DOI: 10.1111/j.1475-6773.2008.00918.x
RESEARCH ARTICLE

Relationship of Safety Climate and Safety Performance in Hospitals

Sara Singer, Shoutzu Lin, Alyson Falwell, David Gaba, and Laurence Baker

Objective. To examine the relationship between measures of hospital safety climate and hospital performance on selected Patient Safety Indicators (PSIs).
Data Sources. Primary data from a 2004 survey of hospital personnel. Secondary data from the 2005 Medicare Provider Analysis and Review File and 2004 American Hospital Association's Annual Survey of Hospitals.
Study Design. A cross-sectional study of 91 hospitals.
Data Collection. Negative binomial regressions used an unweighted, risk-adjusted PSI composite as dependent variable and safety climate scores and controls as independent variables. Some specifications included interpersonal, work unit, and organizational safety climate dimensions. Others included separate measures for senior managers and frontline personnel's safety climate perceptions.
Principal Findings. Hospitals with better safety climate overall had lower relative incidence of PSIs, as did hospitals with better scores on safety climate dimensions measuring interpersonal beliefs regarding shame and blame. Frontline personnel's perceptions of better safety climate predicted lower risk of experiencing PSIs, but senior manager perceptions did not.
Conclusions. The results link hospital safety climate to indicators of potential safety events. Some aspects of safety climate are more closely related to safety events than others. Perceptions about safety climate among some groups, such as frontline staff, are more closely related than perceptions in other groups.

Key Words. Safety culture, safety climate, safety performance, hospital quality indicators

Despite substantial efforts by many health care organizations, medical errors remain too common and continue to generate significant personal and financial burdens (Institute of Medicine 2006). Researchers who study organizations that face hazardous and turbulent task conditions, yet demonstrate sustained superior safety performance, attribute their achievement in large part to their culture of safety (Roberts 1990; Weick and Sutcliffe 2001). These organizations, often termed high-reliability organizations (HROs), are "systems operating in hazardous conditions that have fewer than their share of adverse events" (Reason 2000) and include aircraft carriers, air traffic control systems, and nuclear power plants. The main distinguishing feature of HROs is their ability to perform demanding activities with low incident rates and an almost complete absence of catastrophic failures over several years. Based on evidence from HROs, policy makers interested in improving health care delivery have called upon health care organizations to strengthen their safety culture to reduce adverse events (Institute of Medicine 2001).

In this study, the safety culture of an organization is viewed as the values shared among organization members about what is important, their beliefs about how things operate in the organization, and the interaction of these with work unit and organizational structures and systems, which together produce behavioral norms in the organization that promote safety. Although this definition is similar to definitions of organizational culture more generally (Schein 1992), it is specific to the safety culture of an organization and highlights the role of interpersonal, work unit, and organizational contributions in forming shared basic assumptions that individuals working in organizations develop over time. Like others, we adopt the view that culture is difficult to measure, and that it is more feasible to track a related construct called safety climate (Zohar 1980; Griffin and Neal 2000), the perceptions and attitudes of the organization's workforce about surface features of the culture of safety in hospitals at a given point in time (Flin 2007).

While most presume that better safety climate in hospitals will be associated with fewer errors and better outcomes, quantitative evidence establishing this link is limited. Anticipated benefits would stem from the ability of organizations with strong safety climates to cultivate behaviors that enhance collective learning by addressing unproductive beliefs and attitudes about errors, their cause and cure. Obtaining better information about the relationship between hospital safety climate and safety performance would be beneficial. By highlighting the importance of safety climate, such information would facilitate the development of benchmarks and initiatives to improve it. Further recognition of safety climate's importance would promote collabora-

Address correspondence to Sara Singer, M.B.A., Ph.D., Department of Health Policy and Management, Harvard School of Public Health, Kresge 3-336, Boston, MA 02115; e-mail: ssinger@hsph.harvard.edu. Shoutzu Lin and Alyson Falwell are with the Center for Health Policy/Center for Primary Care and Outcomes Research, Stanford University, Stanford, CA. David Gaba, M.D., is with the Patient Safety Culture Institute, VA Palo Alto Health Care System, Palo Alto, CA. Laurence Baker, Ph.D., is with the Department of Health Research and Policy, Stanford University, Stanford, CA.

tion within and among organizations to compare the measures of safety climate and share useful approaches. Such information would also help hospital managers and clinicians target approaches to safety improvement of greatest potential value.

In this study, we examined the relationship between hospital safety climate and measures of hospital performance on selected indicators of patient safety. We combined data from a survey that measured safety climate among personnel in a national sample of hospitals, with indicators of potential safety events from the Agency for Healthcare Research and Quality's Patient Safety Indicators (AHRQ PSIs).

BACKGROUND

Hospitals with strong safety climates prioritize safety and integrate it into the daily functioning of the organization and the routines of individuals and teams that work within it. They also empower workers and provide psychological safety (i.e., comfort to take interpersonal risks), which enables personnel to prevent, solve, and learn collectively from problems that occur at the frontlines of care delivery (Edmondson 1999).

A number of surveys produce quantitative measures of hospital safety climate (see Singla et al. 2006). Differences in measurement approaches reflect divergent opinions regarding open questions. One question concerns the level of aggregation at which climate should be measured (Gaba, Singer, and Rosen 2007). In this study, we focus on institution-level measures. Assessing the overall level of climate of an organization is valuable, because many kinds of outcomes, especially those assessable using administrative data, result from patient care in multiple work units. We also study some measures for individuals in specific job types on an organization-wide basis, capturing all individuals in a hospital in the same job category.

Another measurement question concerns the components of climate. Our survey instrument identifies three groups of dimensions that include important components of an overall climate of safety. First, some aspects of safety climate reflect features of an entire organization, such as the allocation of organizational resources and engagement of organizations' senior managers. Second, dimensions reveal normative features of work units, including norms of socially acceptable behavior and use of patient safety standards in unit operations. Finally, dimensions reflect interpersonal dynamics among individuals who work in the unit, such as their willingness to take interpersonal risks for the sake of safety.

