# Disaster and Emergency Management: Canadian Nurses' Perceptions of Preparedness on Hospital Front Lines

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**Keywords:** disaster training; emergency preparedness; first responders; infection control; infectious disease outbreaks; pandemic influenza; response community; severe acute respiratory syndrome

**Abbreviations:**
CBRN = chemical, biological, radiological, and nuclear
SARS = severe acute respiratory syndrome

**Web publication:** 20 June 2008

## Abstract

**Introduction:** Three years following the global outbreak of severe acute respiratory syndrome (SARS), a national, Web-based survey of Canadian nurses was conducted to assess perceptions of preparedness for disasters and access to support mechanisms, particularly for nurses in emergency and critical care units.

**Hypotheses:** The following hypotheses were tested: (1) nurses' sense of preparedness for infectious disease outbreaks and naturally occurring disasters will be higher than for chemical, biological, radiological, and nuclear (CBRN)-type disasters associated with terrorist attacks; (2) perceptions of preparedness will vary according to previous outbreak experience; and (3) perceptions of personal preparedness will be related to perceived institutional preparedness.

**Methods:** Nurses from emergency departments and intensive care units across Canada were recruited via flyer mailouts and e-mail notices to complete a 30-minute online survey.

**Results:** A total of 1,543 nurses completed the survey (90% female; 10% male). The results indicate that nurses feel unprepared to respond to large-scale disasters/attacks. The sense of preparedness varied according to the outbreak/disaster scenario with nurses feeling least prepared to respond to a CBRN event. A variety of socio-demographic factors, notably gender, previous outbreak experience (particularly with SARS), full-time vs. part-time job status, and region of employment also were related to perceptions of risk. Approximately 40% of respondents were unaware if their hospital had an emergency plan for a large-scale outbreak. Nurses reported inadequate access to resources to support disaster response capacity and expressed a low degree of confidence in the preparedness of Canadian healthcare institutions for future outbreaks.

**Conclusions:** Canadian nurses have indicated that considerably more training and information are needed to enhance preparedness for frontline healthcare workers as important members of the response community.

**O'Sullivan TL, Dow D, Turner MC, Lemyre L, Corneil W, Krewski D, Phillips KP, Amaratunga CA: Disaster and emergency management: Canadian nurses' perceptions of preparedness on hospital front lines.** ***Prehospital Disast Med*** **2008;23(3):s11–s18.**

## Introduction

In the wake of the terrorist attacks of 11 September, 2001, the severe acute respiratory syndrome (SARS) outbreak in Toronto, Hurricane Katrina in the southern United States, and the global threat of pandemic influenza, North Americans are becoming increasingly aware of the critical importance of healthcare workers and the services they provide to the community in response to disaster scenarios. During the 2003 SARS outbreak, emergency and critical care nurses in the Greater Toronto Area worked under extreme duress with dwindling supplies, constantly changing and conflicting infection control guidelines, widespread stigma both within and outside of the hospital, and emotionally distraught patients, visitors, and fellow co-workers.[1–3]

In response to SARS, health researchers, policy-makers, and healthcare professionals have taken steps to ensure that the healthcare system can effec-

tively respond to another outbreak or act of terrorism. Federal, provincial/territorial, and municipal jurisdictions in Canada have developed pandemic preparedness plans to ensure that the necessary operational supports are in place in hospitals so that healthcare workers can provide the best possible patient care.[4,5] It remains unclear, however, to what extent frontline Canadian healthcare workers feel prepared, or believe their institutions to be prepared, for future disasters. Understanding nurses' perceptions of preparedness and related factors is critical to design more effective preparedness strategies and training programs.

This paper presents findings on nurses' perceptions of preparedness from a national, Web-based survey conducted with emergency and critical care nurses in Canada during the summer of 2006. This survey is part of a larger project examining the roles and support needs of frontline healthcare professionals during infectious disease outbreaks.

A descriptive account of the survey findings as they relate to nurses' perceptions of preparedness for both natural catastrophes and chemical, biological, radiological, and nuclear (CBRN) attacks is provided here. The specific research questions of interest include: (1) Do nurses feel personally prepared to respond to various types of large-scale disasters or attacks? (2) Do perceptions of preparedness vary according to socio-demographic factors or outbreak experience? (3) Do nurses believe that they have adequate access to resources and support services, such as equipment, facilities, information, and psychological services, in the event of a large-scale outbreak? and (4) Do nurses perceive that their institution and institutions across Canada are prepared for future outbreaks?

It was hypothesized that nurses' sense of preparedness for infectious disease outbreaks and disasters due to natural events would be higher than for CBRN-type disasters. Furthermore, it was anticipated that perceptions of preparedness would vary according to previous outbreak experience, with more experienced nurses reporting higher perceived preparedness than less experienced nurses. Finally, it was hypothesized that perceptions of personal preparedness would be positively associated with perceptions of institutional preparedness.

