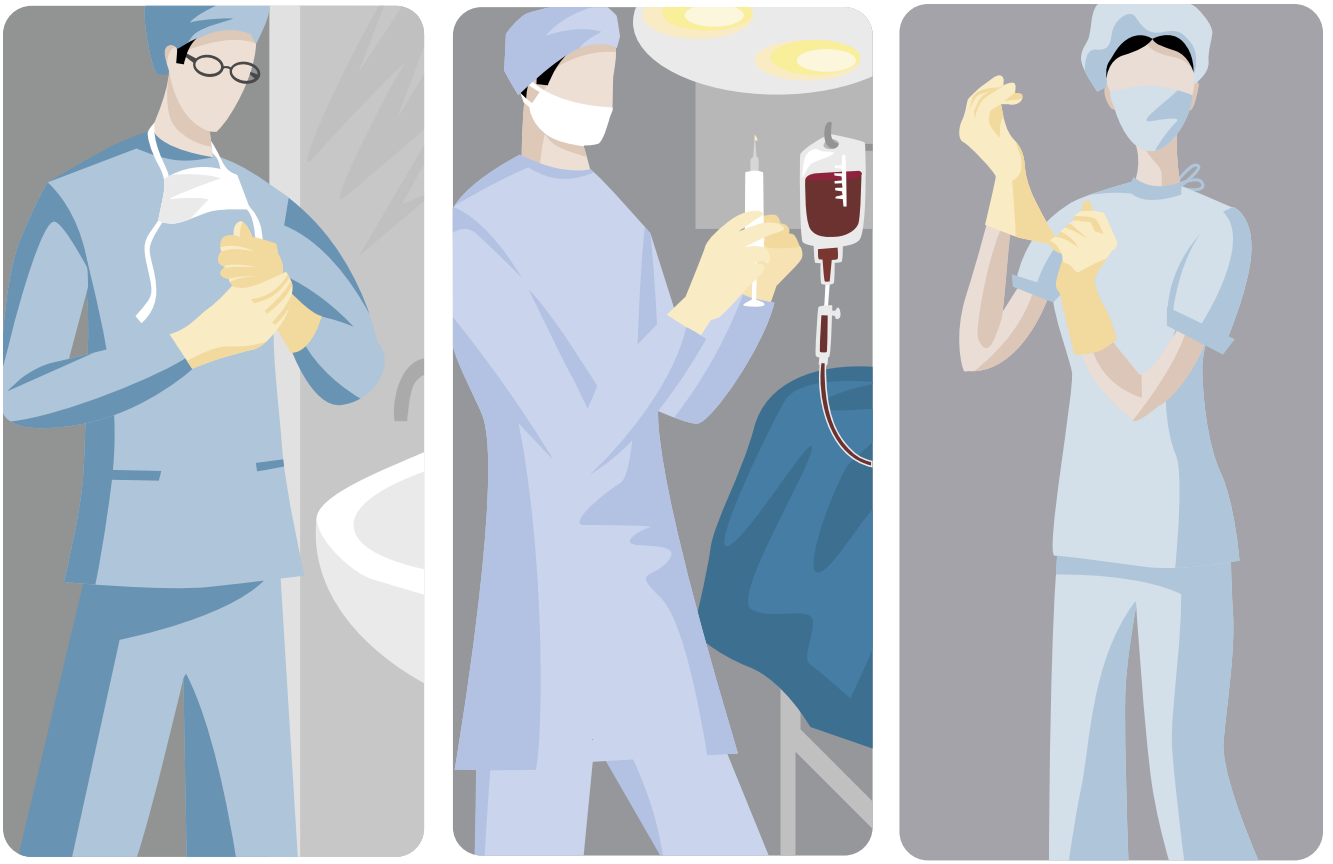
Determinants of Healthcare Workers' Compliance with **Infection Control Procedures**



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Abstract

The purpose of this study was to assess determinants of healthcare worker (HCW) self-reported compliance with infection control procedures. A survey was conducted of HCWs in 16 healthcare facilities. A strong correlation was found between both environmental and organizational factors and self-reported compliance. No relationship was found with individual factors. Only 5% of respondents rated their training in infection control as excellent, and 30% felt they were not offered the necessary training.

