The Impact of Safety Organizing, Trusted Leadership, and Care Pathways on Reported Medication Errors in Hospital Nursing Units

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Context: Prior research has found that safety organizing behaviors of registered nurses (RNs) positively impact patient safety. However, little research exists on the joint benefits of safety organizing and other contextual factors that help foster safety.

Objectives: Although we know that organizational practices often have more powerful effects when combined with other mutually reinforcing practices, little research exists on the joint benefits of safety organizing and other contextual factors believed to foster safety. Specifically, we examined the benefits of bundling safety organizing with leadership (trust in manager) and design (use of care pathways) factors on reported medication errors.

Subjects: A total of 1033 RNs and 78 nurse managers in 78 emergency, internal medicine, intensive care, and surgery nursing units in 10 acute-care hospitals in Indiana, Iowa, Maryland, Michigan, and Ohio who completed questionnaires between December 2003 and June 2004.

Research Design: Cross-sectional analysis of medication errors reported to the hospital incident reporting system for the 6 months after the administration of the survey linked to survey data on safety organizing, trust in manager, use of care pathways, and RN characteristics and staffing.

Results: Multilevel Poisson regression analyses indicated that the benefits of safety organizing on reported medication errors were amplified when paired with high levels of trust in manager or the use of care pathways.

Conclusions: Safety organizing plays a key role in improving patient safety on hospital nursing units especially when bundled with other organizational components of a safety supportive system.

Key Words: high reliability, patient safety, reported medication errors, safety culture, safety organizing

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In the effort to make health care delivery safer, researchers and practitioners have turned to research on high reliability organizations (HROs) that operate under trying conditions in a nearly error-free manner.[1,2] This research suggests that HROs achieve their exceptional performance through ongoing processes of safety organizing—collecting, analyzing, and disseminating information from errors as well as proactive checks on the organization's vital signs.[3–7] Recent research in hospital nursing units supports this proposition and finds that safety organizing positively influences patient safety.[7] However, HROs' effectiveness also derives from their leaders[5] and their clear and comprehensive standardized protocols.[1,2,8] Although research on high performance work systems[9,10] demonstrates that organizational practices often have more powerful effects when combined with other complementary practices, little research exists on the joint benefits of safety organizing and other contextual factors believed to foster safety.

Recent studies do suggest trusted leaders[11,12] and standardized protocols (care pathways)[13,14] create a context likely to bolster the effects of safety organizing on patient safety. When registered nurses (RNs) trust their manager they are more likely to fully engage in the behaviors of safety organizing (eg, discussing errors and ways to learn from them, questioning assumptions and current modes of operating[7]) because they think it is interpersonally safe and efficacious to do so.[12,15,16] A trusted manager amplifies the positive effects of safety organizing by ensuring that these behaviors are supported, such that RNs are able to pursue systemic changes to their everyday work practice to ensure patient safety.

In addition to their positive effects on reliability,[17] care pathways clarify responsibilities and provide a "big picture" of the care process and the individuals comprising it.[14,18] In doing so, they structure interactions[19] and build connections[14,20] among providers, both of which facilitate shared understandings that enable organizational learning[21] and effective care.[14] Care pathways enhance the positive effects of safety organizing because clear responsibilities, interactions, and connections enable RNs to better detect emerging and manifest errors and correct them.[1–4] In sum, we hypothesize that the benefits of safety organizing will be amplified when bundled with trusted leadership and use of care pathways. Consistent with prior work,[7,22] we examined an outcome primarily influenced by RNs (reported medication errors) at the level of the caregiving unit.

Methods

Sample

The units and RNs for this study were drawn from private, nonprofit Catholic hospitals that are members of a large health system in the United States with member hospitals in California, Idaho, Indiana, Iowa, Maryland, Michigan, and Ohio. We conducted our cross-sectional study between December 2003 and June 2004 using a convenience sample of 10 hospitals from this system—3 urban, 4 midsize metropolitan, and 3 rural hospitals. In addition to varying in geographic location, the participating hospitals also varied in size from 89 to 478 acute-care beds. Participants were members of 81 inpatient units including 48 internal medicine units, 13 surgical units, 13 intensive care units, and 7 emergency departments. The number of respondents in each unit ranged from 4 to 32, with an average of approximately 12.

