HHS Public Access

Author manuscript

J Patient Saf. Author manuscript; available in PMC 2021 September 01.

Published in final edited form as:

J Patient Saf. 2020 September ; 16(3): 187–193. doi:10.1097/PTS.0000000000000336.

A Multilevel Analysis of U.S. Hospital Patient Safety Culture Relationships with Perceptions of Voluntary Event Reporting

Jonathan D. Burlison, PhD[1], **Rebecca R. Quillivan, MS**[1], **Lisa M. Kath, PhD**[2], **Yinmei Zhou, MS**[3], **Sam C. Courtney, MS**[2], **Cheng Cheng, PhD**[3], **James M. Hoffman, PharmD**[1,4]

[1]Department of Pharmaceutical Sciences, St. Jude Children's Research Hospital, Memphis, TN

[2]Department of Psychology, College of Sciences, San Diego State University, San Diego, CA

[3]Department of Biostatistics, St. Jude Children's Research Hospital, Memphis, TN

[4]Department of Clinical Pharmacy, College of Pharmacy, University of Tennessee Health Sciences Center, Memphis, TN

Abstract

Objectives—Patient safety events offer opportunities to improve patient care, but, unfortunately, events often go unreported. Although some barriers to event reporting can be reduced with electronic reporting systems, insight on organizational and cultural factors that influence reporting frequency may help hospitals increase reporting rates and improve patient safety. The purpose of this study was to evaluate the associations between dimensions of patient safety culture and perceived reporting practices of safety events of varying severity.

Methods—We conducted a cross-sectional survey study using previously collected data from The Agency for Healthcare Research and Quality Hospital Survey of Patient Safety Culture as predictors and outcome variables. The dataset included healthcare professionals in U.S. hospitals, and data were analyzed by using multilevel modeling techniques.

Results—Data from 223,412 individuals, 7816 work areas/units and 967 hospitals were analyzed. Whether examining Near-miss, No harm, or Potential for harm safety events, the dimension Feedback about error accounted for the most unique predictive variance in the outcome Frequency of events reported. Other significantly associated variables included Organizational learning, Nonpunitive response to error, and Teamwork within units (all $p<.001$). As the perceived severity of the safety event increased, more culture dimensions became significantly associated with voluntary reporting.

Conclusions—To increase the likelihood that a patient safety event will be voluntarily reported, our study suggests placing priority on improving event feedback mechanisms and communication of event-related improvements. Focusing efforts on these aspects may be more efficient than other forms of culture change.

Correspondence to James M. Hoffman, 262 Danny Thomas Place, MS 150, Memphis, Tennessee 38105 USA; Phone: 901-595-2767; Fax: 901-595-3111; James.Hoffman@stjude.org.

Conflicts of Interest

There are no known possible conflicts of interest to declare.

INTRODUCTION

In the past 2 decades, many healthcare organizations aimed to reform their perspectives on patient safety events away from a strictly punitive approach that blames individuals. There is ample evidence that the greatest improvements in patient care come through critically evaluating the systems and processes that place individuals at a higher likelihood for committing errors.[1-3] Although the effort expended to address patient safety events sometimes revolves around policy and procedure development, it is clear that policies and procedures alone will not be enough to ensure that adverse events are minimized. A strong patient safety culture is represented by a work environment which ensures that policies and procedures are actually followed. Patient safety is best supported when the culture of the hospital itself is oriented toward those factors that make it a high-reliability organization with a just culture.[4-6]

A natural, human tendency when errors have occurred is to ignore or minimize the error. It takes a lot of work to build an environment that supports the opposite reaction: open and honest reporting of errors so they can be evaluated to contribute to organizational learning.[7-10] The patient safety culture dimensions that makes patient safety policies and procedures truly work include excellent communication, an orientation toward learning, clear expectations, and strong teamwork, just to name a few. Without these cultural dimensions in place, policies and procedures may be ignored or followed merely to “check the box” to placate hospital administrators. With these culture dimensions in place, units and hospitals can leverage social pressures to follow the spirit of the law with regards to policies and procedures. The best hospitals can even enter a state of continuous improvement that is responsive to ever-present change in the healthcare industry.

