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The individual, environmental, and organizational factors that influence nurses' use of facial protection to prevent occupational transmission of communicable respiratory illness in acute care hospitals

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Background: Communicable respiratory illness is an important cause of morbidity among nurses. One of the key reasons for occupational transmission of this illness is the failure to implement appropriate barrier precautions, particularly facial protection. The objectives of this study were to describe the factors that influence nurses' decisions to use facial protection and to determine their relative importance in predicting compliance.

Methods: This cross-sectional survey was conducted in 9 units of 2 urban hospitals in which nursing staff regularly use facial protection.

Results: A total of 400 self-administered questionnaires were provided to nurses, and 177 were returned (44% response rate). Less than half of respondents reported compliance with the recommended use of facial protection (eye/face protection, respirators, and surgical masks) to prevent occupational transmission of communicable respiratory disease. Multivariate analysis showed 5 factors to be key predictors of nurses' compliance with the recommended use of facial protection. These factors include full-time work status, greater than 5 years tenure as a nurse, at least monthly use of facial protection, a belief that media coverage of infectious diseases impacts risk perception and work practices, and organizational support for health and safety.

Conclusion: Strategies and interventions based on these findings should result in enhanced compliance with facial protection and, ultimately, a reduction in occupational transmission of communicable respiratory illness. (Am J Infect Control 2008;36:481-7.)

Communicable respiratory illness is an important cause of morbidity among health care workers each year. In Ontario, this problem gained international recognition with the outbreak of severe acute respiratory syndrome (SARS) in Toronto in 2003. In Toronto, SARS resulted in the deaths of 3 health care workers and ongoing morbidity in many others. In a review of the scientific literature on the efficacy of personal

protective equipment to prevent the transmission of SARS, it was determined that failure to implement appropriate barrier precautions was one of the key reasons for occupational transmission of communicable respiratory disease.¹ Facial protection (respirators, surgical masks, and eye/face protection) was identified as the personal protective equipment that was least complied with by health care workers, yet it is an important barrier precaution against respiratory illness.²⁻⁴ Understanding why health care workers fail to appropriately use facial protection has not been well researched.

The Predisposing, Reinforcing, and Enabling Factors in Educational Diagnosis and Evaluation (PRECEDE) model provides a framework to examine the factors that influence health behavior.⁵ This model has been adapted for application to self-protective behavior at work.⁶ Predisposing factors are individual characteristics such as beliefs, attitudes, and values. Enabling factors are environmental factors such as knowledge and availability of equipment and resources. Reinforcing factors are organizational factors such as communication, policies and procedures, and management commitment to health and safety.¹

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The PRECEDE model was used to frame recent literature reviews to identify knowledge gaps and research priorities for effective prevention against occupationally acquired communicable respiratory diseases.¹ These reviews categorized factors as organizational, environmental, and individual. Results showed that an abundance of studies have examined factors related to compliance with universal precautions among health care workers,⁷⁻¹⁰ and the majority have found that environmental and organizational factors played a more important role in compliance than individual factors. Results also showed that there has been very little work done regarding factors that influence compliance of health care workers with precautions taken to protect against communicable respiratory illness. The authors suggest that determinants of adherence to universal precautions are likely applicable to many types of self-protective behavior, including those taken to prevent transmission of communicable respiratory illness.¹

The objectives of this study were to describe the individual, environmental, and organizational factors that affect nurses' compliance with the use of facial protection and to determine the relative importance of these factors. Once the most influential factors are identified, strategies and interventions to enhance compliance can be formulated, tested, and implemented to reduce the prevalence of worker morbidity and mortality from communicable respiratory illness.

METHODS

Study design and study participants

This research study was designed as a preliminary investigation to inform a larger and more comprehensive project. A cross-sectional survey design was used. The study took place in 2 acute care hospitals in Toronto, Canada. The vice president and/or chief nursing officer of each hospital were approached to discuss recruitment of the hospital as a site for study. Ethics approval was obtained from the research ethics boards in each hospital.

Units in which nurses were more likely to require regular use of facial protection were identified by the vice president and/or chief nursing officer of each hospital. Five units from one hospital and 4 units from another agreed to participate. Approximately 500 full- and part-time nurses were employed on the 9 units at the time of the study. Taking summer vacation activity, limited time available to collect data on the units, and the demanding work environment into consideration, the researcher aimed to collect completed surveys from 150 nurses or 30% of the total population. Estimating a 35% to 40% response rate, 400 questionnaires were distributed over a 6-week period during the summer

of 2006. The researcher (K.N.) spent 2 to 4 days over different shifts on each unit handing out and collecting surveys. A survey drop box was also placed on each unit.

