations with ORs

	M	SD	1	2	3	4
1. Safety climate level	3.99	0.30	1.00			
2. Safety climate strength	0.69	0.14	-0.79**	1.00		
3. Postoperative bleeding	6.02	6.85	0.16	-0.09	1.00	
4. Postoperative infections	8.37	10.13	0.03	-1.14	-0.15	1.00

Table 5

Correlations at Hospital Level of Analysis

	M	SD	1	2	3	4	5	6	7
1. SC-Elevation (ER, ICU, Med/Surg)	3.97	0.16	1.00						
2. SC-Variability (ER, ICU, Med/Surg)	0.21	0.11	.05	1.00					
3. SC-Elevation (ER, Med/Surg, Resp.)	3.99	0.17	.76**	.37*	1.00				
4. SC-Variability (ER, Med/Surg, Resp.)	0.18	0.11	.26	.22	.16	1.00			
5. Heart Failure	0.77	0.13	-.39*	.05	-.44**	-.15	1.00		
6. Heart Attack	0.88	0.12	-.14	-.39*	-.26	-.30	.48**	1.00	
7. Pneumonia	0.78	0.08	-.26	-.10	-.22	-.16	.46**	.25	1.00

Table 6

Hierarchical Linear Modeling of ICUs

	Coefficient	SE	t	df	p
Days Lost to Injury					
Intercept	18.12	4.17	4.35	30	0.00
Safety climate level	27.86	35.73	0.78	45	0.44
Safety climate strength	321.46	166.23	1.93	45	0.06
Interaction of level and strength	-98.82	39.56	-2.50	45	0.02
Cost of Injury to the Hospital					
Intercept	7909.13	1907.91	4.15	30	0.00
Safety climate level	-19162.77	35696.89	-0.54	45	0.59
Safety climate strength	158118.69	207107.73	0.76	45	0.45
Interaction of level and strength	-47159.04	52355.87	-0.90	45	0.37

Table 7

Hierarchical Regressions for Operating Room

		Postoperative Bleeding			**Postoperative Infections**		
Step	Predictor	*β*	*SE B*	R^2	*β*	*SE B*	R^2
1	SC Level	.16	4.03	.03	.03	6.04	.03
2	SC Strength	2.39	126.17	.03	-.24	19.92	.17
3	SC Level x Strength	-1.77	30.11	.06	-4.26*	40.80	.45

Table 8

Hierarchical Regressions for Heart Failure and Heart Attack (Configurational Approach)

	Heart Failure				Heart Attack			
Variable	β	*S.E.*	*Adj* R^2	ΔR^2	β	*S.E.*	*Adj* R^2	ΔR^2
Step 1			.10*	.13			-.02	.02
Elevation	.28	.24			-.32	.22		
Step 2			.08	.00			.14*	.18
Variability	.27	.21			-.51*	.20		
Step 3			.43**	.44			.16	.18
Shape 1	-1.12**	.09			.07	.09		
Shape 2	.40+	.05			.18	.05		
Shape 3	-.01	.05			-.40	.05		
Shape 4	.44	.06			.20	.06		
Shape 5	.91**	.07			-.29	.07		
Shape 6	-.11	.06			.37	.05		

Includes 3 units: ER, ICU, and Medical/Surgical
Shape 7 is omitted
n = 33
+ $p < 0.1$
* $p < .05$
** $p < .01$

Table 9

Hierarchical Regressions for Pneumonia (Configurational Approach)

	Pneumonia			
Variable	**B**	**S.E.**	**Adj R^2**	**ΔR^2**
Step 1			.18*	.23
Elevation	.33	.13		
Step 2			.18	.04
Variability	.07	.10		
Step 3			.51*	.38
Shape 1	1.11**	.02		
Shape 2	-.65*	.02		
Shape 4	-.89+	.04		

Includes 3 units: ER, Med/Surg, and Respiratory
Shape 4 is omitted
n = 18
+ $p < 0.1$
* $p < .05$
** $p < .01$

