Organizational Factors of Safety Culture Associated with Perceived Success in Patient Handoffs, Error Reporting, and Central Line-Associated Bloodstream Infections

DISSERTATION

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Abstract

Patient safety is a significant problem and one that merits further attention. Errors are underreported, handoffs are inadequate, and central line-associated bloodstream infections (CLABSIs) continue to occur unnecessarily. As many as 70 percent of medical errors result from poor patient handoffs. Underreporting of these adverse events may be as high as 96 percent. Furthermore, a conservative estimate puts annual deaths from CLABSIs at 31,000.

The objective of this three-study dissertation was to identify perceived organizational factors of safety associated with a high frequency of error reporting, successful handoffs, and lower CLABSI rates. The error reporting and handoff studies aimed to find an organizational factor that had the highest association with that outcome. Those studies also assessed differences in perceptions between management and clinical staff, as well as between different clinical staff groups. The CLABSI study sought to identify the organizational factors of safety associated with reduced CLABSI rates. Another goal of that study was to try to identify the hospital units most likely to achieve zero CLABSIs after implementation of the Comprehensive Unit Based Safety (CUSP) methodology.

The Hospital Survey on Patient Safety Culture (HSOPS) was analyzed in conjunction with data on CLABSIs from On the CUSP: Stop BSI program funded by the Agency for Healthcare Research and Quality (AHRQ). The data set for the handoff and error reporting studies consisted of 515,637 respondents in 1,052 hospitals. It was analyzed
using weighted least squares multiple regressions. Poisson, and logistic regressions were used for the CLABSI study of 438 hospitals.

Management support for safety, error feedback, and organizational learning were all significantly associated with error reporting. Feedback on error reports had the most significant association with error reporting. Management support for safety was not a significant predictor of error reporting for managers, but it was for physicians and nurses.

In the second study, management support, teamwork across units, and staffing were all significant predictors of successful handoffs. Teamwork across units similarly had the greatest positive perceived impact on patient handoffs. There was a significant difference in perceptions between management and clinical staff regarding organizational learning, or continuous improvement activities.

In the third study, CLABSI rates decreased significantly following the introduction of the CUSP program. Hospitals should prioritize introduction of CUSP to units that have better perceived staffing and teamwork across units since these organizational factors were associated with zero CLABSIIs after CUSP implementation. Once CUSP is introduced on a unit, hospital leadership needs to support patient safety, and ensure there are strong mechanisms for reflective activities, such as organizational learning and error feedback.

To summarize all three studies, improvements in organizational factors of safety are positively linked to safety outcomes. Management support for safety, teamwork across units, and organizational learning had a positive effect in all three studies, thus demonstrating their consistent influence on patient safety. Furthermore, there was
support for the conceptual model that enabling, enacting, and elaborating actions impact patient safety outcomes.
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Chapter 1: Introduction

Background

The groundbreaking 1999 Institute of Medicine report, *To Err is Human*, increased public awareness of the widespread failure of hospitals on patient safety. This report suggested that up to a million people in the United States are injured and 98,000 die each year due to preventable medical errors (Kohn, Corrigan, and Donaldson 1999). Despite the additional emphasis on quality in the years after that report was released, more recent studies have shown that harm from medical errors is still very common (Leape and Berwick 2005; Landrigan, Parry, Bones, Hackbarth, Goldmann, and Sharek 2010).

Studies have estimated that up to 70 percent of medical errors are due to communication breakdown or poor patient handoffs (Gawande, Zinner, Studdert, and Brennan 2003; Greenberg et al. 2007; Jagsi, Kitch, Weinstein, Campbell, Hutter, and Weissman 2005). Studies have shown that even though patient handoffs are critical in the continuum of care, they are often done in a haphazard fashion (Volpp and Grande 2003). Handoffs have been considered to be flawed to the point that the Joint Commission, an organization that accredits more than 8,000 hospitals and 15,000 health care organizations, made handoff communications one of its 2009 national patient safety goals, and has since made it one of its evaluated standards (Riesenberet al. 2009).

Failure to report medical errors is another patient safety concern that leads to adverse outcomes. Studies in the U.S. and U.K. illustrate that underreporting of adverse events
may be as high as 96 percent (Vincent, Stanhope, and Crowley-Murphy 1999; Barach and Small 2002). The underreporting prevents the opportunity to learn from mistakes. Existing evidence that links error reporting and health outcomes suggests that error reporting contributes to better health outcomes. Actions that foster error reporting create conditions where there are fewer treatment errors (Katz-Navon, Naveh, and Stern 2005; Hofmann and Mark 2006; Naveh, Katz-Navon, and Stern 2005).

Healthcare-associated infections (HAI) similarly have a profound negative impact on the health care system. According to a study of data collected from 1990-2002, it is estimated that 1.7 million people develop an HAI in the United States annually, with 99,000 estimated deaths from those cases (Klevens et al. 2007). According to the U.S. Department of Health and Human Services, one in twenty hospital inpatients develop an HAI and HAIs result in $28-33 billion dollars in preventable health expenditures annually (“Healthcare-Associated Infections”). HAIs are a global problem, not limited to the U.S. England has an estimated 320,000 people per year with an HAI, and Italy has 450,000-700,000 (Tarricone, Torbica, Franzetti, and Rosenthal 2010). This dissertation focuses on central line-associated bloodstream infections (CLABSIs), the leading cause of death of all HAIs (Klevens et al. 2007).

Conceptual Model

Vogus, Sutcliffe, and Weick (2010) consider safety culture to be impacted by enabling, enacting, and elaborating actions, all of which impact safety outcomes. Enabling refers to leader actions that direct attention to safety and make it safe to speak up and act in ways that improve safety. In this stage, leaders create an environment for
staff to safely communicate when faced with threats to patient safety. One way this occurs is when leaders empower employees to speak up and act to resolve patient safety threats (Naveh, Katz-Navon, and Stern 2006). The enacting stage centers on frontline staff actions that highlight threats to safety and mobilize resources to reduce those threats. If enacting characteristics are strong, resources can be quickly mobilized and effectively used to resolve threats to safety. Meanwhile, elaborating consists of learning practices that reflect on safety outcomes and the use of feedback to modify enabling and enacting practices. In the elaborating stage, frontline employees reflect on problems to evolve and expand safety practices. This has potential to also strengthen enabling and enacting when the recommendations are communicated to management.

In a slightly different manner from Vogus et al. (2010), Pidgeon and O’Leary (2000) argue that a good safety culture is made up of four components: 1) senior management commitment to safety, 2) shared care and concern for hazards and a solicitude over their impacts upon people, 3) realistic, flexible norms and rules about hazards, and 4) continual reflection through monitoring, analysis and feedback systems. The Vogus et al. model matches up well with Pidgeon and O’Leary’s framework and strengthens its validity. Senior management commitment to safety mirrors Vogus’ enabling, shared care parallels enacting, and continual reflection suggests elaborating.

The conceptual model used in this study modifies and blends the enabling, enacting, and elaborating model with the four components of a good safety culture. The variables in the Hospital Survey on Patient Safety Culture (HSOPS) data set translate well to the conceptual model, as shown in Figure 1. The enabling or senior management
commitment stage includes the following predictor variables: management support, supervisor support, communication openness, non-punitive response to errors, and staffing levels. These variables center on a system that facilitates a successful safety climate through leadership support. The enacting or shared care stage includes teamwork within units and teamwork across units as variables. These variables reflect the ability of frontline employees to quickly identify and resolve threats to patient safety. These teamwork variables reflect the frontline actions of employees in their patient care, so they fit better in the enacting stage versus the enabling stage. Placement of teamwork in this stage is supported by research by Singer and Vogus (2013). The elaborating or organizational learning stage includes organizational learning and error feedback as the variables. These variables account for the reflection and learning that must take place for optimal patient safety. Outcomes for the three studies are as follows: high frequency of error reporting, successful handoffs, and CLABSI rates.

As broken elements of the health environment, patient handoffs, error reporting, and CLABSI merit continuing study. This dissertation will focus on organizational factors of patient safety culture that impact those critical elements of patient safety. Each study in this dissertation incorporates those factors through the conceptual model, with a few modifications. Rationale for the inclusion of the organizational factors of safety in each model is described in the corresponding chapter of this dissertation.
Research Aims

Chapters 2, 3, and 4 each consist of a paper prepared for publication that examines patient safety. Each of the three studies analyzes the impact of organizational factors of safety on a patient safety outcome. The specific aims covered by each chapter are presented below.

Study 1: Organizational Factors of Safety Associated with a High Frequency of Medical Error Reporting

Aim 1. To determine whether organizational factors of safety are positively associated with a high frequency of error reporting
Aim 2. To determine whether management and clinical staff have different perceptions of the organizational factors of safety associated with error reporting
Aim 3. To determine whether each clinical staff group has different perceptions of organizational factors of safety associated with a high frequency of error reporting
Aim 4. To identify the organizational factor of safety with the greatest impact on error reporting

Study 2: Organizational Factors of Safety Associated with Successful Patient Handoffs

Aim 5. To determine whether organizational factors of safety are positively associated with successful patient handoffs
Aim 6. To determine whether management and clinical staff have different perceptions of the organizational factors of safety associated with successful patient handoffs
Aim 7. To determine whether each clinical staff group has different perceptions of organizational factors of safety associated with successful patient handoffs

Aim 8. To identify the organizational factor of safety with the greatest impact on successful patient handoffs

**Study 3: How Safety Culture Influences Infection Rates: An Analysis of the Comprehensive Unit Based Safety Program**

Aim 9. To determine whether higher performance on organizational factors of safety is associated with reduced CLABSI rates

Aim 10. To determine whether superior organizational factors of safety prior to CUSP implementation are associated with zero CLABSI in the periods following implementation
References


Tarricone, R., Tornica, A., Franzetti, F., and Rosenthal, V. 2010. Hospital costs of central line-associated bloodstream infections and cost effectiveness of closed vs. open
Figure 1. Conceptual Model

- Enabling
  - Management Support
  - Supervisor Support
  - Communication Openness
  - Non-Punitive Response to Errors
  - Staffing Levels

- Enacting
  - Teamwork Within Units
  - Teamwork Across Units

- Elaborating
  - Organizational Learning
  - Error Feedback

Outcome:
- Error Reporting
- Patient Handoffs
- CLABSIs
Chapter 2: Organizational Factors of Patient Safety Associated with a High Frequency of Medical Error Reporting

Abstract

Underreporting of medical errors is a major problem in hospitals. Previous studies that analyzed safety factors associated with error reporting are small, predominately qualitative, and tested predictors using descriptive and univariate methods. Additionally, these studies did not quantitatively examine differences between management and clinical staff, as conducted in this study. A total of 515,637 respondents in 1,052 hospitals completed a survey that assessed organizational factors of patient safety. Using a weighted least squares multiple regression, nine organizational factors of safety were tested as predictors of a high frequency of medical error reporting. Results indicated that hospital staff perceived feedback about errors as the most significant positive predictor of error reporting. Based on these perceptions, hospitals should employ a strong feedback mechanism for error reports. To a lesser extent, teamwork across units, management support for safety, communication openness, organizational learning, and non-punitive response to errors were also significantly associated with a high frequency of error reporting when analyzing all hospital staff. A more focused comparison of management and clinical staff yielded similarities, but also significant differences. Organizational learning and error feedback were perceived as significant predictors of error reporting in analysis of both staff groups. However, management also considered supervisor support
for safety, non-punitive response to errors, and teamwork across units as significant, while clinical staff did not. Clinical staff perceived management support as a significant factor, while management did not. These differences are relevant because management may expend resources based on perceptions that are different from those of the frontline clinical staff that actually report errors.

Introduction

Medical errors consist of near misses and adverse events, cause widespread harm, and are known to be largely preventable. The Institute of Medicine defines a medical error to be the failure of a planned action to be completed as intended, or the use of a wrong plan to achieve an aim (Kohn, Corrigan, and Donaldson 1999). Much of the literature and media attention focuses on adverse events, unintended events that result in harm and prolong the length of stay by at least one day or produce disability evident at the time of discharge (Brennan et al. 1991). Despite the additional emphasis on quality in the years after that report was released, more recent studies have shown that harm from medical errors is still very common (Leape and Berwick 2005; Landrigan, Parry, Bones, Hackbarth, Goldmann, and Sharek 2010).

Adverse events are prevalent and costly. A literature review of eight studies examined adverse events at hospitals and found the median incidence of adverse events was 9.2 percent (De Vries, Gouma, Boermeester, Ramrattan, and Smorenburg 2008). Of those, 43.5 percent were deemed preventable. The median percentage of adverse events that led to no or minor disability was 56.3 percent, permanent disability 7.0 percent, and death 7.4 percent. The review found that 80.8 percent of the adverse events occurred in
the hospital, compared to 14.9 percent out of the hospital before admission or after discharge. A startling statistic is that a hospital patient is expected to have one medication error per hospital day (Aspden, Wolcott, Bootman, and Cronewett 2007).

Studies that analyzed patient safety indicators (PSI) have found similar negative outcomes. PSIs, such as infections due to medical care, are associated with excess risk-adjusted mortality, length of stay, and cost as a result of the patient safety events (Rivard et al. 2008; Encinosa and Hellinger 2005). Collectively, the added cost associated with patients who experience events is estimated annually at $4.4 billion (Levinson 2010).

Less publicized are near misses, although near misses are important because their understanding can still be used to improve processes. A near miss is an event or situation that has the potential to harm a patient but does not produce patient injury because of chance, prevention, or mitigation (Kohn et al. 1999; Aspden 2004). Near misses have been shown to have similar causal pathways to adverse events and provide opportunities for quality improvement (Alamgir, Yu, Gorman, Ngan, and Guzman 2009; Wright and Van Der Schaaf 2004; McCafferty and Polk 2004). They have been observed to encompass more than 50 percent of all errors and are 7 to 100 times more common than adverse events (Kohn et al. 1999; Dovey et al. 2002; Bosma, Veen, and Roukema 2011).

There is some evidence that preventable medical errors can be improved through increased error reporting. By increasing the amount of available data through error reporting, lessons can be learned and changes made to hospital processes to improve health outcomes. One study of medication error reporting found that reports were used to enhance the communication process, provide impetus for additional education or training,
and change policies (Pham et al. 2011). The Joint Commission argues that the development of mandatory or voluntary reporting error reporting systems should result in a decrease in medical errors (Harper and Helmreich 2005). Furthermore, Holden and Karsh (2007) suggest that increased error reporting can improve patient safety by understanding the nature and extent of errors, tracking system performance over time to monitor changes in the system, and by providing evidence that changes perceptions of health providers. Reactive efforts may prevent the error from resulting in harm, while proactive efforts that use error reports to identify the root causes of errors may improve safety system design and ultimately reduce future errors (Uribe, Schweikhart, Pathak, and Marsh 2002).

Strong quantitative research on the link between error reporting and health outcomes is limited, but the existing evidence suggests that error reporting contributes to better outcomes. Actions that foster error reporting create conditions where there are fewer treatment errors (Katz-Navon, Naveh, and Stern 2005; Hofmann and Mark 2006; Naveh, Katz-Navon, and Stern 2005). A specific example was when the New York State Cardiac Surgery Reporting System instituted mandatory reporting of deaths and complications of post-coronary artery bypass grafts in 1989. Only four years after the reporting system was introduced, risk-adjusted mortality rates fell from 4.17 percent to 2.45 percent (Hannan, Kilburn, Racz, Shields, and Chassin 1994). Other incidence reports have enabled learning and system improvements. In the United Kingdom, error reports were used to generate a national safety alert. This alert facilitated actions that led to the successful removal of a potentially harmful substance from most hospitals in the country.
(Lankshear, Sheldon, Lowson, Watt, and Wright 2005). In another example, hospitals achieved substantive improvements in medication practices after the introduction of non-punitive incident reporting (Lehmann et al. 2007; Thomas et al. 2011). Other studies found evidence of a correlation between reporting culture and safety performance indicators (Hutchinson et al. 2009).

Given that error reporting may be associated with improved outcomes, an important question regarding medical errors is whether they are sufficiently reported. The evidence suggests they are not. Studies in the U.S. and U.K. illustrate that underreporting of adverse events may be as high as 96 percent (Vincent, Stanhope, and Crowley-Murphy 1999; Barach and Small 2002). Another study found that medication errors were 300 times more likely to be detected through direct observation than incident reports, were 17 times more likely to be identified through chart reviews (Flynn, Barker, Pepper, Bates, Mikeal 2002). Some hospitals use electronic incident reporting systems to improve error reporting. However, hospitals with incident reporting systems capture only 10 percent of all errors (Sari, Sheldon, Cracknell, and Turnbull 2007). There is also some disparity between staff groups that report errors. One study of 26 hospitals found that physicians submitted only 1-3 percent of the error reports, while registered nurses submitted 45-47 percent (Rowin et al. 2008, Milch et al. 2006).

The purpose of this study, given underreporting of errors, is to identify the organizational factors of safety that have the strongest associations with a high frequency of error reporting, and assess whether those associations are different for management and clinical staff. For reference, the phrase organizational factors of safety has also been
referred to as safety climate or safety culture in other studies. This study adds four elements to existing literature on error reporting. First, it models nine oft-cited organizational factors of safety associated with error reporting to identify those most critical. Beyond descriptive statistics, earlier studies did not assess the influence of a single organizational factor of safety, given the presence of other factors. While they provided insights into factors associated with error reporting, they did not test the factors collectively, nor identify those of greatest importance. The closure of this gap is highly relevant given hospital resource constraints and the tradeoffs between patient safety and costs. Improved patient safety leads to better health outcomes, but not always at lower costs.

Second, this analysis examined the differences in perceptions of nurses, physician assistants (PA) and nurse practitioners (NP), physicians, and management. A literature search indicated that nearly all studies that examined error reporting studied only one specific staff group (i.e., nurses, physicians) or pooled all responses. No quantitative study was found that directly compared perceptions of management and clinical staff on error reporting. An advantage of this study, for comparison purposes, is that the same survey questions were asked of all types of hospital staff. An assessment of differences in perceptions among staff groups is important because management controls the resources, while clinical staff members likely report errors. If management believes certain organizational factors influence error reporting, they may make decisions based on those beliefs. However, those decisions may not produce the desired outcome if they do not influence whether clinical staff report errors.
Third, this research examines a national sample of hospitals on a much larger scale than previously studied. The literature consists of small quantitative or qualitative studies that assessed the nine organizational factors of safety included in this study to varying degrees, but primarily in only 1-3 hospitals. This study expands the scope of previous studies to a national sample that includes 1,052 hospitals and 515,637 staff. The large sample enabled the use of multiple regression techniques, whereas other studies examined error reporting primarily with descriptive methods. The expanded scope of this study provides an opportunity to confirm qualitative findings and those from other prior small studies. It also allows the findings to be generalized to hospitals across the United States.