Ultimately, safety climate in a hospital is determined by the internalized values and beliefs of hospital personnel, which evidence themselves in their behaviors. Daily activities and experiences at work heavily influence workers through acculturation. Peers and managers in a work unit and within a professional discipline in a unit strongly influence individual attitudes and behaviors toward safety and establish an identifiable climate of work processes. The hospital represents an aggregation of the interacting subcultures of its work units. Senior executives, and the decisions and resources they control, strongly influence the safety climate that individuals and work units express. The instrument used in this paper explicitly assesses factors that reflect contributions by all three levels.

Prior Research Regarding the Relationship of Safety Climate and Safety Performance

Prior research has demonstrated a link between organizational culture or climate and organizational outcomes, including financial (Kotter and Heskett 1992), quality (Carman et al. 1996), and safety (Clarke et al. 2002; Brewer 2006; Stone and Gershon 2006) performance. Evidence more closely related to safety climate has come from case studies of HROs, which have attributed their safety records to strong safety culture, and from accident investigations, which have identified the absence of important aspects of safety culture as a major cause (see, e.g., Vaughan 1996). In addition, relationships between safety performance and many of the specific dimensions typically considered part of safety culture also have been suggested on theoretical grounds (see Appendix SA2).

Work from other industries has linked rates of injuries and accidents with safety climate and related dimensions (Clarke 2006). Within health care, four studies (Katz-Navon, Naveh, and Stern 2005; Hofmann and Mark 2006; Neal and Griffin 2006; Vogus and Sutcliffe 2007) report a link between numbers of medication errors and other outcomes with measures of selected safety behaviors and contextual factors in hospital units. In addition, one study found that better safety climate corresponded to lower rates of incident reports for four hospitals (Weingart et al. 2004). However, careful analyses of the link between hospital safety climate and patient safety outcomes at the organizational level of analysis have not been conducted.

Prior studies used measures that assumed safety climate is one-dimensional or captured only selected dimensions. In addition, all but one (Hofmann and Mark 2006) used perceptual measures or self-reported estimates of clinical impact rather than objectively derived measures of clinical quality. These indicators may be poorly associated with actual error rates and may be less sensitive than tracking based on medical records (Edmondson 1999; Thomas and Petersen 2003). In contrast, the AHRQ PSIs are less subject to bias and provide more reliable estimates of rates of potential preventable adverse events (Thomas, Sexton, and Helmreich 2003; Rivard, Rosen, and Carroll 2006).

Hypotheses

Building on literature about HROs, our central hypothesis presumes that safety climate achieves its greatest impact when personnel are strongly inclined toward doing what is required to provide safe care, even at the expense of production and efficiency. Evidence from HROs suggests that to achieve high reliability, nearly everyone in an organization must espouse safety principles and enact appropriate behaviors almost all the time (Roberts 1990).

> $\mathbf{H}_1$: Higher levels of hospital safety climate will relate to lower rates of hospital PSIs.

In addition, we expect that the relationship between safety climate and organizational-level safety performance will vary by dimension. Specifically, we expect that dimensions of safety climate representing interpersonal components, i.e., individuals' own beliefs about safety derived through ongoing interpersonal interactions and their perceptions about what drives their own behavior, will more powerfully relate to organizational safety performance than will individuals' perceptions of the safety climate in their work units and institution overall.

> $\mathbf{H}_2$: Safety climate scores on dimensions reflecting the contribution of interpersonal beliefs to safety climate will be more strongly associated with PSIs than will be safety climate scores on dimensions that reflect beliefs about work units or hospitals.

The relationship of safety climate with indicators of safety performance may vary among groups of personnel depending on the extent to which personnel are directly exposed to hazards experienced at the frontlines. Research comparing perceptions of hospital safety climate by management level suggests that senior managers consistently perceive safety climate more positively than frontline workers across multiple dimensions of safety climate (Singer et al. 2008). Given their less frequent exposure to the frontline work context, senior managers may be less knowledgeable about safety than frontline workers whose actions directly impact patients. This suggests that measures of safety climate based on perceptions of frontline personnel may be more predictive of outcomes than those derived from more senior personnel.

H_3: Safety climate scores among frontline personnel will be more strongly associated with PSIs than will be senior managers' scores.

Failure of results to support this hypothesis would suggest instead that different standpoints relative to power and status (Hartsock 1983; Harding 1991), rather than different knowledge about health care delivery, may shape different perceptions among senior managers and frontline personnel.

METHODS

Data Sources

Data on hospital safety climate were derived from a survey of personnel from a nationwide sample of 105 acute-care hospitals administered March 2004–May 2005. The Patient Safety Climate in Healthcare Organizations (PSCHO) survey measures climate at the level of the hospital overall, and has been used in a number of previous studies (Singer 2003; Ginsburg et al. 2005; Murphy 2006; Cooper et al. 2008; Singer et al. 2008, forthcoming) (see Appendix SA3). The survey included 38 questions about safety climate topics considered important in HROs, plus six demographic questions. Item response options used a five-point Likert scale, with response categories ranging from strongly agree to strongly disagree. In order to increase the consistency and comparability of respondents' answers, the survey provided a definition of "patient safety" and a statement alerting subjects that survey items would relate to patient safety in either their unit or facility. Surveys were sent via interoffice mail to 100 percent of hospitals' active, hospital-based physicians, 100 percent of senior managers (defined as department head or above), and a 10 percent random sample of all other employees. Surveys were distributed up to three times in waves spaced approximately 6 weeks apart and returned in U.S. postage prepaid reply envelopes. Surveys were processed in ways that would ensure respondent anonymity. Raw data were weighted multiplicatively to account for the differences in sampling by job type and to adjust for known differences in response rates from individuals of different job types.