Table 10

Description of Shapes for Heart Failure and Heart Attack

Shapes	**Name**	**Description**	**Number of Hospitals**
Shape 1	Low ICU, High Elevation Safety Climate	Equal levels of safety climate in ER and med/surg units, but the safety climate in ICUs was lower	2
Shape 2	High ER Safety Climate	Highest safety climate in ER, and lower (but approximately equal) safety climate in med/surg units and ICUs	5
Shape 3	Increasing Safety Climate	Increasing safety climate: lowest in ER, highest in med/surg units	3
Shape 4	Low ICU, Low Elevation Safety Climate	Equal levels of safety climate in ER and med/surg units, but the safety climate in ICUs was lower	6
Shape 5	Equal Safety Climate	Equal levels of safety climate in ER, ICU, and med/surg units.	5
Shape 6	High ICU Safety Climate	Equal levels of safety climate in the ER and med/surg units, but the safety climate in ICUs was higher	4
Shape 7	High Med/Surg Safety Climate	Highest safety climate in med/surg units, and lower (but approximately equal) safety climate in ER and ICUs	5

Table 11

Description of Shapes for Pneumonia

Shapes	**Name**	**Description**	**Number of Hospitals**
Shape 1	Diminishing Safety Climate	Highest safety climate in ERs, lowest in respiratory units	7
Shape 2	Increasing Safety Climate	Lowest safety climate in ER, highest in respiratory units	5
Shape 3	High Med/Surg Safety Climate	Highest safety climate in med/surg units, equal levels of safety climate in ER and respiratory	7
Shape 4	High ER Safety Climate	Highest safety climate in ER, and lower (but approximately equal) safety climate in med/surg units and respiratory	3

Table 12

Hierarchical Regressions for Heart Failure, Heart Attack, and Pneumonia (Regression Approach)

	Heart Failure				**Heart Attack**				**Pneumonia**			
Variable	β	*S.E.*	*Adj* R^2	ΔR^2	β	*S.E.*	*Adj* R^2	ΔR^2	β	*S.E.*	*Adj* R^2	ΔR^2
Step 1			.29	.35**			.26	.33**			.31	.42*
1. ER Safety Climate	.19	.08			.31	.06			-.04	.05		
2. Med/Surg Safety Climate	-.64*	.11			-.65*	.08			-.13	.08		
3. ICU or Respiratory Safety Climate#	-.10	.07			.13	.05			-.59*	.06		
Step 2			.36	.12			.24	.77			.21	.05
Interaction 1 x 2	-1.48	.73			-5.44	.61			1.11	.45		
Interaction 1 x 3	.80	1.12			7.03	.94			4.35	.54		
Interaction 1 x 2 x 3	-7.55	.17			2.08	.14			-5.58	.07		

For heart failure and heart attack, ICU was the third unit, for pneumonia, Respiratory was the third unit
Interaction 2 x 3 was excluded because tolerance limits were reached
+ $p < 0.1$
* $p < .05$
** $p < .01$

Figures

Figure 1. Multi-level confirmatory factor analysis for safety climate-general scale