Finally, this study has expansive practical implications because it analyzes a survey in use at more than 1,000 hospitals. These hospitals do not need to survey additional staff to gather perceptions of safety, since the surveys at those hospitals have already been completed. Rather, each hospital can take significant findings and quickly apply the evidence in a targeted manner to improve safety.

Theoretical Background and Hypotheses

The organizational factors of safety displayed in Figure 1 are examined in this study as they relate to error reporting. Enabling factors of safety are suggested by other studies as barriers specific to error reporting. Leadership participation in safety activities, along with a provision of resources to foster safety, is associated with better safety outcomes (Neal and Griffin 2006; Sexton et al. 2006; Shortell, et al. 1994). It has been shown that when frontline staff members feel comfortable to speak up, they report more errors
(Naveh et al. 2006; Helmreich, Wilhelm, Gregorich, and Chidester 1990). Introduction of a non-punitive reporting system has been associated with increased event reporting (Lehmann et al. 2007). In a literature review of 19 key articles, Pfeiffer, Manser, and Wehner (2010) found that a fear of blame and lack of time for reporting were common barriers that led to a culture of underreporting.

As part of the enacting construct, the frontline behavior of employees is associated with outcomes. In aviation, an industry with oft-cited parallels to the health industry, it is established that teamwork is tied to performance (Helmreich et al. 1990). A Joint Commission study found that 70 percent of preventable errors that resulted in death or serious injury were a result of frontline communication failures (Gittell, Seidner, and Wimbush 2010).

Small studies found evidence that elaborating activities, such as organizational learning and feedback-seeking, are associated with the development of new practices that reduce errors or improve error reporting (Tucker et al. 2007; Hartnell, MacKinnon, Sketris, and Fleming 2012; Pham et al. 2011). Feedback to the person who submitted the error report is considered to be highly important and a barrier that is one of the easier ones to remove (Taylor et al. 2004; Evans, Berry, and Smith 2006). The literature review by Pfeiffer et al. (2010) found that a failure to provide feedback on reported incidents was cited as a barrier to reporting in nearly half of the 19 reviewed articles. Given the findings from previous studies, hypothesis 1 is that higher organizational factors of safety are associated with a higher frequency of error reporting.
Many small studies have focused on clinical staff perceptions of barriers to medical error reporting, but no study has directly compared clinical staff perceptions to management perceptions on the subject of error reporting. Studies that examined differences in perceptions on other related patient safety matters found that managers and frontline staff have different perceptions (Parand et al. 2010; Scherb, Specht, Loes, and Reed 2011). Managers are not the dominant reporting group, yet managers control resources. Frontline clinical staff members, predominantly nurses, are most likely to report errors. Thus, it is important to identify whether the perceptions of the perceived factors associated with error reporting are different between groups. Hypothesis 2a is that management and clinical groups have different organizational factors of safety associated with a perceived high frequency of error reporting.

While no study tested significant differences in nurse and physician reporting behaviors, there are a few studies that descriptively identified factors that influence error reporting. Several studies that surveyed a single health system or single hospital found that physicians, nurses, and/or direct patient care staff identified non-punitive responses to error reporting as the most frequent reason for a failure to report near-misses and errors (Kingston, Evans, Smith, and Berry 2004; Potylycki et al. 2006; “Some Physicians Avoid” 2012). These studies also considered error feedback to be an important driver of reporting. These factors seemed to be common in studies of nurses and physicians. One study asked the same questions of nurses and physicians at a single medical center. Authors found the following barriers most commonly mentioned by physicians as affecting error reporting: lack of feedback from reporting and belief that reporting does
not improve quality of care, additional time and effort involved in reporting, and lack of
knowledge of what to report and how to report an error (Uribe et al. 2002). Barriers most
commonly cited by nurses as affecting error reporting included: additional time and effort
involved in reporting, not being able to report anonymously, an unwillingness to blame
someone else, a belief that reporting is unnecessary if it had no negative outcome, and a
fear of lawsuits. In that study, both nurses and physicians identified the extra work
involved in documenting an error as a barrier. Nurses were more concerned with a non-
punitive response, while physicians were more focused on feedback. Commonality of
organizational factors of safety that impact error reporting is expected, as are differences.
Thus, hypothesis 2b is that among clinical staff groups, there are similarities but also
differences in the organizational factors of safety associated with a perceived high
frequency of error reporting.

While this study had several hypotheses, it was also exploratory. One of its goals was
to identify the organizational factors of safety with the greatest impact on error reporting.
The Pfeiffer et al. (2010) literature review indicated that fear of blame (68% of articles
reviewed), a lack of time for reporting (54%), and no feedback given on reported
incidents (47%) were three of the reasons most commonly cited as barriers to error
reporting. For the purposes of this study, ‘fear of blame’ was measured under the
variable ‘non-punitive response to errors’, ‘lack of time for reporting’ was considered as
‘staffing’, and ‘no feedback’ was considered as ‘error feedback’. Although non-punitive
response to errors, staffing, and error feedback are most commonly cited in the literature
as reasons to avoid error reporting, there is no unanimous evidence that identifies the
specific organizational factor of safety with the greatest association. Therefore, this portion of the study was more exploratory in nature.

Methods

Data and Sample

The data source for this study was the Agency for Healthcare Research and Quality’s (AHRQ) Hospital Survey on Patient Safety Culture (HSOPS) comparative database. The database is a central repository for survey data from hospitals in all 50 states plus U.S. territories that have administered the HSOPS survey. The hospital survey was first released in 2004.

The HSOPS survey has been shown to be a reliable survey instrument that can be studied at multiple levels of analysis. The HSOPS survey has the following 12 dimensions that are comprised of 3-4 questions each: supervisor support for safety, management support for safety, teamwork within units, teamwork across units, organizational learning, staffing, overall perceptions of patient safety, feedback and communication about errors, communication openness, frequency of events reported, handoffs and transitions, and non-punitive response to errors. Psychometric analysis conducted by multiple studies confirmed that the HSOPS dimensions, each comprised of multiple survey questions, are reliable measures valid at the individual, unit, and hospital levels and can be used by researchers to assess patient safety culture (Sorra and Dyer 2010; Blegen, Gearhart, O’Brien, Sehgal, and Alldredge 2009).

Participation in the AHRQ HSOPS survey was initially determined at the hospital or health system level. All types of hospitals were eligible, but the hospital had to be
located in the United States or in a U.S. territory. Reporting survey results was voluntary for hospitals.

The data set incorporated surveys completed by hospital staff from 2008-2011 and was aggregated to the hospital level. As identified by Smits, Wagner, Spreeuwemberg, Goenewegen, and Van Der Wal (2009), there is significant clustering of responses at the hospital level, confirming that the HSOPS survey can measure group culture and not solely individual attitudes. A reason the hospital was chosen as the unit of analysis was because of interpretability of results based on organizational factors of safety for the entire hospital. Hospitals submitted data annually for a range of one to four years; each hospital does not administer the HSOPS survey annually. Data from prior years was used in the data set only when a hospital did not submit new data; older data were replaced with more recent data.

A total of 1,081 hospitals contributed to the data set used for this study. Of those, 29 hospitals were removed because of missing data, leaving a final study sample of 1,052 hospitals and 515,637 individual responses. Subsamples of the data were used to identify differences between staff groups. Hospitals that did not have respondents in each of the staff groups were removed in subgroup analyses. In the management versus clinical staff comparison, clinical staff consisted of the following: physicians, physician assistants (PA), nurse practitioners (NP), registered nurses, licensed practical nurses, and medical assistants. A total of 1,047 hospitals had responses for both managers (36,290 respondents) and clinical staff (237,409) and were used in this analysis. A further subsample of 498 hospitals had responses for each of the following groups and was used
in the comparison of management, physician extenders (NPs and PAs), nurse, and physician staff groups: management (27,814 respondents), nurses (133,688), physicians (17,682), and physician extenders (5,371).

The characteristics of the hospitals, in terms of teaching hospital, government-ownership, geographic region, and bed size variables were consistent with the overall distribution of hospitals registered with the American Hospital Association. As shown in Appendix B, there were slightly more teaching and government hospitals in the study, as well as hospitals with more than 200 beds, compared to the national average.

Survey methods for the HSOPS varied by hospital. Some hospitals relied on paper surveys (24 percent of participating hospitals), while others used web-based surveys (56 percent) or a combination of both (19 percent). The proportion of participants that completed each survey type varied as well. Each hospital developed its own criteria to select staff members to complete the HSOPS survey. Hospitals sampled in the following manner: all staff or a sample of all staff from all work units (78 percent), selected staff only (12 percent), selected units only (4 percent), selected staff and selected work units (6 percent).

**Measures**

The primary variables in this study, along with the survey questions that comprise them, are shown in Appendix C. Of the 12 dimensions in the HSOPS survey, 10 were used in this study. The nine predictor variables were included because similar variables were significant in previous studies or there was a sound theoretical basis, as discussed in the background section of this study. Overall perception of patient safety was not used.
because its questions have a general focus on safety, and this study focuses on specific factors of safety that affect error reporting. Handoffs were not included because of a lack of theoretical basis to include it in the model. Existing literature does not indicate any link between handoffs and error reporting.

The HSOPS survey used a 5-point Likert scale with the following choices for most questions: strongly disagree, disagree, neither agree nor disagree, agree, and strongly agree. Some questions had response options as follows: never, rarely, sometimes, most of the time, and always. If questions were positively worded, responses were considered positive if the person agreed or strongly agreed, or disagreed or strongly disagreed if the questions were negatively worded. The percent of positive responses among hospital staff survey respondents was used as the variable value. The percent positive score was used as the variable value instead of the five-point Likert scale mean primarily for interpretability reasons. For example, an outcome that indicated that a 10 percent improvement in positive error feedback scores was associated with a similar 5 percent expected improvement in error reporting was considered more interpretable than a discussion of incremental changes on the Likert scale.

*Independent Variables*

The predictor variables of interest were perceptions of the following: supervisor support for safety, organizational learning, teamwork within units, communication openness, error feedback, non-punitive response to error, management support for patient safety, staffing levels, and teamwork across units. Supervisor support demonstrated the priority a supervisor placed on safety. Organizational learning reflected continuous
improvement regarding patient safety, in which mistakes led to positive changes and improvements were evaluated for their effectiveness. Teamwork within units exhibited the support and respect that people have for one another within a unit. Communication openness was the ability and willingness of staff to speak up against actions that adversely affect patient care. Error feedback was whether feedback was given after an error report, and whether staff discussed ways to prevent recurrence of errors. Non-punitive response to errors was whether the person who committed an error was punished. Management support was the prioritization and interest hospital management placed on safety. Staffing was whether there was sufficient staff to appropriately handle patient care. Teamwork across units examined the coordination of patient care from one unit to another.

Each survey dimension was treated as a continuous variable and was comprised of 3-4 related questions. The percent positive score was the proportion of survey respondents in a hospital that agreed or strongly agreed with the question, using a 5-point Likert scale for responses. The percent positive scores for the 3-4 related questions that comprise each organizational factor of safety were averaged to represent the variable value. The percent positive score was used as the variable value instead of the five-point Likert scale mean primarily for interpretability reasons.

Consistent with the literature, hospital variables were included to control for bed size, region, teaching hospital, and government hospital. Bed size and region were treated as categorical dummy variables with eight levels, while hospital and government were binary.
Dependent Variable

The dependent variable was a high frequency of error reporting. This variable was derived from the perception of how often an error was reported. Questions focus on near miss errors, errors that were made but did not result in harm to the patient. The same method as the predictor variables was used to generate the variable value.

Procedures

A weighted least-square multiple regression analysis was conducted to obtain measures of association between organizational factors of safety and a high frequency of error reporting. The weight used was the percent of respondents for that hospital. The model included bed size to adjust for the size of the hospital. However, given the divergent sampling methods used at each hospital and varying response rates, controlling for size alone was not enough to alleviate bias from unequal response rates. The main advantage weighted least squares has over a standard linear regression is its ability to handle situations in which the data points are of varying quality (Carroll and Ruppert 1988). Responses from hospitals with a greater proportion of respondents are more precise and were afforded a higher weight. For comparison purposes, a sensitivity analysis was conducted without weights. Assumptions of ordinary least square regression held true.

Partial R-squares were used to tease out the distinct effect of each organizational factor’s impact on error reporting. The partial R-squares measured the percentage of variability in the outcome explained by each safety factor when the other factors were
held constant. Thus, the values of the partial R-squares determined which factor explained the greatest amount of variability in error reporting.

A concordance correlation examined the agreement in responses between the management, nurse, physician, and physician extender groups within each hospital to ensure that separate analysis by groups was warranted. Unlike the Pearson correlation, it combines measures of both precision and accuracy to determine how far the observed data deviates from the 45-degree line of perfect concordance (Krippendorff 1970; Lin 1989; Lin 2000).

All statistical analyses were performed using Stata: Release 11 software (College Station, TX: StataCorp LP.).

Results

The mean hospital survey response rate was 52 percent, with 458 completed surveys per hospital. Appendix D presents the numbers and proportions of all respondents by staff category. The largest percentage of respondents was nurses at 35 percent, management had 8 percent, and physicians and physician extenders represented 6 percent. Results displayed in Table 1 indicate that hospital staff generally had a positive view of organizational factors of safety, with the exception of non-punitive response to errors.

An examination of concordance correlations and variance inflation factors (VIF) suggests that hypotheses analysis was not significantly hindered by multicollinearity or similar within-hospital staffing group responses. Concordance correlations were low, with the highest at 0.40. Thus, the management, physician extenders, physician, and
nurse staffing group responses were distinct enough to warrant separate analysis between groups. To reduce concerns about multicollinearity, variance inflation factors (VIF) were obtained for each model. Each variable had a VIF less than six, with an average less than three, less than the threshold of ten considered a serious concern (Hair, Anderson, Tatham, and Black 1995; Marquardt 1970; Mason, Gunst, and Hess 1989).

The principal findings for my study are as follows: error feedback had the largest effect of any variable on error reporting, hypothesis 1 had partial support, hypotheses 2a and 2b had complete support, and elaborating activities had the largest effect of any stage of the conceptual model. Each finding is explained in greater detail in this section.

Effect of Error Feedback

Of the nine primary independent variables tested, error feedback showed the largest effect on error reporting. Error feedback had the strongest positive association with successful error reporting in each level of analysis: all hospital staff, management and clinical staff comparison, and the NP/PA/Physician/Nurse/Management group comparison. The results were consistent across all models using univariate and multiple regression techniques. The partial R-square in Table 2 indicated that 50 percent of the remaining variability left unexplained by the regression of error reporting on the control variables was explained by error feedback. Similarly, the coefficient ($\beta=0.66$, 95% CI: 0.60-0.72) from the univariate analysis was the highest of any variable in the study.

The weighted least squares multiple regression of all hospital staff provided further evidence of the effect of error reporting. Again, error feedback had the largest effect on high frequency of error reporting ($\beta$: 0.47, 95% CI: 0.39-0.54). An interpretation is
hospital staff perceived a 10 percent improvement in error feedback is associated with an expected increase in high frequency of error reporting of 4.7 percent. Error feedback also had the highest partial R-square of 0.14. No other variable had a partial R-square greater than 0.01.

Error feedback similarly had the largest effect on error reporting in the group level comparisons. Table 6 displays the effect of error feedback on error reporting among members of each staff group (management $\beta=0.58$, NP/PA $\beta=0.30$, physician $\beta=0.40$, nurse $\beta=0.44$)

*Partial Support for Hypothesis 1*

Hypothesis 1 was fully supported by the univariate analysis after adjustment for the control variables (Table 2), but was only partially supported by the multiple regression analysis of Table 3. The univariate analysis indicated that all factors were positively and significantly associated with a high frequency of error reporting. Although all variables were significant in the univariate analysis, many of the factors were not significant in the multiple regression analysis. The variables communication openness, management support for safety, teamwork across units, feedback on errors, and non-punitive response to errors were all significantly associated with a high frequency of error reporting. Management support for safety, teamwork across units, error feedback, and non-punitive response to error reporting were positively associated with a high frequency of error reporting, as expected. Surprisingly, communication openness was negatively associated with high frequency of error reporting, after including the other organizational factors of safety in the multiple regression model.
Similarities and Differences of Perceptions Among Staff Groups

A few notable differences were discovered in the management and clinical staff analyses that support hypothesis 2a. Table 4 shows that for each variable of interest, managers averaged higher positive perceptions of organizational factors of safety than clinical staff. All differences were highly statistically significant (p<.001), using the paired t-test.

The clinical and management staff groups had significant differences with regard to teamwork across units, non-punitive response to errors, and management support for safety. Table 5 displays results from two separate weighted least squares regressions, one that used management responses, and the other clinical staff responses. Non-punitive response to errors and teamwork across units were significant predictors for management, while they were not significant for clinical staff. Management support was significant for clinical staff but not for management. Four variables were significant in only one group: supervisor support, non-punitive response to errors, and teamwork across units (management model), and management support (clinical staff model). All significant variables were positively associated with a high frequency of error reporting except for the supervisor support for safety variable in the management group, with a coefficient of -0.16.

The sub-group analysis of the clinical staff group showed that each clinical staff group had different variables significantly associated with error reporting, thus providing support for hypothesis 2b. Noteworthy differences include the positive effect of communication openness in the physician group and the negative effect of staffing in the
nurse group, with neither having an effect in the other clinical groups. Table 6 provides the coefficient estimates from separate weighted least squares multiple regression analyses, one for each group. The NP/PA group had organizational learning ($\beta=0.18$), non-punitive response to errors ($\beta=0.15$) and teamwork across units ($\beta=0.11$). The physician group had teamwork within units ($\beta=-0.23$), communication openness ($\beta=0.13$) and management support for safety ($\beta=0.16$). The nurse group had teamwork within units ($\beta=0.13$), staffing ($\beta=-0.12$), and management support for safety ($\beta=0.16$).