The Medicare Provider Analysis and Review (MEDPAR) File from 2005 provided data for the PSIs used in the study. The MEDPAR File contains uniform data from claims for services provided to all Medicare beneficiaries enrolled or entitled in a given year, who are admitted to Medicare-certified inpatient hospitals. Having been collected in the year following administration of the PSCHO survey, these data allow for predictive modeling, such that our climate measures predicted outcomes later in time.

The 2004 American Hospital Association's (AHA) Annual Survey of Hospitals provided data on organizational characteristics.

Sample

Of the 105 hospitals that participated in the 2004 PSCHO survey, 92 were from a stratified random sample representing the four regions of the United States and three size categories. Of these 92 hospitals, PSI data were available for all but one hospital, generating a usable sample of 91 hospitals from 37 states. A comparison of mean rates of PSIs for sample hospitals compared with all U.S. hospitals showed no statistically significant difference on average (see Table 1). However, because we recruited equal proportions of small, medium, and large hospitals, the average bed-size of sample hospitals was larger than the U.S. average, and this difference is reflected in relatively more nonprofit and teaching hospitals in our sample. Also, hospitals from the West are disproportionately represented in the sample relative to other regions.

Measures

Independent Variables. For each of the 38 items in the PSCHO survey, responses of disagree/strongly disagree were considered "problematic" with respect to safety climate for positively worded items such as "Senior management provides a climate that promotes patient safety" and agree/strongly agree responses were problematic for negatively worded items such as "Asking for help is a sign of incompetence." The percent problematic response (PPR) is considered an inverse indicator of safety climate, i.e., a high PPR suggests a poor climate of safety and vice versa. Use of PPR reflects the belief that to achieve high reliability requires not just strongly positive but also highly uniform safety climate (Roberts 1990).

Table 1: Descriptive Statistics

	Sample Hospitals			All Randomly Selected Patient Safety Consortium Hospitals			
Independent Variables	*N*	*Mean % Problematic Response*	*Standard Deviation*	*N*	*Mean % Problematic Response*	*Standard Deviation*	*p Value for t-Test*
Safety climate overall	91	17.62	2.97	92	17.65	2.96	.9591
Senior managers' engagement	91	12.22	4.22	92	12.21	4.20	.9860
Organizational resources	91	24.60	6.72	92	24.68	6.72	.9371
Overall emphasis on patient safety	91	11.04	4.94	92	11.08	4.93	.9536
Unit safety norms	91	9.86	3.16	92	9.92	3.19	.9016
Unit support and recognition for safety efforts	91	30.28	6.82	92	30.20	6.82	.9369
Fear of blame	91	31.30	6.86	92	31.41	6.90	.9152
Fear of shame	91	11.56	1.50	92	11.56	1.49	.9787

	Sample Hospitals			All U.S. Hospitals Excluding VA and Children's Hospitals			
Dependent Variables	*N*	*Rate/100,000 Discharges*	*Standard Deviation*	*N*	*Rate/100,000 Discharges*	*Standard Deviation*	*p Value for t-Test*
Mean of 12 PSIs	91	527.97	303.18	4,553	479.91	438.98	.1417
Complication of anesthesia	86	11.05	38.31	4,014	17.78	108.78	.1351
Decubitus ulcer	90	2161.6	1258.79	4,498	2093.76	1851.02	.6178
Iatrogenic pneumothorax	91	51.39	64.17	4,552	43.15	112.69	.2370
Infection due to medical care	91	163.47	161.08	4,551	151.68	476.34	.5209
Postoperative hip fracture	86	29.3	74.43	3,972	32.94	192.53	.6722
Postoperative hemorrhage or hematoma	86	299.44	742.63	4,012	194.94	457.01	.1972
Postoperative physio-metabolic derangement	81	24.84	48.33	3,543	20.85	87.18	.4755
Postoperative respiratory failure	81	828.05	738.92	3,525	719.94	1162.31	.2035
Postoperative PE or DVT	86	913.59	690.7	4,012	757.59	1019.41	.0434
Postoperative sepsis	77	1190.34	1454.2	3,231	1246.1	2218.83	.7441
Postoperative wound dehiscence	86	359.88	1175.48	3,718	257.63	1014.42	.4260
Accidental puncture/laceration	91	426.85	332.52	4,552	348.59	557.46	.0313

	Sample Hospitals			All U.S. Hospitals Excluding VA and Children's Hospitals			
Control Variables	*N*	*Mean*	*Standard Deviation*	*N*	*Mean*	*Standard Deviation*	*p Value for t-Test or* χ^2
Hospital bed size	91	256.80	215.47	4,559	166.17	181.39	.0001
Registered nurse hours per patient day	91	11.24	4.94	4,559	18.16	257.07	.0719

	N	*Frequency*	*%*	*N*	*Frequency*	*%*	
Tax status	91			4,559			.0056
For-profit		4	4.40		678	14.87	
Government		19	20.88		1,137	24.94	
Non-for-profit		68	74.73		2,744	60.19	
Teaching status							
Major teaching	91	14	15.38	4,559	280	6.14	.0008
Other teaching		14	15.38		566	12.42	
Nonteaching		63	69.23		3,713	81.44	
Region	91			4,559			<.0001
Midwest		15	16.48		1,353	29.68	
Northeast		23	25.27		607	13.31	
South		25	27.47		1,733	38.01	
West		28	30.77		866	19.00	

PSI, Patient Safety Indicator.

