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Major article

Hospital unit safety climate: Relationship with nurses' adherence to recommended use of facial protective equipment

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Background: Despite the existence of formal guidelines for the acute health care sector, nurses' adherence to recommended use of facial protective equipment (FPE) to prevent occupational transmission of communicable respiratory disease remains suboptimal. In addition to individual factors such as knowledge and education, group factors such as shared perceptions of organizational support for safety may influence adherence. These group safety climate perceptions can differ depending on the pace and type of work, local leadership, and organizational structure of each unit.

Methods: An analysis of a data set from a cross-sectional survey of 1,074 nurses in 45 units of 6 acute care hospitals was conducted. Variance components analysis was performed to examine the variance in perceptions of safety climate and adherence between units. Hierarchical linear modeling using unit-level safety climate dimensions was conducted to determine if unit-level safety climate dimensions were predictors of nurses' adherence to FPE.

Results: Findings revealed statistically significant unit variances in adherence and 5 of the 6 unit-level safety climate dimensions ($P < .05$). Furthermore, a hierarchical model suggested that tenure and unit-level communication were significantly associated with increased adherence to FPE ($P < .05$).

Conclusion: Unit-level safety climate measures varied significantly between units. Strategies to improve unit-level communication regarding safety should assist in improving adherence to FPE.

In recent years, highly infectious diseases such as severe acute respiratory syndrome and influenza A have escalated concern for the well-being of health care workers.[1] This has led to the development of multiple guidelines for the use of facial protective equipment (FPE) as an important strategy to prevent transmission of occupational respiratory disease.[2] Despite the existence of these guidelines, the literature shows adherence to such precautions remains suboptimal. A review of the evidence on compliance of health care practitioners to standard precautions before the 2009 influenza A epidemic found that, on average, adherence to FPE was 30% (range, 4%-55%).[3] More recently, a study of 21 intensive care units in China found that 55% of health care workers complied with the proper use of FPE.[4] Two studies from Canada found 44% of nurses in 6 hospitals[5] and 11% of doctors in 14 hospitals reported they properly adhered to FPE.[6] Such suboptimal adherence rates are of great concern because it is estimated that 1 in 4 health care workers contract a communicable respiratory illness through work.[7] Furthermore, FPE has been cited as the most uncomfortable and problematic of all types of personal protective equipment, and is often more poorly adhered to than other components of standard precautions such as hand washing and glove use.[3,8] Together, these findings highlight the need to develop strategies to improve adherence to FPE, especially among nurses, who represent the largest occupational workgroup in the health sector and have the most patient interactions.[9]

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A review of the literature showed that the majority of interventions to improve adherence focused on individual factors such as education and training; however, many of these studies report no or minimal improvements in adherence.[10] Such findings have raised concerns about the key assumption in the literature that safe work behaviors are predominantly determined by individuals' knowledge and beliefs.[11] In response, a growing body of literature has demonstrated that organizational and psychosocial aspects of the workplace may play a significant role in determining safety behaviors and outcomes,[12,13] and the product of individual and group attitudes, perceptions, and patterns—also described as safety climate—may determine an individual's, team's, or organization's commitment to safety.[14-16]

Using a 6-dimension safety climate scale model, researchers have shown an association between individuals' safety climate perceptions and their compliance with standard precautions in hospitals.[14] Furthermore, studies have identified particular dimensions of safety climate that are most influential in predicting behavior.[8,14] However, these studies did not examine group-level differences within hospitals, such as specific nursing units. In hospitals, "units differ by type of patients, acuity, pace of clinical care activities, workload, as well as by staff composition, local leadership, and organizational structure."[17] These factors create discrete microsystems that develop their own interpretation of the global or hospital organizational climate.[18] As a result, heterogeneity exists between units, and this phenomenon has been recently demonstrated across intensive care units of a single hospital, as well as across different types of units in multiple hospitals.[17,19] Despite such findings, no research has been conducted to examined the effect of unit-level perceptions of safety climate on adherence to FPE. We examined 6 dimensions of unit-level safety climate in 45 hospital units, and their relationship with nurses' self-reported adherence to recommended use of FPE.