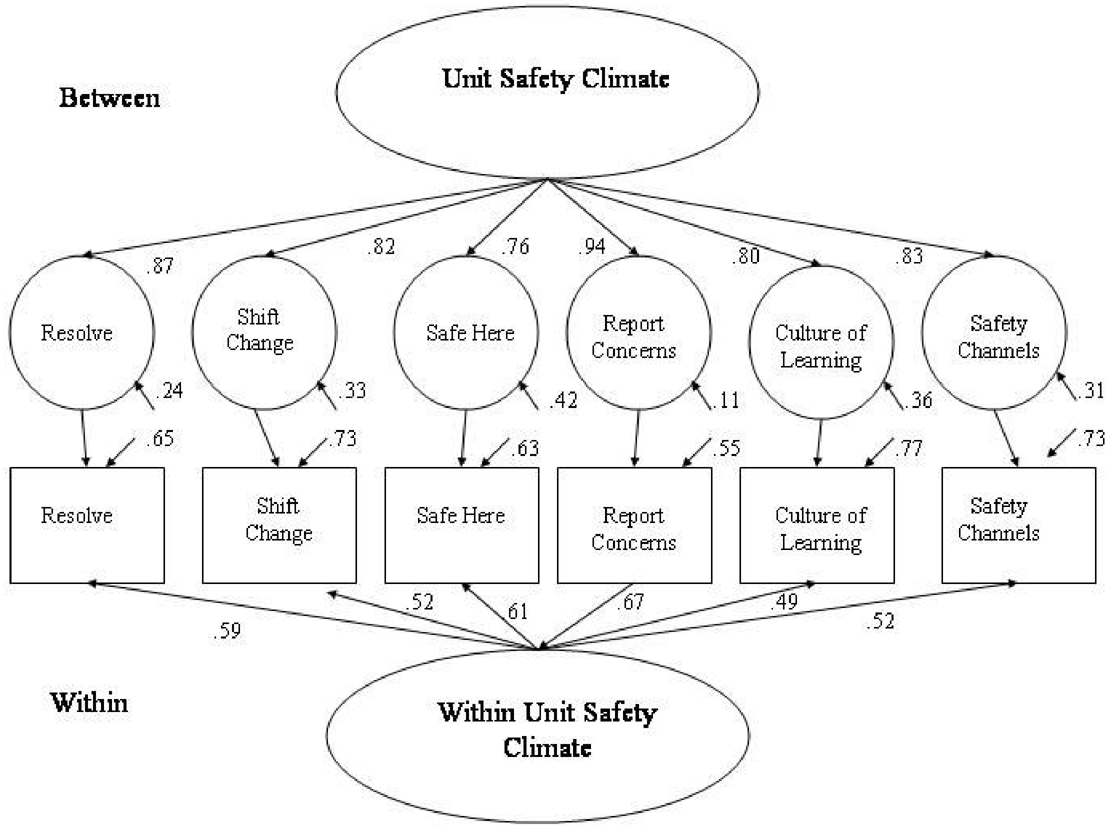


Figure 2. Multi-level confirmatory factor analysis for safety climate-ICU scale

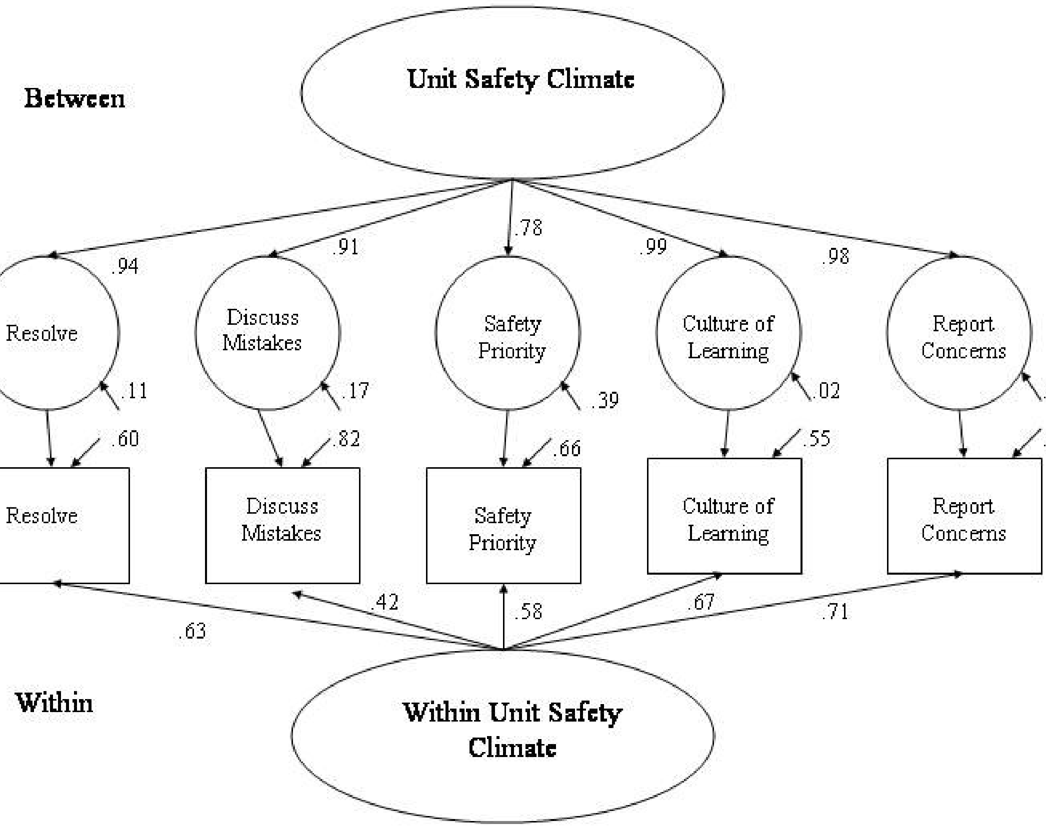


Figure 3. Multi-level confirmatory factor