Survey tool

A new, 5-page, 61-item questionnaire was developed for the study. The questionnaire was divided into 5 parts: demographics, individual factors, compliance, environmental factors, and organizational factors.

Part 1 included 7 items that measured basic demographic data. Respondents answered by checking boxes or filling in the blanks. Part 2 examined individual factors that may influence compliance including knowledge of droplet and airborne spread respiratory disease (8 items), perception of effectiveness of preventive actions (4 items), exposure history (2 items), perception of occupational risk (3 items), and personal barriers to the use of facial protection (13 items). The measure to assess knowledge was developed based on government guidelines on preventing the occupational transmission of airborne and droplet spread communicable disease in health care facilities.¹¹ A response scale of *true/false/don't know* was used. The remaining individual factors were measured using elements and scales from established tools.^{8,12-14} Most questions used a 5-point Likert response scale of *strongly agree/agree/neutral/disagree/strongly disagree* for answers.

Part 3 of the survey examined compliance with recommended use of facial protection. An 8-item scale was developed to measure compliance based on government guidelines.¹¹ Participants were asked about their compliance with N95 respirators, surgical masks, and eye protection when they suspected a patient had a communicable respiratory illness and when a diagnosis had been made. Responses were measured with a 5-point Likert scale of *always/mostly/sometimes/rarely/never*. "Compliant" was defined as answering *always* or *mostly* to at least 7 of the 8 items.

Part 4 of the survey examined environmental factors that could influence use of facial protection including training (8 items), cleanliness/orderliness of the workplace (3 items), availability of facial protection (3 items), and media coverage of infectious diseases (2 items). Training measures included frequency and content of the training program, as well as fit testing of respirators. The measures for the training program content were determined using government guidelines,¹¹ and a response scale of *yes/no/don't know* was used. Cleanliness and orderliness of the workplace and availability of facial protective equipment were measured using elements from established scales.^{15,16} Measures related to media coverage were based on a qualitative study that examined the factors that influenced compliance

with bloodborne precautions.¹⁰ A 5-point Likert response scale of *strongly agree/agree/neutral/disagree/strongly disagree* was used.

Organizational factors were measured in part 5 of the survey and included organizational support for health and safety (5 items), absence of job hindrances (3 items), peer and supervisor feedback (4 items), and conflict/communication (3 items). These factors were measured using elements from established scales.^{15,16} Where necessary, wording was changed to make the statements relevant to preventing the transmission of respiratory illness as opposed to bloodborne illness. A 5-point Likert response scale of *strongly agree/agree/neutral/disagree/strongly disagree* was used. At the end of the survey, nurses were encouraged to share any further relevant information on the back of the last page.

Pretesting of the survey tool

The questionnaire was reviewed by occupational health and infection control experts on facial protection and airborne and droplet spread illness, senior nursing officials at both hospitals, and one local of the Ontario Nurses Association. Two focus groups were held to test the survey tool. Nurses participating in the focus groups completed the survey and provided feedback on the accuracy and format of the tool and the time it took for completion. As a result of the focus groups, minor changes were made to the tool. The final version of the questionnaire contained 61 items and was completed by most respondents within 15 minutes.

Statistical analysis

All statistical analysis was performed using Statistical Analysis Software (SAS) Version 8.0 (1999; SAS Institute Inc., Cary, NC). Descriptive statistics consisted primarily of frequency distributions and means. Reliability of scales was assessed using Cronbach coefficient α . χ^2 tests for categorical variables and t tests for continuous variables were conducted to examine the direct effects of each factor on compliance. Variables with a univariate P value $< .15$ were selected for inclusion in a stepwise logistic regression model to determine those factors with independent predictive value.¹⁷ Interpretation was based on odds ratios (OR) where an OR of 1.0 refers to the equal probability of exposure to the factor in nurses classified as compliant and those classified as noncompliant.

RESULTS

Demographics

A total of 177 completed surveys were returned for a response rate of 44%. The sample was predominantly

Table 1. Demographic characteristics of participating nurses

Variable		N = 177, n (%)
Sex	Female	154 (87.5)
Age, yr	20-30	59 (34)
	31-40	53 (30)
	41-50	47 (27)
	51+	16 (9)
Education	Diploma	74 (42)
	Baccalaureate	89 (51)
	Master's	13 (7)
Work status	Full-time	148 (84)
Supervisory status	Yes	75 (43)
Tenure as a nurse		11.7 \pm 9.6 (sample mean, yr)
Current job tenure		6.9 \pm 7.4 (sample mean, yr)

female and young (one third of respondents reported being less than 30 years of age) (Table 1). Most of the respondents were from an intensive care unit (44%), whereas the rest represented inpatient units or outpatient clinics (30%) and emergency (26%).