The Agency for Healthcare Research Quality has already identified many patient safety culture dimensions that are expected to influence patient safety outcomes.[11] There are 7 factors that are focused on the psychosocial environment of the unit (see Table 1 for definitions): Communication openness, Feedback about error, Supervisor/manager expectations and actions promoting safety, Teamwork within units, Non-punitive response to error, Organizational learning, and Staffing. There are 3 factors that are focused on the psychosocial environment of the hospital (see Table 1 for definitions): Handoffs and transitions, Management support for patient safety, and Teamwork across units.

In addition, patient safety culture in hospitals manifests itself differently across various contexts (or levels) within the organization. For example, the culture within one's immediate work area or unit can be perceived differently from that of the hospital overall.[12,13] Therefore, when conducting patient safety culture research, it is important to consider the effect of both the work area or unit *and* the hospital overall in the formation of patient safety culture perceptions. Ignoring the hierarchical structure of patient safety culture data can result in drawing flawed conclusions.

Using organizational behavior approach, we are interested in studying these patient safety culture dimensions that may be related to patient safety outcomes using multilevel modeling. This analytic approach supports the aggregation of individual responses to create a measure

of the patient safety culture dimensions in each unit or hospital (as appropriate). Multilevel modeling is necessary to account for the nesting of individuals within units within hospitals, yet, to our knowledge, little research on patient safety culture dimensions has employed this method of analysis to study this important issue.

METHODS

HSOPSC Dataset Characteristics and Exclusion Criteria

We used a large, existing dataset (The Agency for Healthcare Research and Quality (AHRQ) Hospital Survey on Patient Safety Culture (HSOPSC)) which represents a variety of healthcare workers in 650 hospitals across the United States. The AHRQ HSOPSC was published in 2004 as one of the first validated self-report survey instruments for hospitals to assess their patient safety culture.[11] Since then, the HSOPSC has been demonstrated to be psychometrically sound in many contexts and cultures.[14-16]

AHRQ collects HSOPSC responses from U.S. hospitals to produce individual reports for participating hospitals and publishes a comparative database report, the first of which was published in 2007.[17] The most recent comparative database report includes results from 680 hospitals and 447,584 respondents.[18] The data used for this study are publicly available from AHRQ through an application process and range from 2008-2011. The HSOPSC dataset we obtained includes responses from 526,645 individuals working at one of 1088 U.S. hospitals. The average response rate was 51.3%. Details on the method AHRQ used to calculate the response rate for each hospital are located in any of the HSOPSC Comparative Database Reports.[18] The study was reviewed and approved by the St. Jude institutional review board as non-human subjects research.

Similar to the study by Sorra and colleagues, exclusion criteria were applied in order to conduct multilevel modeling analyses.[13] The exclusion criteria for entire hospitals were: hospitals that did not administer the entire survey, ask the work unit question, or only had one unit respond. The exclusion criteria for units within hospitals were: units with fewer than 3 respondents or units that were identified as “Other” or “Many different work units.” Based on these criteria, a total of 99 hospitals, 1,089 units, and 223,429 respondents were dropped from the dataset.

Missing values for the HSOPSC items ranged from 1.2% to 7.2%. Using Little's Missing Completely at Random Test (SPSS software, version 22.0, SPSS, Chicago, IL), our analyses found data to be missing completely at random ($p = 1.00$), and therefore cases with missing values were deleted listwise. After removing missing data and other responses on the basis of the exclusion criteria, the final sample contained responses from 223,412 individuals, corresponding to 7816 work areas/units and 967 hospitals.