The 38 items that comprise the PSCHO climate measures were grouped to form subscales measuring different dimensions of safety climate. These dimensions were determined through exploratory factor analysis (Tabachnick and Fidell 1983) and multitrait analysis (Campbell and Fiske 1959) and with consideration of theoretical links between items and constructs. This analysis, described elsewhere (Singer et al. 2007), supported the construction of eight valid and reliable subscales, with internal consistency near or above acceptable levels (Hargraves, Hays, and Cleary 2003). Of the eight constructs, three measured organizational factors, two examined normative work unit factors, and two assessed interpersonal factors (see Table 2). The remaining factor was a self-reported outcome measure and was excluded from our analyses.

To assess the extent to which staff assessments of safety climate may be regarded as hospital-level characteristics, we used one-way analysis of variance models to assess within-group versus between-group variance for safety climate overall and for each dimension. Intraclass correlation

Table 2: Patient Safety Climate in Health Care Organizations Survey Dimensions

Label	*Number of Items*	*Cronbach's α*	*Sample Item*
Organizational dimensions			
Senior managers' engagement	7	0.89	Senior management has a clear picture of the risk associated with patient care.*
Organizational resources	3	0.67	I am provided with adequate resources (personnel, budget, and equipment) to provide safe patient care.*
Overall emphasis on patient safety	3	0.65	Overall, the level of patient safety at this facility is improving.*
Work unit dimensions			
Unit safety norms	7	0.82	In my unit, disregarding policy and procedures is rare.*
Unit support and recognition for safety efforts	4	0.74	I am rewarded for taking quick action to identify a serious mistake.*
Interpersonal dimensions			
Fear of blame	2	0.61	If people find out that I made a mistake, I will be disciplined.†
Fear of shame	5	0.58	Asking for help is a sign of incompetence.†

*Positively worded item; a response of "disagree/strongly disagree" is problematic.

†Negatively worded item; a response of "agree/strongly agree" is problematic.

coefficients evaluated at the hospital level based on an average of 192 respondents per hospital of 0.004–0.038 were all statistically significant. Corresponding inter-hospital reliabilities ranged from 0.69 to 0.88, with one exception (0.45 for fear of shame). These results suggest that grouping individually reported data according to organization leads to significant similarity between the results of individuals in the hospital, supporting aggregation to the hospital level. However, reliability of the hospital contribution to the fear of shame variable is markedly lower than the other variables.

We thus constructed measures of PPR for each safety climate dimension at the hospital level. We also calculated hospital safety climate "overall" as the average PPR for all 38 questions in the survey. For each measure, PPR was computed as the average of all responses for an institution, with each question weighted equally, and then separately for senior managers (those who indicated they were department heads or above) and frontline workers (individuals who indicated they were neither senior managers nor supervisors).

Dependent Variables. Analysis focused on a composite of 12 unweighted, risk-adjusted, hospital-level PSIs (see technical Appendix SA4 for additional information). This measure captured the total number of events in 2005 across the 12 included PSIs. The complete set of PSIs contains 20 indicators that use discharge abstracts to highlight potential safety concerns that may require further study. They include measures of potentially preventable inpatient complications and adverse events following surgeries and procedures. Of the 20 PSIs, our composite included 12 recommended by the AHRQ Quality Indicators Support Team for inclusion in a composite measure (PSI Composite Measure Workgroup 2006). We also performed analyses using a composite based on 11 PSIs excluding complications of anesthesia, because this indicator was recently removed from the recommended set based on unstable results (PSI Composite Measure Workgroup 2008). These analyses supported results presented.

Control Variables. We considered as covariates selected hospital characteristics expected to relate to the strength of safety climate, PSIs, or both. These included the number of hospital beds and its square, teaching status, tax status, region, location within an urban center, and nurse staffing ratios.

Statistical Analysis

As the PSI measures are counts of events per year, we addressed our study hypotheses by estimating relationships between hospital-level PSIs and safety climate measures using negative binomial regression models in which the risk-adjusted PSI composite was the dependent variable and measures of climate and controls were the independent variables. In some specifications, we extended this model to include measures of climate representing one of the three aspects: organizational, work unit, or interpersonal dimensions. In other specifications, we also extended the model to include separate measures for senior managers and frontline personnel's perceptions of safety climate dimensions. To determine the best set of independent variables to use in each model, we applied backward stepwise regression, eliminating any nonsignificant control variables. We report results in terms of incidence rate ratios (IRRs).

RESULTS

Of 35,006 individuals surveyed in 91 hospitals, 18,223 responded (52 percent). Consistent with other clinician surveys, physician response (29 percent) was lower than responses among senior managers (76 percent) and other personnel (66 percent) (Asch, Jedrziewski, and Christakis 1997; Jepson et al. 2005).

The results support Hypothesis 1, which predicted that higher levels of safety climate (i.e., lower PPR) would be associated with higher safety performance (i.e., lower relative incidence of PSIs) (see Table 3). The rate ratio at which PSIs were observed was 1.034 ($p < .05$), indicating that a 1 percent higher PPR overall was associated with a 3.4 percent relative increase in the risk of experiencing one of the PSIs included in the composite.

Regression models also supported Hypothesis 2. In contrast to the organizational and work unit dimensions tested, hospitals in which personnel reported more problems with fear of shame (IRR = 1.050, $p < .05$) and fear of blame (IRR = 1.013, $p < .05$) had significantly greater risk of experiencing PSIs. None of the organizational or work unit dimensions significantly predicted the PSIs.

Hypothesis 3 was also generally supported by the results (Table 4). Perceptions of higher safety climate overall among frontline personnel were associated with a relative increase in the risk of experiencing PSIs (IRR = 1.029, $p < .05$), but safety climate perceptions overall among senior managers were not. In addition, frontline personnel's perceptions of greater fear of shame were associated with greater risk of experiencing PSIs (IRR = 1.048, $p < .05$).