**Importance of Elaborating Actions**

There was support for the theoretical model that enabling, enacting, and elaborating actions affect outcomes. Each stage of the model had at least one element of statistically significance. The elaborating actions had the greatest effect on a perceived high frequency of error reporting. The elaborating stage’s two variables, organizational learning and error feedback, were the only variables statistically significant in both the management and clinical staff groups. Error feedback had the largest effect on a high frequency of error reporting ($\beta=0.44$ in the management model, $0.37$ clinical staff model), with organizational learning next ($\beta=0.20$ management, $0.14$ clinical). Enabling activities are still important, in that management support and non-punitive response to errors were positively associated with error reporting. Similarly, enacting activities are relevant, as teamwork across units was supported by all hospital staff and by the management subgroup. Despite the statistical significance of some enabling and enacting activities, elaborating activities, specifically error feedback, generated the most pronounced impact on error reporting.
Discussion

Despite the efforts of hospital leaders, the underreporting of errors continues to be a significant problem (Barach and Small 2002). Although hospitals pour money into initiatives that create incident reporting systems, there is little consensus as to the most significant organizational factors of safety required to optimize error reporting. Similarly, differences between management and clinical staff were not sufficiently assessed in the literature.

The elaborating actions, error feedback and organizational learning, had the greatest effect on a perceived high frequency of error reporting. Failure to provide error feedback was commonly mentioned in previous studies as a barrier to error reporting (Pfeiffer et al. 2010). Understanding the degree to which various factors of safety influence error reporting is necessary in the resource constrained setting in which hospitals operate. Warburton (2005) infers that only a fraction of recommended patient safety improvements can be adopted due to constraints on finances and staffing.

It is recommended that management take actions that prioritize improvement in error feedback. Some suggestions to improve feedback are to make it timely, increase management commitment to making changes from error reports, and assume that all perceptions are real (Folkman 1998). Feedback should be provided to the unit soon after the error report since delays between decisions and feedback hurt performance (Sterman 1989). Management must be committed to using the error reports to make changes to the work environment. The changes indicate to the person that reported the error that the reporting made a difference. Folkman (1998) also argues that the perceptions of
employees should be treated as reality. In the context of error reporting, that means that each report should be taken seriously. No report should be ignored as an impossibility.

Similar to error feedback, if hospitals want to improve error reporting, an emphasis should be placed on organizational learning activities. Previous studies indicate that organizational learning can be improved through feedback associated with the development of new practices, safety rounds, and video reflexive ethnography (Tucker et al. 2007; Campbell and Thompson 2007; Carroll, Iedema, and Kerridge 2008).

Another important finding was the difference in management and clinical staff perceptions of the organizational factors of safety culture that affect error reporting. Among managers, teamwork across units and non-punitive response to errors were perceived to affect error reporting, while management support was not perceived to have an impact; the opposite perceptions were true among clinical staff. Clinical staff members are more likely to report errors so management may inadvertently lessen error reporting if it fails to realize the importance of management support for safety to clinical staff (Rowin et al. 2008). As discussed in Parand et al. (2010), there is a danger in only consulting managers about the design of an organizational initiative. Managers need to acknowledge the perceptions of frontline staff and make improved management support for safety a priority. One effective way for managers to demonstrate support is to implement a safety board with safety subcommittees (Wong, Helsingher, and Petry 2002).

In the case of teamwork across units and non-punitive response to error reporting, the differences in management and clinical perceptions may lead to wasted resources. Since there was no effect of non-punitive response among clinical staff, it may behoove
management to have a more targeted focus on non-punitive response than previous management perceptions dictate. While previous studies indicated the importance of non-punitive response, there is a noticeable difference in study design. The previous studies that showed an effect related questions on non-punitive response to the person reporting the error, while my study questions addressed the person committing the error (Potylycki et al. 2006; Kingston et al. 2004; Uribe et al. 2002). Management may believe that all non-punitive response programs improve error reporting, but my study does not necessarily show that to be true.

Unexpectedly, communication openness was negatively associated with error reporting in the complete hospital analysis, although there is a plausible explanation. Since communication openness deals with the willingness of staff to speak up or question others, it is possible that improvements in this area lead staff to fix errors as they occur, rather than report them. Even though the VIF did not indicate multicollinearity, it is also possible that the high correlations among the predictor variables in this study account for the unexpected negative effect, since the effect was positive in the univariate analysis.

Limitations and Suggestions for Future Research

This study used a secondary data set, so there are some limitations. I was unable to make changes to the survey or ask additional survey questions. Other potential factors that some studies have shown to impact error reporting, such as whether an electronic reporting system was employed, whether error reporting was mandatory or voluntary at a given hospital, or if a fear of malpractice impacted a willingness to report, were not examined in this study (Holden and Karsh 2007; Garbutt et al. 2007). Future studies can
test how important these factors are in the presence of feedback on errors, and whether they moderate the strength of that association with a high frequency of error reporting.

Common method bias, the degree to which correlations are altered due to a methods effect, is a potential problem in survey research, although it was not a major issue in this study. It occurs when there is shared systematic error variance among variables measured with and introduced as a function of the same method or source (Doty and Glick 1998). One way it may appear is when there is simultaneous measurement of predictor and outcome variables. Tests of common method bias indicated that it was not a significant threat to the validity of the findings. Common methods bias is partially controlled by the design of the survey instrument: reverse-coded questions, spatial separation of dependent and independent variables, question order randomization, and survey respondent anonymity (Richardson, Simmering, and Sturman 2009). Podsakoff, MacKenzie, and Podsakoff (2012) suggest that elimination of common scale properties shared by the predictor and outcome variable helps reduce common method bias. The survey instrument varied questions, with some positively and others negatively worded. Also, the response options were different for some of the questions. The scale choices for the outcome variable were different from seven out of the nine predictor variables. Common method bias was assessed with Harman’s single factor test and a confirmatory factor analysis. This testing was consistent with other studies in the literature (Schoenherr and Swink 2012; Boyer and Hult 2005). If common method variance is largely responsible for the relationships among the variables then the confirmatory factor analysis model should fit the data well (Korsgaard and Roberson 1995; Mossholder,
Bennett, Kemery, and Wesolowski 1998). However, the single factor model was a worse fit than the proposed model with the differentiated measurement items ($\chi^2 = 3869.525$, d.f. = 170, RMSEA = 0.144, CFI = 0.503, TLI = 0.444).

Another possible limitation of this study is that the responses are based on perceptions. Answers may reflect what respondents think is happening, but the reality may be very different. Yet, those perceptions are still important indicators of organizational factors of safety and have been associated with actual leadership commitment to safety, the priority placed on safety, and medical outcomes (Mardon, Khanna, Sorra, Dyer, and Famolaro 2010; Katz-Navon et al. 2005). Future studies can validate whether the perceptions are reality, and attempt to test causality.

An additional limitation involves the sampling method and generalizability of results. This was essentially a convenience sample since hospitals that submitted data were not a statistically selected sample of all U.S. hospitals; submissions were voluntary. However, the sample was large and the structural characteristics of the database hospitals were fairly consistent with the distribution of hospitals registered with the American Hospital Association, leading to confidence that the results are representative of all U.S. hospitals. Please see Appendix B for a comparison.

Another limitation of this study stems from bias inherent in surveys. The predictors of interest and dependent variable were obtained using survey data, which is subject to recall bias and measurement error. Recall bias was not much of a limiting factor in this study because the questions were not based on historical events. The survey instead asked questions that typically had a yes or no answer, without regard to timelines.
Measurement error is a concern if respondents inflated otherwise undesirable responses out of fear of repercussions or selected the same response to all questions. The measurement error has to have a statistically significant impact on the sample in order to be of concern to the study. Differential measurement error can bias results away from the null. Consistent with Nederhof (1985), the desirability bias that affect measurement error was partially controlled in my study through the survey respondent anonymity, self-reporting, and mixture of positive and negatively worded questions. In addition, potentially sensitive topics like the frequency of error reporting were worded in a way that did not imply direct involvement of the respondent in the undesirable behavior. This type of wording has reduced desirability bias (Podsakoff et al. 2012). Neither measurement error nor recall bias likely had a major impact on this study.

Missing data is another limitation in many studies, but is particularly common when using surveys. For the analysis of all staff, fewer than three percent of cases were dropped. Langkamp, Lehman, and Lemeshow (2010) studied missing data in large surveys and found that only when more than 10 percent of cases had missing data was re-weighting or use of multiple imputation techniques superior to dropping the cases. The amount of missing data in the study was small enough not to be a major concern.

Future research should assess the optimal manner in which to provide error feedback and clearly establish a link between error reporting and actual errors. Considering the important role error feedback plays in increased error reporting, research should analyze how different methods of error feedback affect error reporting. Separately, research on the effect of error reporting on future errors needs to be conducted. While a few studies
have shown the positive effect of error reporting on risk-adjusted morbidity and mortality rates, there has not been a study that demonstrates the effect of error reporting on future errors. This is an important question, considering the resources that have gone into improving our nation’s error reporting systems and the adverse consequences of medical errors.

Conclusion

In summary, it appears that error reporting can be improved the most through increased error feedback, hospital leadership that demonstrates safety is a priority, and an environment that inspires organizational learning. Clinical staff and management have different perceptions of organizational factors that affect error reporting. Knowledge of the differences may improve a hospital’s ability to optimize error reporting by making managers aware that clinical staff do not entirely share their perceptions. Since clinical staff members are more likely than managers to report errors, managers must be cognizant that their own perceptions may differ from clinical members.

Since learning results from error reporting, it is important that hospitals continue efforts to improve error reporting to reduce future medical errors. Medical errors unnecessarily inflate levels of morbidity and mortality and are largely preventable.
References


### Table 1. Means, Standard Deviations, and Correlations Among Primary Variables

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>s.d.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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</thead>
<tbody>
<tr>
<td>1. Error Reporting</td>
<td>63.5</td>
<td>7.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2. Supervisor Support</td>
<td>75.1</td>
<td>6.4</td>
<td>0.62</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3. Organizational Learning</td>
<td>72.3</td>
<td>7.1</td>
<td>0.67</td>
<td>0.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>4. Teamwork Within Units</td>
<td>80.1</td>
<td>5.7</td>
<td>0.51</td>
<td>0.68</td>
<td>0.64</td>
<td></td>
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<tr>
<td>5. Communication Openness</td>
<td>61.6</td>
<td>6.5</td>
<td>0.56</td>
<td>0.72</td>
<td>0.60</td>
<td>0.60</td>
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</tr>
<tr>
<td>6. Error Feedback</td>
<td>64.6</td>
<td>8.0</td>
<td>0.73</td>
<td>0.74</td>
<td>0.77</td>
<td>0.56</td>
<td>0.73</td>
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<tr>
<td>7. Nonpunitive Response to Errors</td>
<td>43.9</td>
<td>8.5</td>
<td>0.49</td>
<td>0.67</td>
<td>0.57</td>
<td>0.59</td>
<td>0.73</td>
<td>0.55</td>
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<tr>
<td>8. Staffing Levels</td>
<td>57.0</td>
<td>9.1</td>
<td>0.43</td>
<td>0.63</td>
<td>0.60</td>
<td>0.61</td>
<td>0.53</td>
<td>0.48</td>
<td>0.68</td>
<td></td>
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<tr>
<td>9. Management Support</td>
<td>72.2</td>
<td>9.3</td>
<td>0.64</td>
<td>0.74</td>
<td>0.82</td>
<td>0.65</td>
<td>0.60</td>
<td>0.71</td>
<td>0.62</td>
<td>0.70</td>
<td></td>
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<tr>
<td>10. Teamwork Across Units</td>
<td>58.5</td>
<td>10.0</td>
<td>0.62</td>
<td>0.68</td>
<td>0.73</td>
<td>0.70</td>
<td>0.58</td>
<td>0.65</td>
<td>0.62</td>
<td>0.65</td>
<td>0.82</td>
</tr>
</tbody>
</table>

N = 1,052 hospitals

All correlations are significantly different from zero (p<.001)

Means reflect the average percentage of respondents at each hospital that agreed or strongly agreed

Question responses were based on a 5-point Likert scale
Table 2. Predictors of High Perceived Frequency of Error Reporting: Univariate Results

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Partial R-Square</th>
<th>β</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error Feedback</td>
<td>0.50</td>
<td>0.66</td>
<td>(0.60, 0.72)</td>
</tr>
<tr>
<td>Organizational Learning</td>
<td>0.41</td>
<td>0.65</td>
<td>(0.60, 0.70)</td>
</tr>
<tr>
<td>Management Support</td>
<td>0.39</td>
<td>0.61</td>
<td>(0.54, 0.68)</td>
</tr>
<tr>
<td>Teamwork Across Units</td>
<td>0.34</td>
<td>0.56</td>
<td>(0.51, 0.62)</td>
</tr>
<tr>
<td>Supervisor Support</td>
<td>0.30</td>
<td>0.64</td>
<td>(0.60, 0.68)</td>
</tr>
<tr>
<td>Communication Openness</td>
<td>0.27</td>
<td>0.40</td>
<td>(0.36, 0.45)</td>
</tr>
<tr>
<td>Non-Punitive Response to Errors</td>
<td>0.23</td>
<td>0.36</td>
<td>(0.31, 0.41)</td>
</tr>
<tr>
<td>Teamwork Within Units</td>
<td>0.22</td>
<td>0.50</td>
<td>(0.46, 0.54)</td>
</tr>
<tr>
<td>Staffing</td>
<td>0.18</td>
<td>0.44</td>
<td>(0.40, 0.48)</td>
</tr>
</tbody>
</table>

Weight was a hospital’s overall survey response rate; n = 1,052 hospitals
R-square solely from inclusion of control variables was 0.23
Adjusted for control variables (government, teaching, bed size, region)
*p<.05
**p<.01
***p<.001

Table 3. Weighted Least Squares Multiple Regression of Organizational Factors of Safety on High Perceived Frequency of Error Reporting

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Partial R-Square</th>
<th>β</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervisor Support</td>
<td>0.14</td>
<td>-0.02</td>
<td>(-0.11, 0.06)</td>
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<td>Organizational Learning</td>
<td>&lt;0.01</td>
<td>0.08</td>
<td>(-0.01, 0.16)</td>
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<tr>
<td>Teamwork Within Units</td>
<td>0.01</td>
<td>0.05</td>
<td>(-0.03, 0.13)</td>
</tr>
<tr>
<td>Communication Openness</td>
<td>0.01</td>
<td>-0.09</td>
<td>(-0.17, 0.00)</td>
</tr>
<tr>
<td>Staffing</td>
<td>&lt;0.01</td>
<td>0.01</td>
<td>(-0.04, 0.06)</td>
</tr>
<tr>
<td>Management Support</td>
<td>&lt;0.01</td>
<td>0.08</td>
<td>(0.01, 0.15)</td>
</tr>
<tr>
<td>Teamwork Across Units</td>
<td>&lt;0.01</td>
<td>0.09</td>
<td>(0.03, 0.14)</td>
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<tr>
<td>Feedback on Errors</td>
<td>&lt;0.01</td>
<td>0.47</td>
<td>(0.39, 0.54)</td>
</tr>
<tr>
<td>Non-Punitive Response to Errors</td>
<td>&lt;0.01</td>
<td>0.06</td>
<td>(0.01, 0.12)</td>
</tr>
</tbody>
</table>

Weight was a hospital’s overall response rate; n = 1,052
Controls included teaching hospital, government hospital, bed size and region
*p<.05
**p<.01
***p<.001
R² was .65; adjusted R² was .64
Table 4. Organizational Factors of Safety: Management and Clinical Staff Comparison

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Management</th>
<th>Clinical</th>
<th>Difference</th>
<th>Sig (T-Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error Reporting</td>
<td>70.9</td>
<td>62.9</td>
<td>8.0</td>
<td>***</td>
</tr>
<tr>
<td>Supervisor Support for Safety</td>
<td>86.3</td>
<td>73.2</td>
<td>13.1</td>
<td>***</td>
</tr>
<tr>
<td>Organizational Learning</td>
<td>84.3</td>
<td>72.1</td>
<td>12.2</td>
<td>***</td>
</tr>
<tr>
<td>Teamwork Within Units</td>
<td>89.4</td>
<td>79.9</td>
<td>9.5</td>
<td>***</td>
</tr>
<tr>
<td>Communication Openness</td>
<td>77.5</td>
<td>60.0</td>
<td>17.5</td>
<td>***</td>
</tr>
<tr>
<td>Error Feedback</td>
<td>79.3</td>
<td>61.3</td>
<td>18.0</td>
<td>***</td>
</tr>
<tr>
<td>Non-Punitive Response to Errors</td>
<td>63.4</td>
<td>42.2</td>
<td>21.2</td>
<td>***</td>
</tr>
<tr>
<td>Staffing Levels</td>
<td>66.0</td>
<td>57.3</td>
<td>8.7</td>
<td>***</td>
</tr>
<tr>
<td>Management Support for Safety</td>
<td>85.8</td>
<td>67.6</td>
<td>18.2</td>
<td>***</td>
</tr>
<tr>
<td>Teamwork Across Units</td>
<td>68.0</td>
<td>57.0</td>
<td>11.0</td>
<td>***</td>
</tr>
</tbody>
</table>

*Values reflect the average percent of people at each hospital that agreed or strongly agreed with the questions that related to the variable of interest; n = 1,047 hospitals

Question responses were based on a 5-point Likert scale

Management consists of hospital staff that selected their primary staff position as administration/management

Clinical staff consists of physicians, physician assistants, nurse practitioners, registered nurses, licensed practical nurses, and medical assistants

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

Table 5. Weighted Least Squares Regression of Perceived Organizational Factors of Safety on High Frequency of Error Reporting: Management and Clinical Staff Comparison with Distinct Models

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Management</th>
<th>Clinical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervisor Support</td>
<td>-0.16</td>
<td>-0.01</td>
</tr>
<tr>
<td>Organizational Learning</td>
<td>0.20</td>
<td>0.14</td>
</tr>
<tr>
<td>Teamwork Within Units</td>
<td>-0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>Communication Openness</td>
<td>-0.01</td>
<td>-0.04</td>
</tr>
<tr>
<td>Error Feedback</td>
<td>0.44</td>
<td>0.37</td>
</tr>
<tr>
<td>Non-Punitive Response to Errors</td>
<td>0.10</td>
<td>0.03</td>
</tr>
<tr>
<td>Staffing</td>
<td>-0.06</td>
<td>-0.02</td>
</tr>
<tr>
<td>Management Support</td>
<td>0.09</td>
<td>0.11</td>
</tr>
<tr>
<td>Teamwork Across Units</td>
<td>0.12</td>
<td>0.03</td>
</tr>
</tbody>
</table>