Measurement of Patient Safety Culture and Event Reporting

The HSOPSC survey contains 35 items/10 dimensions + 4 outcomes (1 4-item outcome dimension, 1 3-item outcome dimension, 2 single-item outcome measures). Table 1 lists the dimensions, their definitions, number of items, and response scale. For the HSOPSC outcomes, 2 are general perceptions of patient safety, Patient safety grade (one item) and

Overall perceptions of patient safety (4 items). The additional outcomes relate to voluntary event reporting, Number of events reported (1 item) and Frequency of events reported (3 items). Most of the patient safety culture items are measured using a 5-point Likert scale (Strongly Disagree to Strongly Agree), with exceptions noted in Table 1. Some of the items are negatively worded, and the scores for those were reversed for our analyses.

As noted earlier, some of the patient safety culture dimensions refer to the unit level, and 3 refer to the hospital level. Psychometrically, this is a very important distinction. For example, for the dimension Teamwork within units, a sample item is, “When one area in this unit gets really busy, others help out.” This item is presented under the instructions: “Please indicate your agreement or disagreement with the following statements about your work area/unit.” Then, above the items in that section, it says, “Think about your hospital work area/unit...” The phrasing of the item, plus the instructions, all indicate that the respondent should provide an evaluation of the item with his/her unit in mind. As a result, these items are considered to be a measure of the individual respondent's perceptions of the psychosocial environment *of the unit* for that dimension. If the intention was to measure individuals’ helping behaviors, the sample item would instead say “When one area in this unit gets really busy, you help out.”

The most straightforward way to measure Teamwork within units (staying with this as an example) is to ask individuals within the units to provide their perspectives, and then test to see if the responses have sufficient agreement to warrant aggregation to the unit level. If there is such a thing as a psychosocial environment regarding Teamwork within units (i.e., a shared perception of the unit's policies and procedures regarding teamwork), then individual responses within a unit should have reasonable levels of agreement with one another. In addition, responses should vary between units to some degree as well. These properties were measured using r_{wg} (a measure of within group agreement) and ICC(1) (intra-class correlation coefficient; a measure of between-group variability) to determine whether it is appropriate to aggregate individual responses to the unit (or hospital) level. If, for example, there is not adequate within group agreement (low r_{wg}), or if there is no significant variation between groups (low ICC(1)), then one can conclude that the patient safety dimension is not really a culture variable, but rather is best conceptualized and studied at the individual level instead.

We examined the r_{wg} and ICC(1) values for each of the patient safety culture dimensions (7 at the unit level, 3 at the hospital level). The average r_{wg} value and the ICC(1) value for each dimension is reported in Table 2 ; please note that these values are calculated for either the unit level or the hospital level, according to the level of the patient safety culture dimension. The r_{wg} values near or above .70 and ICC(1) values near or above .05 support the aggregation of the individual responses to represent a psychosocial culture dimension at the unit or hospital level, as intended by the original survey designers.[11,19] Further, these results indicate that examining these patient safety culture dimensions at the individual level is inappropriate, given the within-group agreement and between-group variability.

Measurement of Patient Safety Event Reporting

The HSOPSC variable, Frequency of event reporting, was used as our measure of voluntary patient safety event reporting, which assessed the perception of how frequently a patient safety event would be reported when detected in the respondent's work area or unit. There are three items in this section, measuring the "extent to which mistakes of the following types are reported: 1) mistakes caught and corrected before affecting the patient, 2) mistakes having no potential to harm the patient, and 3) mistakes that could harm the patient but did not."[11] Each of the 3 items from this dimension was assessed as a unique outcome, and we also averaged the responses of all 3 items to assess as an overall average event reporting measure. Although the definition of a near-miss patient safety event varies depending on the source,[20,21] the current study characterizes a near-miss event by using the first item measured by this outcome dimension (i.e., "When a mistake is made, but is caught and corrected before affecting the patient"). The other two items are described as "No potential for harm" and "Potential for harm" events.