We concluded that compliance with infection control procedures is tied to environmental factors and organizational characteristics, suggesting that efforts to improve availability of equipment and promote a safety culture are key. Training should be offered to high-risk HCWs, demonstrating an organizational commitment to their safety.

Infection control is a key component of practice for all healthcare professionals, not only for their health (Stratton 2001) but also to reduce nosocomial infections (Jackson et al. 2002; Scheckler et al. 1998) and thus improve patient safety (Christenson et al. 2006). Healthcare workers (HCWs) are at increased risk of occupationally acquired infections transmitted from both blood-borne pathogens, such as hepatitis B and C and human immunodeficiency virus (Stein et al. 2003), as well as respiratory pathogens, such as influenza, tuberculosis, diphtheria and varicella (Sepkowitz 1996). Severe acute respiratory syndrome (SARS) is a more recent illustration of a disease spread primarily through respiratory droplets (Drosten et al. 2003; Ksiazek et al. 2003) that, in Canada, Singapore and Vietnam, affected HCWs (World Health Organization 2003). Moore et al. (2005) and Yassi et al. (2005) reviewed the literature regarding individual, organizational and environmental factors affecting HCW behaviour at work with regard to self-protection relevant to SARS. Building on the focus group work done in the Moore et al. (2005b) study to orient that review, our team developed a questionnaire to assess the knowledge, beliefs, attitudes, perceptions and behavioural intentions related to SARS (and other infectious diseases) of HCWs and their environmental, organizational and individual determinants.

While much research has been done since the SARS outbreak to better understand the facets of infection control that either worked or did not work well in various settings (Abdullah et al. 2003; Lau et al. 2004; Le et al. 2004; Seto et al. 2003; Shaw 2006; Wong et al. 2004), a study exploring compliance behaviour using a framework of analysis appropriate for occupational health has not yet been published. Analysis of the experience in British Columbia, Canada, using such a framework could thus provide an important contribution to our understanding of the factors influencing compliance with infection control in healthcare settings.

Many models can be used to explain actions around infection control; for the purpose of this study, we chose to adapt DeJoy's Behavioural Diagnostic Model (1986) which itself is based upon the PRECEDE framework (Green et al. 1980). This model is particularly suitable for our research as it integrates worker-related, as well as organizational, factors that affect behavioural intentions toward safe work practices. Worker-centred variables include employees' beliefs, knowledge, attitudes, perceptions, demographics, type of work setting and job status, all of which may be affected by outside influences, including co-workers' attitudes, supervisors' support and institutional culture. Organizational factors, such as safety culture, infection control resources and occupational health, and the working environment (e.g., accessibility to safety equipment, isolation or single rooms and barrier supplies) that supports and reinforces safe work behaviours are also crucial and are included in our model.

Methods

Design and Data Collection

A cross-sectional correlational survey approach was used to explore compliance factors in a total of 16 acute care facilities in the province of British Columbia, Canada. Nine of the sites are in the Fraser Health region, and seven are in the Vancouver Coastal Health region. The questionnaire was administered between October 2004 and August 2005. A parallel study was conducted in Ontario and will be the subject of a future report. The evaluation was conducted on the hospital units by a study team member and was given to intensive care unit nurses, emergency department nurses, general medicine nurses (general medicine, respiratory, acute care, cardiac care, palliative and rehabilitation wards), physicians (emergency, intensive care unit, respirology and anesthesiology), respiratory therapists and physiotherapists.

Questionnaires

The HCW questionnaire was designed with 103 items, which were assembled from the Johns Hopkins University School of Hygiene and Public Health Safety Climate Questionnaire as well as the Effort-Reward Imbalance scale (Siegrist 1996) and the Copenhagen burnout scale (Borritz and Kristensen 2001). Additional supplemental items were also created by the research team, composed of experts in the fields of infection control, occupational medicine, psychology and questionnaire construction, and stemmed from an extensive literature review we conducted regarding individual, organizational and environ-