*Weight was hospital’s overall response rate; n=1,047 hospitals; controls included teaching hospital, government hospital, bed size and region; management and clinical staff models were run separately

Management consists of hospital staff that selected their primary staff position as administration/management

Clinical staff consists of physicians, physician assistants, nurse practitioners, registered nurses, licensed practical nurses, and medical assistants

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

Management R² was 0.32, adjusted R² was 0.31; clinical staff R² was 0.53, adjusted R² was 0.51
Table 6. Weighted Least Squares Regression of Organizational Factors of Safety on Perceived High Frequency of Error Reporting: Comparison by Staff Position

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Management</th>
<th>NP/PA</th>
<th>Physicians</th>
<th>Nurses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta$</td>
<td>95% CI</td>
<td>$\beta$</td>
<td>95% CI</td>
</tr>
<tr>
<td>Supervisor Support</td>
<td>-0.05</td>
<td>(-0.19, 0.10)</td>
<td>0.11</td>
<td>(-0.03, 0.24)</td>
</tr>
<tr>
<td>Organizational Learning</td>
<td>0.04</td>
<td>(-0.13, 0.21)</td>
<td>0.18</td>
<td>(0.04, 0.31)</td>
</tr>
<tr>
<td>Teamwork Within Units</td>
<td>-0.08</td>
<td>(-0.23, 0.08)</td>
<td>-0.03</td>
<td>(-0.19, 0.13)</td>
</tr>
<tr>
<td>Communication Openness</td>
<td>-0.08</td>
<td>(-0.21, 0.05)</td>
<td>-0.03</td>
<td>(-0.16, 0.10)</td>
</tr>
<tr>
<td>Error Feedback</td>
<td>0.58</td>
<td>(0.45, 0.70)</td>
<td>***0.30</td>
<td>(0.17, 0.42)</td>
</tr>
<tr>
<td>Nonpunitive Response to Errors</td>
<td>0.13</td>
<td>(0.04, 0.23)</td>
<td>**0.15</td>
<td>(0.06, 0.25)</td>
</tr>
<tr>
<td>Staffing</td>
<td>-0.15</td>
<td>(-0.26, -0.05)</td>
<td>**0.04</td>
<td>(-0.07, 0.14)</td>
</tr>
<tr>
<td>Management Support</td>
<td>-0.03</td>
<td>(-0.17, 0.11)</td>
<td>0.02</td>
<td>(-0.11, 0.15)</td>
</tr>
<tr>
<td>Teamwork Across Units</td>
<td>0.20</td>
<td>(0.10, 0.30)</td>
<td>***0.11</td>
<td>(0.00, 0.22)</td>
</tr>
</tbody>
</table>

* Weight was a hospital’s overall response rate; n = 498; controls included teaching hospital, government hospital, and bed size and region dummies; four distinct models were run, one for each staff position

*p<.05

**p<.01

***p<.001

Management R² was 0.40; NP/PA R² was 0.33; Physician R² was 0.37; Nurse R² was 0.66
Chapter 3: Organizational Factors of Patient Safety Associated with Successful Handoffs

Abstract

Patient handoffs continue to be problematic for hospitals. Studies have shown poor handoffs are associated with increased morbidity, mortality, and financial costs. Previous studies that analyzed safety factors associated with successful handoffs are small, predominantly qualitative, and tested predictors using descriptive and univariate methods. These studies did not examine differences between management and clinical staff, as in this study. For this study, a total of 515,637 respondents in 1,052 hospitals completed a survey that assessed organizational factors of patient safety. Using a weighted least squares multiple regression, seven organizational factors of patient safety were tested as predictors of successful handoffs. Results indicated that teamwork across units was perceived as the most significant positive predictor of successful handoffs. Based on these perceptions, hospitals should prioritize teamwork across units in any effort to improve handoffs. When analyzing all hospital staff, staffing and management support for safety were also significantly associated with successful handoffs. A more focused comparison of management and clinical staff yielded similarities, but also a significant difference. Both groups had the same significant predictors of handoffs as in the aggregate analysis of all hospital staff. However, analysis of managers also showed that organizational learning, or continuous improvement, was a significant positive predictor, whereas clinical staff perceived it as a significant negative predictor. This difference is
relevant because management may expend resources based on perceptions that are
different from those of the frontline clinical staff that perform patient handoffs.

Introduction

A patient handoff is defined as the exchange of information and responsibility for a
patient that occurs between two or more healthcare workers (Lardner 1996). In other
words, it is the transfer of rights, duties, and obligations from one person or team to
another (Solet, Norvell, Rutan, and Frankel 2005). For the purpose of this study, the
focus is on the transfer within hospital units and across them. The within-unit handoffs
typically occur during shift changes. Meanwhile, the across-unit handoffs primarily
occur as the patient moves from one area of the hospital to another.

The number of patient handoffs increased in the past 10-15 years due to more
physician specialization as well as policy changes, such as 24-hour physician coverage
and duty hour restrictions for residents. Both measures have increased fragmentation of
care and promoted discontinuity (Fletcher, Saint, and Mangruilkar 2005). The 24-hour
physician coverage requires shift work systems that increase the volume of handoffs
(Gandhi, Sittig, Franklin, Sussman, Fairchild, and Bates 2000). In 2003, the
Accreditation Council for Graduate Medical Education instituted a work hour restriction
for resident physicians. While this was intended to reduce the effects of sleep deprivation
on resident physicians, it had the unintended consequence of increased handoffs. The
number of handoffs increased due to the use of duty shifts and cross-coverage models in
which the responsibility for the patient is transferred several times during the traditional
24 hour call period (Vidyarthi, Arora, Schnipper, Wall, and Wachter 2006; Horwitz, Krumholz, Green, and Huot 2006; Philibert and Leach 2005).

Poor patient handoffs are associated with higher mortality, morbidity, and medical errors, as well as treatment delays and repetitive testing. One study found that hospitals that trained and evaluated medical residents on proper patient handoff techniques had lower risk-adjusted pneumonia mortality rates (Mueller, Call, McDonald, Halvorsen, Schnipper, and Hicks 2012). Another study found that an increased level of positive communication and collaboration between attending physicians and surgeons was correlated with lower risk-adjusted morbidity (Davenport, Henderson, Mosca, Khuri, and Metzer 2007). Poor patient handoffs unnecessarily expend resources because of repeat or unnecessary testing and additional malpractice claims (Volpp and Grande 2003).

Greenberg et al. (2007) found that patient handoffs and transfers are especially vulnerable to communication breakdowns, and that 43 percent of medical malpractice cases had these breakdowns. Furthermore, a study of three emergency departments found that 8.8% of doctors and 4.7% of patients were affected by inadequate handoffs, a patient transfer in which all required information was not handed over. The impact of the inadequate handoffs was repetition of assessment and delays in disposition and care (Ye, Taylor, Knott, Dent, and MacBean 2007).

The purpose of the current study was to identify the organizational factors of patient safety that have the strongest associations with successful handoffs, and assess whether the associations differ for management and clinical staff. Please see Chapter 2 for a description on what my study adds to the literature. The four primary additions to the
literature are the same as the error reporting study, except that the additions to the literature for this chapter relate to patient handoffs and not error reporting.

To summarize the literature, successful patient handoffs have a positive impact on patient care. For the purposes of this study, a successful handoff is when important patient information is properly exchanged during shift changes and patient transfers to other units. While the success of a patient handoff does not guarantee optimal treatment by the new caregiver, its absence increases patient risk of morbidity and mortality, and increases the cost of healthcare. For those reasons, it is important to understand the primary organizational factors associated with successful patient handoffs.

Theoretical Background and Hypotheses

Hypothesis 1 is higher organizational factors of safety are associated with successful patient handoffs. The conceptual model displayed in Figure 1, and discussed in the error reporting study, also fits patient handoffs. The literature showed various factors such as communication failures, hierarchy, language barriers, lack of leadership focus on safety, and lack of formal handoff education are barriers to successful handoffs (Sutcliffe, Lewton, and Rosenthal 2004). Relational coordination improves communication, a key element in handoffs, by eliminating missing and erroneous information through frequent, timely, and accurate cross-functional communication (Gittell et al. 2010). Specifically, relational coordination entails actions that promote shared goals, shared knowledge, and mutual respect, all of which result in timely, problem-solving communication among team members. In a series of studies conducted in orthopedic units, relational
coordination resulted in fewer missed signals among employees with different areas of functional expertise.

Hypothesis 2a is that between managers and clinical staff groups there are different organizational factors of safety associated with perceived successful handoffs. There is limited research that compares management and clinical staff perceptions of the organizational factors of safety associated with successful patient handoffs. A study of HSOPS data for 29 acute care hospitals in West Virginia that examined differences in perceptions found management had a higher perception of positive patient safety than nurses in 11 of the 12 organizational factors of safety studied (Hannah, Schade, Lomely, Ruddick, and Bellamy 2008). The largest gap was in the perceived management support for patient safety. This gap indicates management, at least in those hospitals studied in West Virginia, perceived the hospital to have stronger organizational factors of safety than nurses. My study expands on the small West Virginia study to identify differences on a national scale, and measure associations between organizational factors of safety and successful handoffs beyond the use of descriptive statistics.

A comparison of the literature indicates that nurses and physicians have many similarities and a few differences with respect to barriers to handoffs and the use of strategies that enhance handoffs. A literature review of nurse perceptions of handoffs conducted by Riesenber, Leisch, and Cunningham (2010) found communication to be the most common barrier, with a lack of standardization, environmental issues, complexity of cases, lack of education in handoffs, staffing shortages and long shifts listed as other common barriers. Social and hierarchical problems were observed by
nurses most often under the category of communication issues, and included problems communicating with physicians, confusion about roles and responsibilities of team members, and problems with the hierarchical structure of the health care team. Meanwhile, common environmental issues included interruptions, distractions, and too much noise. Education failures related to an absence of organizational learning practices and prior training.

Hypothesis 2b is that among clinical staff groups there are similarities but also differences in the organizational factors of safety associated with perceived successful handoffs. Although there were no direct comparisons made, the same lead author that performed the literature review on patient handoff barriers for nurses conducted a separate review on physicians. The physician review included 46 articles regarding barriers to effective resident and attending physician handoffs (Riesenberge et al. 2009). It found communication problems, such as teamwork and hierarchy/social barriers, were cited most frequently. In the context of the Riesenberge et al. study (2009), hierarchy refers to relational communication barriers and the inability of junior residents to hand off work to more senior residents or physicians. Lack of education, time pressure, missing information, and a lack of standardization were the other most frequently cited barriers. Lack of education was not surprising since a survey of medical schools indicated that only 8 percent of schools teach physicians how to properly handoff patients (Solet, Norvell, Rutan, and Frankel 2004). That indicates that physicians are not properly trained at academic institutions, so further training must take place in the hospital setting. Time pressure results in physician choice of whether to provide a longer patient handoff
potentially at the expense of other patient care. A comparison of the two Riesenberg et al. studies (2009; 2010) indicates that there may be some overlap in handoff barriers common to physicians and nurses. Barriers related to communication, hierarchy, standardization, and time pressure were included prominently in both studies. One difference between the physician and nurse reviews was problems associated with teamwork within units commonly appeared in nurse studies as a result of poor peer relationships and lack of supportive behavior.

While the present study had several hypotheses, it was also exploratory because one of its aims was identification of the organizational factor of safety with the greatest impact on successful handoffs. Other prior studies did not use inferential statistics to identify the variable with the greatest impact.

Methods

Data and Sample

The data set and sample for this study was the same as used in the error reporting study discussed in Chapter 2. Of the 12 dimensions in the HSOPS survey, 8 were used in this study.

Measures

Independent Variables

The included measures are the same as described in the error reporting study in Chapter 2, except that the error reporting variables were excluded. The following seven primary variables of interest were used: teamwork across units, management support, organizational learning, staffing, teamwork across units, supervisor support, and
communication openness. Error reporting variables (frequency of error reporting, non-punitive response to errors, and error feedback) were not included because of a lack of theoretical basis to include them in the model. Existing literature does not indicate any link between handoffs and error reporting. The method for obtaining the variable values was the same as in the error reporting study in Chapter 2.

**Dependent Variable**

The dependent variable was successful handoffs. This variable was based on how well patient information was transferred. Its four questions focused on transfers of patients to different units and the effect of shift changes on patient information transfer. The method for obtaining the variable value was the same as in the error reporting study in Chapter 2.

**Procedures**

The same procedures were used as in the error reporting study from Chapter 2.

**Results**

Hypothesis 1 was completely supported by the univariate analysis with adjustment in Table 7, but was only partially supported by the multiple regression analysis of Table 8. The univariate analysis indicated that all factors were positively and significantly associated with successful handoffs. However, in the presence of the other organizational factors of patient safety, teamwork within units had a negative association with successful handoffs. The multiple regression with all predictors indicated that organizational learning, staffing, and teamwork across units were positively associated
with successful handoffs, while teamwork within units was negatively associated with handoffs. Analysis between groups fully supported Hypotheses 2a and 2b.

Often a hazard to survey research, common method bias is not a serious threat to the validity of my findings. The test for common method bias yielded the following results from Harman’s single factor test and confirmatory factor analysis: $\chi^2 = 3005.697$, d.f. = 135, RMSEA = 0.142, CFI = 0.494, TLI = 0.427. Results indicate that the single factor model was a worse fit than the proposed model with the differentiated measurement items.

The most notable results of my study are the effect of teamwork, the importance of management support and staffing, differences between management and clinical staff, and support for the conceptual model.

*Effect of Teamwork*

This study expanded on previous work to identify that teamwork across units had the largest effect on successful handoffs of any variable studied. Table 7 shows the partial R-squares and coefficients from the weighted least squares univariate regression of all hospital staff members on perceived successful handoffs, after controlling for government ownership, teaching hospital, bed size, and the hospital region. The partial R-square indicated that 72 percent of the remaining variability left unexplained by the regression of successful handoffs on the control variables was explained by the inclusion of the teamwork across units variable. The next highest partial R-square was 0.50 for management support.
Teamwork across units had the largest effect on perceived successful handoffs ($\beta$: 0.83, 95% CI: 0.77-0.89) in the multiple regression analyses shown in Table 8. This result indicates that a perceived 10 percent improvement in teamwork across units was associated with an expected increase in successful handoffs of 8.3 percent, after including all other predictors in the model and controlling for government ownership, teaching hospital, bed size, and hospital region. The partial R-square indicated that 44 percent of the remaining variability left unexplained by the multiple regression on the control variables and all other predictors was explained with the addition of the teamwork across units variable. No other predictor variable matched the degree of explanatory power of the teamwork across units variable; the predictor with the next highest partial R-square in the multiple regression model was staffing at seven percent. The effect was comparably large in the clinical ($\beta$: 0.68, 95% CI: 0.63, 0.73) and management staff ($\beta$: 0.69, 95% CI: 0.63, 0.75) comparison exhibited in Table 9. Table 9 displays results from two separate weighted least squares regressions, one that used management responses, and the other clinical staff responses. Table 10 reveals a deeper sub-group analysis of each clinical groups that indicates teamwork across units was the only variable tested that was significantly associated with successful handoffs across all groups (management $\beta$=0.71, NP/PA $\beta$=0.62, physician $\beta$=0.54, nurse $\beta$=0.71).

In contrast to teamwork across units, teamwork within units had a negative effect on successful handoffs in the multiple regression analysis of all hospital staff ($\beta$: -0.19, 95% CI: -0.27, -0.10). The effect was similarly negative in the clinical ($\beta$: -0.11, 95% CI: -
0.18, -0.04) and management staff (β: -0.15, 95% CI: -0.27, -0.04) comparison exhibited in Table 9.

**Importance of Management Support and Staffing**

The staffing and management support for safety variables had a positive effect on successful handoffs, among both management and clinical staff. Staffing had a positive effect on handoffs among managers (β: 0.21, 95% CI: 0.15-0.28) and clinical staff (β: 0.18, 95% CI: 0.13-0.22). Similarly, management support for safety had a positive effect on handoffs among managers (β: 0.10, 95% CI: 0.01-0.18) and clinical staff (β: 0.11, 95% CI: 0.04-0.17). Similarly,

**Different Perceptions Between Staff Groups**

Hypotheses 2a and 2b were supported in Tables 9 and 10. Table 4 in Chapter 2 shows that for each variable of interest, managers averaged higher positive perceptions of organizational factors of patient safety than clinical staff. All differences except successful handoffs (management mean of 48.1 and clinical mean of 48.0) were highly statistically significant (p < .001), using the paired t-test.

The results from the multiple regression analyses were similar between the clinical and management staff groups except for the organizational learning and communication openness variables. Although analysis of all staff indicated that organizational learning was a significant predictor of successful handoffs, the subgroup analysis revealed that association was not true of all staff. Holding the other organizational factors of safety constant, organizational learning was associated with more successful patient handoffs among managers, while the opposite was true among the clinical staff.
A comparison of management, physician extenders (nurse practitioners and physician assistants), nurses, and physicians provided a more thorough examination of the perceptions of organizational factors of patient safety in each group. Table 10 reflects differences in communication openness within the clinical group. Communication openness only had a statistically significant positive association with successful handoffs in the physician group, while all other groups did not have significant associations.

Support for Conceptual Model

There was support for the theoretical model that enabling, enacting, and elaborating actions affect outcomes. In the analysis of all staff, one of the four enabling activities, staffing, was significantly associated with handoffs. In addition, managers and clinical staff had significant associations for management support for safety. The enacting activities had the greatest perceived influence on handoffs. In analysis of all staff, as well as subgroups, teamwork across units was the strongest predictor of patient handoffs in regard to the size of its beta coefficient and partial R-square. Both teamwork within units and teamwork across units were statistically significant predictors of successful handoffs in the multiple regression analysis of all staff members. Organizational learning was the only elaborating activity that was statistically significant. Since each stage of the model had at least one element of statistical significance, it can be construed that each of the enabling, enacting, and elaborating stages has an effect on patient handoffs.

Discussion

Despite the efforts of hospital leaders, poor patient handoffs continue to result in unnecessary costs and increased morbidity and mortality (Mueller et al. 2012; Greenberg
et al. 2007). Considering the adverse impact that poor handoffs have on patient health, handoffs should be a patient safety priority for hospitals. Although handoffs may be a priority for hospitals, there is little consensus as to what organizational factors of safety are most important to achieve success. This study helps further understanding of the relationships between patient handoffs and organizational factors of safety.