As with the patient safety culture dimensions described above, the Frequency of events reported items are intended to measure a unit-level phenomenon, as noted by the section header, which reads: "In your hospital work area/unit, when the following mistakes happen, how often are they reported?" If the intention was to measure individuals' own propensity to report events, the item header would read: "When the following mistakes happen, how often do you report them?" However, different from the patient safety culture dimensions above, these items do not assess a psychosocial environment phenomenon. As a result, it is not a prerequisite for the statistical check regarding agreement within groups (r_{wg}) and variability between groups (ICC(1)) to pass a certain threshold. Table 2 shows that the average r_{wg} values are considerably lower for these outcomes measures than for the patient safety culture dimensions. This is an indication that there is less agreement within the group regarding the Frequency of event reporting. However, the ICC(1) values indicate significant variance between groups on the outcomes. Additionally, as noted above, the items were intended to measure the unit's Frequency of events reported. Finally, we do not have access to any other measure of patient safety event reporting in this dataset, so the unit's average of the individual responses on this item is the best measure we have available. Concerns with this measure are discussed in the Discussion section below.

Data Analysis

The HSOPSC data are best described as "nested" data, where individual responses cannot be considered independent of one another because there are individuals nested within work areas/units (level 1 in our model) and hospitals (level 2 in our model). Multilevel modeling techniques account for the variance at each level, providing a more accurate portrayal of the data, possibly even reducing Type 1 Errors. The multilevel structure of the HSOPSC has been previously assessed and validated at the individual, unit, and hospital levels.[12,13] However, due to reasons previously mentioned, we did not analyze the data at the individual-level. Multilevel modeling software (HLM, version 7) was used to build two-level random coefficients regression models using a full maximum likelihood estimation method. The overall intercept was allowed to vary across hospitals and all work area/unit-level predictor variables were centered around their respective group means.

We determined that a 2-level model, with the respondents' unit perceptions of patient safety culture being the first and hospital-based perceptions as the second, was appropriate due to the design of the HSOPSC. As noted above, we examined the level of measurement and calculated statistical indices, which supported the aggregation of individual-level responses to either the unit or hospital level. Although the computation of effect sizes for multilevel models is notoriously challenging, we provide pseudo-R^2 values as a way to better understand approximately how much variance these predictors account for in the outcome variable.[22]

Multicollinearity in the predictors can affect results in multilevel modeling in ways similar to other multiple regression techniques, such as making it difficult to determine accurate effect sizes of individual variables. Multilevel variance inflation factor (MVIF), a form of the analysis used in multilevel modeling, was calculated to check for multicollinearity among the predictors. Previous research suggested that caution should be employed in using variables with MVIF values greater than 10,[23] no MVIF values exceed this threshold. The overall average of the 3 items of Frequency of events reported was assessed as an outcome variable (Composite), along with 3 additional models in which the 3 items comprising this dimension were also distinct outcome variables (Near miss, No potential for harm, and Potential for harm).

RESULTS

Table 2 provides the aggregation and descriptive statistics for the study variables. We computed demographics descriptive statistics for the respondents, work units, and hospitals, and they were similar to those reported in the 2011 AHRQ Comparative Database Report. As noted earlier, the aggregation statistics (Mean r_{wg} and ICC(1)) largely support the aggregation of the individual responses to the unit or hospital level, as intended. The means of the study variables are all near the midpoint of their scales, with the highest means being found for Teamwork within units ($M = 3.95$, $SD = 0.37$) Potential for harm events ($M = 4.03$, $SD = 0.37$). Histograms and quantile-quantile plots (generated using SPSS software, version 22.0, SPSS, Chicago, IL) were used to review the distributions of the responses, which were determined to be normal.

Table 3 provides the work area/unit- and hospital-level correlations for all variables. The patient safety culture dimensions at the unit level that correlated 0.5 or higher with the outcomes are: Feedback about errors and Nonpunitive responses to errors. The patient safety culture dimensions at the hospital level that correlated 0.5 or higher with the outcomes are: Management support for safety and Teamwork across units.