We surveyed all RNs in the participating units by mail and received usable responses to 1033 of 2043 questionnaires sent, for a response rate of 50.6%. Although this rate is consistent with published healthcare studies using a mailed questionnaire,[23] such a response rate may be problematic if it is biased. Therefore, we investigated whether the response rate for a given unit was correlated with safety organizing, reported medication errors, average RN experience, patient-to-RN ratio, or unit size. None of the correlations between response rate and these variables were statistically significant. To further assess potential bias, we conducted a series of *t* tests comparing the unit-level means reported by RN respondents with unit-level data derived from the hospital's human resource information systems to determine whether the RNs that responded to our survey were significantly different from those who did not respond in terms of age, tenure, and level of education. None of these *t* tests revealed significant differences between respondents and nonrespondents. We also surveyed all nurse managers in the participating units and received usable responses to 78 of 81 questionnaires sent, for a response rate of 96.3%.

Measures

We used survey data from the 2 sets of respondents to assess the independent and control variables and data from the hospital risk management system for our dependent variable. Reported medication errors were defined as occurring whenever the right medication was not given to either the right patient, at the right time, in the right dose, or via the right route (eg, intravenous), and were measured using the number of errors reported to a unit's incident reporting system for the 6 months after the collection of the survey data.

We measured safety organizing using the 9-item safety organizing scale.[7] The items in the safety organizing scale were measured using a 7-point Likert scale and are detailed in the Appendix.[7] Trust in manager was measured using 2 survey items (Appendix) assessing the extent to which RNs perceive that their nurse manager treats RNs fairly and acts with integrity. Use of care pathways was measured using nurse managers' responses on a 7-point Likert scale to a single survey item ("The majority of our patients are on care

pathways"), although other approaches are also valid.[14] We then coded the response as 1 if the nurse manager agreed, strongly agreed, or very strongly agreed with the question (ie, a response of 5 or higher) and 0 otherwise.

We included 5 control variables that have been previously demonstrated to be linked to safety and patient outcomes including the percentage of RNs with at least a Bachelor of Science in Nursing (BSN) degree,[24] the average level of nursing experience on each unit,[24] RN staffing (average patients per nurse),[25] unit size (natural logarithm of number of beds), and unit type (4 dummy variables; emergency department, intensive care, internal medicine, and surgery). RN characteristics were measured by RN responses to our questionnaire, RN staffing and unit size were measured using data provided by nurse managers.

Level of Analysis

Our analyses were conducted at the unit level because safety organizing and trust in manager are collective constructs reflecting the shared characterization of ongoing patterns of behavior on a nursing unit and are, therefore, most meaningfully construed at the unit level.[7,22,26–29] For aggregation of individual responses to the unit-level to be statistically appropriate it is necessary to demonstrate within unit agreement. We tested for homogeneity by calculating 3 coefficients within-group interrater reliability ($r_{wg(j)}$),[30] the intraclass correlation (ICC1),[31] and the reliability of the unit mean (ICC2)[31] for both safety organizing and trust in manager. The median values of $r_{wg(j)}$ were 0.98 and 0.80 for safety organizing and trust in manager, respectively. Results for ICC1 and ICC2 for safety organizing were 0.27 and 0.82, and for trust in manager 0.16 and 0.69. These results indicate that individual responses to safety organizing and trust in manager can be aggregated to the unit level.[30,31]

Data Analysis

We modeled reported medication errors using Poisson regression with random effects in STATA 9.2.[32] Poisson regression with random effects accounts for the multilevel nature of our data (units nested within hospitals) and also accounts for the extra-Poisson variation (ie, overdispersion) in reported medication errors.[33,34] Interaction terms in the regression models were centered at the mean to reduce concerns of multicollinearity.[35]