Table 3: Relationship of Patient Safety Indicators to Safety Climate, Overall and by Dimension

	12-PSI Composite			
Safety climate overall	1.034**			
	(0.018)			
Senior manager engagement		0.997		
		(0.018)		
Organizational resources		1.011		
		(0.009)		
Overall safety emphasis		1.015		
		(0.016)		
Unit norms			1.001	
			(0.015)	
Unit recognition and support			1.001	
			(0.010)	
Fear of shame				1.050**
				(0.023)
Fear of blame				1.013**
				(0.006)
Constant	0.00227***	0.00279***	0.00330***	0.00199***
	(0.001)	(0.000)	(0.001)	(0.001)
Observations	91	91	91	91
Log pseudolikelihood	– 378.4	– 375.5	– 379	– 374.4
Wald's χ^2 (df)	33.97	40.38	36.65	49.79
Prob. $> \chi^2$	0.000	0.000	0.000	0.000
Pseudo-R^2	0.029	0.0364	0.0276	0.0393

Robust standard errors in parentheses.

Dependent variable: risk-adjusted number of PSIs per year.

Independent variables: % responses indicating weak safety climate.

Results derived from negative binomial regressions, which adjust for the PSI population denominator. Models also apply backward stepwise regression, including the following control variables where significant: number of hospital beds and its square, a variable indicating whether the hospital belonged to the Council of Teaching Hospitals, was affiliated with a medical school, or neither; a variable indicating whether the tax status of the hospital was for-profit, nonprofit, or government-owned; a variable indicating the census region in which the hospital is located; a binary variable indicating whether the hospital was located in an urban center or not; and the hospital's ratio of average registered nursing hours per average number of patients per day.

***$p < 0.01$.

**$p < 0.05$.

*$p < 0.1$.

PSI, Patient Safety Indicator.

Frontline personnel's perceptions of higher emphasis on safety were also marginally associated with greater risk of experiencing PSIs (IRR = 1.029, $p < .01$). In contrast, senior manager perceptions of safety climate did not predict rates of PSIs. Where perceptions among senior managers were mar-

Table 4: Relationship of Patient Safety Indicators (PSIs) to Safety Climate by Type of Personnel

	Senior Managers				*Frontline Workers*			
	12-PSI Composite				*12-PSI Composite*			
Safety climate overall	1.010 (0.018)				1.029** (0.014)			
Senior manager engagement		0.995 (0.014)				0.985 (0.013)		
Organizational resources		1.005 (0.005)				1.005 (0.008)		
Overall safety emphasis		1.005 (0.014)				1.029* (0.015)		
Unit norms			1.024 (0.018)				1.002 (0.018)	
Unit recognition and support			0.988* (0.006)				1.000 (0.009)	
Fear of shame				1.017 (0.013)				1.048** (0.021)
Fear of blame				1.003 (0.006)				1.007 (0.005)
Hospital size (number beds)	1.001** (0.001)	1.001** (0.001)	1.001** (0.001)	1.001** (0.001)			1.001** (0.001)	1.001** (0.001)
Number of beds squared	1.000*** (0.000)	1.000** (0.000)	1.000*** (0.000)	1.000*** (0.000)			1.000*** (0.000)	1.000*** (0.000)
Constant	0.00409*** (0.001)	0.00320*** (0.000)	0.00471*** (0.001)	0.00384*** (0.001)	0.00349*** (0.001)	0.00388*** (0.001)	0.00469*** (0.001)	0.00299*** (0.001)
Observations	91	91	91	91	91	91	91	91

Log pseudolikelihood	– 378.7	– 377.7	– 376.8	– 378.1	– 379.1	– 376.5	– 379	– 374.6
Wald's χ^2 (df)	44.2	44.66	64.88	37.98	34.79	49.78	35.71	59.37
Prob $>\chi^2$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pseudo-R^2	0.0284	0.031	0.0331	0.0299	0.0273	0.0341	0.0275	0.0388

Robust standard errors in parentheses.

Dependent variable: risk-adjusted number of PSIs per year.

Independent variables: % responses indicating weak safety climate.

Results derived from negative binomial regressions, which adjust for the PSI population denominator. Models also apply backward stepwise regression, including the following control variables where significant: number of hospital beds and its square, a variable indicating whether the hospital belonged to the Council of Teaching Hospitals, was affiliated with a medical school, or neither; a variable indicating whether the tax status of the hospital was for-profit, nonprofit, or government-owned; a variable indicating the census region in which the hospital is located; a binary variable indicating whether the hospital was located in an urban center or not; and the hospital's ratio of average registered nursing hours per average number of patients per day.

***$p<0.01$.

**$p<0.05$.

*$p<0.1$.

ginally predictive of PSIs, i.e., with regard to unit recognition and support, the risk of experiencing PSIs was decreased when senior managers reported higher PPR (worse safety climate).

To understand safety climate–safety performance patterns underlying these results, we adapted our basic model by using individual PSIs as dependent variables to explore the relationships between our measures of safety climate and individual indicators (see Appendix SA4). This analysis identified substantial inconsistency in the relationships across performance indicators. Patterns suggest that the results were largely driven by a strong and relatively consistent relationship between the measures of better safety climate and lower risk of decubitus ulcer. Risk of failure to rescue, which is not part of the PSI composite measure because of its high frequency relative to the other PSIs, also exhibited a consistent relationship with better safety climate scores. Most PSIs exhibited no consistent relationship with measures of safety climate. However, results were not exclusively driven by decubitus ulcer. For the two safety climate survey dimensions that predicted significantly greater risk of PSIs using our composite measure (i.e., fear of shame and blame), the rate ratio observed was > 1.00 for 14 of the 24 individual PSI comparisons. In contrast, for the dimensions that did not predict greater risk of PSIs using the composite—the five organization and work unit dimensions—the rate ratio was greater than 1.00 for only 20 of the 60 individual PSI comparisons.