Overall Frequency of Events Reported

Table 4 presents results from the multilevel modeling analyses. When the modeled outcome was the overall average composite score of the 3 items from the dimension Frequency of events reported, several work area/unit-level culture variables were significant predictors. The patient safety culture dimensions that accounted for the most unique variance in overall Frequency of events reported were: Feedback about error ($B = 0.37$, $p < .001$), Management support for patient safety ($B = 0.37$, $p < .001$), Organizational learning ($B = 0.24$, $p < .001$),

Nonpunitive response to error ($B = 0.06$, $p < .001$), and Teamwork within units ($B = 0.04$, $p < .05$). Because the regression coefficients (B's) were all positive, this indicates that higher levels of patient safety culture dimensions are associated with higher frequency of patient safety event reporting. Pseudo R^2 was also calculated for the model overall, which is similar to R^2 in linear regression analyses. The R^2 within-groups was 0.47 and the R^2 between groups was 0.74.

Frequency of Near-Miss Events Reported

The patient safety culture dimensions that accounted for the most unique variance in Near-miss events reported were: Feedback about error ($B = 0.44$, $p < .001$), Management support for patient safety ($B = 0.43$, $p < .001$), Organizational learning ($B = 0.23$, $p < .001$), Nonpunitive response to error ($B = 0.04$, $p < .001$), and Teamwork within units ($B = 0.04$, $p < .05$). These are the same dimensions, in the same order of regression coefficient size, as were reported for the overall Frequency of events reported outcome above. Pseudo R^2 within-groups for this outcome variable's overall model was 0.44 and the R^2 between groups was 0.80.

Frequency of No Potential for Harm Events Reported

The patient safety culture dimensions that accounted for the most unique variance in No potential for harm events reported were: Management support for patient safety ($B = 0.38$, $t = 8.48$, $p < .001$), Feedback about error ($B = 0.36$, $p < .001$), Organizational learning ($B = 0.29$, $p < .001$), Handoffs and transitions ($B = 0.15$, $p < .01$), Nonpunitive response to error ($B = 0.06$, $p < .001$), and Teamwork within units ($B = 0.05$, $p < .05$). The only difference between these results and the ones for Near-miss events reported outcome reported above is the inclusion of Handoffs and transitions as a significant predictor. Pseudo R^2 within-groups for this outcome variable's overall model was 0.40 and the R^2 between groups was 0.81.

Frequency of Potential for Harm Events Reported

The patient safety culture dimensions that accounted for the most unique variance in Potential for harm events reported were: Feedback about error ($B = 0.31$, $p < .001$), Management support for patient safety ($B = 0.29$, $p < .001$), Handoffs and transitions ($B = 0.21$, $p < .001$), Organizational learning ($B = 0.20$, $p < .001$), Nonpunitive response to error ($B = 0.06$, $p < .001$), Staffing ($B = 0.04$, $p < .01$), and Communication openness ($B = 0.07$, $p < .01$). Here, we see that Staffing and Communication openness are also significant predictors for this outcome, where they were not significant for the other outcomes studied. Pseudo R^2 within-groups for this outcome variable's overall model was 0.44 and the R^2 between groups was 0.78.

DISCUSSION

Although voluntary event reporting is often described as an inadequate method to detect patient safety events and is marked by underreporting rates, reporting systems are very common in U.S. hospitals. Many of the barriers to reporting can be minimized through targeted efforts and are reflected in a hospital's patient safety culture.[2,7,9,10,24-28] Reducing or eliminating these barriers can increase reporting rates, which can reveal more

opportunities to improve patient safety and patient care systems. Using multilevel modeling techniques, which account for the established multilevel structure of the patient safety culture construct, this study's results indicate that many aspects of patient safety culture influence the perceived likelihood that a patient safety event will be voluntarily reported. Although results varied slightly depending on the outcome tested in our 4 models, Feedback about errors was the highest correlated with the outcomes, and it also consistently had the largest regression coefficients for predicting Frequency of events reported, whether it be a Near-miss, No potential for harm, or Potential for harm safety event. Other significantly related cultural dimensions included Organizational learning about errors, Management support for patient safety, and Nonpunitive responses to errors.