## Methods

The data were obtained by means of a Web-based survey in French and English conducted across Canada between May and August 2006.

### *Survey Tool*

The survey used for this study was entitled: "Caring about Healthcare Workers as First Responders: A Survey of Nurses". The survey tool included items from the Canadian Community Health Survey (CCHS)[6] and Corneil *et al's* APEX study,[7] as well as a variety of unique survey items created by our research team. The survey contained sections to assess: (1) perceptions of preparedness; (2) previous outbreak experience and working conditions; (3) outbreak support; and (4) work satisfaction.

To assess perceptions, respondents were asked to rate their feelings of professional preparedness to respond to a large-scale infectious disease outbreak, a disaster from a natural event, nuclear attack, chemical weapons attack, biological weapons attack, nuclear attack/accident, radiological attack (dirty bombs), and chemical accidents. Responses were based on a 4-point Likert scale (1 = not at all, up to 4 = very much); respondents also could decline to respond using a fifth response option.

To gain better understanding of nurses' awareness of hospital plans and policies, respondents were asked to indicate if their institution has adequate programs and policies to respond to an outbreak. They also were asked if their institution has a formal emergency plan for an outbreak, and if so, how familiar they were with the plan. Additional questions pertained to perceived availability of a variety of routine supports for front-line workers and the adequacy of stockpiles for specific supplies in the event of a large-scale outbreak. Respondents were asked variety of to respond to statements related to infectious disease outbreaks, such as whether they felt adequately equipped and trained to respond in the event of a large outbreak. Finally, respondents were asked to indicate if they felt confident that Canadian healthcare institutions are prepared for future outbreaks; and if they felt confident they would be protected during a future, large-scale, infectious disease outbreak. A variety of demographic data also was collected, permitting evaluation of perceptions of preparedness according to a variety of such factors identified *a priori*.

### *Data Collection*

The target sample for this study was 1,500 participants. Nursing professionals who had worked in emergency departments or intensive care units during the past three years were recruited via flyer mailout, e-mail notices, and newspaper advertisements. The mailings were conducted with the assistance of provincial nursing colleges/associations from April through July 2006.

The sampling strategy was based on the number of emergency and/or critical care nurses in each Province. Flyers sent to each region approximated the regional distribution of the Canadian nursing population, taking into account the desired sample size and a predicted 10% response rate.

Potential respondents were invited to participate in the anonymous, Web-based survey in either English or French. The survey took approximately 30 minutes to complete. The study protocol was reviewed and approved by the University of Ottawa Research Ethics Board.

### *Statistical Process*

All statistics were calculated using SAS version 9.1.8. Descriptive statistics were used to characterize perceptions related to individual, institutional, and health system preparedness, as well as available organizational supports. A within-subjects multivariate analysis of variance (MANOVA) was conducted to examine perceptions of preparedness across different types of disasters. A between-subjects MANOVA was conducted to examine if perceptions of preparedness varied according to a range of social and demographic factors. A statistical significance level of $p < 0.01$ was used in all analyses. Pearson correlation co-efficients