analysis for safety climate-OR scale

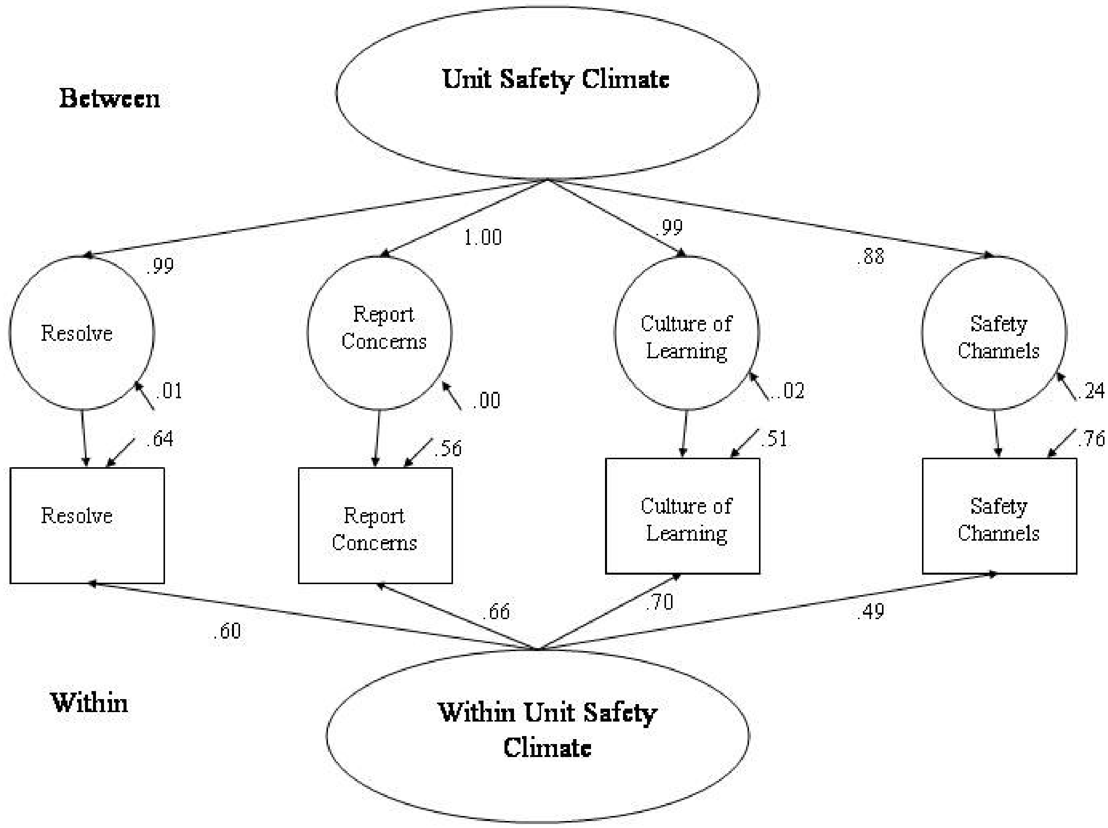


Figure 4. Interaction of safety climate level and strength on caregiver injuries

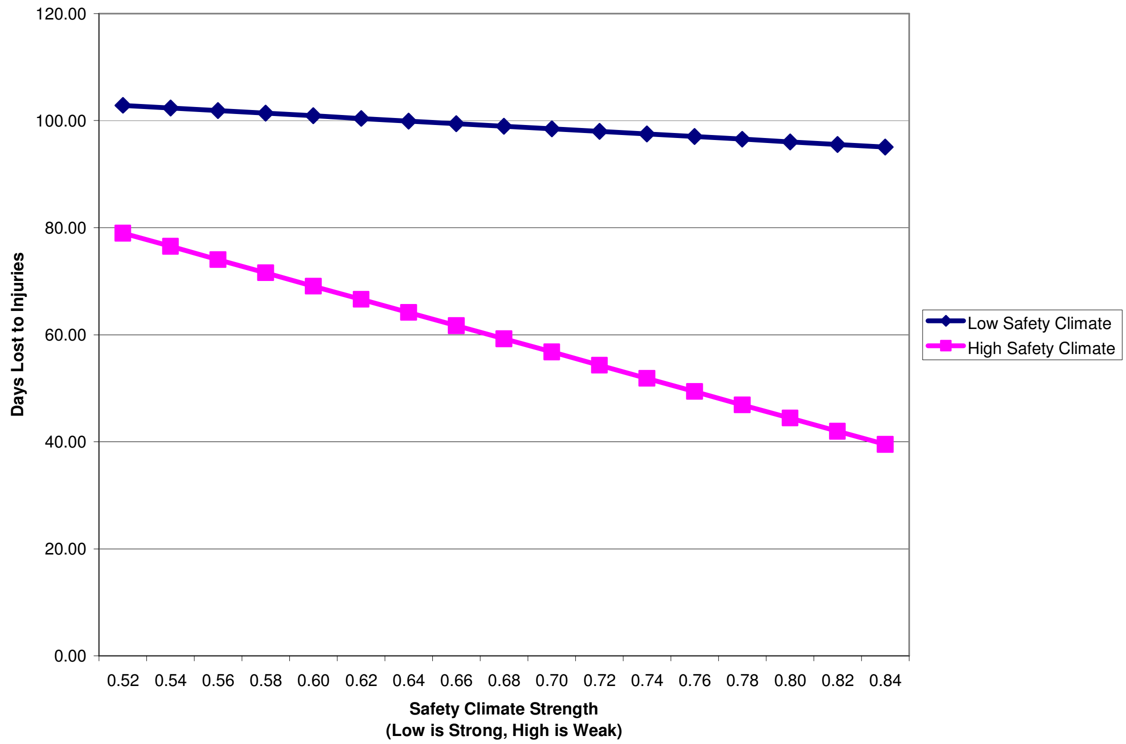