Compliance

Results showed that 42% of respondents met our definition of compliance and answered *always* or *mostly* to at least 7 of the 8 items within the compliance scale. Twenty-one percent of respondents answered *always* or *mostly* to all 8 items.

Reliability testing

Cronbach coefficient α estimates the reliability of a scale. It is suggested that a score ≥ 0.70 is an acceptable reliability coefficient.¹⁸ Cronbach α raw scores were calculated for each measure, and 3 scales (knowledge, effectiveness of preventive actions, and perception of risk) had scores less than 0.70. The scale to measure knowledge demonstrated a reliability coefficient of 0.32. Although this low score might be considered problematic for scales measuring a single trait or content domain, a high α statistic cannot be expected for a multidimensional knowledge scale such as the one used. The scale to measure perception of risk demonstrated a reliability coefficient of 0.64. When the item measuring risk was separated from those measuring impact, the raw score increased to 0.79, suggesting that risk and impact, need to be measured separately. The scale to measure perception of effectiveness of preventive actions demonstrated a reliability coefficient of 0.50. This could be due to the discrepancy between nurses' perception of effectiveness of respirators and hand hygiene as opposed to surgical masks and eye protection. Equipment may need to be evaluated on an individual basis.

Table 2. Relationship between compliance with the use of facial protection and each demographic, individual, environmental, and organization factor

Variable	Description	Level	Noncompliant	Compliant	Total	
			n (%)	n (%)	n (%)	
Demographic	Sex	Female	87 (87)	65 (89)	152 (88)	
	Age, yr	20-30	41 (41)	18 (25)	59 (34)	
		31-40	28 (28)	24 (33)	52 (30)	
		41-50	24 (24)	22 (31)	46 (27)	
		51+	7 (7)	8 (11)	15 (9)	
	Education	Diploma	53 (53)	34 (47)	87 (50)	
		Bachelor's	40 (40)	33 (45)	73 (42)	
		Master's	7 (7)	6 (8)	13 (8)	
	Work status	Full-time	81 (81)	65 (89)	146 (84)	
	Supervisory status	Yes	43 (44)	30 (42)	73 (43)	
Tenure as a nurse (yr)*	Mean (SD)	9.8 (8.8)	13.8 (9.9)	11.6 (9.5)		
Job tenure (yr)	Mean (SD)	6.1 (7.0)	7.9 (7.8)	7.0 (7.5)		
Individual	Knowledge	Knowledgeable	46 (46)	41 (56)	87 (50)	
	Effectiveness of preventive actions	Perceived facial protection to be effective	34 (34)	28 (38)	62 (36)	
	Exposure: frequency of use of facial protection	≥Monthly	78 (79)	64 (88)	142 (83)	
		Rarely/never	21 (21)	9 (12)	30 (17)	
	Exposure: personal experience	Reported personal experience with exposure	41 (42)	38 (52)	79 (46)	
	Perception of risk	Perceived occupational risk	86 (86)	60 (82)	146 (84)	
	Personal barriers to use	Reported personal barriers to using facial protection	81 (93)	58 (89)	139 (91)	
	Environmental	Cleanliness/orderliness*	Reported unit to be clean/orderly	19 (19)	24 (33)	43 (25)
		Availability of facial protection*	Reported facial protection to be available	39 (39)	40 (56)	79 (46)
		Training	Reported being trained and fit tested within last 12 months	28 (28)	22 (30)	50 (29)
Media coverage [†]		Reported media influenced risk perception and work practices	23 (23)	35 (48)	58 (34)	
Organizational	Organizational support*	Reported organizational support for health and safety	27 (28)	29 (41)	56 (34)	
	Absence of job hindrances*	Reported absence of job hindrances to working safely	34 (35)	38 (53)	72 (43)	
	Feedback	Reported peer/supervisor feedback re: health and safety	27 (28)	27 (40)	54 (33)	
	Conflict/communication	Reported good employee relations and communication	47 (48)	34 (50)	81 (49)	

* $P \leq .05$.[†] $P \leq .001$.