Results

Table 1 summarizes the means, standard deviations, and correlations among the variables at the nursing unit level of analysis. Results of our regression analyses reported in Table 2 demonstrate that the interaction effects between safety organizing and trusted leadership ($\beta = -0.68$, $P < 0.001$) and safety organizing and care pathways ($\beta = -0.82$, $P = 0.001$) had significant, negative relationships with reported medication errors. That is, the benefits of increasing safety organizing are more pronounced when coupled with high levels of trust in one's manager and extensive use of care pathways on a unit. To more clearly illustrate this impact of the interactions on reported medication errors, we plotted the effects of safety organizing at low, mean, and high levels for

TABLE 1. Variable Means, Standard Deviations, and Correlations*

	Mean ± SD	1	2	3	4	5	6	7
Reported medication errors	12.04 ± 11.31							
Safety organizing[†]	5.08 ± 0.35	−0.18	(0.86)					
Trust in manager[†]	4.90 ± 0.75	0.04	0.33[¶]	(0.89)				
Care pathways	0.51 ± 0.50	0.05	0.07	0.11				
Percentage of RNs with BSN	38.42 ± 23.07	−0.18	0.02	−0.07	−0.12			
Tenure on unit	6.53 ± 2.94	0.07	0.09	−0.13	−0.07	−0.12		
Patient-to-RN ratio	4.63 ± 1.93	0.26[§]	−0.30[¶]	0.21[‡]	−0.09	−0.12	−0.28[§]	
Beds	22.72 ± 10.51	0.58[‖]	−0.30[¶]	0.13	−0.05	−0.13	0.02	0.68[‖]

Cronbach's alphas appear in the diagonal of the correlation matrix.
*At the unit level of analysis.
[†]Safety organizing and Trust in manager were measured on a scale from 1 = not at all to 7 = to a very great extent.
[‡]$P < 0.1$.
[§]$P < 0.05$.
[¶]$P < 0.01$.
[‖]$P < 0.001$.

TABLE 2. Multilevel Poisson Regression of Reported Medication Errors

Variable	Reported Medication Errors*	95% CI	Reported Medication Errors*	95% CI
Safety organizing	−0.34[¶] (0.13)	(−0.61, −0.08)	−0.29[¶] (0.14)	(−0.57, −0.01)
Trust in manager	0.20[‖] (0.06)	(0.09, 0.31)	0.19[‖] (0.06)	(0.08, 0.31)
Care pathways	−0.04 (0.08)	(−0.20, 0.11)	−0.12 (0.09)	(−0.29, 0.04)
Interactions				
Safety organizing and Trust			−0.68[‖] (0.18)	(−1.03, −0.32)
Safety organizing and Pathways			−0.82[‖] (0.25)	(−1.31, −0.33)
Control variables				
Percentage of RNs with BSN	−0.21 (0.21)	(−0.62, 0.20)	−0.03 (0.21)	(−0.44, 0.39)
RN experience	0.04[§] (0.02)	(0.01, 0.07)	0.05[§] (0.02)	(0.01, 0.08)
Patient-to-RN ratio	−0.01 (0.04)	(−0.08, 0.06)	−0.04 (0.04)	(−0.11, 0.03)
Unit type[†]				
Emergency department	−0.78[‖] (0.17)	(−1.12, −0.44)	−0.67[‖] (0.17)	(−1.01, −0.33)
Intensive care	0.53[‖] (0.14)	(0.26, 0.81)	0.32[§] (0.15)	(0.03, 0.61)
Surgery	−0.14 (0.15)	(−0.42, 0.15)	−0.13 (0.15)	(−0.42, 0.16)
Beds[‡]	1.12[‖] (0.11)	(0.90, 1.33)	1.13[‖] (0.11)	(0.92, 1.34)
Constant	−0.34 (0.73)	(−1.77, 1.10)	−0.40 (0.78)	(−1.92, 1.13)
Log Likelihood	−337.76		−327.78	
Wald	250.29[‖]		275.93[‖]	
N	78		78	

*Coefficient estimate with standard error in parentheses.
[†]Unit type is a series of dummy variables with internal medicine departments serving as the omitted reference category.
[‡]Natural logarithm of the number of beds on the unit.
[§]$P < 0.05$.
[¶]$P < 0.01$.
[‖]$P < 0.001$.
CI indicates confidence interval.