DISCUSSION

This study assessed the relationship between hospital safety climate and a group of hospital-level indicators of potential safety events. Results imply that a 1 SD improvement in our aggregate measure of safety climate was associated with 10 percent lower risk of a hospital experiencing a PSI (3.4 percent IRR $\times$ 2.97 SD), and with 19 percent lower risk of experiencing decubitus ulcer. These effects, albeit relatively small, provide the first quantitative evidence of a positive relationship between safety climate and safety performance at the hospital level, providing support to calls for continued effort to improve safety culture in health care organizations as a means toward reducing potential safety events.

Study results suggest that the PSIs were associated with hospital safety climate dimensions representing interpersonal aspects of safety climate. Hospitals with a higher percent of responses indicating the presence of fear of blame and shame had higher risk of experiencing PSIs. Dimensions that measured normative work unit and organizational aspects of safety climate were unrelated to the PSIs. These findings suggest that survey measures of individuals' psychological state may be more directly associated with their safety behaviors and thus PSIs than measures evaluating the context in which they work. If so, then the presence in hospitals of blame rather than acceptance of systems as the root cause of most errors and of shame about seeking help when one has a question, concern, or has made an error suggests interventions that address these deeply ingrained beliefs will be necessary for organizational learning and safety improvement to occur. The more distal organization and work unit factors may still be important, likely serving as enabling conditions or moderators of interpersonal perceptions and individual behaviors rather than being directly related to them.

We also found that better safety climate was associated with lower risk of experiencing PSIs when safety climate was measured as perceptions of frontline personnel but absent when measured as perceptions of senior managers. These findings suggest that executives may not fully appreciate the safety hazards present in their organizations. If so, then senior managers may fail to act in ways that improve the underlying systems that create these hazards (MacDuffie 1997; Auty and Long 1999), many of which require investment or boundary spanning that only senior managers can provide (Tushman 1997; Tucker 2004). The persistent finding of this difference signals a need to intervene in ways that help managers to perceive more accurately the risks and faults occurring at the frontlines of care, so that they can more effectively work with their subordinates to identify, prioritize, and mitigate patient safety concerns.

Results should be viewed with some caution, however, as our analysis of patterns underlying our findings suggests that, although not exclusively, the relationships identified may derive from an apparently strong relationship between better safety climate and lower risk of decubitus ulcer. Decubitus ulcer may bear a greater relationship to staff perceptions of safety climate, because this condition is highly visible to a broad range of personnel. As an indicator of safety performance, however, decubitus ulcer has been criticized because it includes substantial cases present on admission (Bahl et al. 2008). The high frequency of decubitus ulcer relative to other events may be offsetting other relationships in the composite.

Study Limitations

Four important study limitations, inherent in many cross-sectional studies, should be noted. First, because our analysis relied on a stratified random sample, it is not statistically representative of the population of U.S. community hospitals. Sampling bias remains possible, and some caution must be exercised in generalizing our study findings to specific hospital populations.

Second—although we used a predictive design—as a cross-sectional study, it is possible that our results are confounded by omitted variables. While we believe that we controlled for the key potential confounders for which data were available, future research should assess the potential impact of other important factors, such as the structure and extent of hospital safety improvement programs and available technology, which we did not measure. If, for example, the use of information technology is related to safety climate and if its use enhances patient safety, our analysis may have overestimated the relationship of safety climate and safety performance. However, a culture of safety may also be a necessary precondition to successfully implement technological and procedural remedies for patient safety (Edmondson, Bohmer, and Pisano 2001).

Third, inherent in any survey of safety climate is the potential for measurement error. Our methods relied on an organization's workforce to describe safety climate in a valid manner. While ethnographic methods could have provided a more accurate assessment of safety culture, they would have been prohibitively expensive for an effort that sought to include many organizations.

Finally, the criterion validity of the PSIs as "true" measures of safety is currently unknown. Although several studies have shown that the PSIs have good face and construct validity (Quality Indicators-II Support Team 2003), comparisons with clinical data are just beginning. Thus, the sensitivity and reliability of some PSIs may be poor or variable across hospitals. Inconsistencies in our results using individual PSIs attest to this issue. In keeping with others who have used the PSIs for research purposes (Weiner et al. 2006), we have suggested that our dependent variables measure *indicators* of potential patient safety problems, rather than measures of patient safety. We believe the advantages of these discharge abstract-based measures make them attractive relative to other measures of hospital safety performance. The significant effort required to obtain such indirect safety data is a major challenge in the health care sector. In other hazardous settings, such as aviation and military operations, unambiguous data on accidents and major near misses is available. In contrast, no easily obtainable, objective, standardized, or alternative measures of hospital safety performance currently exist (Thomas and Petersen 2003).

Despite these limitations, as the first study to link hospital safety climate to PSIs through a theoretically driven analysis, we believe that it represents an advance over previous studies of the relationship between safety climate and safety performance and that it provides a solid basis for subsequent research. No prior studies have considered the range of dimensions addressed here or the hierarchical nature of dimensions commonly considered part of safety climate. In addition, while others have examined this relationship among organizational units, this study represents the first attempt to link systematically safety climate and its constituent dimensions in hospitals with hospital-level PSIs. Further investigation should explore patterns of individual PSIs with measures of hospital safety climate.

Purchasers and accrediting agencies are demanding greater attention to safety climate as a means of improving patient safety. Despite this shift in attention, we lack evidence about the aspects of safety climate that need most to change and how to change them. The present study suggests that, despite considerable effort by hospitals and patient safety and quality improvement organizations to reduce "blame and shame" and establish "just" and "systems-oriented" organizations (see, e.g., Bagian et al. 2001; O'Connor 2005), deep feelings of fear of punishment and loss of self-esteem on the part of frontline workers remain an issue that stymies attempts to improve patient safety. More research is needed in order to investigate the association between other aspects of safety climate and hospital-level PSIs and also to identify the organizational conditions under which specific dimensions of safety climate affect PSIs.