Univariate analysis

Table 2 presents the results of the univariate analysis of associations between explanatory variables and compliance. One demographic variable was found to be significantly associated with compliance: nurses with more tenure reported better compliance with recommended use of facial protection. No individual factors demonstrated a significant association. Of the 4 environmental factors measured, 3 showed a significant association with enhanced compliance: cleanliness, availability of facial protection, and media coverage. Two of the 4 organizational factors assessed in this study expressed a significant association with compliance: organizational support for health and safety and an absence of job hindrances.

Multivariate analysis

Significant variables and variables of interest were entered into a stepwise logistic regression model. Five significant predictors of compliance were revealed (Table 3).

DISCUSSION

Demographics

According to the 2005 Canadian Nurses Association *RN Workforce Profile by Area of Responsibility*, our sample is fairly representative of the population of nurses working in medicine/surgery, critical care, and emergency.¹⁹ The Canadian Nurses Association profile indicates that the average age of this population was

Table 3. Adjusted odds ratios for compliance with the use of facial protection

Variable	Description	Level	Odds ratio (95% CI)
Demographic	Work status	Part-time vs full-time	0.34 (0.11-0.999)
	Tenure as a nurse	5-10 yr vs <5 yr	2.97 (1.05-8.39)
		10-20 yr vs <5 yr	3.92 (1.46-10.53)
		20+ yr vs <5 yr	4.83 (1.72-13.58)
Individual	Frequency of use of facial protection	≥Monthly vs rarely/never	2.66 (1.05-6.75)
Environmental	Media coverage	Media coverage important vs not	2.8 (1.26-6.2)
Organizational	Organizational support	Organizational support present vs not	2.37 (1.13-4.97)

approximately 41 years, and our sample showed the average age to be 45 years. Regarding sex, the profile showed that approximately 7% of the population was male, and our sample was 4% male. Approximately 55% of the population worked full-time, and 67% of our sample reported full-time work status. Finally, a higher percentage of the population in the profile was trained at the diploma level (approximately 72%), compared with our sample (42% diploma trained).

Compliance

Health care workers' compliance with safe work behaviors to prevent the spread of infectious disease is historically poor.^{3,9} Although adherence with hand hygiene, glove use, and immunization has been well studied, compliance with the use of facial protection to prevent the spread of communicable respiratory disease has not been as well studied. One study of 3 US hospitals over 3 years found that health care workers wore appropriate respiratory protection with tuberculosis patients 44% to 97% of the time.²⁰ Another study showed compliance with respirator use to be 57% when the diagnosis of tuberculosis was unconfirmed and 84% when it was confirmed.²¹ A third study retrospectively reviewed health care workers who worked during the SARS outbreaks and their compliance with respirator use.²² Sixty-six health care workers reported exposure to a patient who was coughing and later found to be SARS positive, yet 40% of these workers did not use a respirator.²² Our study of acute care nurses in 2 hospitals in Toronto described a comparable rate, with 42% of responding nurses reporting compliance with the recommended use of facial protection.

Demographic characteristics influencing compliance

Demographic factors such as sex, education level, and occupation have not been found to be consistently associated with compliance with infection control procedures.⁷ Our study was consistent with this finding and did not show a relationship between age, education, job tenure, or supervisory status and compliance.

Work status was shown to be significantly associated with compliance. Full-time nurses were 3 times more likely to report compliance with the recommended use of facial protection than part-time nurses. This finding is important because part-time nurses may need more intervention than full-time nurses to enhance their level of compliance, and interventions with this group may be logistically more difficult because they spend less time at the workplace. We also found that tenured nurses were more likely to report compliance than new nurses. The literature provides conflicting reports. In a study of correctional workers, it was found that young workers were more likely to be compliant with universal precautions than older workers.⁸ On the other hand, another study showed that longer job tenure was related to health care worker compliance with universal precautions and suggests that health care workers with more time on the job have had the opportunity to incorporate experience and judgment into their clinical practice, which could promote the use of appropriate preventive behaviors.⁴ This finding is important because managers could enhance compliance by placing nurses with greater tenure into supervisory and mentoring roles.

Individual factors influencing compliance

Our study found that nurses who reported using facial protection at least monthly were more likely to report compliance than nurses who reported using facial protection rarely or never. Although this relationship may have some inherent contributory bias, it is important to note that nurses who report daily, weekly, or monthly use of facial protection should be the ones to care for patients with communicable respiratory disease or supervise those who are providing the care.