Feedback about errors and Organizational learning are work area/unit-based assessments of how informed staff members feel about safety-related errors (i.e., events) and any related improvements. Our results are consistent with those of previous studies that discussed the significance of patient safety event report feedback[9,23,29] and communicating systems and process improvements based on information gleaned from event reports.[30,31] The importance of meaningful feedback and communication about safety events was also recently stressed by 11 international patient safety experts. In this publication, the authors stated, “If the healthcare industry wants to learn from its mistakes, miss or near miss events, it will need to take incident reporting as seriously as the health budget.”[10]

Punitive reactions to errors have been discussed repeatedly as barriers to event reporting in previous studies, and it was also a significant finding in our study.[24,25,30,32] However, the results of this study show that although statistically significant, Nonpunitive responses to errors did not correlate with outcomes as highly or have as large a regression coefficient as Feedback about errors for any of the 4 models. Although the extensive literature on the detrimental effects of punitive safety cultures should not be disregarded, these results indicate that this cultural element may have less of an effect on event reporting tendencies than previously thought. This has practical implications for hospitals attempting to improve their patient safety event reporting likelihoods. For example, it may require fewer resources and less time to improve feedback mechanisms about safety events than those necessary for affecting large-scale cultural changes, which can take years to implement.[33]

The more serious a patient safety event, the more likely it is to be voluntarily reported.[24,34] However, our results suggest that the magnitude of the influence of patient safety culture on the reporting of events varied little across the level of perceived severity. Compared to the models that assessed Near-miss and No potential for harm events, two additional culture dimension predictors (Communication openness and Staffing) did become significant for the model assessing Potential for harm events. The two additional significant predictors emerging in the model assessing potential for harm events may be explained by patient safety culture being more salient overall to the voluntary reporting of these types of events. The lack in large observed differences across the 3 types of events may be attributed to the manner in which patient safety culture events are measured by the HSOPSC. Rather than referring to events that resulted in harm, the most severe types of events measured by the HSOPSC are those that had the potential for harm, yet did not result in harm. Evaluating the

influence of patient safety culture on the reporting of safety events that actually resulted in harm could reveal more differences between events that are severe and minor.

In contrast to other recent studies that used similar patient safety culture data, our study used multilevel data analysis techniques to account inherent structure of the HSOPSC.[34,35] Failing to recognize this characteristic underestimates the standard error of the regression coefficients and can result in Type I errors. In their definition of safety culture, Pronovost and Sexton said, “In essence, culture is the way we do things around here.” In our study, *here* was modeled as both the staff member's work area/unit and hospital, and patient safety culture dimensions at both of these levels were predictive of event reporting.[35] Multilevel modeling also allowed the data to be modeled in such a way that differences in the associations between predictors and outcomes across hospitals could be controlled for when testing hypotheses.

Patient safety culture should not be expected to entirely predict voluntary event reporting because it does not assess issues that reflect the perceived ease of reporting, such as electronic reporting system usability and functionality.[8,24,31,36,37] Future research could examine the effects of these elements concurrently with patient safety culture to clarify their varying effects. Our study accounted for the variability in scores across work areas/units and hospitals, but additional research could be conducted on the influence of other hospital characteristics measured in the HSOPSC, such as region, teaching status, and number of beds.

Although this study used best practices to test its hypotheses, its conclusions have their limitations. The outcomes used for this research were based on self-reported perceptions of safety event reporting likelihood. Ideally, completely objective data (i.e., actual event reporting data) would be preferred, but collecting that information on a scale as large as the one used for this study would be exceptionally challenging. Also, the data used for the analyses did not sample evenly across work areas/units and hospitals; therefore, there may be some nonrandomness to the patterns of nonresponders that could have significantly affected the results. Also, determining the unique variance of predictors is a challenge for multilevel modeling research, where regression coefficients on their own are not necessarily sufficient. Therefore, we heed caution in over interpreting the observed differences in our regression coefficients, even though Feedback about errors had the largest values across all 4 of our models.[22] Despite its widespread use, the HSOPSC data used for the study was cross-sectional in the nature of data collection and the correlational study design does not clarify the causal direction. We assume that the direction is from patient safety culture to patient safety event reporting, but reciprocal causation or third-variable causation cannot be ruled out.