ACKNOWLEDGMENTS

Joint Acknowledgment/Disclosure Statement: The authors wish to thank Elizabeth Bradley, Anna Sinaiko, Gillian SteelFisher, Tim Vogus, Amy Rosen, and anonymous reviewers from *Health Services Research* journal and the Academy of Management for comments on earlier drafts. Financial support for this research has been provided by the Agency for Healthcare Research and Quality RO1 HSO13920. The first author also acknowledges fellowships provided by the Harvard Business School and the Center for Public Leadership at the Kennedy School of Government.

REFERENCES

Asch, D., M. Jedrziewski, and N. Christakis. 1997. "Response Rates to Mail Surveys Published in Medical Journals." *Journal of Clinical Epidemiology* 50 (10): 1129–36.

Auty, S., and G. Long. 1999. "“Tribal Warfare” and Gaps Affecting Internal Service Quality." *International Journal of Service Industry Management* 10 (1): 7–22.

Bagian, J., C. Lee, J. Gosbee, J. DeRosier, E. Stalhandske, N. Eldridge, R. Williams, and M. Burkhardt. 2001. "Developing and Deploying a Patient Safety Program in a Large Health Care Delivery System: You Can't Fix What You Don't Know About." *Joint Commission Journal on Quality Improvement* 27 (10): 522–32.

Bahl, V., M. Thompson, T. Kau, H. Hu, and D. Campbell. 2008. "Do the AHRQ Patient Safety Indicators Flag Conditions That Are Present at the Time of Hospital Admission?" *Medical Care* 46 (5): 516–22.

Brewer, B. 2006. "Relationships among Teams, Culture, Safety, and Cost Outcomes." *Western Journal of Nursing Research* 28 (6): 641–53.

Campbell, D., and D. Fiske. 1959. "Convergent and Discriminant Validity by the Multitrait–Multimethod Matrix." *Psychological Bulletin* 56: 81–105.

Carman, J. M., S. M. Shortell, R. W. Foster, E. F. X. Hughes, H. Boerstler, J. L. O'Brien, and E. J. O'Conner. 1996. "Keys for Successful Implementation of Total Quality Management in Hospitals." *Health Care Management Review* 21 (1): 48–60.

Clarke, S. 2006. "The Relationship between Safety Climate and Safety Performance: A Meta-Analytic Review." *Journal of Occupational Health Psychology* 11 (4): 315–27.

Clarke, S., J. Rockett, D. Sloane, and L. Aiken. 2002. "Organizational Climate, Staffing, and Safety Equipment as Predictors of Needlestick Injuries and Near-Misses in Hospital Nurses." *American Journal of Infection Control* 30 (4): 207–16.

Cooper, J. B., R. H. Blum, J. S. Carroll, M. Dershwitz, D. M. Feinstein, D. M. Gaba, J. C. Morey, and A. K. Singla. 2008. "Differences in Safety Climate among Hospital Anesthesia Departments and the Effect of a Realistic Simulation-Based Training Program." *Anesthesia and Analgesia* 106 (2): 574–84.

Edmondson, A. C. 1999. "Psychological Safety and Learning Behavior in Work Teams." *Administrative Science Quarterly* 44 (2): 350–83.

Edmondson, A. C., R. M. Bohmer, and G. P. Pisano. 2001. "Disrupted Routines: Team Learning and New Technology Implementation in Hospitals." *Administrative Science Quarterly* 46 (4): 685–716.

Flin, R. 2007. "Measuring Safety Culture in Healthcare: A Case for Accurate Diagnosis." *Safety Science* 45: 653–67.

Gaba, D., S. Singer, and A. Rosen. 2007. "Safety Culture: Is the 'Unit' the Right 'Unit of Analysis'?" *Critical Care Medicine* 35 (1): 314–16.

Ginsburg, L., P. G. Norton, A. Casebeer, and S. Lewis. 2005. "An Educational Intervention to Enhance Nurse Leaders' Perceptions of Patient Safety Culture." *Health Services Research* 40 (4): 997–1020.

Griffin, M. A., and A. Neal. 2000. "Perceptions of Safety at Work: A Framework for Linking Safety Climate to Safety Performance, Knowledge, and Motivation." *Journal of Occupational Health Psychology* 5 (3): 347–58.

Harding, S. 1991. *Whose Science? Whose Knowledge? Thinking from Women's Lives.* Ithaca, NY: Cornell University Press.

Hargraves, J. L., R. D. Hays, and P. D. Cleary. 2003. "Psychometric Properties of the Consumer Assessment of Health Plans Study (CAHPS) 2.0 Adult Core Survey." *Health Services Research* 38 (6): 1509–27.

Hartsock, N. 1983. "The Feminist Standpoint: Developing the Ground for a Specifically Feminist Historical Materialism." In *Discovering Reality: Feminist Perspectives on Epistemology, Metaphysics, Methodology, and Philosophy of Science*, edited by S. Harding and M. Hintikka, pp. 283–310. Boston: D. Reidel.

Hofmann, D. A., and B. Mark. 2006. "An Investigation of the Relationship between Safety Climate and Medication Errors as Well as Other Nurse and Patient Outcomes." *Personnel Psychology* 59 (4): 847–69.

Institute of Medicine. 2001. *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC: National Academy Press.

———. 2006. *Preventing Medication Errors*. Washington, DC: The National Academies Press.

Jepson, C., D. Asch, J. Hershey, and P. Ubel. 2005. "In a Mailed Physician Survey, Questionnaire Length Had a Threshold Effect on Response Rate." *Journal of Clinical Epidemiology* 58 (1): 103–5.

Katz-Navon, T., E. Naveh, and Z. Stern. 2005. "Safety Climate in Healthcare Organizations: A Multidimensional Approach." *Academy of Management Journal* 48 (6): 1075–89.