METHODS

Setting, subjects, and study design

This study was a secondary analysis of data collected by Nichol et al.[5] The group conducted a cross-sectional study to describe nurses' adherence to recommended use of FPE to prevent occupational transmission of communicable respiratory illness, and to determine specific factors that influence adherence.[5] A total of 1,074 registered nurses and registered practical nurses in 45 distinct units located in 6 different hospitals in Toronto, Canada, completed a questionnaire (response rate 82%).[5] The questionnaire was derived from Moore's framework, which divides factors associated with self-protective behavior at work into 3 categories: organizational, environmental, and individual factors.[20] The questionnaire consisted of 84 items, primarily based on a 5-point Likert response scale that ranged from strongly agree to strongly disagree. Scales to measure organization and environmental factors were tested for reliability using Cronbach's α raw scores, and all had reliability scores of 0.7 and above.[5] Ethics approval for the initial study was obtained from the administering organization, the partner academic institution, and all 6 participating hospitals. Ethics approval for this secondary analysis was obtained from the administering hospital's Research Ethics Board.

This secondary analysis focused on 42 of the 84 items to identify and define demographic variables, safety climate dimensions, and adherence. Safety climate was measured using a combination of 3 environmental and 3 organizational factors. These 6 factors, or dimensions, were based on a revised version of a tool developed by Gershon et al[21] to examine safety climate in health care settings. Scales in the original tool were tested for reliability and all had Cronbach's α scores of 0.7 and above.[21]

Demographic variables

Eight demographic variables were included in this analysis. These included age, education, gender, nurse type (registered nurse or registered practical nurse), supervisory status, tenure as a nurse, tenure on the unit, and work status (full-time or part-time).

Safety climate dimensions

Safety climate was characterized using 6 dimensions: availability of FPE, absence of job hindrances, cleanliness and orderliness of unit, minimal conflict and good communication practices, organizational support for health and safety, and safety-related training and fit testing. Availability of FPE, absence of job hindrances, and cleanliness were measured with 3-item scales. Communication was measured using an 8-item scale, whereas organizational support and training and fit testing used 6-item scales. Examples of items include "my work area is kept clean" (cleanliness) or "there is open communication between supervisors and staff" (communication). For the first 5 dimensions, a participant received a score of 1 for a safety climate dimension if they answered "strongly agree" or "agree" to all items within the scale. For training and fit testing, a score of 1 was given when a participant was fit tested within the past 2 years and answered "strongly agree" or "agree" to 5 out of the 6 items within the scale.

Adherence

Individual adherence was defined as a participant responding always or mostly to at least 7 of the 8 items within the adherence scale.

Statistical analyses

SPSS version 21.0.0.0 software (IBM-SPSS Inc, Armonk, NY) was used to perform descriptive statistics and to aggregate individual perceptions of the 6 safety climate dimensions to the unit level.[22] Before aggregation, the 1,074 participants were sorted according to their unit of work. Individual safety-climate dimension scores were summed, averaged by the number of participants in the unit, and multiplied by 100% to generate a positive percentage score for each unit. To remain consistent with the primary study published, where individuals received a 0 or a 1 for each safety climate dimension,[5] all unit-level safety climate scores were analyzed as dichotomous variables. Due to the low percentage of positive responses observed in this dataset, a cutoff of 50% was chosen instead of the 60% recommended in the literature. Therefore, if a unit had $>$50% of individuals reporting a positively for a safety climate dimension, the unit received a score of 1.

Hierarchical linear modeling was used as participating nurses were nested within units, and units were nested within hospitals.[23] HLM software version 7.01 (Scientific Software International, Skokie, Ill) was used to perform variance component analysis,[24] and R software version 3.1.0 (R Foundation for Statistical Computing, Vienna, Austria) was used to compute bivariate analyses and logistic hierarchical model using individual factors and unit-level safety climate dimensions.[25] A $P < .2$ cutoff was used as the inclusion criterion for a generalized logistic mixed model consisting of 3 levels: individual, unit, and hospital.[23,26] This model was then simplified using backward selection and a cutoff of $P < .2$ to yield a final model that predicted nurses' adherence to FPE.[26]

Table 1
Descriptive statistics

Variable	Mean (range)	n (%)
Individual level (N = 1,074)		
Education		
Diploma		538 (51)
Degree		525 (49)
Nurse type		
Registered nurse		1018 (95)
Registered practical nurse		54 (5)
Sex, female		976 (91)
Supervisor status, yes		502 (47)
Work status, full-time		816 (77)
Age (y)	38.8 (20-67)	
Tenure as nurse (y)	14.4 (0-49)	
Tenure on unit (y)	6.5 (0-36)	
Adherence, yes		456 (44)