Conclusions

By using multilevel modeling techniques on a large sample of patient safety culture responses from U.S. hospitals, this study assessed the associations between patient safety culture dimensions and patient safety event reporting. Feedback about error, Organizational learning, and Management support for safety were the most predictive patient safety culture dimensions for the outcomes assessing the frequency of patient safety event reporting. The

findings of this study provide insights for hospital leaders as they work to improve voluntary event reporting rates. To increase the frequency of voluntarily reported patient safety events, our study suggests prioritizing efforts to improve event reporting feedback mechanisms, communication regarding systems and process changes made in response to submitted event reports, and voicing support for safety by top-level hospital leadership. By primarily focusing on these areas, increases in event reporting may be realized more efficiently than attempting other forms of culture change, which can take years to successfully implement.

Acknowledgement

We thank Vani Shanker, PhD, for editing the manuscript.

Sources of Funding

This study was supported by the Cancer Center Core Grant # NIH CA 21765 and ALSAC. Data used in this analysis were from the Agency for Healthcare Research and Quality (AHRQ) Hospital Survey on Patient Safety Culture Comparative Database. The database is funded by AHRQ and managed by Westat under contract # HHSA 290200710024C.

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Table 1

HSOPSC Dimensions, Definitions, Number of Items per Dimension, and Response Scale

Patient Safety Culture Dimension	Definition: The extent to which...	Number of Survey Items	Response Scale
Communication openness	Staff will freely speak up if they see something that may negatively affect patient care, and feel free to question those with more authority	3	1-5 Agree-Disagree
Feedback about error	Staff are informed about errors that happen, given feedback about changes put into place based on event reports, and discuss ways to prevent errors	3	1-5 Never-Always
Nonpunitive response to error	Staff feel that their mistakes are not held against them, and mistakes are not kept in their personnel file	3	1-5 Agree-Disagree
Organizational learning	Mistakes have led to positive changes and changes are evaluated for their effectiveness	3	1-5 Agree-Disagree
Staffing	There are enough staff to handle the workload and work hours are appropriate to provide the best care for patients	4	1-5 Agree-Disagree
Manager expectations for safety	Supervisors/managers consider staff suggestions for improving patient safety, praise staff for following patient safety procedures, and do not overlook patient safety problems	4	1-5 Agree-Disagree
Teamwork within units	Staff support one another, treat each other with respect, and work together as a team	4	1-5 Agree-Disagree
Handoffs and transitions	Important patient care information is transferred across hospital units and during shift changes	4	1-5 Agree-Disagree
Management support for safety	Hospital management provides a work climate that promotes patient safety and shows that patient safety is a top priority	3	1-5 Agree-Disagree
Teamwork across units	Hospital units cooperate and coordinate with one another to provide the best care for patients	4	1-5 Agree-Disagree

Table 2

Mean r_{wg}, ICC(1), and Descriptive Statistics for all Study Variables.

Variables	Mean r_{wg}	ICC(1)	Mean	SD	Min	Max
Level 1 – Work Area/Unit [a]						
Communication openness	.815	.075	3.67	.365	1.75	5.00
Feedback about error	.796	.093	3.74	.375	1.75	5.00
Nonpunitive response to error	.696	.104	3.18	.449	1.37	5.00
Organizational learning	.905	.091	3.78	.310	1.83	5.00
Staffing	.883	.164	3.48	.413	1.42	5.00
Management expectations for safety	.821	.094	3.87	.378	1.67	5.00
Teamwork within units	.848	.101	3.95	.373	1.97	5.00
Level 2 – Hospital [b]						
Handoffs and transitions	.801	.046	3.25	.257	2.34	4.42
Management support for safety	.769	.061	3.72	.256	2.77	4.47
Teamwork across units	.843	.050	3.45	.243	2.45	4.43
Outcomes [a]						
Frequency of events reported - Composite	.678	.059	3.74	.380	1.00	5.00
Near-miss event	.421	.062	3.55	.437	1.00	5.00
No potential for harm event	.442	.053	3.65	.424	1.00	5.00
Potential for harm event	.596	.054	4.03	.374	1.00	5.00

Abbreviations: ICC, Intraclass Coefficient; SD, standard deviation; Min, minimum; Max, maximum.