Environmental factors influencing compliance

Cleanliness and orderliness of the workplace were shown to be associated with compliance at the univariate level. In a study on adherence to universal precautions, it was found that cleanliness and orderliness of the worksite were significantly associated with enhanced compliance.¹⁵ Ensuring that there are resources

to keep the workplace clean, allocating adequate storage space, and ensuring that this storage space is used are important strategies to improve compliance on a unit.

Availability of facial protection was also significantly associated with enhanced compliance at the univariate level. One hospital study in the United States found availability of protective equipment to be associated with compliance with universal precautions.¹⁵ In a study on SARS transmission in health care workers in Hong Kong, it was found that workers who perceived the amount of available personal protective equipment to be poor were more likely to have developed SARS.²³ It is possible that, in our study, availability of facial protection was not found to be significant at the multivariate level because of a correlation with the frequency of use of facial protection. Having dedicated and convenient areas to store facial protection and the resources to keep these areas well stocked may assist with compliance.

Media coverage was shown to be very strongly associated with compliance at both the univariate and multivariate level. Nurses who thought that media coverage of communicable diseases made them more aware of their risk at work and work more carefully were more likely to report compliance with the recommended use of facial protection. One qualitative study found that media coverage of HIV and hepatitis B was an important factor in health care workers' compliance with universal precautions.¹⁰ The author comments that, although first- and secondhand experience of events are more emotionally loaded, mass media coverage of blood-borne disease has resulted in a sharpened attention to the problems. This finding provides opportunities for further research. Using the media to communicate risk and affect healthy work behaviors to prevent occupational transmission of communicable respiratory illness is an area that has not been well studied.

Organizational factors influencing compliance

Several studies have found organizational factors to be the most significant predictor of safe work behaviors, specifically compliance with universal precautions.^{8,9,15,16,24} Our study found that nurses who felt they had organizational support for health and safety were significantly more likely to report compliance with the recommended use of facial protection. This finding was significant at the univariate and multivariate levels of analysis. Measures for organizational support included management making health and safety a high priority, taking all reasonable steps to minimize hazards, encouraging employees' involvement in health and safety matters, and actively working to protect employees. This finding shows

how important it is that nurses think their health and safety are valued by their employer. Those who think that they are valued will engage in healthier work behaviors. Interventions targeted at improving how supportive the organization is of employee health and safety can result in enhanced compliance. This finding is supported in the literature related to universal precautions.^{4,25}

An absence of job hindrances was shown to be linked to enhanced compliance at the univariate level. Proper use of facial protection can be hindered by the type of duty carried out (eg, carrying out a long procedure while using a tight-fitting respirator), a lack of time to properly use and dispose of the equipment (eg, busy unit or emergency situation), and the desire to provide good quality patient care (eg, having the patient unable to see your facial expression while explaining a risky procedure). One study found that a worker's perception that the use of universal precautions interfered with their work (job hindrance) was a strong predictor of failure to comply with universal precautions.¹⁶ Reducing or eliminating these or other identified job hindrances is a good strategy to enhance compliance. The literature has also shown that a lack of available time and a heavy workload negatively influenced compliance with hand hygiene precautions.²⁶⁻²⁹

Study limitations

Our study used a new data collection tool. Reliability testing for 3 of the explanatory measures fell below the acceptable range and require further evaluation. The cross-sectional study design precludes the determination of causality. Study results may not be generalized to all professions, geographic location, or type of health care facility because these findings are from a convenience sample from 2 acute care, urban hospitals with a 44% response rate. Self-selection bias may be a limitation because participation in the study was voluntary and a decision to participate may be correlated with traits that affect the study, making the participants a nonrepresentative sample. For example, people who have strong opinions or substantial knowledge may be more willing to spend time answering the survey than those who do not. Subject recall and social desirability bias may be a problem given the reliance on self-report data for this study. Self-reported compliance has been found to be higher than actual compliance,³⁰⁻³² and it is possible that our data might be an overestimate of our respondents' true compliance.

CONCLUSION

The objectives of this study were to describe the factors that influence nurses' decisions to use facial protection and to determine their relative importance in

predicting compliance. Multivariate analysis showed 5 factors to be key predictors of nurses' compliance with the recommended use of facial protection. These factors include full-time work status, greater than 5 years tenure as a nurse, at least monthly use of facial protection, a belief that media coverage of infectious diseases impacts risk perception and work practices, and organizational support for health and safety. Strategies and interventions based on these findings should result in enhanced compliance with facial protection and, ultimately, a reduction in occupational transmission of communicable respiratory illness.

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