Table 2
Unit-level safety climate variables

Unit level (n = 45)	
Safety climate dimension	Number of units (%)
Absence of job hindrances, yes	31 (69)
Availability of facial protective equipment, yes	29 (64)
Cleanliness/orderliness of unit, yes	8 (18)
Communication, yes	4 (9)
Organizational support, yes	7 (16)
Training and fit testing, yes	38 (84)

NOTE. Yes indicates units where ≥50% of individuals reported "yes" for the dimension.

RESULTS

Demographics

Most respondents were female registered nurses working full-time. Individual adherence to FPE was reported at 44% (Table 1). These results are identical to those obtained in the primary study.[5]

Six dimensions of unit-level safety climate

Training and fit testing was the best performing dimension, with 38 of the 45 units reporting positive responses. Communication was the dimension with the lowest score, with only 4 units reporting positive responses (Table 2).

Unit-level variations in safety climate and adherence

Results revealed significant unit-level contributions toward the variance in adherence to FPE, and toward 5 of the 6 safety climate dimensions (Availability of FPE, Cleanliness, Communication, Organizational Support, and Training) (Table 3). The sixth safety climate dimension, Job Hindrances, was not found to be significant ($P = .24$), and was excluded from further analysis.

Relationship between unit-level safety climate dimensions and adherence to FPE

Thirteen variables were examined for their association with an individuals' adherence to FPE. Results revealed 3 individual demographic variables (age, education, and tenure) and 4 unit safety climate variables (availability of FPE, communication, organizational support, and training) that met the inclusion criterion ($P < .2$) for the final model (Table 4).

Table 3
Unit variability in adherence and safety climate dimensions

Variable	SD	Variance component	*df*	χ^2	*P* value
Adherence	0.395	0.156	39	74.91	<.001
Availability of facial protective equipment	0.560	0.314	39	116.32	<.001
Cleanliness/orderliness of unit	0.682	0.465	39	127.28	<.001
Communication	0.504	0.254	39	88.29	<.001
Job hindrances	0.183	0.033	39	44.77	.24
Organizational support	0.402	0.162	39	78.54	<.001
Training and fit testing	0.247	0.061	39	58.06	.025

NOTE. χ^2 tests were used to determine whether nurses' self-reported adherence rates or perceptions of 6 safety climate dimensions varied by their unit of work. $P < .05$ suggests that the unit of work contributes significantly toward the variance in nurses' responses.

Table 4
Bivariate analysis of association between individual and unit-level factors and adherence to facial protective equipment (FPE) use

Variable	*P* value	Odds ratio (95% confidence interval)
Individual level		
Education, degree	.05	0.77 (0.60-1.00)
Nurse type, registered nurse	.67	1.14 (0.62-2.07)
Sex, female	.71	1.09 (0.70-1.70)
Supervisor status, yes	.27	1.15 (0.89-1.49)
Work status, full-time	.93	1.05 (0.32-3.49)
Age (y)	.005	1.02 (1.006-1.03)
Tenure as nurse (y)	.01	1.02 (1.004-1.03)
Tenure on unit (y)	.44	1.01 (0.99-1.03)
Unit level		
Availability of FPE, yes	.14	1.64 (0.76-1.86)
Cleanliness/orderliness of unit, yes	.93	1.02 (0.64-1.64)
Communication, yes	.03	1.64 (1.08-4.05)
Organizational support, yes	.08	1.64 (0.95-2.83)
Training and fit testing, yes	.19	1.37 (0.85-2.21)

Note: Yes indicates units where ≥50% of individuals reported "yes" for the dimension.

Table 5
Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for adherence to facial protective equipment use

Variable category	Variable	*P* value	Odds ratio (95% CI)
Individual	Tenure as nurse	.01	1.02 (1.003-1.03)
Unit	Availability of facial protective equipment	.16	1.27 (0.91-1.78)
	Communication	.03	2.04 (1.07-3.86)

Hierarchical modeling

Seven factors found to be significant through bivariate analysis were included in the model. Backward selection using a cutoff of $P < .2$ yielded a final model with 3 variables, including 1 individual demographic variable, tenure, and 2 unit safety climate dimensions: communication and availability of FPE. Two factors were significant predictors of adherence: unit-level communication ($P = .03$) and individual tenure as a nurse ($P = .01$) (Table 5).