Probably the most significant result of this study is that teamwork across units had the greatest impact on successful handoffs, compared to other organizational factors of safety tested. This finding was consistent across all staff groups. Understanding the degree to which various factors of safety influence is necessary in the resource constrained setting in which hospitals operate. Warburton (2005) infers that only a fraction of recommended patient safety improvements can be adopted due to constraints on finances and staffing. Given that only 45 percent of hospital staff in this study had a positive view of handoffs, there is sufficient opportunity for improvement. It is recommended that management take actions that prioritize improvement in teamwork across units. Improvement in this area is challenging because it involves multiple hospital units. One manager does not have the unilateral ability to make all improvements. Instead, enhancement in this area requires the work of multiple units, with potential facilitation from executive hospital management. Several actions have been denoted in the literature to foster improved teamwork. Examples include teamwork training, use of team huddles, interdisciplinary rounds, introduction of focus groups that identify teamwork issues (Farley, Sorbero, Lovejoy, and Salisbury 2010; Curley, Kalisch, and Stefanoy 2007; O’Leary et al. 2010)
Management should not simply ignore the other organizational factors of patient safety, as management support for safety and staffing impact handoffs. An adequate number of staff is essential to adequate information transfer from one hospital unit to another. Previous studies suggested that insufficient time was a barrier to successful handoffs (Riesenberg et al. 2009; Riesenber et al. 2010). The significance of staffing seems to corroborate those findings. In some hospitals it may be difficult to implement a strategy centered on increased staff. Hospitals are generally understaffed and it adds financial strain to the organization to add staff (May, Bazzoli, and Gerland 2006).

Management support for safety was another variable identified by both the management and clinical staff that affected handoffs. Clinical staff members viewed management support for safety as weaker than management. Perhaps there should be more frequent discussions between management and clinical staff to determine how management can best demonstrate its support for safety. One effective way for managers to demonstrate support is to implement a safety board with safety subcommittees (Wong, Helsingher, and Petry 2002).

High correlations among the predictor variables in this study may account for the unexpected negative association of teamwork within units on handoffs, particularly since the association was positive in the univariate analysis. It is also possible that when holding teamwork across units constant, the strengthening of teamwork within units led staff to perceive that a handoff to an inferior unit increased unsuccessful handoffs.

The management and clinical staff comparison illustrated some important differences in terms of organizational learning and communication openness. This divide is relevant
because management controls resources and indirectly influences patient safety, but clinical staff directly influences patient safety through patient interactions. It is possible that organizational learning leads to more successful handoffs but management does not share these learned outcomes with clinical staff. It is also possible that learning actions are assumed by management to have a positive impact when in actuality that is not true. Furthermore, it is conceivable that the continuous improvement activities led to changes that reduced financial costs from handoffs, but did not positively impact the clinical status of patients. The idea that managers generally prioritize finances and clinicians prioritize patient health, is another possible explanation for the different effect of organizational learning. Utilization management and gatekeeping programs, for example, emphasize a financial focus. Further research should be employed to move beyond perceptions to determine how learning activities affect successful handoffs.

Organizational learning can be improved through feedback, safety rounds, and video reflexive ethnography (Campbell and Thompson 2007; Carroll et al. 2008).

Communication openness had an effect on patient handoffs in the physician group but did not have an impact in the other groups. Because of the differences, managers that wish to improve handoffs may not devote resources to the facilitation of communications. This study indicates that managers may want to take actions to better enable clinical staff to speak up, since communication openness centers on the willingness of staff to speak up or question others. The importance of communication openness is consistent with other studies that identified communication failures and hierarchy as barriers to handoffs (Gandhi et al. 2006; Tangirala and Ramanujam 2008). Communication openness can be
improved through increased employee identification with the workgroup and perceived fairness in the workplace (Tangirala et al. 2008).

In general, organizational factors of safety are positively associated with successful handoffs. Univariate analysis confirmed results of other qualitative studies and small quantitative ones (Sutcliffe et al. 2004; Gittell et al. 2010; Riesenberg et al. 2009; Riesenberg et al. 2010). Since the conceptual model was supported by my study, it may have relevance in future studies that examine other patient safety topics.

Limitations and Suggestions for Future Research

The limitations noted in the error reporting study are also evident in this study. Please see Chapter 2 of the dissertation for a thorough discussion of limitations. Because an existing survey was used, there was an inability to make changes to the survey questions or ask additional questions. Other potential factors that some studies have shown to impact handoffs, such as the use of different technologies and standardization of the handoffs process, were not examined in this study (Holden and Karsh 2007; Garbutt et al. 2007).

There are several paths for future studies. Future research can provide further insights into the optimal way to improve teamwork across units. Future studies can also test how important technology and standardization are in the presence of teamwork across units, and whether those factors modify the association of teamwork across units. A future study should clarify the role of organizational learning. Among managers, organizational learning was viewed as having a positive effect on handoffs, while the opposite was true among clinical staff.
Conclusion

Hospital staff perceptions indicate that many organizational factors of safety are associated with successful patient handoffs. Hospitals concerned with patient handoffs should make improved teamwork across units a priority. All levels of analysis indicated that teamwork across units was the most significant predictor of successful handoffs. Sufficient staffing should also be provided, although resource constraints may limit the ability to add staff. Management support was important to both the management and clinical staff groups so leadership should demonstrate their support for safety. There were differences in perceptions between the management and clinical staff groups on the effect of organizational learning. Organizational learning among managers had a significant positive association with handoffs, while it had a significant negative association among clinical staff. The different clinical staff groups had generally similar perceptions, but there were a few differences. Among physicians, communication openness was associated with successful handoffs, although other staff groups did not have a similarly significant association.

Patient handoffs have proved to be a difficult to improve, but there is hope. This study shows that a devotion of time and resources to those significant organizational factors may lead to improved handoffs, and ultimately fewer medical errors.
References


### Table 7. Predictors of Successful Handoffs: Univariate Results

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Partial R-Square</th>
<th>β</th>
<th>95% CI</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork Across Units</td>
<td>0.72</td>
<td>0.92</td>
<td>(0.89, 0.96)</td>
<td>***</td>
</tr>
<tr>
<td>Management Support</td>
<td>0.50</td>
<td>0.81</td>
<td>(0.76, 0.86)</td>
<td>***</td>
</tr>
<tr>
<td>Organizational Learning</td>
<td>0.44</td>
<td>0.97</td>
<td>(0.90, 1.04)</td>
<td>***</td>
</tr>
<tr>
<td>Staffing</td>
<td>0.37</td>
<td>0.73</td>
<td>(0.67, 0.79)</td>
<td>***</td>
</tr>
<tr>
<td>Teamwork Within Units</td>
<td>0.30</td>
<td>1.02</td>
<td>(0.93, 1.12)</td>
<td>***</td>
</tr>
<tr>
<td>Supervisor Support</td>
<td>0.30</td>
<td>0.95</td>
<td>(0.86, 1.04)</td>
<td>***</td>
</tr>
<tr>
<td>Communication Openness</td>
<td>0.24</td>
<td>0.76</td>
<td>(0.68, 0.84)</td>
<td>***</td>
</tr>
</tbody>
</table>

Weight was a hospital’s overall survey response rate; n = 1,052 hospitals

R-square solely from inclusion of control variables was 0.31

Adjusted for control variables (government, teaching, bed size, region)

*p<.05  
**p<.01  
***p<.001

### Table 8. Weighted Least Squares Multiple Regression of Organizational Factors of Safety on Successful Handoffs

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Partial R-Square</th>
<th>β</th>
<th>95% CI</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervisor Support</td>
<td>&lt;0.01</td>
<td>0.02</td>
<td>(-0.07, 0.11)</td>
<td></td>
</tr>
<tr>
<td>Organizational Learning</td>
<td>0.01</td>
<td>0.15</td>
<td>(0.07, 0.23)</td>
<td>***</td>
</tr>
<tr>
<td>Teamwork Within Units</td>
<td>0.02</td>
<td>-0.19</td>
<td>(-0.27, -0.10)</td>
<td>***</td>
</tr>
<tr>
<td>Communication Openness</td>
<td>&lt;0.01</td>
<td>-0.01</td>
<td>(-0.08, 0.06)</td>
<td></td>
</tr>
<tr>
<td>Staffing</td>
<td>0.07</td>
<td>0.23</td>
<td>(0.18, 0.28)</td>
<td>***</td>
</tr>
<tr>
<td>Management Support</td>
<td>&lt;0.01</td>
<td>-0.04</td>
<td>(-0.11, 0.03)</td>
<td></td>
</tr>
<tr>
<td>Teamwork Across Units</td>
<td>0.44</td>
<td>0.83</td>
<td>(0.77, 0.89)</td>
<td>***</td>
</tr>
</tbody>
</table>

Weight was a hospital’s overall response rate; n = 1,052

Controls included teaching hospital, government hospital, bed size and region

*p<.05  
**p<.01  
***p<.001

R² was 0.83; adjusted R² was 0.82
Table 9. Weighted Least Squares Multiple Regression of Perceived Organizational Factors of Safety on Successful Handoffs: Management and Clinical Staff Comparison with Distinct Models

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Management $^b$</th>
<th>Clinical Staff $^c$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta$ 95% CI</td>
<td>$\beta$ 95% CI</td>
</tr>
<tr>
<td>Supervisor Support</td>
<td>-0.06 (-0.17, 0.04)</td>
<td>0.01 (-0.06, 0.08)</td>
</tr>
<tr>
<td>Organizational Learning</td>
<td>0.20 (0.10, 0.29)</td>
<td>*** -0.08 (-0.15, -0.01)</td>
</tr>
<tr>
<td>Teamwork Within Units</td>
<td>-0.15 (-0.27, -0.04)</td>
<td>** -0.11 (-0.18, -0.04)</td>
</tr>
<tr>
<td>Communication Openness</td>
<td>0.02 (-0.05, 0.10)</td>
<td>*** 0.13 (0.07, 0.20)</td>
</tr>
<tr>
<td>Staffing</td>
<td>0.21 (0.15, 0.28)</td>
<td>*** 0.18 (0.13, 0.22)</td>
</tr>
<tr>
<td>Management Support</td>
<td>0.10 (0.01, 0.18)</td>
<td>* 0.11 (0.04, 0.17)</td>
</tr>
<tr>
<td>Teamwork Across Units</td>
<td>0.69 (0.63, 0.75)</td>
<td>*** 0.68 (0.63, 0.73)</td>
</tr>
</tbody>
</table>

$^a$ Weight was hospital’s overall response rate; n=1,047 hospitals; controls included teaching hospital, government hospital, and bed size and region dummies; management and clinical staff models were run separately

$^b$ Management consists of hospital staff that selected their primary staff position as administration/management

$^c$ Clinical staff consists of physicians, physician assistants, nurse practitioners, registered nurses, licensed practical nurses, and medical assistants

*p<.05  
**p<.01  
***p<.001

Management $R^2$ was 0.65; adjusted $R^2$ was 0.64; clinical staff $R^2$ was 0.77; adjusted $R^2$ was 0.76
Table 10. Multiple Regression of Organizational Factors of Safety on Successful Handoffs: Comparison by Staff Position

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Management</th>
<th>NP/PA</th>
<th>Physicians</th>
<th>Nurses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>95% CI</td>
<td>β</td>
<td>95% CI</td>
</tr>
<tr>
<td>Supervisor Support</td>
<td>-0.01</td>
<td>(-0.16, 0.13)</td>
<td>0.15</td>
<td>(0.05, 0.26)</td>
</tr>
<tr>
<td>Organizational Learning</td>
<td>0.04</td>
<td>(-0.10, 0.19)</td>
<td>-0.02</td>
<td>(-0.12, 0.08)</td>
</tr>
<tr>
<td>Teamwork Within Units</td>
<td>-0.22</td>
<td>(-0.38, -0.07)</td>
<td>**</td>
<td>0.01</td>
</tr>
<tr>
<td>Communication Openness</td>
<td>-0.04</td>
<td>(-0.16, 0.07)</td>
<td>**</td>
<td>0.01</td>
</tr>
<tr>
<td>Staffing</td>
<td>0.32</td>
<td>(0.22, 0.42)</td>
<td>***</td>
<td>0.06</td>
</tr>
<tr>
<td>Management Support</td>
<td>0.15</td>
<td>(0.02, 0.29)</td>
<td>*</td>
<td>0.02</td>
</tr>
<tr>
<td>Teamwork Across Units</td>
<td>0.71</td>
<td>(0.61, 0.80)</td>
<td>***</td>
<td>0.62</td>
</tr>
</tbody>
</table>

* Weight in weighted least squares regression was a hospital’s overall response rate
n = 498; controls included teaching hospital, government hospital, bed size and region
Four distinct models were run, one for each staff position
*p<.05
**p<.01
***p<.001

Management $R^2$ was 0.65; NP/PA $R^2$ was 0.51; Physician $R^2$ was 0.55; Nurse $R^2$ was 0.75
Chapter 4: How Safety Culture Influences Central Line-Associated Bloodstream Infection Rates: An Analysis of the Comprehensive Unit Based Safety Program

Abstract

There are an estimated 31,000 avoidable deaths each year due to Central Line-Associated Bloodstream Infections (CLABSIs). This paper is important because it identifies organizational factors of safety associated with a reduction or elimination of CLABSIs. This study analyzed 438 hospitals that completed the Comprehensive Unit Based Safety Program (CUSP) study during the period between May 2009 and June 2012. Hospitals provided baseline CLABSI rates and survey responses from staff members on 12 different organizational factors of safety for the eight quarters prior to CUSP implementation, and the six quarters thereafter. Findings indicate that in order to achieve optimal reductions in CLABSIs, hospitals should prioritize introduction of CUSP to units that have higher perceived staffing and teamwork across units. Once CUSP is introduced on a unit, hospitals should ensure leadership supports patient safety, and that there are open communications and strong mechanisms for reflective activities, such as organizational learning and error feedback. There is evidence that improvements in these organizational factors of safety are associated with reduced CLABSIs. Elimination of CLABSIs is a feasible goal, one that can be accomplished through improvement in organizational factors of safety.
Introduction

This study focuses on one dangerous subset of healthcare-associated infections (HAIs), the Central Line-Associated Bloodstream Infection (CLABSI). A CLABSI is an infection that occurs through the use of a central line. A central line, or central venous catheter, is a tube that a physician places in a large vein in a patient’s neck or chest. It is typically used to administer medication or fluids and remains in place longer than other venous access devices, hence the greater opportunity for infection. Central lines facilitate bloodstream infections when they are not inserted correctly or kept clean.

CLABSIs unnecessarily cause mortality, increase morbidity and length of stay, and result in higher health costs (Dimick, Pelz, Consunji, Swoboda, Hendrix, and Lipsett 2001; Rosenthal, Guzman, Migone, and Crnich 2003; Rosenthal et al. 2006; Pittet, Tarara, and Wenzel 1994; Rello et al. 2000; Renaud and Brun-Buisson 2001; Warren, Ouadir, Hollenbeak, Elward, Cox, and Fraser 2006). These infections are the leading cause of death of all HAIs (O’Grady et al. 2002). The Centers for Disease Control and Prevention estimate that 25 percent of patients that contract a CLABSI die from the infection (“Making Healthcare Safer”). An oft-cited study by Klevens et al. (2007) used the National Nosocomial Infections Surveillance System and estimated that 31,000 deaths each year are due to CLABSIs, at an additional cost of $18,000 per case. A separate estimate from the Health Research and Education Trust puts the death toll in a range of 30,000-62,000 (“On the CUSP: Stop BSI”). In both estimates, there are a large number of preventable deaths from CLABSIs. The unnecessary deaths and cost to the health system indicate that CLABSIs are a significant health concern and one that should be corrected.
The Intensive Care Unit (ICU) is the hospital unit with the highest incidence of CLABSIs for various reasons. Of the 31,000 estimated annual deaths from CLABSIs, 18,000 occur in the ICU (“On the CUSP”). One reason is that central venous access might be needed for extended periods of time in the ICU. This may result in colonization of the patient with hospital-acquired organisms. Similarly, the catheter may be manipulated multiple times per day for the administration of fluids, drugs, and blood products, and for hemodynamic measurements to treat the high risk ICU patient. These required clinical steps increase the potential for contamination and subsequent clinical infection.

With the high mortality rates from CLABSIs, some clinical strategies have found success in reducing this type of infection. There has been increased use of silver or antiseptic-impregnated catheters, cutaneous antisepsis and antimicrobial lock solutions, instead of the standard central venous catheter. The literature indicates that multiple interventions, both behavioral and technological, can significantly reduce CLABSI rates (Jarvis 2006). Behavioral improvements include improved hand hygiene, maximal sterile barrier precautions, catheter placement and optimal timing of catheter replacement. Technological improvements include use of preferred skin antiseptics, closed infusion containers, and catheter dressings (Rosenthal and Maki 2004).

Organizations successful at reducing HAIs have succeeded largely by implementing significant changes to clinician and staff behavior (Pronovost and Vohr 2010; Ranji et al. 2007). The Comprehensive Unit-based Safety Program (CUSP) is a program that summons such change. It is a widely used model that makes financial resources available and pools intellectual resources to strengthen safety within an organization (Pronovost
and Vohr, 2010). It originated in intensive care units but has since expanded to other hospital units. It has been publicized to improve the safety and teamwork climates, and reduce nurse turnover (Timmel, Kent, Holzmueller, Paine, Schulick, and Pronovost 2010). It must be noted that many of the organizational factors of safety are referred to interchangeably as “safety climate” or “safety culture” in other studies.

CUSP was designed to improve teamwork and safety culture and to help clinical teams learn from mistakes through the integration of safety practices into daily work. CUSP is executed at the unit level, with support at the hospital level, and represents a scalable intervention that can eventually be implemented throughout an organization. In a structured manner, CUSP empowers front-line staff to use teamwork to identify the greatest unit-level safety problems, and removes obstacles that would otherwise prevent solutions (Pronovost and Vohr, 2010).

The CUSP team is formed on a hospital unit and is interdisciplinary in nature. The team is comprised of unit staff and a hospital executive leader, such as a CEO, CFO, or COO. The CUSP team typically includes at least one nurse, physician, and administrator from the hospital unit. Teams are often larger, but those are the minimum expectations. The team has the knowledge and skill to review empirical evidence for appropriate interventions that solve the unit’s safety issues. The CUSP team meets regularly to discuss safety issues and ascertain progress toward their resolution.