| | n | Radiological Attack | Nuclear Attack/ Incident | Biological Weapons Attack | Chemical Weapons Attack | Chemical Accidents | Natural Disaster | Infectious Disease Outbreak |
|---|---|---|---|---|---|---|---|---|
| | 1,536 | 1.32 (0.68)[a] | 1.34 (0.69)[a] | 1.44 (0.75)[b] | 1.44 (0.76)[b] | 1.92 (0.85) | 2.35 (0.91)[c] | 2.35 (0.85)[c] |
| Gender | | | | | | | | |
| Female | 1,388 | 1.28 (0.62) | 1.30 (0.64) | 1.40 (0.70) | 1.40 (0.71) | 1.88 (0.84) | 2.31 (0.90) | 2.33 (0.84) |
| Male | 146 | 1.64 (1.03) | 1.66 (1.03) | 1.77 (1.03) | 1.85 (1.05) | 2.24 (0.94) | 2.73 (0.91) | 2.51 (0.93) |
| Employment Category | | | | | | | | |
| Civilian | 1,432 | 1.32 (0.69) | 1.34 (0.69) | 1.44 (0.76) | 1.45 (0.77) | 1.91 (0.85) | 2.35 (0.91) | 2.34 (0.85) |
| Military | 101 | 1.17 (0.49) | 1.25 (0.61) | 1.30 (0.59) | 1.33 (0.62) | 1.94 (0.86) | 2.39 (0.95) | 2.43 (0.88) |
| Employment Status | | | | | | | | |
| Full-Time | 990 | 1.37 (0.74) | 1.38 (0.75) | 1.49 (0.80) | 1.50 (0.81) | 1.95 (0.86) | 2.33 (0.92) | 2.37 (0.87) |
| Part-Time | 540 | 1.22 (0.54) | 1.25 (0.57) | 1.34 (0.65) | 1.34 (0.64) | 1.86 (0.85) | 2.38 (0.90) | 2.31 (0.83) |
| Outbreak Experience | | | | | | | | |
| Yes | 747 | 1.29 (0.65) | 1.31 (0.66) | 1.42 (0.74) | 1.43 (0.75) | 1.94 (0.87) | 2.38 (0.91) | 2.42 (0.87) |
| No | 749 | 1.34 (0.71) | 1.36 (0.73) | 1.45 (0.76) | 1.46 (0.78) | 1.90 (0.84) | 2.33 (0.91) | 2.28 (0.84) |
| Prior SARS Exposure | | | | | | | | |
| Yes | 181 | 1.49 (0.85) | 1.50 (0.83) | 1.61 (0.92) | 1.58 (0.89) | 2.02 (0.93) | 2.33 (0.97) | 2.61 (0.88) |
| No | 1,288 | 1.29 (0.65) | 1.31 (0.67) | 1.41 (0.72) | 1.43 (0.74) | 1.90 (0.84) | 2.36 (0.90) | 2.32 (0.84) |
| Education | | | | | | | | |
| ≥Bachelor's | 668 | 1.32 (0.68) | 1.34 (0.70) | 1.45 (0.76) | 1.48 (0.79) | 1.93 (0.86) | 2.37 (0.92) | 2.33 (0.85) |
| <Bachelor's | 741 | 1.28 (0.63) | 1.30 (0.64) | 1.38 (0.69) | 1.39 (0.70) | 1.90 (0.83) | 2.31 (0.90) | 2.34 (0.86) |
| Marital Status | | | | | | | | |
| Married | 1,096 | 1.28 (0.65) | 1.30 (0.66) | 1.40 (0.72) | 1.40 (0.74) | 1.88 (0.85) | 2.30 (0.92) | 2.31 (0.86) |
| Single | 429 | 1.41 (0.74) | 1.43 (0.76) | 1.53 (0.80) | 1.56 (0.81) | 2.01 (0.85) | 2.47 (0.87) | 2.45 (0.82) |
| Dependent Children | | | | | | | | |
| Yes | 785 | 1.32 (0.70) | 1.33 (0.70) | 1.43 (0.76) | 1.44 (0.78) | 1.90 (0.86) | 2.36 (0.93) | 2.33 (0.85) |
| No | 694 | 1.31 (0.66) | 1.34 (0.68) | 1.44 (0.73) | 1.45 (0.74) | 1.91 (0.84) | 2.34 (0.89) | 2.35 (0.85) |
| Workplace | | | | | | | | |
| Urban | 1,244 | 1.32 (0.68) | 1.34 (0.70) | 1.44 (0.75) | 1.45 (0.76) | 1.91 (0.85) | 2.36 (0.91) | 2.35 (0.84) |
| Rural | 271 | 1.27 (0.63) | 1.31 (0.64) | 1.36 (0.68) | 1.38 (0.72) | 1.94 (0.84) | 2.32 (0.92) | 2.35 (0.89) |
| Age Group (years) | | | | | | | | |
| ≤35 | 532 | 1.34 (0.67) | 1.36 (0.68) | 1.46 (0.73) | 1.47 (0.74) | 1.86 (0.81) | 2.32 (0.86) | 2.20 (0.79) |
| 36–45 | 497 | 1.36 (0.77) | 1.37 (0.76) | 1.45 (0.80) | 1.45 (0.80) | 1.99 (0.92) | 2.36 (0.92) | 2.40 (0.87) |
| ≥46 | 507 | 1.24 (0.60) | 1.28 (0.63) | 1.40 (0.72) | 1.41 (0.72) | 1.90 (0.83) | 2.37 (0.95) | 2.45 (0.88) |
| Region | | | | | | | | |
| Atlantic | 196 | 1.18 (0.55) | 1.20 (0.57) | 1.30 (0.69) | 1.29 (0.70) | 1.80 (0.80) | 2.16 (0.90) | 2.17 (0.82) |
| Quebec | 341 | 1.50 (0.78) | 1.54 (0.81) | 1.68 (0.81) | 1.68 (0.82) | 1.89 (0.83) | 2.52 (0.85) | 2.43 (0.77) |
| Ontario | 475 | 1.36 (0.73) | 1.39 (0.73) | 1.46 (0.78) | 1.47 (0.80) | 1.93 (0.86) | 2.26 (0.94) | 2.51 (0.87) |
| Prairies | 119 | 1.11 (0.50) | 1.11 (0.50) | 1.17 (0.54) | 1.20 (0.58) | 1.84 (0.78) | 2.15 (0.88) | 1.96 (0.82) |
| Alberta | 226 | 1.27 (0.61) | 1.28 (0.62) | 1.41 (0.69) | 1.43 (0.71) | 2.11 (0.88) | 2.62 (0.89) | 2.29 (0.85) |
| BC | 164 | 1.16 (0.51) | 1.16 (0.51) | 1.23 (0.57) | 1.24 (0.58) | 1.87 (0.90) | 2.23 (0.83) | 2.27 (0.88) |