low, mean, and high levels of trust in manager, where low is 1 standard deviation below the mean and high is 1 standard deviation above the mean (Figure 1).[35] We similarly plotted the effects of safety organizing for minimal (dummy code 0) or extensive (dummy code 1) use of care pathways in Figure 2.[35] In both cases, all other variables in the model were set to their mean level. Figure 1 shows high levels of trust in manager coupled with high levels of safety organizing results in approximately 1 fewer reported medication error per unit than those with lower levels of trust. Figure 2 shows the extensive use of care pathways

and high levels of safety organizing in combination results in approximately 3 fewer reported medication errors per unit than those with less extensive use of pathways.

Discussion

Our results suggest that moving toward safer care is a function of the combination of safety organizing and a well-designed and led caregiving system. Specifically, we found that the extensive use of care pathways in hospital nursing units increased the positive effects of safety organizing. This is consistent with other work demonstrating that standardized
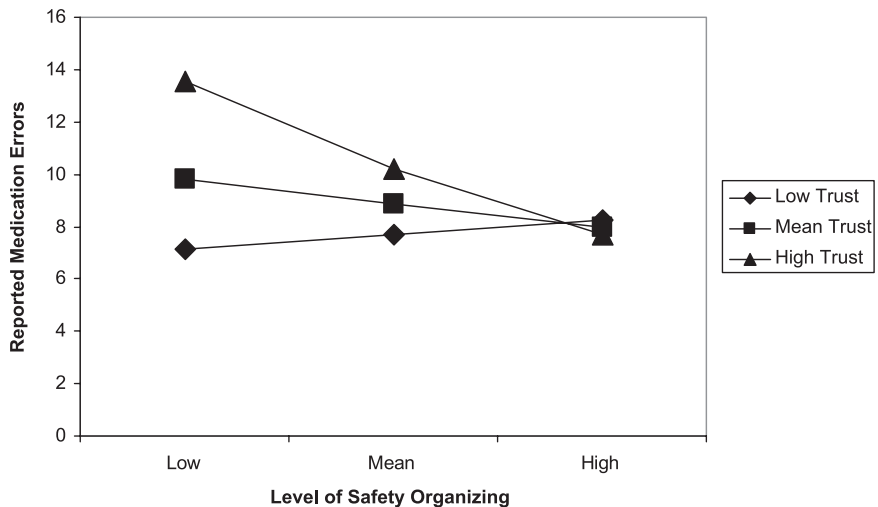
FIGURE 1. Reported medication errors as a function of safety organizing and trust in manager.
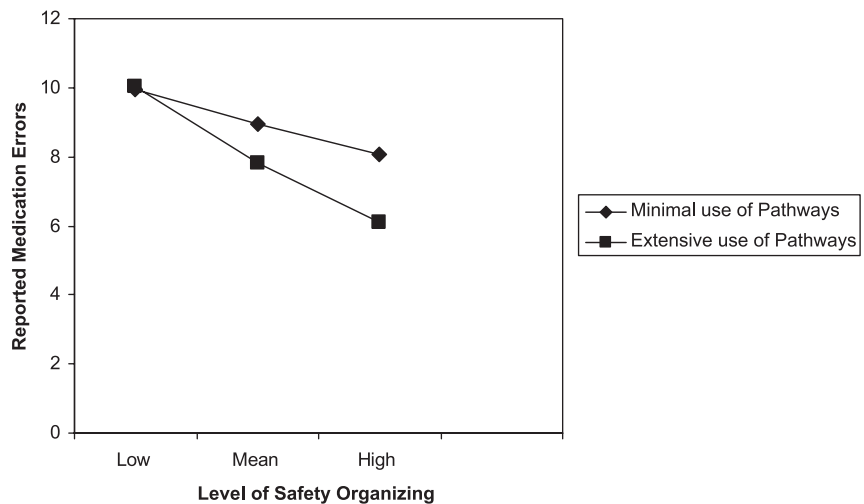

FIGURE 2. Reported medication errors as a function of safety organizing and use of care pathways.