Kotter, J. P., and J. L. Heskett. 1992. *Corporate Culture and Performance*. New York: Free Press.

MacDuffie, J. P. 1997. "The Road to 'Root Cause': Shop-Floor Problem-Solving at Three Auto Assembly Plants." *Management Science* 43 (4): 479–502.

Murphy, T. 2006. "CCHSA Client/Patient Safety Culture Assessment Project: Lessons Learned." *Healthcare Quarterly* 9 (2): 52–4.

Neal, A., and M. Griffin. 2006. "A Study of the Lagged Relationships among Safety Climate, Safety Motivation, Safety Behavior, and Accidents at the Individual and Group Levels." *Journal of Applied Psychology* 91 (4): 946–53.

O'Connor, P. 2005. "Safer Patients Initiative—Transforming Safety Culture for Lasting Safety Improvement" [accessed on December 22, 2006, 2005]. Available at http://www.saferhealthcare.org.uk/IHI/Topics/SafetyCulture/CaseStudies/saferpatientsinitiative.html

PSI Composite Measure Workgroup. 2006. *AHRQ Quality Indicators Patient Safety Indicator Composite Measure: Draft Technical Report*. Rockville, MD: Agency for Healthcare Research and Quality.

———. 2008. *AHRQ Quality Indicators Patient Safety Indicator Composite Measure: Workgroup Final Report*. Rockville, MD: Agency for Healthcare Research and Quality.

Quality Indicators-II Support Team. 2003. *AHRQ Quality Indicators Guide to Patient Safety Indicators Version 3.1 (March 12, 2007)*. Rockville, MD: Agency for Healthcare Research and Quality.

Reason, J. 2000. "Human Error: Models and Management." *British Medical Journal* 320 (7237): 768–70.

Rivard, P. E., A. K. Rosen, and J. S. Carroll. 2006. "Enhancing Patient Safety through Organizational Learning: Are Patient Safety Indicators a Step in the Right Direction?" *Health Services Research* 41 (4, part 2): 1633–53.

Roberts, K. H. 1990. "Some Characteristics of One Type of High Reliability Organization." *Organization Science* 1 (2): 160–77.

Schein, E. H. 1992. *Organizational Culture and Leadership.* San Francisco: Jossey-Bass.
Singer, S., A. Falwell, D. Gaba, and L. Baker. 2008. "Hospital Patient Safety Climate: Variation by Management Level." *Medical Care* 46 (11): 1149–56.
Singer, S., D. Gaba, A. Falwell, S. Lin, J. Hayes, and L. C. Baker. "Patient Safety Climate in 92 US Hospitals: Differences by Work Area and Discipline." *Medical Care*, forthcoming.
Singer, S. J., D. M. Gaba, J. J. Geppert, A. D. Sinalko, S. K. Howard, and K. C. Park. 2003. "The Culture of Safety in California Hospitals." *Quality and Safety in Health Care* 12 (2): 112–18.
Singer, S., M. Meterko, L. Baker, D. Gaba, A. Falwell, and A. Rosen. 2007. "Workforce Perceptions of Hospital Safety Culture: Development and Validation of the Patient Safety Climate in Healthcare Organizations Survey." *Health Services Research* 42 (5): 1999–2021.
Singla, A. K., B. T. Kitch, J. S. Weissman, and E. G. Campbell. 2006. "Assessing Patient Safety Culture: A Review and Synthesis of the Measurement Tools." *Journal of Patient Safety* 2 (3): 105–15.
Stone, P., and R. Gershon. 2006. "Nurse Work Environments and Occupational Safety in Intensive Care Units." *Policy, Politics and Nursing Practice* 7 (4): 240–7.
Tabachnick, B., and L. Fidell. 1983. *Using Multivariate Statistics.* New York: Harper & Row.
Thomas, E., J. Sexton, and R. Helmreich. 2003. "Discrepant Attitudes about Team-Work among Critical Care Nurses and Physicians." *Critical Care Medicine* 31 (3): 956–9.
Thomas, E. J., and L. A. Petersen. 2003. "Measuring Errors and Adverse Events in Health Care." *Journal of General Internal Medicine* 18 (1): 61–7.
Tucker, A. L. 2004. "The Impact of Operational Failures on Hospital Nurses and Their Patients." *Journal of Operations Management* 22 (2): 151–67.
Tushman, M. L. 1997. "Winning through Innovation." *Strategy and Leadership* 25 (4): 14–19.
Vaughan, D. 1996. *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA.* Chicago: University of Chicago Press.
Vogus, T. J., and K. M. Sutcliffe. 2007. "The Impact of Safety Organizing, Trusted Leadership, and Care Pathways on Reported Medication Errors in Hospital Nursing Units." *Medical Care* 45 (10): 997–1002.
Weick, K. E., and K. M. Sutcliffe. 2001. *Managing the Unexpected: Assuring High Performance in an Age of Complexity.* San Francisco: Jossey-Bass.
Weiner, B., J. Alexander, L. Baker, S. Shortell, and M. Becker. 2006. "Quality Improvement Implementation and Hospital Performance on Patient Safety Indicators." *Medical Care Research and Review* 63 (1): 29–57.
Weingart, S., K. Farbstein, R. Davis, and R. Phillips. 2004. "Using a Multihospital Survey to Examine the Safety Culture." *Joint Commission Journal on Quality and Safety* 30 (3): 125–32.
Zohar, D. 1980. "Safety Climate in Industrial Organizations: Theoretical and Applied Implications." *Journal of Applied Psychology* 65 (1): 96–102.

Supporting Information

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Appendix SA2: Theoretical Support for the Relationship between Safety Climate and Safety Performance by Dimension.

Appendix SA3: Patient Safety Climate in Healthcare Organizations Survey.

Appendix SA4: Relationship of Safety Climate and Safety Performance in Hospitals.

Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting materials supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article.