DISCUSSION

Results from this study revealed 3 major findings. First, safety climate dimensions varied significantly between units. Second, adherence to FPE also varied significantly among the 45 units. Last, individual tenure and unit-level communication were significant

predictors of adherence to FPE. The implications of these findings are discussed in the next 3 sections.

Variation of safety climate dimensions between units

Results from our study showed that the unit of work significantly contributed to the variance in nurses' perspectives on 5 of 6 safety climate dimensions ($P < .05$). These findings are consistent with several studies, and support the notion that units develop their own interpretation of the global or hospital-level organizational climate.[13,18] Units may differ in various aspects, including patient factors such as severity, complexity, acuity of illness, and length of stay; workforce factors such as staffing levels, nurse type mix, average tenure, education, and training; and performance factors such as pace of work, technologic complexity, and communication and management style of frontline managers.[11,17,27] Together, unit differences in patient type, staffing composition, and performance expectations may influence nurses' perceptions of the organizations' commitment to safety. From a policy and practice perspective, these findings suggest initiatives tailored to the context of the unit will influence safe work perceptions and behaviors. For example, an organization may have an overarching policy on training and fit testing but require that each unit do a risk assessment and determine additional procedures or requirements needed to keep workers safe and healthy. In those units where the risk of transmission of occupational respiratory disease is low, training may need to be focused on general knowledge and skills with resources available (procedures and experts) for supervisors and workers to access in the event they have a patient with a communicable respiratory disease. In those units where the risk of transmission is high, training may be more frequent, more comprehensive, and may include competency testing. In these 2 scenarios the same overarching organizational policy is in place, but the context of the unit is taken into consideration.

Variation in self-reported adherence to FPE between units

Findings from this study showed that the unit of work significantly contributed to the variance in nurses' self-reported adherence to recommended use of FPE ($P < .001$). Although similar studies have examined the variability in the incidence of medical errors, error reporting, and patient outcomes between units,[27,28] ours is the first study to examine variability in adherence to FPE between units. Studies examining the incidence of medical errors found that units with a greater proportion of registered nurses or stronger perceptions of safety climate reported lower incidences of medical errors.[27,29] These studies suggest that policy makers focus their efforts on improving safety climates and introducing more registered nurses to reduce medical errors.[27,29] Therefore, understanding how unit-level factors affect adherence to FPE may have important implications for leaders and policymakers aiming to improve the health and wellness of health care workers.

Determinants of adherence to FPE

The 2 significant predictors of adherence to FPE were found to be individual-level tenure as a nurse and unit-level communication.

The literature has largely shown demographic factors to have no significant association with adherence to FPE.[16,30] In our study, a relationship between education and adherence was demonstrated at the bivariate level but it was lost during multivariable analysis. The only demographic variable that remained a predictor of adherence was tenure as a nurse, and was associated with a 2% increase in adherence to FPE for every additional year of a nurse's tenure at a hospital. This finding differs from the primary study, which did not report a statistically significant relationship between any of the demographic variables and adherence to FPE use ($P \leq .05$). Differences in the findings of this study and the primary study may be attributed to the nested or hierarchical methodology performed in this study.[15] No other studies were found linking tenure and adherence, but higher tenure has been associated with stronger safety climate perceptions.[31,32] Because a strong safety climate influences safe behaviors,[33] the role of tenure on safe behaviors might be implicated directly or indirectly through its mediation of safety climate. Therefore, the possibility of an association between tenure and safe behaviors is an important area for further research.

Unit-level safety communication

Our study showed that communication practices regarding safety were reported to be positive in 9% of units, and nurses on these units were 2.04 times more likely to report adherence to recommended use of FPE. Examples of good within-unit communication practices include regular opportunities for open communication between frontline managers and staff, positive expectations and actions on promoting safety by frontline managers, and nonpunitive feedback on errors related to safety. Such findings add to the safety climate literature by proposing that in addition to organization-level relationships,[16,34] unit-level safety climate relationships with safe behaviors also exist. These relationships support theories that propose that workers' safe behaviors vary within a hospital, and are in part influenced by different unit environments, as well as each unit's frontline managerial staff and their performance expectations.[17,18] Furthermore, these findings highlight the importance of good within-unit communication practices in fostering a strong safety climate and a positive commitment to safe behaviors.