Table 1. Demographics of respondents

Characteristics	*n* (%)
Sex	
Female	1,037 (82)
Male	235 (18)
Occupation	
ICU nurses	227 (18)
Emergency nurses	240 (19)
General medical nurses	465 (35)
Physicians	114 (9)
Respiratory therapists	118 (9)
Physiotherapists	126 (10)
Age (yr)	
19–29	204 (17)
30–39	358 (29)
40–49	376 (30)
50–59	252 (21)
60+	37 (3)
Marital status	
Single	312 (25)
Divorced, separated or widowed	130 (11)
Married or living with partner	821 (64)
Job status	
Full-time	862 (68)
Part-time	270 (21)
Casual	138 (11)
Highest level of education	
High school	6 (<1)
Diploma or certificate	634 (50)
Bachelor's degree	488 (38)
Master's degree	30 (2)
Medical doctor (MD)	107 (8)
Doctor of philosophy (PhD)	5 (<1)

ICU = intensive care unit.

mental factors affecting HCW behaviour at work with regard to self-protection relevant to SARS (Moore et al. 2005a; Yassi et al. 2005). The questionnaires were coded to ensure confidentiality and took approximately 20 minutes to complete.

Participants

The demographics of the 1,290 respondents are shown in Table 1. Overall, 82% of the respondents were female and almost all (97%) were involved in direct patient contact. A total of 68% of the respondents held full-time employment status, with the rest being a combination of part-time (21%) and casual (11%) workers. The majority of the respondents held a diploma, degree or certificate (89%) from a post-secondary institution. Most respondents were married or living with a partner (64%), and the ages of the respondents were distributed throughout the age categories.

Statistical Analysis

Standard descriptive statistics (e.g., frequency, per cent and measures of central tendency and dispersion) were calculated to demonstrate the demographics of subjects and characterize the distribution of variables. Compliance (the dependent variable) was measured by six "questions" (clean your hands with water and soap or waterless hand rubs after removing disposable gloves; wear disposable gloves whenever there is a possibility of exposure to blood and other body fluids; wear a disposable outer garment that is resistant to blood and body fluids whenever there is a possibility of soiling your clothes; wear an N95 mask when there is potential exposure to an airborne respiratory communicable disease; wear protective eyewear whenever there is a possibility of splashes of blood or other body fluids; and wear a face shield whenever there is a possibility of splashes of blood or other body fluids). A number of independent variables were examined for possible association with compliance, including demographic, environmental and organizational factors as well as individual items chosen a priori to reflect aspects of the underlying model guiding the study.

Chi-square test was conducted to examine the bivariate relationship between each compliant measure and predicator; Kendall's tau-b, a nonparametric measure of association, was used to ascertain the direction and strength of the relationship. Another measure of association, eta coefficient, was conducted when a dependent variable was an interval measure and an independent variable with a limited number of categories. Variables that were statistically significant in bivariate analyses were further analyzed by a multinomial logistic regression model for the association with the categorical compliancy measure (Hosmer and Lerneshow 1989). The results were presented as the odds ratio (OR) and 95% confidence intervals for each compliancy category relative to the least compliant. All tests were two-sided significance levels of $p \leq .05$ estimated from

Table 2. Responses to questions pertaining to infection control

Statement	No. of Responses (%)				
	Always	Often	Sometimes	Rarely	Never
I follow the safety rules for infection control at work.	611 (49)	596 (47)	47 (4)	4 (<1)	0 (0)
I make my own judgments as to when to use PPE to prevent SARS or other respiratory communicable disease transmission.	392 (33)	403 (34)	165 (14)	120 (10)	105 (9)
Statement	**No. of Responses (%)**				
	Excellent	**Sufficient**	**Moderate**	**Insufficient**	
I believe my current level of training with respect to protective measures against infectious diseases is …	60 (5)	466 (37)	515 (41)	226 (18)	
Question	**No. of Responses (%)**				
	Yes		**No**		
Do you feel that precautionary measures interfere with your ability to do your job?	330 (26)		918 (74)		

PPE = personal protective equipment; SARS = severe acute respiratory syndrome.

the Statistical Package for Social Sciences (SPSS, Version 14.0, Chicago, Illinois). Partially missing values were automatically excluded from the analyses.

Results

The majority of workers responded that they do follow the rules for infection control at work (48% always + 47% often = 95%); however, 27% of respondents felt that precautionary measures interfere with their ability to do their job (Table 2).