Once formed, a CUSP team should follow five steps to achieve optimal success (Sawyer et al. 2010). Step one involves the education of staff about the science of safety. This step is typically conducted with a video presentation and a series of interactive discussions with staff. The goals of this step are to: understand the importance of safety,
understand the importance of standardized work and independent checks for critical processes, and understand that interdisciplinary teams make better decisions than teams of like mind. Step two attempts to identify defects. It uses team leaders to ask all staff how the next patient will be harmed. The CUSP team consolidates the responses and decides which safety hazards present the most risk. Step three assigns an executive leader to be a part of the unit-level CUSP team. The goal in this step is for the executive leader to remove barriers by ensuring that necessary resources are made available to the unit to solve its patient safety concerns. The evidence from the literature indicates that more frequent executive visits are associated with better safety culture (Frankel et al. 2008). Step four involves training the unit’s CUSP team on how to use a structured tool to learn from defects. In the case of CLABSIs, an infection is considered a defect. The tool prompts the user to answer what happened, why it happened, what was done to reduce the risk of it happening again, and whether the intervention actually reduced the risk. This step reinforces the idea that infections are preventable. Step five implements tools to improve communication and teamwork. The CUSP team leader guides a discussion on communication and cultural problems in need of improvement. The CUSP team then intervenes to address those areas that need improvement. A few examples of interventions are a patient daily goals checklist, shadowing, morning briefings, and barrier removal tools.

CUSP has been shown as a successful model to reduce CLABSIs. The first statewide CUSP project was launched in 2003 in Michigan. Michigan implemented CUSP to reduce CLABSIs and ventilator-associated pneumonia. Within 18 months, the units reduced the rate of CLABSIs to a median of zero, with a 66 percent reduction
overall (Sawyer et al. 2010). More importantly, those rates were largely sustained. Researchers found that 60 percent of the Michigan ICUs evaluated went one year or more without an infection and 26 percent achieved two years or more. Michigan units that participated in the CUSP study had significantly lower CLABSI rates than other units in the region (Lipitz-Snyderman et al. 2011). Within the first 18 months of the CUSP statewide launch in Michigan, an estimated 1,500 lives and $200 million were saved (Pronovost and Vohr 2010).

While CUSP started as a pilot program, its success led to national and international expansion. The CUSP program expanded beyond 127 intensive care units in Michigan, Johns Hopkins Hospital, and the Adventist Health Care System ICUs. It is now used in all 50 states, Puerto Rico, Spain, England, and Peru (Sawyer et al. 2010). Currently, more than 1,000 hospitals in the United States use CUSP as a program to reduce infection rates.

Despite the CUSP efforts in Michigan and other efforts nationally to reduce CLABSI, rates in parts of the country remain high. In 2009, U.S. Department of Health and Human Services Secretary Kathleen Sebelius called on all hospitals to reduce CLABSI by 75 percent over 3 years (“Secretary Sebelius Highlights” 2009). Although the CUSP program has demonstrated success, not all hospitals use CUSP or similar programs. When Congressman Waxman surveyed states about infection practices, only 11 states said they measured CLABSI rates and most states were far above the rate that Michigan attained (Sawyer et al. 2010). Rates are high even though it has been demonstrated that virtually all CLABSI are preventable (Berenholtz et al. 2004;
Pronovost et al. 2006). Thus, reducing CLABSI rates should be a focus of national quality improvement efforts and CUSP can be used as a tool toward their elimination.

If CUSP has demonstrated reductions in CLABSI rates are possible through its implementation, why do some hospitals in the country fail to follow that model or a similar one? Some explanations are that these hospitals either are not aware of its existence, do not believe in its merits, or deem it too costly to implement. Since CUSP uses valuable resources, and resource scarcity dictates that hospitals must be efficient in their allocation, cost may be a hindrance in CUSP implementation.

The purpose of this study is twofold: 1) for those hospitals that achieved zero CLABSIIs after CUSP implementation, to identify their organizational factors of safety prior to CUSP implementation, and 2) to identify the organizational factors of safety significantly associated with CLABSIIs. No previous study examined the types of hospitals and units most successful at implementing CUSP. It is still unknown what organizational safety factors should be in place before CUSP implementation in order to experience zero CLABSIIs. Given that more than 1,000 hospitals use CUSP and thousands more are capable of its implementation, it is important that this is answered. A further benefit of this study is that the predictor variables are derived from the Hospital Survey on Patient Safety Culture (HSOPS) survey, in use at more than 1,100 hospitals. That allows a hospital to quickly examine results from its HSOPS survey to focus on units most likely to have zero CLABSI rates following CUSP implementation. The goal is for hospitals to maximize scarce resources through targeted implementation of CUSP, thereby alleviating some of the cost concerns. The second significant element of this study is that it identifies organizational factors of safety that significantly impact
CLABSI rates. While one study described the change in safety culture in ICUs in Michigan following implementation of CUSP, no study analyzed the association of those organizational factors of safety with CLABSI rates.

Theoretical Background and Hypotheses

The theoretical background is the same as the error reporting and handoff studies. Please reference the study in Chapter 2 for a complete theoretical background. Additional information specific to this study follows.

Hypothesis 1a is that higher baseline performance on organizational factors of safety among CUSP participants is associated with reduced baseline CLABSI rates. Hypothesis 1b is similar; improvements in organizational factors of safety among CUSP participants are associated with reduced CLABSIs over time. Since the safety factors under study have previously been shown, to varying degrees, to be linked to other hospital outcomes, there is reason to believe that they are also associated with CLABSI rates. A study of Rhode Island ICUs found that completion and adherence to a safety attitudes questionnaire action plan led to improved safety culture and lower CLABSI and ventilator-associated pneumonia rates (Vigorito, McNicoll, Adams, and Sexton 2011).

CUSP is an intervention that affects organizational factors of safety in participating units. An examination of a safety attitudes questionnaire on 72 ICUs involved in a Michigan CUSP study found significant improvement in teamwork climate and overall safety climate from baseline to the post-CUSP implementation (Pronovost et al. 2008; Sexton et al. 2011). Similarly, Timmel et al. (2010) used the safety attitudes questionnaire on a single surgical unit and assessed staff perceptions of safety climate, teamwork climate, job satisfaction, perceptions of management, perceptions of unit
management, stress recognition, and working conditions. All dimensions, except for stress recognition, showed statistically significant improvement following CUSP implementation.

Hypothesis 2 is that superior organizational factors of safety prior to CUSP implementation are associated with zero CLABSIs in the periods following implementation. While previous studies demonstrate that CUSP may influence various organizational factors of safety, the effect that pre-implementation (baseline) safety has on post-implementation (post) CLABSI results is unknown. The CUSP program design focuses on leadership, teamwork, organizational learning, and availability of resources. Considering the difficulty in quickly changing a safety culture, I hypothesize that stronger organizational factors of safety are associated with lower CLABSIs (O’Reilly 1989).

Methods

Data and Sample

The American Hospital Association’s Health Research & Educational Trust provided the data for this study. It is derived from the On the CUSP: Stop BSI program funded by the Agency for Healthcare Research and Quality (AHRQ). Hospital participation in the program was voluntary. The percentage of a state’s hospitals that participated in the CUSP CLABSI program ranged from 4-100, with a median of 23.

There were some requirements placed on hospitals that agreed to participate in the study. This program required states to have a lead organization, typically a state hospital association, to work with hospitals across the state to implement clinical and cultural changes needed to reduce CLABSIs. Lead organizations in participating states were
expected to have one annual face-to-face meeting and regular conference calls with participating units. These discussions were intended for units to share best practices, failures, and serve as motivation to maintain safety as a priority. Participating hospitals had CEOs sign a letter of commitment to allocate resources to the program. In addition, the CEO and board of trustees were asked to review infection rates on a quarterly basis.

Contributing hospitals had a range of structural characteristics and unit involvement. Hospitals selected the units that joined the CUSP CLABSI rate reduction program; not all hospital units participated. The range of participating units per hospital was 1 to 14, with a median of one. Hospital ICU units comprised over 75 percent of the units. Participating units were involved in the study a minimum of two and a maximum of six quarters. Hospitals were from the non-profit, for-profit, and government sectors and ranged in size from small (minimum of 12 beds) to large (maximum of 1452 beds).

The survey from which the primary independent variables were derived was the Hospital Survey on Patient Safety Culture (HSOPS). HSOPS was introduced by AHRQ in 2004 and is currently used by more than 1,100 hospitals. Survey data was aggregated to two time points for the participating units: prior to CUSP implementation (baseline period), and six quarters following implementation (post period). Only units that completed the entire post period were eligible to complete the post period survey.

The study is comprised of seven cohorts of hospitals with various start dates. The first cohort’s intervention period began on May 1, 2009 and each subsequent cohort had a different start time, with a typical gap of 4-5 months between cohort start dates.

A total of 718 hospitals completed the CUSP study during the period between May 2009 and June 2012. Hospitals provided baseline CLABSI rates and survey responses on
organizational factors of safety for the baseline and post periods from staff members of corresponding units. For the analysis associated with hypothesis 1a, a complete case analysis approach to missing data resulted in a sample of 438 hospitals located in 38 states for the baseline analysis; 280 hospitals were missing baseline safety factors or baseline CLABSI rates and removed. A total of 432 hospitals were used in the analysis associated with hypothesis 2 after six additional hospitals were removed because of missing CLABSI rates in the post period. The change analysis of hypothesis 1b used 195 hospitals after 237 additional hospitals were removed because of missing organizational factors in the post period.

**Measures**

The analyses associated with hypotheses 1a, 1b and hypothesis 2 incorporated slightly different versions of the independent and dependent variables of interest. All differences are noted in this section.

**Independent Variables**

The independent variables of interest reflect the perceptions of hospital staff on the following organizational factors of safety: teamwork within units, supervisor support for safety, organizational learning, management support for safety, error feedback, communication openness, frequency of error reporting, non-punitive response to error reporting, teamwork across units, staffing levels, and successful handoffs. The survey questions that comprise each variable are from the HSOPS survey and are located in Appendix C. Of the 12 dimensions of the survey, information from 11 formed the primary independent variables in this study. Overall perceptions of patient safety was not used because its questions have a general focus on safety, and the purpose of this study
was to analyze specific factors of safety that affect CLABSIs. Each dimension was treated as a continuous variable and was comprised of 3-4 related questions. The percent positive score was the proportion of survey respondents in a hospital that agreed or strongly agreed with the question, using a 5-point Likert scale for responses. The percent positive scores for the 3-4 related questions that comprise each organizational factor of safety were averaged to represent the variable value. The percent positive score was used as the variable value instead of the five-point Likert scale mean primarily for interpretability reasons. The hypothesis development section of this paper discussed any rationale for a variable’s inclusion in the study.

Similar independent variables were used in the hypothesis 1 and hypothesis 2 analyses. Hypothesis 1 analyses included a baseline analysis and a change analysis. For the baseline analysis, the independent variables of interest were the baseline survey responses for each organizational factor of safety. For the change analysis, they were the difference in survey responses from the baseline period to the post period. The hypothesis 2 analyses used the same baseline organizational factors of safety described in the baseline hypothesis 1a baseline analyses.

Hospital control variables for all hypotheses tests included: bed size, teaching, rural, for-profit, and government. Bed size was a continuous variable based on the number of hospital beds. Teaching, rural, for-profit, and government were binary variables. Use of these variables is consistent with the literature. All analyses also included the number of central line days to account for the different duration of infection exposure for each hospital. Baseline analysis (hypothesis 1a) included it as an offset term, while the change analysis (hypothesis 1b) included it as a covariate. Hypothesis 2 analyses included
central line days as a covariate, and also included an additional control variable, baseline CLABSI rate, to account for CLABSI differences at baseline.

**Dependent Variable**

In the hypothesis 1a baseline analysis, the baseline number of CLABSIs was the dependent variable. CLABSIs were pooled over the entire available period of eight quarters (baseline) or six quarters (post). This smoothed some of the variability otherwise observed if a hospital had one infection with a low number of central line days in a single quarter.

In the hypothesis 1b change analysis I used the CLABSI change group as the dependent variable. The CDC-identified average of 1.65 CLABSIs per 1,000 central line days was used as a cutoff point to determine whether a hospital was in the “good” or “bad” CLABSI group (“Making Healthcare Safer” 2011). A hospital that had a CLABSI rate greater than 1.65 per 1,000 central line days was placed in the “bad” group for that period. The baseline CLABSI rate and the post CLABSI rate defined group representation. Four CLABSI change groups were created: bad-to-good, bad-to-bad, good-to-good, and good-to-bad. For example, a bad-to-good group represented a unit that had a baseline CLABSI rate greater than 1.65 per 1,000 central line days, but a post CLABSI rate less than or equal to 1.65.

For analyses associated with hypothesis 2, the dependent variable was whether a hospital had zero infections in the post period, and was binary in nature. This variable was examined because previous studies indicated that it is both optimal and feasible to achieve zero CLABSIs following CUSP implementation (Pronovost et al. 2008; Timmel et al. 2010; Sexton et al. 2011).
Procedures

Analyses of hypothesis 1a used a zero inflated Poisson (ZIP) regression of baseline CLABSI rate on baseline factors of safety. The ZIP procedure was used in lieu of an ordinary Poisson because of the excess number of zeros in the data. Data for the baseline analysis indicated that 32 percent of hospitals had a CLABSI rate of zero. The Vuong test that compared the ZIP model to the standard Poisson model, confirmed that the ZIP model was significantly better (Greene 1994). Had this technique not been used, results may have been biased and/or standard errors may have been under-estimated because the probability of a hospital with zero infections would have been greater than expected under the standard Poisson distribution (Hinde and Demetrio 1998). The ZIP is a two-part model that includes a logit model for zero CLABSIs and a truncated Poisson model that conditions on hospitals that have more than zero CLABSIs (Bewick, Cheek, and Ball 2005). The same variables were included in both parts of the ZIP model. Independent variables of interest under the ZIP analysis were the baseline organizational factors of safety. The ZIP analysis used central line days as an offset variable to account for the different duration of infection exposure for each hospital. All analyses tested each organizational factor of safety in a univariate manner, and adjusted for control variables that included teaching hospital, rural, government, for-profit, and the number of hospital beds.

Analyses of hypothesis 1b used a multinomial logistic regression that examined the change in organizational factors of safety and CLABSI rate from baseline to follow-up. The addition of this method of analysis attempted to isolate the intervention and observe change over time. Independent variables consisted of the change in organizational
factors of safety from baseline to follow-up. This analysis also included central line days as a covariate. CLABSI rates were examined at baseline and follow-up. Hospitals fell into one of four groups: good-to-bad, good-to-good, bad-to-bad, or bad-to-good. The dependent variable was group category and the reference group was bad-to-good. The change analysis provided an opportunity to examine the effect of the intervention and offered a better inference of causality than the baseline analysis.

For hypothesis 2, the method of analysis was a logistic regression that regressed whether a hospital had zero infections in the post period on the baseline organizational factors of safety. As hospitals strive to achieve the ultimate goal of zero infections, it was appropriate to study the association of organizational safety factors on that result. Regressions were run in a univariate manner with adjustment for the control variables.

The hospital was the unit of analysis for all testing. As identified by Smits et al. (2009), there is significant clustering of responses at the hospital level, confirming that the HSOPS survey can measure group culture and not solely individual attitudes. This allows for interpretation at the level of interest, the hospital, rather than the individual.

All statistical analyses were performed using Stata: Release 11 software (College Station, TX: StataCorp LP.).

Results

**Effect of CUSP Intervention on CLABSI Rates**

The introduction of CUSP was followed by a precipitous decline in CLABSI rates, as observed in Figure 2. Hospitals observed a reduction in CLABSI from 1.84 per 1,000 central line days at baseline to 1.19 CLABSI in the post period. Worth noting is the fairly constant CLABSI rate from quarters 2 through 6, with a range of 0.92-1.09
CLABSIs per 1,000 central line days. Considerable improvement occurred in the hospitals in the “bad” group, as noted in Table 12. Of the 195 hospitals in the subsample, 19 transitioned from the “good” group to the “bad” group, in contrast to the 52 hospitals that transitioned from the bad-to-good group. Among the 84 hospitals in this study that had baseline rates worse than the national average, 62 percent transitioned to the “good” group in a period of 18 months. Hospitals in the bad-to-good group had a corresponding CLABSI rate improvement from 3.79 infections per 1,000 central line days at baseline to 0.75 in the follow-up period. In contrast, hospitals in the good-to-bad group averaged a CLABSI rate change from 0.39 per 1,000 central line days at baseline to 3.03 in the post period.

**Effect of Organizational Factors of Safety on CLABSI Rates**

As depicted in Table 12, hospitals in the good CLABSI group at baseline had better organizational factors of safety, on average, than those in the “bad” group. Similarly, hospitals in the “good” group in the post period had better organizational factors of safety. Hospitals in the bad-to-good group had the greatest positive change in organizational safety factors. On average, those hospitals improved organizational factors of safety by 0.7 percent. In contrast with the bad-to-good group, hospitals in the good-to-bad group predictably had the best baseline safety factor scores, on average, but the worst follow-up scores. These hospitals saw reductions in each organizational factor of safety, with an average decrease of 5.6 percent. The greatest reduction was in management support for safety at 10.7 percent.

The results presented in Table 11 support hypothesis 1a; higher performance on organizational factors of safety were associated with reduced and/or zero CLABSIs. The
regression of baseline safety climate on baseline CLABSI identified 5 of 11
organizational factors of safety tested as statistically significant, all in the expected
direction. The following variables had significant positive associations: organizational
learning, communication openness, supervisor support for safety, error feedback, and
teamwork across units. Increases in organizational learning (Rate Ratio = 0.995, \( p < .05 \)),
communication openness (\( \beta = 0.991, p < .001 \)), and supervisor support for safety (\( \beta =
0.996, p < .05 \)) were all significantly associated with reduced CLABSI in the baseline
analysis. An interpretation is if a hospital increased its positive perceptions of
communication openness by 10 percent, the expected number of CLABSI would
decrease by 9 percent after controlling for other hospital structural variables in the model.
Meanwhile, error feedback (Odds Ratio = 1.018, \( p < .05 \)), communication openness (\( \beta =
1.023, p < .05 \)), and teamwork across units (\( \beta = 1.023, p < .05 \)) were all significantly
associated with the odds of zero infections at baseline. An interpretation is an increase in
positive perceptions of error feedback by 10 percent is associated with an expected 18
percent increase in the odds of zero infections.