The association between unit-level communication perceptions and adherence to FPE has important implications for policy decisions and setting priorities for interventions targeted at improving adherence to FPE. Although some top-down, organization-wide interventions have been effective in improving communication,[34] research has found frontline managerial staff to be significant mediators in the implementation of such interventions.[35,36] For instance, a study comparing organization- to group-level managerial outcomes found frontline managerial staff to be more effective than organizational leaders in promoting safe behaviors.[33] Within their own units, frontline managers have the opportunity to interact with their staff on a regular basis. Due to these close interactions, frontline managers have the ability to listen to workers' concerns, exchange information, offer feedback, and ultimately mitigate immediate consequences as part of their daily routine.[11,15,35,37] In turn, actions mediated by frontline managers have been shown to produce more frequent and immediate positive outcomes when compared with those of top managerial staff.[36]

Frontline managers have also been found to be important mediators in the dissemination of information about policy and innovation implementation.[35] Often, managers translate organizational strategies into clinically relevant terms so they can be implemented by workers. Furthermore, each frontline manager may interpret safety policies and procedures differently depending on the job tasks, environments, and performance expectations within each unit.[33,35,37] Differences in interpretation and dissemination of such strategies could therefore affect how a particular group of workers perceive a policy, and consequently, their decision to engage in safe work behaviors.[17,33,35] This creates a potential for discrepancy between formal and executed policy, and may result in

workers of particular units becoming misinformed about the organization's priorities.[13] The discrepancy between formal and executed policy has been observed in medium-sized manufacturing plants,[33] and may be attributed to organization guidelines being vague in defining the roles, goals, and expectations of unit managers.[37] To align unit managers to the organizations' priorities, policies need to have flexibility. For example, a policy regarding training and fit testing could set frequency guidance but specify that unit managers can conduct training and fit testing more frequently according to the specific context of the unit. Policies should also include leadership training and development programs for unit managers to promote leadership styles that foster open and frequent communication.[38,39] The role of open and frequent communication regarding the organizations' commitment to safety has been reported in the literature to be positively associated with safe work behaviors.[38] Given the association between unit-level safety communication and adherence to FPE demonstrated in this study, interventions targeted at improving frontline managers' communication may be an effective way to address longstanding suboptimal adherence rates.

Limitations

There are 3 main limitations to this study. First, the use of a cross-sectional study design precludes the determination of causality. Because this study used self-report data, subject recall and social desirability bias may have been a problem. Second, the study sample, consisting of nurses in acute care hospitals located in Toronto, Canada, may also limit the generalizability of the findings to all health professionals, other types of health care organizations, or different geographic locations. Third, dichotomization of unit-level data led to low event rates for certain unit-level safety climate dimensions. The low event rate required a cutoff of 50%, instead of 60%, which is recommended in the literature. Where response rates >60% are said to be representative of a unit's culture or climate,[40,41] the range between 50% and 60% could be seen as important because it represents a transition zone where individual options begin to come together to create a climate of safety. Lastly, the low number of hospital units (6 hospitals) in this study limited the ability to calculate interclass correlation coefficients (ICCs).[42] ICCs represent the percentage of total variance explained by individual, unit, and hospital levels, and help determine if a statistically significant variation has practical significance.[15,19] Future studies with larger sample sizes could use ICCs to examine both the significance and magnitude of the effect of unit variation on the adherence to FPE.

CONCLUSIONS

This study highlights the significance of the unit of work on nurses' perceptions of safety climate, and their self-reported adherence to recommended use of FPE. Findings demonstrate that units vary significantly in terms of adherence and safety climate dimensions and suggest that aggregated, unit-level perceptions of communication practices regarding safety and availability of FPE were associated with nurses' self-reported adherence to FPE. These results add to the safety climate literature by establishing an association between unit-level safety climate dimensions and adherence to safe work behaviors. This association supports unit-level interventions to be important; specifically, interventions led by frontline managers to improve unit communication practices regarding safety. These interventions could assist in improving safe work behaviors and practices, reduce occupational transmission of communicable respiratory illness, and better protect our health care workers.

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