Overall, 90% of workers reported cleaning their hands after removing gloves ≥ 70% of the time; 91% reported wearing disposable gloves when there was a possibility of exposure to blood or other bodily fluids ≥ 70% of the time; 62% reported wearing a disposable garment when there was a possibility of soiling their clothes ≥ 70% of the time; 71% reported wearing an N95 mask when there is potential exposure to an airborne respiratory communicable disease ≥ 70% of the time; and 52% reported wearing protective eyewear whenever there was a possibility of splashes of blood or other bodily fluids ≥ 70% of the time (Table 3).

Males across all occupations were less likely to comply with infection control across all questions and were significantly less likely to clean their hands (OR = 0.30, p <.001). Physicians reported a lower compliance with hand cleaning (OR = 0.22, p < .001), wearing of disposable gloves (OR = 0.32, p = .004) wearing an N95 mask (OR = 0.14, p < .001), wearing protective eyewear (OR = 0.80, p = .03) and wearing a face shield (OR = 0.43) when compared with general medical ward nurses. However, physicians had higher self-reported compliance with regard to wearing a disposable outer garment (OR = 1.61). Additionally, younger workers (19–29 years of age) had better self-reported compliance than older workers (50+ years). Single workers had significantly better self-reported compliance (OR = 2.46, p < .001) than married or common-law workers.

Overall, only 5% of respondents rated their training with respect to protective measures against infectious diseases as excellent (see Table 2). Many respondents felt that their level of training was below what it should be in their current profession. A total of 26% of questionnaire respondents indicated that they had never been fit-tested for a respirator. Other questions that explored training are shown in Table 4.

Between the individuals who worked directly with patients who either had or were suspected of having SARS (18% of respondents) and those who did not, there were no significantly different responses to the questions with regard to compliance.

There was a significant correlation between scoring in the high range for environmental factors (consistently ranking your workplace as >80% with regard to availability of resources) and reporting high safety behaviour compliance, with those people scoring high on environmental factors being almost 12 times as likely to also report high compliance. Similar results were found for organizational factors as well; respondents who rated their workplace highly with regard to management support

> **The SARS outbreak itself is an example of how, despite the reported use of standard and airborne infection control safety measures, the precautions were apparently incomplete or were intermittently applied, thereby resulting in occupational transmission.**

Table 3. Response distributions to questions on compliance by job category

Variable	No. of Responses (%)	
	< 70% of the Time	≥ 70% of the Time
Clean your hands with water and soap or waterless hand rubs after removing disposable gloves		
ICU nurses	9 (4)	214 (96)
Emergency nurses	23 (10)	213 (90)
General medical nurses	32 (7)	423 (93)
Physicians	22 (19)	91 (81)
Respiratory therapists	5 (4)	112 (96)
Physiotherapists	10 (8)	113 (92)
Wear disposable gloves whenever there is a possibility of exposure to blood or other body fluids		
ICU nurses	11 (5)	211 (95)
Emergency nurses	21 (9)	214 (91)
General medical nurses	19 (4)	429 (96)
Physicians	12 (11)	102 (89)
Respiratory therapists	6 (5)	110 (95)
Physiotherapists	9 (7)	114 (93)
Wear a disposable outer garment that is resistant to blood and bodily fluids whenever there is a possibility of soiling your clothes		
ICU nurses	74 (36)	129 (64)
Emergency nurses	108 (48)	116 (52)
General medical nurses	135 (33)	270 (67)
Physicians	54 (50)	55 (50)
Respiratory therapists	32 (30)	76 (70)
Physiotherapists	32 (30)	76 (70)
Wear an N95 mask when there is potential exposure to an airborne respiratory communicable disease		
ICU nurses	24 (13)	155 (87)
Emergency nurses	73 (35)	136 (65)
General medical nurses	80 (21)	293 (79)
Physicians	56 (57)	43 (43)
Respiratory therapists	12 (11)	95 (89)
Physiotherapists	29 (33)	60 (67)
Wear protective eyewear whenever there is a possibility of splashes of blood or other bodily fluids		
ICU nurses	82 (40)	123 (60)
Emergency nurses	99 (46)	114 (54)
General medical nurses	174 (44)	225 (56)
Physicians	60 (58)	44 (42)
Respiratory therapists	45 (42)	63 (58)
Physiotherapists	56 (58)	41 (42)
Wear a face shield whenever there is a possibility of splashes of blood or other bodily fluids		
ICU nurses	115 (56)	90 (44)
Emergency nurses	130 (60)	88 (40)
General medical nurses	218 (55)	175 (45)
Physicians	76 (73)	28 (27)
Respiratory therapists	69 (62)	43 (38)
Physiotherapists	60 (67)	29 (33)

ICU = intensive care unit.

and safety climate were almost 10 times as likely to also report high compliance. This was not the case for individual factors, however; we did not observe any statistically significant associations between high self-reported compliance and the individual factors examined (defined as knowledge, beliefs, attitudes and perception of risk; see Table 5).