To make the baseline findings more robust, I also examined the relationship between
changes in organizational factors of safety and CLABSI changes over time. The group
comparisons in the multinomial logistic regression identified organizational learning,
management support, error feedback, and successful handoffs as statistically significant
predictors of being in the good-to-bad group, as opposed to the bad-to-good group. Table
13 illustrates the results of the multinomial logistic regression that compared the good-to-
good, bad-to-bad, and good-to-bad groups to the bad-to-good comparison group. For
each organizational factor of safety, an improvement from baseline to six quarters after
CUSP implementation was positively associated with whether a hospital would be in the bad-to-good group instead of the good-to-bad group. The direction of all coefficients indicated that improvements in organizational factors of safety decreased the odds of being in the good-to-bad group, compared to the bad-to-good group, although not all variables were statistically significant. The comparison of hospitals in these groups yielded the following variables as significant: organizational learning (OR = 0.901, \( p < .01 \)), management support (OR = 0.907, \( p < .001 \)), error feedback (OR = 0.954, \( p < .05 \)), and successful handoffs (OR = 0.952, \( p < .05 \)). One interpretation follows: among hospitals that increased positive perceptions of management support for safety by one percent, the odds that a hospital was in the good-to-bad group, compared to the bad-to-good group, was nine percent less after controlling for other variables in the model.

Meanwhile, the good-to-good and bad-to-bad groups both had slight improvements to organizational factors of safety. The bad-to-bad group also demonstrated improved CLABSI rates, while the good-to-good group had virtually no change in CLABSI rate. Regressions between these two groups and the bad-to-good comparison group were not significant.

To summarize, the following variables were statistically significant in the baseline or change analyses: management support, supervisor support, communication openness, teamwork across units, successful handoffs, organizational learning, and error feedback. The only two variables significant in both analyses were from the elaborating stage of the conceptual model: organizational learning and error feedback. Of all variables examined in the change analysis, management support for safety was shown to have the largest decline in hospitals that moved from above average to below. Similarly, it had the
second largest improvement, after organizational learning, in hospitals that went from below average to above average on CLABSI rates.

Predictors of Zero Infections Following CUSP Implementation

The logistic regression analysis supported hypothesis 2. Table 14 shows that higher baseline organizational factors of safety are associated with the odds of zero infections in the post period. This analysis gives an indication of the organizational factors of safety that should be present in units prior to CUSP implementation in order to achieve the optimal outcome of zero CLABSIs. Controlling for baseline CLABSI rate and multiple hospital structure variables, an increase in each baseline organizational factor of safety was associated with an increase in the odds of zero infections in the post period. Although not all baseline organizational factors of safety were statistically significant, all were positively associated with increased odds of zero CLABSIs in the post period. Teamwork across units (OR = 1.022, \( p < .05 \)) and staffing levels (OR = 1.024, \( p < .01 \)) were statistically significant. An interpretation is an increase to positive perceptions of baseline staffing of 10 percent is associated with a 24 percent increase in the odds of zero CLABSIs in the post period, after controlling for baseline CLABSIs, central line days, and other hospital structural variables in the model.

Goodness of fit and other diagnostic tests were analyzed. In the logistic regression models, the Hosmer-Lemeshow test was used to assess overall goodness of fit. Fractional polynomial analysis examined the assumption that continuous independent variables are linear in the logit. Tests indicated that second order fractional polynomials were a better model fit. However, a sensitively analysis indicated their use minimally impacted coefficients and did not change levels of significance. Due to the nominal
impact and less practical interpretation of the second order polynomials, the continuous variables remained in their standard form. The variance inflation factor (VIF) test checked multicollinearity and no significant evidence of it was found, with all VIFs less than five.

Discussion

Considering that there are more than 30,000 preventable deaths from CLABSIs each year, hospitals need to target their elimination. This study presents evidence that results from the widely used HSOPS survey can be used for targeted CUSP implementation. Similarly, specific organizational factors of safety assessed in the HSOPS survey should be targeted for improvement in order to reduce CLABSIs.

It is possible to achieve zero CLABSIs in a short period of time. The largest drop occurred between quarters 1 and 2, suggesting that the CUSP program takes up to three months to implement, but ultimately may be an effective tool to lower CLABSI rates. Improvement in CLABSI rates following CUSP implementation is consistent with the literature (Sawyer et al. 2010). Rapid attainment of a CLABSI rate better than the national average is feasible even in hospitals that previously had rates worse than the national average.

Another observation is that it is difficult to make large changes to organizational factors of safety in a short period of time, although modest change is possible; hospitals were only able to change organizational factors of safety a few percentage points in either direction. However, group comparisons indicate that it is possible for some hospitals, particularly the poorer performers, to make large enough improvements in organizational factors of safety that CLABSI rates are impacted. The poor performing hospitals
appeared to benefit more from the introduction of CUSP than good hospitals. A possible explanation is that some CUSP tools and methods were in use at the good hospitals prior to the intervention.

Changes to organizational factors of safety may contribute to the highly attainable elimination of CLABSIs. There is robust evidence that improvements in elaborating activities, organizational learning and error feedback, are associated with a reduction or elimination of CLABSIs; hospitals should prioritize a focus on those factors. These variables predominately deal with learning from mistakes. It is likely that learning ensues from the feedback activities and aids in fewer future mistakes. Some suggestions to improve error feedback are to make it timely, increase management commitment to make changes from error reports, and assume that all perceptions are real. Feedback should be provided to the unit soon after the error report. Delays between decisions and feedback hurt performance (Sterman 1989). Management must be committed to using the error reports to make changes (Folkman 1998). To the person reporting the error, the changes indicate that the reporting made a difference. Folkman (1998) also argues that the perceptions of employees should be treated as reality. In the context of error reporting, that means that each report should be taken seriously. No report should be treated as an impossibility.

If hospitals want to reduce CLABSI rates, an emphasis should also be placed on organizational learning activities. Previous studies indicate that organizational learning can be improved through feedback associated with the development of new practices, safety rounds, and video reflexive ethnography (Tucker et al. 2007; Campbell and Thompson 2007; Carroll, Iedema, and Kerridge 2008).
Improvement in management support for safety, supervisor support, communication openness, teamwork across units, and successful handoffs should also be targeted. If hospital leaders embrace a culture of safety in such a manner, there are likely fewer CLABSIs.

CUSP is a patient safety method that has its roots in management support, and is one methodology for hospitals to improve the learning and management support activities found to have the strongest association with low CLABSI rates. Introduction of CUSP requires executive management support. It is designed so that senior hospital leaders serve on interdisciplinary unit-based teams that regularly meet to discuss safety issues. These managers are expected to have access to resources to make necessary changes. Because CUSP facilitates regular group interactions, there are more opportunities for elaborating activities, such as occasions to learn from mistakes and obtain valuable feedback.

CUSP is a program that has been associated with reduced CLABSI rates, yet is a program that requires executive management commitment of financial and human resources. As a result, the historic rollout of CUSP at hospitals has been slow and staggered. Given that CUSP is a relatively recent phenomenon, there is an opportunity to further enhance the design of the program and expand it to more hospitals worldwide. Considerably more hospitals and more units exist than those that participated in this study. This study helps identify those hospitals and units that are ready for optimal success in reducing CLABSIs. Hospitals can take advantage of the widely used and available HSOPS survey to assess organizational factors of safety in their units. Units that have higher scores in organizational factors of safety should be targeted for early
CUSP implementation. Specifically, units that excel in staffing and teamwork across units should be the ones targeted for early implementation of CUSP if resources are limited, as they have the greatest odds of zero infections after implementation of the CUSP program. The CUSP model requires frequent interdisciplinary meetings so it is not surprising that sufficient staffing is a prerequisite of successful CUSP implementation (Pronovost and Vohr 2010).

CUSP is just one of many options to improve organizational factors of safety. Hospitals that don’t want to employ CUSP but are still interested in improving CLABSI rates should find other methods to improve leadership support for safety, teamwork, organizational learning, and error feedback.

Limitations and Suggestions for Future Research

Although this study attempted to mitigate limitations, there are some limitations in regard to the available data. They primarily come from the use of secondary data, survey data and missing data.

One limitation in the analysis of organizational factors of safety from pre-implementation of CUSP to post-implementation was the lack of a comparison group; it is possible other unmeasured variables affected results. While a lack of comparison group inhibited causality, the analysis over multiple time points contributed to stronger results.

Besides the lack of a comparison group, another limitation of this study was that the predictors of interest were obtained from survey data, and survey data is subject to biases. In this study, sampling error and measurement error may be present. Sampling error may exist because of the use of a convenience sample. Participation in the study was
voluntary. However, the characteristics of the database hospitals are fairly consistent with the distribution of hospitals registered with the AHA so this doesn’t appear to be much of an issue. Measurement error was possible if a paper copy of the survey was used and the data entry person incorrectly entered the information into the local database. Measurement error was also possible if the CLABSI rates were transferred incorrectly into the national database. Highly unusual data points were not noted so this concern was believed to be minor. Finally, desirability bias is a concern if respondents inflated otherwise undesirable responses out of fear of repercussions. Consistent with Nederhof (1985), this bias was partially controlled in this study through the survey respondent anonymity, self-reporting, and mixture of positive and negatively worded questions. In addition, potentially sensitive topics like the frequency of error reporting were worded in a way that did not imply direct involvement of the respondent in the undesirable behavior. This type of wording has reduced desirability bias (Podsakoff, MacKenzie, and Podsakoff 2012).

Missing data is another concern of this study. There was strong encouragement for reporting of CLABSI rates and baseline and follow-up HSOPS, but there was no requirement. It is possible that use of only complete cases led to biased parameter estimates if cases were not missing completely at random. Multiple imputation was considered for the change analysis but not used because missing cases exceeded the number of complete cases. An independent sample t-test was run on the variables of interest to identify if the deleted cases were significantly different from those that remained in the study. Error feedback and communication openness were the only two
variables that were significantly different. Therefore, it is possible that the results for those variables are slightly biased.

Another possible limitation is the generalizability of the findings. All hospitals in this study participated in the On the CUSP: Stop BSI program. It is possible that the organizational factors of safety found associated with CLABSI rates are only applicable for hospitals that utilize CUSP.

Future research should examine the CUSP implementation process. As more hospital units implement CUSP, it is important to gain insight to how some hospitals were able to reduce CLABSI rates, while others were not. This paper may also be used as a quantitative guide for either a qualitative case study or development of a new quantitative survey. Research could focus on each hospital’s approach to CUSP with regard to management actions around safety, organizational learning, and error feedback. It’s virtually guaranteed that not all units implemented CUSP in the exact same manner. For example, it may be of interest to know how frequently staff have safety meetings, how frequently the executive attends those meetings, and whether there are other safety programs that were initiated in conjunction with CUSP. Whether the units followed the CUSP model in its entirety or took shortcuts and eliminated some steps is unknown. Similarly, there is the possibility that other unmeasured safety changes occurred in conjunction with CUSP at some of the units studied.

Future research need not be limited to CUSP, however. In general, researchers can explore the best ways to improve management support for safety and/or the two elaborating activities, organizational learning and error feedback, so that the greatest gains in CLABSI rates can be achieved. Findings from this study can be expanded to
examine other HAIs to see if these organizational factors of safety significantly improve them as well. In fact, an initiative that aligns the CUSP model to prevent catheter-associated urinary tract infections is underway.

Conclusion

CLABSIs are an unfortunate part of our health system, but can be effectively eliminated through the proper focus and commitment. It is important to understand that zero CLABSIs is an attainable goal even for hospitals that currently have poor rates. A focus on organizational factors of safety should be emphasized to reach that goal.

For those hospitals that want to reduce CLABSIs, introduction of the CUSP program has been associated with reduced rates. Hospitals should prioritize introduction of CUSP to units that have better perceived staffing and teamwork across units. These organizational factors of safety have been connected to zero CLABSIs after CUSP implementation. Once CUSP is introduced on a unit, there should be a focus on ensuring that hospital leadership supports patient safety, and that there are strong mechanisms for reflective activities, such as organizational learning and error feedback.
References


Secretary Sebelius Highlights Two New Reports on Health Care Quality, Says Improving Quality is Key Component of Health Reform. *U.S. Department of Health and Human*
Tables and Figures

Figure 2. CLABSI Rate per 1,000 Central Line Days
Table 11. Impact of Baseline Safety Factors on Baseline CLABSI Rates

<table>
<thead>
<tr>
<th>Safety Factor</th>
<th>CLABSIs^</th>
<th>RR</th>
<th>SE</th>
<th>0 Infections^^</th>
<th>OR</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork Within Units</td>
<td>1.000</td>
<td>(0.002)</td>
<td>1.011</td>
<td>(0.010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervisor Support for Safety</td>
<td>0.996    *</td>
<td>(0.002)</td>
<td>1.008</td>
<td>(0.010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organizational Learning</td>
<td>0.995    *</td>
<td>(0.002)</td>
<td>1.009</td>
<td>(0.012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management Support for Safety</td>
<td>1.001</td>
<td>(0.002)</td>
<td>1.017</td>
<td>(0.010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error Feedback</td>
<td>1.000</td>
<td>(0.002)</td>
<td>1.018 *</td>
<td>(0.008)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication Openness</td>
<td>0.991    ***</td>
<td>(0.002)</td>
<td>1.023 *</td>
<td>(0.011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error Reporting</td>
<td>0.999</td>
<td>(0.002)</td>
<td>1.015</td>
<td>(0.009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teamwork Across Units</td>
<td>0.996</td>
<td>(0.002)</td>
<td>1.023 *</td>
<td>(0.010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staffing Levels</td>
<td>1.002</td>
<td>(0.002)</td>
<td>1.016</td>
<td>(0.009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successful Handoffs</td>
<td>1.001</td>
<td>(0.002)</td>
<td>1.008</td>
<td>(0.009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successful Handoffs</td>
<td>0.994</td>
<td>(0.005)</td>
<td>1.017</td>
<td>(0.009)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N=438 Hospitals; Standard errors are in parentheses
The following variables are controls: teaching hospital, rural, government, for-profit, number of beds
^Coefficient is the rate ratio of a one percent increase in the baseline factor
^^Coefficient is effect of 1 percent change in that variable on odds of 0 infections
*p<.05; **p<.01; ***p<.001
Table 12. Descriptive Statistics of Hospital Characteristics and Survey Responses by Group

<table>
<thead>
<tr>
<th></th>
<th>Baseline Period</th>
<th>Post Period</th>
<th>Change (Post-Baseline)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group: 0 1 2 3</td>
<td>Group: 0 1 2 3</td>
<td>Group: 0 1 2 3</td>
</tr>
<tr>
<td>Teamwork Within Units</td>
<td>77.2 77.4 74.8 74.7</td>
<td>71.3 77.9 76.1 74.1</td>
<td>(5.9) 0.5 1.3 (0.6)</td>
</tr>
<tr>
<td>Supervisor Support for Safety</td>
<td>79.4 75.5 73.1 73.8</td>
<td>74.4 75.9 73.5 72.9</td>
<td>(5.0) 0.0 0.4 (0.9)</td>
</tr>
<tr>
<td>Organizational Learning</td>
<td>88.8 85.5 82.8 83.5</td>
<td>81.8 85.2 82.6 85.1</td>
<td>(7.0) (0.3) (0.2) 1.6</td>
</tr>
<tr>
<td>Management Support for Safety</td>
<td>68.5 63.6 61.4 59.9</td>
<td>57.8 64.1 61.0 63.7</td>
<td>(10.7) 0.5 (0.4) 3.8</td>
</tr>
<tr>
<td>Error Feedback</td>
<td>43.5 42.2 34.1 37.7</td>
<td>39.2 44.3 34.7 40.4</td>
<td>(4.3) 2.1 0.6 2.7</td>
</tr>
<tr>
<td>Communication Openness</td>
<td>60.4 60.7 55.4 57.1</td>
<td>55.1 59.1 56.5 57.4</td>
<td>(5.3) (1.6) 1.1 0.3</td>
</tr>
<tr>
<td>Error Reporting</td>
<td>64.4 65.9 64.1 64.5</td>
<td>56.9 64.5 61.6 61.2</td>
<td>(7.5) (1.4) (2.5) (3.3)</td>
</tr>
<tr>
<td>Teamwork Across Units</td>
<td>57.8 58.0 57.4 56.4</td>
<td>55.0 59.2 58.6 56.0</td>
<td>(2.8) 1.2 1.2 (0.4)</td>
</tr>
<tr>
<td>Staffing Levels</td>
<td>52.2 49.2 48.2 47.4</td>
<td>46.8 50.2 48.6 46.7</td>
<td>(5.4) 1.0 0.4 (0.7)</td>
</tr>
<tr>
<td>Successful Handoffs</td>
<td>60.2 58.1 58.3 59.5</td>
<td>56.2 61.2 60.6 63.4</td>
<td>(4.0) 3.1 2.3 3.9</td>
</tr>
<tr>
<td>Nonpunitive Response to Errors</td>
<td>61.7 61.6 57.8 59.9</td>
<td>57.8 62.7 58.5 60.9</td>
<td>(3.9) 1.1 0.7 1.0</td>
</tr>
<tr>
<td>Average</td>
<td>64.9 63.4 60.7 61.3</td>
<td>59.3 64.0 61.1 62.0</td>
<td>(5.6) 0.6 0.4 0.7</td>
</tr>
<tr>
<td>CLABSI</td>
<td>0.39 0.41 4.61 3.79</td>
<td>3.03 0.47 2.96 0.75</td>
<td>2.6 0.1 (1.7) (3.0)</td>
</tr>
<tr>
<td>Teach</td>
<td>0.21 0.42 0.56 0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>0.26 0.29 0.16 0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For-Profit</td>
<td>0.26 0.07 0.13 0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>0.16 0.10 0.22 0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total beds</td>
<td>182 240 435 333</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>19 92 32 52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Group: 0 = good at baseline to bad at post; 1 = good to good; 2 = bad to bad; 3 = bad to good
Means reflect the percent of people at each hospital that agreed or strongly agreed to the questions
Question responses were based on a 5-point Likert scale
Table 13. Change in Safety Factors Effect on Group: Multinomial Regression