Figure 5. Interaction of safety climate level and strength on postoperative infections

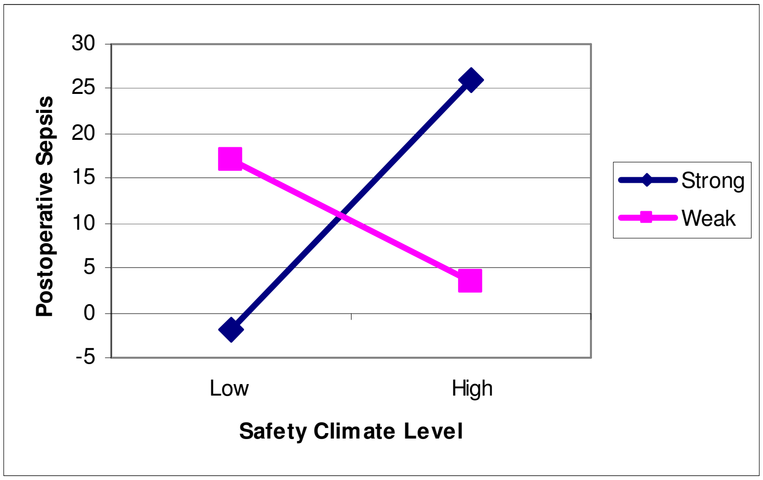


Figure 6. Shapes of hospital safety climate for ER, ICU, and medical/surgical units