Discussion

Training emerged as a key factor in this study. Infection control training usually focuses on hand hygiene and does not include targeted training on other infection control practices such as wearing N95 masks and gloves. Rosenthal et al. (2005) demonstrated that a program focused on education and performance feedback of HCWs is effective in promoting hand hygiene and lowering nosocomial infection rates. In other studies, Rosenthal et al. (2003, 2004) measured the effect of education and performance feedback on specific infection outbreaks (central venous catheter–associated bloodstream infections and catheter-associated urinary tract infections, respectively) and found performance feedback to be effective in achieving increased adherence with hand hygiene practices but difficult to implement and sustain due to a required high level of institutional commitment. Similarly, Colombo et al. (2002) showed that compliance with hand disinfection can be improved through targeted teaching and supportive structural improvements.

This study demonstrates that there are clear differences between occupations, genders and ages with regard to compliance. Physicians' compliance with handwashing was

Table 4. Perception of training

Variable	No. of Responses (%)				
	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
In my current work area, supervisors encourage employees to obtain training in occupational health and safety issues, such as safe patient-handling techniques.	77 (6)	201 (17)	259 (21)	463 (38)	208 (17)
I have received sufficient training in infection control during staff training.	154 (12)	309 (25)	265 (21)	426 (34)	89 (7)
In my current work area, I am offered the necessary training to protect myself from communicable respiratory diseases such as SARS.	125 (10)	249 (20)	256 (20)	493 (40)	118 (10)
I feel that I have received proper training, including how to fit-check before using a respirator (N95 mask), so that I can protect myself from communicable respiratory diseases such as SARS.	178 (14)	191 (15)	136 (11)	515 (41)	223 (18)

SARS = severe acute respiratory syndrome.

Table 5. Multinomial logistic model of compliance with respect to total environmental scores, total organizational scores and total individual scores*

Variable	Low Total Score		Medium Total Score		High Total Score	
	OR (95% CI)	*p* Value	OR (95% CI)	*p* Value	OR (95% CI)	*p* Value
Environmental total score						
Low	1.00		1.00		1.00	
Medium	1.84 (1.00, 3.40)	.050	1.57 (0.89, 2.76)	.121	2.66 (1.40, 5.06)	.003
High	2.26 (1.10, 4.62)	.026	2.49 (1.30, 4.79)	.006	4.62 (2.27, 9.43)	< .001
Organizational total score						
Low	1.00		1.00		1.00	
Medium	1.60 (0.86, 2.98)	.139	1.92 (1.08, 3.40)	.026	2.21 (1.16, 4.20)	.016
High	1.86 (0.90, 3.83)	.094	2.46 (1.27, 4.79)	.008	3.96 (1.96, 8.00)	< .001
Individual total scores						
Low	1.00		1.00		1.00	
Medium	0.63 (0.34, 1.15)	.134	0.63 (0.36, 1.10)	.105	0.79 (0.43, 1.45)	.451
High	0.97 (0.50, 1.90)	.931	0.83 (0.45, 1.56)	.567	1.22 (0.64, 2.35)	.547

CI = confidence interval; OR = odds ratio.

*Main effect model.

self-reported to be the lowest, consistent with findings in other studies (Berhe et al. 2005; Lipsett and Swoboda 2001; Salemi et al. 2002). Men were less compliant with all types of infection control practices and significantly less likely to clean their hands. This has been previously documented (Sharir et al. 2001). Young workers reported better compliance than older workers, which is also consistent with what other studies have found (Gershon et al. 1999).