[a]These statistics are reported on the unit-level aggregate.

[b]These statistics are reported on the hospital-level aggregate.

Table 3

Work Area/Unit-level and Hospital-level Correlations for all Study Variables.[a,b]

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Level 1 – Work Area/Unit														
1. Communication openness	—	.746	.722	.684	.513	.773	.680	.534	.611	.582	.562	.468	.520	.578
2. Feedback about error	.739	—	.502	.812	.432	.758	.591	.554	.711	.621	.721	.676	.667	.653
3. Nonpunitive response to error	.720	.547	—	.514	.565	.650	.617	.494	.533	.525	.357	.269	.335	.399
4. Organizational learning	.663	.771	.559	—	.500	.702	.658	.566	.795	.663	.637	.605	.587	.574
5. Staffing	.513	.463	.545	.543	—	.553	.587	.639	.656	.615	.345	.236	.301	.433
6. Manager expectations for safety	.752	.733	.653	.518	.621	—	.703	.558	.667	.614	.566	.474	.529	.569
7. Teamwork within units	.651	.582	.569	.483	.412	.465	—	.570	.623	.681	.431	.344	.382	.480
Level 2 - Hospital														
8. Handoffs and transitions	.397	.421	.359	.447	.483	.412	.465	—	.701	.860	.481	.406	.437	.499
9. Management support for safety	.561	.656	.506	.715	.595	.635	.501	.558	—	.788	.560	.525	.500	.525
10. Teamwork across units	.500	.532	.458	.567	.497	.506	.541	.734	.685	—	.502	.451	.455	.491
Outcomes														
11. Frequency of events reported - Composite	.457	.597	.325	.535	.309	.462	.392	.392	.490	.414	—	.910	.959	.891
12. Near-miss event	.404	.562	.284	.494	.257	.413	.345	.356	.463	.388	.909	—	.825	.671
13. No potential for harm event	.409	.538	.287	.487	.264	.410	.354	.365	.428	.370	.945	.802	—	.826
14. Potential for harm event	.462	.556	.336	.507	.340	.461	.395	.367	.467	.389	.894	.688	.806	—

[a] Level 1 correlations are below the diagonal and Level 2 correlations are above

[b] All values $p < .01$

Table 4

Hierarchical Regression Model for Frequency of Events Reported (Composite, Near-Miss, No Potential for Harm, and Potential for Harm Events).

Parameters	Composite		Near-Miss		No Potential for Harm		Potential for Harm	
Fixed effects								
Level-1 – Work Area/Unit	*B*	*t*	*B*	*t*	*B*	*t*	*B*	*t*
Communication openness	0.02	0.79	−0.02	−0.80	0.02	0.71	0.07	2.86[b]
Feedback about error	0.37	17.49[c]	0.44	17.60[c]	0.36	14.32[c]	0.31	14.31[c]
Nonpunitive response to error	0.06	3.74[c]	0.04	2.40[a]	0.06	3.76[c]	0.06	3.92[c]
Organizational learning	0.24	9.03[c]	0.23	7.41[c]	0.29	9.60[c]	0.20	7.56[c]
Staffing	0.01	1.11	0.01	0.41	−0.01	−0.65	0.04	2.90[b]
Manager expectations for safety	0.00	0.15	0.01	0.26	−0.02	−0.92	0.02	0.82
Teamwork within units	0.04	2.22[a]	0.04	1.97[a]	0.05	2.35[a]	0.03	1.70
Level-2 – Hospital								
Handoffs and transitions	0.12	2.42[a]	0.03	0.44	0.15	2.58[b]	0.21	4.16[c]
Management support for safety	0.37	9.41[c]	0.43	9.77[c]	0.38	8.48[c]	0.29	7.39[c]
Teamwork across units	0.46	0.80	0.10	1.39	0.02	0.24	0.00	0.01

Abbreviations: B, unstandardized coefficient; t, t-ratio

[a] $p < .05$

[b] $p < .01$

[c] $p < .001$