<table>
<thead>
<tr>
<th></th>
<th>Group 0 vs 3</th>
<th></th>
<th>Group 1 vs 3</th>
<th></th>
<th>Group 2 vs 3</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>SE</td>
<td>OR</td>
<td>SE</td>
<td>OR</td>
<td>SE</td>
</tr>
<tr>
<td>Teamwork Within Units</td>
<td>0.980</td>
<td>(0.019)</td>
<td>1.008</td>
<td>(0.014)</td>
<td>1.012</td>
<td>(0.018)</td>
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<td>Supervisor Support for Safety</td>
<td>0.971</td>
<td>(0.027)</td>
<td>1.013</td>
<td>(0.018)</td>
<td>1.014</td>
<td>(0.023)</td>
</tr>
<tr>
<td>Organizational Learning</td>
<td>0.901 **</td>
<td>(0.030)</td>
<td>0.974</td>
<td>(0.020)</td>
<td>0.981</td>
<td>(0.025)</td>
</tr>
<tr>
<td>Management Support for Safety</td>
<td>0.907 ***</td>
<td>(0.024)</td>
<td>0.975</td>
<td>(0.015)</td>
<td>0.969</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Error Feedback</td>
<td>0.954 *</td>
<td>(0.021)</td>
<td>0.993</td>
<td>(0.014)</td>
<td>0.977</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Communication Openness</td>
<td>0.962</td>
<td>(0.022)</td>
<td>0.981</td>
<td>(0.015)</td>
<td>1.013</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Error Reporting</td>
<td>0.989</td>
<td>(0.018)</td>
<td>1.013</td>
<td>(0.013)</td>
<td>1.002</td>
<td>(0.017)</td>
</tr>
<tr>
<td>Teamwork Across Units</td>
<td>0.986</td>
<td>(0.021)</td>
<td>1.009</td>
<td>(0.015)</td>
<td>1.013</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Staffing Levels</td>
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<td>(0.021)</td>
<td>1.011</td>
<td>(0.015)</td>
<td>1.011</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Successful Handoffs</td>
<td>0.952 *</td>
<td>(0.021)</td>
<td>0.993</td>
<td>(0.014)</td>
<td>0.990</td>
<td>(0.018)</td>
</tr>
<tr>
<td>Nonpunitive Response to Errors</td>
<td>0.968</td>
<td>(0.021)</td>
<td>1.001</td>
<td>(0.014)</td>
<td>1.001</td>
<td>(0.018)</td>
</tr>
</tbody>
</table>

N=195; Standard errors are in parentheses
Group: 0=good at baseline to bad at post; 1=good to good; 2=bad to bad; 3=bad to good (reference group)
Control variables include: teaching hospital, rural, government, for-profit, beds, central line days
Odds of being in the listed group, compared to bad-to-good group
*p<.05; **p<.01; ***p<.001
Table 14. Effect of Baseline Safety Factors on Odds of Zero Infections in Post Period

<table>
<thead>
<tr>
<th></th>
<th>Odds Ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork Within Units</td>
<td>1.009</td>
<td>(0.990-1.028)</td>
</tr>
<tr>
<td>Supervisor Support for Safety</td>
<td>1.009</td>
<td>(0.990-1.028)</td>
</tr>
<tr>
<td>Organizational Learning</td>
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<td>(0.991-1.037)</td>
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<tr>
<td>Management Support for Safety</td>
<td>1.005</td>
<td>(0.987-1.024)</td>
</tr>
<tr>
<td>Error Feedback</td>
<td>1.006</td>
<td>(0.991-1.021)</td>
</tr>
<tr>
<td>Communication Openness</td>
<td>1.008</td>
<td>(0.989-1.027)</td>
</tr>
<tr>
<td>Error Reporting</td>
<td>1.006</td>
<td>(0.990-1.023)</td>
</tr>
<tr>
<td>Teamwork Across Units</td>
<td>1.022*</td>
<td>(1.003-1.041)</td>
</tr>
<tr>
<td>Staffing Levels</td>
<td>1.024**</td>
<td>(1.006-1.042)</td>
</tr>
<tr>
<td>Successful Handoffs</td>
<td>1.017</td>
<td>(1.000-1.035)</td>
</tr>
<tr>
<td>Nonpunitive Response to Errors</td>
<td>1.011</td>
<td>(0.994-1.028)</td>
</tr>
</tbody>
</table>

N=432 hospitals

The following variables are control variables: baseline CLABSI rate, number of central line days, teaching hospital, rural, government, for-profit, number of beds

*p<.05; **p<.01; ***p<.001
Chapter 5: Conclusion

Results Summary

Poor performance by hospitals on patient handoffs, error reporting, and CLABSI rates cost patient lives and increase our country’s health spending. This dissertation studied the effect of organizational factors of safety on each of those outcomes, in the hope that they can be improved.

Increases in perceived organizational factors of safety were associated with a higher frequency of error reporting, more successful handoffs, and reduced CLABSI rates. More specifically, management support for safety, error feedback, and organizational learning were all significantly associated with error reporting. Management support, teamwork across units, and staffing were all significant predictors of successful handoffs. Hospitals should prioritize introduction of CUSP to units that have better perceived staffing, performance on handoffs and teamwork across units. Those organizational factors of safety were significantly associated with zero CLABSIs after CUSP implementation. Once CUSP is introduced on a unit, there should be a focus on ensuring that hospital leadership supports patient safety, and that there are strong mechanisms for reflective activities, such as organizational learning and error feedback. Although not all organizational factors of safety were significantly associated with improved outcomes, hypotheses that indicated organizational factors of safety are positively associated with outcomes were largely true. For those hospitals that focus on CLABSIs, it is important to
understand that zero CLABSIs is an attainable goal. CLABSI rates decreased significantly following the introduction of the CUSP program.

Other hypotheses examined differences between staff groups on the effect of perceived organizational factors of safety on error reporting and successful handoffs. These hypotheses were true. Many of the significant factors were the same between staff groups, but there were a few differences. As a result, it is important for managers to be cognizant that their perceptions occasionally differ from clinical staff members. Management support for safety was not a significant predictor of error reporting for managers, but it was for physicians and nurses. This difference is important because clinical staff members report the errors but managers control the resources that can lead to better processes.

In terms of the greatest influence, feedback on error reports had the most significant association to error reporting. Teamwork across units similarly had the greatest positive perceived impact on patient handoffs. A devotion of time and resources to those their improvement may lead to improved handoffs and increased error reporting.

A comparison of all three patient safety studies identifies management support for safety as a crucial component for all three patient safety improvements. Reflective activities, such as organizational learning and error feedback, were commonly associated with error reporting and CLABSI rates. Also, teamwork across units is very important for those hospitals that wish to improve handoffs or reduce CLABSI rates.

This study focused on several gaps in the literature. First, it examined many organizational factors of safety that the literature deemed significant to error reporting and patient handoffs. This dissertation identified those factors that had the highest
associations. Second, it recognized that there are differences between clinical and management staffing groups of perceived organizational factors associated with successful handoffs and error reporting. This has implications for resource allocations. Third, it identified the pre-intervention organizational factors of safety that are most associated with zero CLABSI rates after CUSP implementation. This study also identified organizational factors of safety associated with CLABSI reductions.

Future Research

Future research on error reporting should assess the optimal manner in which to provide error feedback and establish a clear link between error reporting and future errors. Future research should also identify the optimal method of error feedback.

Future studies on patient handoffs can test the importance of technology and standardization in the presence of teamwork across units, and whether those factors modify its association. A future study should clarify the effect of organizational learning. Organizational learning was perceived by management to have a significant positive association with handoffs, while it had a significant negative association for clinical staff. Future studies can validate whether the perceptions found in this study are reality, and attempt to gauge causality.

Future research on CLABSIs and the CUSP implementation process should further contrast the approaches of good hospitals to bad ones on management support to safety, organizational learning, and error feedback. Those factors were significant predictors of CLABSI rates and it’s virtually guaranteed that not all units implemented CUSP in the exact same manner. For example, it may be of interest to know how frequently the staff
has safety meetings, how frequently the executive attends those meetings, and whether there are other safety programs that were initiated in conjunction with CUSP.

Future research does not need to be limited to CUSP, however. In general, researchers can explore the best ways to improve management support for safety and/or the two elaborating activities, organizational learning and error feedback, so that the greatest gains in CLABSI rates can be achieved. Findings from this dissertation can be expanded to examine other HAIs to see if these organizational factors of safety significantly improve them as well. In fact, an initiative that aligns the CUSP model to prevent catheter-associated urinary tract infections (CAUTI) is underway. A replication of my study on CAUTI may be beneficial.
References


113


Appendix A: Abbreviations

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<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<td>AHA</td>
<td>American Hospital Association</td>
</tr>
<tr>
<td>AHRQ</td>
<td>Agency for Healthcare Research and Quality</td>
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<tr>
<td>CAUTI</td>
<td>Catheter-Associated Urinary Tract Infections</td>
</tr>
<tr>
<td>CLABSI</td>
<td>Central Line-Associated Bloodstream Infection</td>
</tr>
<tr>
<td>CUSP</td>
<td>Comprehensive Unit-based Safety Program</td>
</tr>
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<td>HAI</td>
<td>Healthcare-Associated Infection</td>
</tr>
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<td>HSOPS</td>
<td>Hospital Survey on Patient Safety Culture</td>
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<td>ICU</td>
<td>Intensive Care Unit</td>
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<td>NP</td>
<td>Nurse Practitioner</td>
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<tr>
<td>PA</td>
<td>Physician Assistant</td>
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<tr>
<td>PSI</td>
<td>Patient Safety Indicator</td>
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<td>ZIP</td>
<td>Zero-Inflated Poisson</td>
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Appendix B. Characteristics of Participating Hospitals

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<td>1418</td>
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<td>≥500</td>
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<td>Hospital Region^a</td>
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</tr>
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<td>509</td>
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<tr>
<td>Pacific</td>
<td>78</td>
<td>7</td>
<td>659</td>
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</tbody>
</table>

*Source: Hospital Survey on Patient Safety Culture: Comparative Database Report

^aNew England and Mid-Atlantic: CT, MA, ME, NH, NY, PA, NJ, RI, VT
South Atlantic: DC, DE, FL, GA, MD, NC, SC, VA, WV, Puerto Rico, Virgin Islands
East North Central: IL, IN, MI, OH, WI
East South Central: AL, KY, MS, TN
West North Central: IA, KS, MN, MO, ND, NE, SD
West South Central: AR, LA, OK, TX
Mountain: AZ, CO, ID, MT, NM, NV, UT, WY
Pacific: AK, CA, HI, OR, WA, American Samoa, Guam, Marshall Islands, Northern Mariana Islands
### Appendix C: Hospital Survey on Patient Safety Questions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Survey Question</th>
<th>Coding</th>
</tr>
</thead>
</table>
| High Frequency of Error Reporting | 1) When a mistake is made, but is caught and corrected before affecting the patient, how often is this reported  
2) When a mistake is made, but has no potential to harm the patient, how often is this reported  
3) When a mistake is made that could harm the patient, but does not, how often is this reported | Percentage most of the time or always       |
| Successful Handoffs             | 1) things fall between the cracks when transferring patients from one unit to another (reverse coded)  
2) important patient care information is often lost during shift changes (reverse coded)  
3) problems often occur in the exchange of information across hospital units (reverse coded)  
4) shift changes are problematic for patients in this hospital (reverse coded) | Percentage agree or strongly agree         |
| Supervisor Support              | 1) My supervisor/manager says a good word when he/she sees a job done according to established patient safety procedures  
2) My supervisor/manager seriously considers staff suggestions for improving patient safety  
3) Whenever pressure builds up, my supervisor/manager wants us to work faster, even if it means taking shortcuts (reverse coded)  
4) My supervisor/manager overlooks patient safety problems that happen over and over (reverse coded) | Percentage agree or strongly agree         |
| Management Support              | 1) Hospital management provides a work climate that promotes patient safety  
2) The actions of hospital management show that patient safety is a top priority  
3) Hospital management seems interested in patient safety only after an adverse event happens (reverse coded) | Percentage agree or strongly agree         |
| Teamwork within Units           | 1) People support one another in this unit  
2) When a lot of work needs to be done quickly, we work together as a team to get the work done  
3) In this unit, people treat each other with respect  
4) When one area in this unit gets really busy, others help out | Percentage agree or strongly agree         |
| Teamwork Across Units           | 1) There is good cooperation among hospital units that need to work together  
2) Hospital units work well together to provide the best care for patients  
3) Hospital units do not coordinate well with each other (reverse coded)  
4) It is often unpleasant to work with staff from other hospital units (reverse coded) | Percentage agree or strongly agree         |
| Staffing Levels                 | 1) We have enough staff to handle the workload  
2) Staff in this unit work longer hours than is best for patient care (reverse coded)  
3) We use more agency/temporary staff than is best for patient care (reverse coded)  
4) We work in crisis mode trying to do too much, too quickly (reverse coded) | Percentage agree or strongly agree         |
| Communication Openness          | 1) Staff will freely speak up if they see something that may negatively affect patient care  
2) Staff feel free to question the decisions or actions of those with more authority  
3) Staff are afraid to ask questions when something does not seem right (reverse coded) | Percentage most of the time or always       |
| Organizational Learning         | 1) We are actively doing things to improve patient safety  
2) Mistakes have led to positive changes here  
3) after we make changes to improve patient safety, we evaluate their effectiveness | Percentage agree or strongly agree         |
| Nonpunitive Response to Error Reporting | 1) Staff feel like their mistakes are held against them  
2) When an event is reported, it feels like the person is being written up, not the problem (reverse coded)  
3) Staff worry that mistakes they make are kept in their personnel file (reverse coded) | Percentage agree or strongly agree         |
| Error Feedback                  | 1) We are given feedback about changes put into place based on event reports  
2) We are informed about errors that happen in this unit  
3) In this unit, we discuss ways to prevent errors from happening again | Percentage most of the time or always       |
### Appendix D. HSOPS Respondents by Category

<table>
<thead>
<tr>
<th>Staff Category</th>
<th>Number of Respondents</th>
<th>Percentage of All Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse (RN, LPN, LVN)</td>
<td>158,485</td>
<td>35%</td>
</tr>
<tr>
<td>Other</td>
<td>95,374</td>
<td>21%</td>
</tr>
<tr>
<td>Technician (EKG, Lab, Radiology)</td>
<td>47,242</td>
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</tr>
<tr>
<td>Administration/Management</td>
<td>36,305</td>
<td>8%</td>
</tr>
<tr>
<td>Unit Assistant/Clerk/Secretary</td>
<td>29,404</td>
<td>7%</td>
</tr>
<tr>
<td>Physician, Physician Assistant, Nurse Practitioner</td>
<td>25,039</td>
<td>6%</td>
</tr>
<tr>
<td>Patient Care Assistant/Hospital Aide/Care Partner</td>
<td>24,109</td>
<td>5%</td>
</tr>
<tr>
<td>Therapist (Respiratory, Physical, Occupational, Speech)</td>
<td>21,599</td>
<td>5%</td>
</tr>
<tr>
<td>Pharmacist</td>
<td>8,527</td>
<td>2%</td>
</tr>
<tr>
<td>Dietician</td>
<td>2,743</td>
<td>1%</td>
</tr>
<tr>
<td>Missing</td>
<td>23,570</td>
<td>5%</td>
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</table>
Appendix E. R-Square Impact of Predictors on High Perceived Frequency of Error Reporting, by Staff Position

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Management</th>
<th>NP/PA</th>
<th>Physicians</th>
<th>Nurses</th>
<th>Management</th>
<th>NP/PA</th>
<th>Physicians</th>
<th>Nurses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervisor Support</td>
<td>0.09</td>
<td>0.11</td>
<td>0.10</td>
<td>0.26</td>
<td>0.00</td>
<td>0.01</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>Organizational Learning</td>
<td>0.14</td>
<td>0.14</td>
<td>0.16</td>
<td>0.46</td>
<td>0.00</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Teamwork Within Units</td>
<td>0.03</td>
<td>0.08</td>
<td>0.05</td>
<td>0.27</td>
<td>0.00</td>
<td>0.00</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Communication Openness</td>
<td>0.09</td>
<td>0.11</td>
<td>0.16</td>
<td>0.20</td>
<td>0.00</td>
<td>0.00</td>
<td>0.01</td>
<td>0.01</td>
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<tr>
<td>Error Feedback</td>
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<td>0.21</td>
<td>0.28</td>
<td>0.54</td>
<td>0.15</td>
<td>0.05</td>
<td>0.08</td>
<td>0.16</td>
</tr>
<tr>
<td>Nonpunitive Response to Errors</td>
<td>0.09</td>
<td>0.11</td>
<td>0.09</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
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<td>0.01</td>
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<td>0.06</td>
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<td>0.00</td>
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<td>Management Support for Safety</td>
<td>0.06</td>
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<td>0.21</td>
<td>0.36</td>
<td>0.00</td>
<td>0.00</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>Teamwork Across Units</td>
<td>0.15</td>
<td>0.10</td>
<td>0.19</td>
<td>0.26</td>
<td>0.03</td>
<td>0.01</td>
<td>0.01</td>
<td>0.00</td>
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</tbody>
</table>

\(^a\) Weight was a hospital's overall survey response rate; n = 498 hospitals

\(^b\) Output is the addition of that predictor variable to a model that included only control variables (government, teaching, bed size dummies, region dummies)

\(^c\) Output is addition of that predictor variable to a model that included all other predictor variables and all control variables
Appendix F. R-Square Impact of Predictors on Successful Handoffs, by Staff Position

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Management</th>
<th>NP/PA</th>
<th>Physicians</th>
<th>Nurses</th>
<th>Management</th>
<th>NP/PA</th>
<th>Physicians</th>
<th>Nurses</th>
</tr>
</thead>
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<tr>
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<td>0.14</td>
<td>0.15</td>
<td>0.00</td>
<td>0.02</td>
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<td>Organizational Learning</td>
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<td>0.14</td>
<td>0.20</td>
<td>0.00</td>
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<td>Teamwork Within Units</td>
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<td>0.57</td>
<td>0.33</td>
<td>0.29</td>
<td>0.20</td>
<td>0.38</td>
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</table>

*Weight was a hospital's overall survey response rate; n = 498 hospitals

*Output is the addition of that predictor variable to a model that included only control variables (government, teaching, bed size, region)

*Output is addition of that predictor variable to a model that included all other predictor variables and all control variables
Appendix G. Descriptive Statistics of Baseline Organizational Factors of Safety

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<th>Mean</th>
<th>Diff</th>
<th>Sig^</th>
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<td></td>
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<td>1.1</td>
<td>1.0</td>
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<td>61.2</td>
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N=195 hospitals
Question responses were based on a 5-point Likert scale
Values reflect the average percent of people at each hospital that agreed or strongly agreed
with the questions related to the variable of interest
^Unadjusted for control variables; paired t-test
Baseline is eight quarters prior to CUSP intervention; post is up to six quarters thereafter
*p<.05; **p<.01; ***p<.001