While overall self-reported compliance to hand hygiene and glove use were consistent with expected results (90% and 91% ≥ 70% of the time, respectively), only 52% of respondents reported wearing protective eyewear whenever there was a possibility of splashes of blood or other bodily fluids ≥ 70% of the time. A total of 26% of questionnaire respondents felt that precautionary measures interfered with their ability to do their jobs, with respirators (N95 masks), face shields and goggles being reported as the most cumbersome. The necessity of wearing respirators, such as N95 masks, was highlighted during the SARS outbreak. Loeb et al. (2004), in a retrospective cohort study of 43 nurses in two critical care units with SARS patients, examined the risks for disease acquisition, reporting a trend toward increased protection from N95 masks compared with surgical masks, but this was not statistically significant. The Loeb et al. (2004) study also reported that eight of 32 nurses working with SARS patients later became infected themselves, and that three of 23 nurses (13%) who consistently wore a mask (either surgical or an N95 mask) acquired SARS compared with five of nine nurses (56%) who did not consistently wear a mask (p = .02). While the knowledge of the importance of masks and other infection control practices may be present in HCWs, compliance does not always follow. Issues such as comfort, familiarity, recognition and rapport may be compromised (Nickell et al. 2004).

We sought to study the relationship between the environmental, organizational and individual factors and self-reported compliance with regard to infection control practices. Our findings that compliance of workers with infection control is significantly affected by the organization and environment they work in but not by their personal beliefs or attitudes is encouraging and telling. There is increasing emphasis on measures to promote a healthy and safe workplace culture in healthcare (Hooper and Charney 2005; Yassi and Hancock 2005). Our finding that better safety compliance is strongly associated with a healthier organizational culture that promotes safety agree with similar results reported for the impact of organizational culture on musculoskeletal injuries (Hooper and Charney 2005; Yassi and Hancock 2005) and blood and body fluid exposure (White and Berger 1992) as shown by Gershon et al. (2000). Using a 13-item scale to measure safety climate, Gershon et al. (1995) found that respondents who perceived a strong commitment to safety at their institution were over 2.5 times more likely to be compliant than respondents who did not perceive a strong safety climate. Similar results were obtained in our study, where those with high organizational scores were almost 10 times more likely to also report high compliance. A healthy organizational culture has also been shown to improve compliance with infection control procedures such as hand washing and donning and doffing personal protective equipment properly (DeJoy et al. 1995; Larson et al. 2000).

> **There was a significant correlation between scoring in the high range for environmental factors and reporting high safety behaviour compliance, with those people scoring high on environmental factors being almost 12 times as likely to also report high compliance.**

The role of training and the perception of the level of training emerged in this study as variables of particular importance. As mentioned, the majority of workers felt that their training was below their expectations and was not sufficient. This highlights the need for ongoing infection control training of high-risk workers in direct patient contact. The SARS outbreak itself is an example of how, despite the reported use of standard and airborne infection control safety measures, the precautions were apparently incomplete or were intermittently applied, thereby resulting in occupational transmission (Centers for Disease Control and Prevention and Health Canada 2003). HCWs need refresher training throughout their careers in the basics of infection control in order to increase compliance. While much literature, research and guidelines focus on the need for training in facets of infection control, what this study suggests is that the importance of training may be less related to building knowledge or skills and more to demonstrating organizational commitment to keeping workers informed and allowing HCWs to feel confident in their organization's abilities to manage existing and emerging infections.

Previous studies have espoused the importance of tailoring infection control training to participants (Kretzer and Larson 1998). While this may be true for some demographic level characteristics, the findings here indicate that individual level characteristics such as knowledge, perception of risk and beliefs and attitudes are not as important in infection control as clear and consistent policies and management supportiveness for safety procedures. Thus, training should focus less on changing beliefs and more on ensuring that HCWs know the organization's policies, procedures and expectations. Any new occupational health initiatives geared toward infection control should thus focus on availability of resources, equipment and supplies,

management supportiveness and policies and procedures, as well as training individuals in these matters.

The strength of our findings and the conclusions we have drawn from them need to be considered in light of possible limitations in our research, including the use of cross-sectional data and reliance upon self-reported surveys for assessing the dependent and independent study variables. While of note, these possible limitations have also been offset by the consistency of the direction and strength of our findings, the large and varied sample employed that cut across traditional professional boundaries and the use of standardized assessment tools where possible. HQ

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