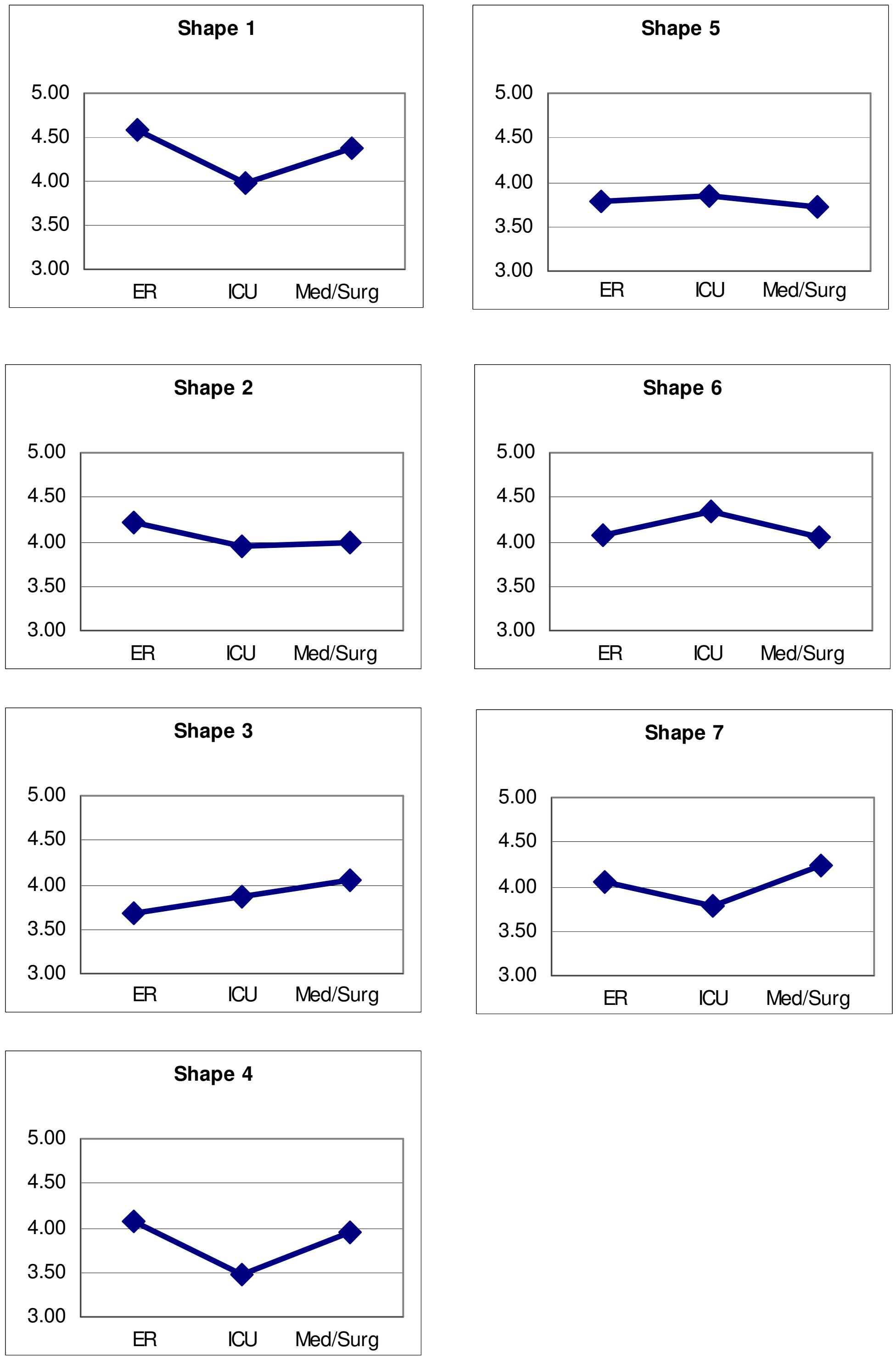
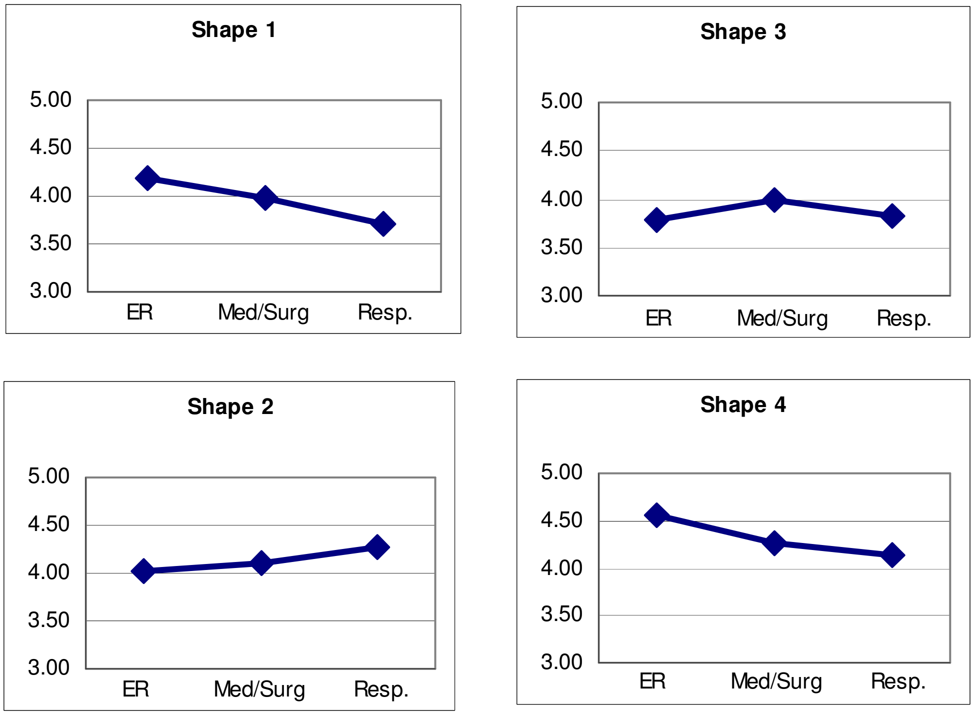


Figure 7. Shapes of hospital safety climate for ER, medical/surgical units, and respiratory



Appendices

Appendix A

Safety Climate-General

- Disagreements in this clinical area are resolved appropriately (i.e., not who is right, but what is best for the patient).
- Important issues are well communicated at shift changes.
- I would feel safe being treated here as a patient.
- I am encouraged by my colleagues to report any patient safety concerns I may have.
- The culture in this clinical area makes it easy to learn from the errors of others.
- I know the proper channels to direct questions regarding patient safety in this clinical area.

Safety Climate-Intensive Care Unit

- The culture in this ICU makes it easy to learn from the errors of others
- In this ICU it is difficult to discuss mistakes (Reverse Scored)
- Patient safety is constantly reinforced as the priority in this ICU
- Disagreements in this ICU are appropriately resolved (i.e., not who is right, but what is best for the patient)
- I am encouraged by my colleagues to report any patient safety concerns I may have

Safety Climate-Operating Room

- I am encouraged by my colleagues to report any patient safety concerns I may have
- The culture in this clinical area makes it easy to learn from the mistakes of others
- I know the proper channels to direct questions regarding patient safety in this clinical area
- Disagreements in this clinical area are appropriately resolved (i.e., not who is right, but what is best for the patient)

References

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