protocols actually enable more effective organizing[18] by creating connections among employees,[20] or otherwise structuring interactions to facilitate coordination.[14] We also found that when RNs highly trust their managers, the benefits of safety organizing were enhanced, but, when trust was low, the benefits were significantly diminished. This finding is important because safety cultures have typically been discussed as relying upon effective and committed hospital-level leadership and interventions.[36–38] Our results indicate, consistent with prior non-health care research on teams,[15] that units within hospitals exhibit considerable variation in safety organizing, trust in leadership, and outcomes. This suggests that in addition to hospital-level programs communicating and reinforcing the importance of safety, unit-level leaders are able to enhance the effects of safety organizing on patient safety by fostering trust and making it safe for their employees to discuss errors and close calls.[12,15,16]

Although it is intuitively appealing, and some studies suggest that a well-developed safety culture[39] should be associated with more reporting of errors, the preponderance of empirical studies show the opposite.[7,22,26,27] We find that high levels of safety organizing coupled with high levels of trust in a unit's manager or extensive use of care pathways are associated with fewer reported medication errors. If reporting more errors is associated with being a high functioning (ie, safe) unit, we would expect reported medication errors to be positively associated with other indicators of safety performance. However, prior research has found that safety climate and safety organizing are negatively associated with RN back injuries[22] and patient falls, respectively.[7] We also find that another indicator of safety performance, nurse managers' assessments of their unit's safety performance (a 2-item survey measure), is also negatively associated with reported medication errors ($P < 0.01$). That is, high numbers of reported medication errors were associated with low ratings of quality of care by nurse managers.

Limitations

The findings of our study should be considered in light of its limitations. First, the research was conducted using a convenience sample of Catholic hospitals with exclusively RN respondents, possibly limiting generaliz-

ability. Second, although recent research has shown reports to be adequate for routine errors with immediate outcomes (eg, medication errors),[40] earlier work found that error reporting systems captured only 5–15% of medication errors.[41,42] Therefore, caution should be used in interpreting our results as indicative of error rates,[43] and subsequent work should validate the findings of this study using other methods (eg, direct observation).[43]

Conclusions

To date researchers have primarily approached the challenge of patient safety by focusing on various technical (eg, information technology) and organizational (leader behaviors or safety culture) factors in isolation. The present study deepens our understanding of patient safety by demonstrating the importance of a mutually reinforcing system of complementary practices.[9,10] That is, when high levels of safety organizing are coupled with trusted leadership and extensive use of care pathways, units experience fewer reported medication errors.

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Appendix

Safety Organizing Scale Items

- We have a good "map" of each other's talents and skills.
- We talk about mistakes and ways to learn from them.
- We discuss our unique skills with each other, so that we know who on the unit has relevant specialized skills and knowledge.
- We discuss alternatives of how to go about our normal work activities.
- When giving report to an oncoming nurse, we usually discuss what to look out for.
- When attempting to resolve a problem, we take advantage of the unique skills of our colleagues.
- We spend time identifying activities we do not want to go wrong.
- When errors happen, we discuss how we could have prevented them.
- When a patient crisis occurs, we rapidly pool our collective expertise to attempt to resolve it.

Trust in Manager Scale Items

- My manager has a reputation for fairness in dealing with nurses.
- My manager demonstrates absolute integrity.

Measure Validation

To test that each survey measure adequately and uniquely captures its underlying construct, we conducted a confirmatory factor analysis (CFA) on the individual level of analysis using AMOS 5.0[44] and evaluate these models using 2 fit indices, Incremental Fit Index (IFI)[45] and the Comparative Fit Index (CFI),[46] and 2 indices of misfit, the Root Mean-Square Error of Approximation (RMSEA) and the Standardized Root Mean Residual (SRMR).[47] Fit index values at or above 0.95 and misfit index values at or below 0.08 indicate acceptable fit.[47] The CFA yielded an acceptable fit level [χ^2(39, N = 1033) = 223.46, $P < 0.001$, IFI = 0.954, CFI = 0.953, RMSEA = 0.072, and SRMR = 0.040] with highly significant factor loadings and all standardized loadings were greater than 0.518.