**Table 1**—Perceptions of preparedness to respond to large scale attacks/disasters by social and demographic factors (mean score (SD)). (BC = British Columbia; SARS = severer acute respiratory syndrome)
Notes: Mean response scores represent positive responses only; Scale from 1 to 4
Similar subscripts (e.g., a,b,c) indicate no significant difference in post-hoc paired *t*-test ($p > 0.01$).
** Note: The sums of individual cells do not add up to the total, due to missing values.



https://doi.org/10.1017/S1049023X00024043 Published online by Cambridge University Press

were calculated to relate responses of various opinion statements to perceptions of preparedness.

## Results

A total of 1,543 nurses responded to the survey (90% female; 10% male). More than 97% of respondents were registered nurses and more than 90% worked in an emergency department or intensive care unit at the time the survey was completed; 81.6% of the nurses worked in an urban area. Respondents who indicated previous outbreak experience (n = 752; 48.7%) completed filtered questions relating to their outbreak experience.

Mean values for the ratings of perceived preparedness to respond to large-scale disaster scenarios are in Table 1. Ratings of perceived preparedness varied significantly according to the type of disaster scenario, $F(6,1530) = 448.32$, $p < 0.0001$. Respondents reported higher ratings of preparedness for responding to an infectious disease outbreak and a disaster due to natural hazards, and lower ratings of preparedness for CBRN events, (radiological and nuclear attacks/accidents in particular). Ratings of perceived preparedness varied significantly by gender, $F(7,1526) = 8.22$, $p < 0.0001$; employment status, $F(7,1522) = 4.87$, $p < 0.0001$; previous outbreak experience, $F(7,1488) = 2.80$, $p < 0.01$; previous SARS exposure, $F(7,1461) = 6.54$, $p < 0.0001$; age group, $F(14,3054) = 4.38$, $p < 0.0001$; and region of employment, $F(35,6350) = 7.47$, $p < 0.0001$.

Follow-up univariate analyses of variance indicated that, with the exception of preparedness for an infectious disease outbreak, women perceived that they were less prepared for all scenarios than did men (all $p$-values <0.0001). Nurses employed full-time reported higher levels of preparedness for a chemical weapons attack, $F(1,1531) = 15.76$, $p < 0.0001$; biological weapons attack, $F(1,1530) = 12.24$, $p < 0.001$; nuclear attack/accident, $F(1,1530) = 13.54$, $p < 0.001$; and a radiological attack, $F(1,1531) = 15.89$, $p < 0.0001$ than did nurses employed on a part-time basis.

Nurses who had been involved in an infectious disease outbreak in the previous three years reported higher perceptions of preparedness for a large-scale infectious disease outbreak compared to those with no outbreak experience, $F(2,1539) = 12.78$, $p < 0.0001$. Similarly, nurses who had provided direct patient care for a person with SARS in the previous three years reported higher levels of preparedness for a large-scale infectious disease outbreak, $F(1,1472) = 18.64$, $p < 0.0001$; for a biological weapons attack, $F(1,1469) = 11.36$, $p < 0.001$; nuclear attack/accident, $F(1,1468) = 12.03$, $p < 0.001$; and for a radiological attack, $F(1,1469) = 12.75$, $p < 0.001$.

Perceptions of preparedness for a large-scale infectious disease outbreak, varied significantly by age group $F(2,1539) = 12.78$, $p < 0.0001$ with nurses <46 years of age indicating a higher perception of preparedness than did younger nurses. Lastly, perceptions varied significantly by region of employment for each scenario considered, with all $p$-values ranging from <0.01 to <0.0001 (Table 1).

The nurses' perceptions of the adequacy of the supplies in their institution for responding to a large-scale outbreak are summarized in Table 2. Respondents reported that their institutions had the most adequate supplies of gloves, gauze, and masks, and the least adequate supplies of emergency food and water, isolation facilities, and ventilators. High proportions of respondents (range 10.2 to 53.1%) reported that they did not know (or had no answer) regarding the adequacy of nearly all of the supplies/resources listed.

Findings related to perceived availability of a variety of institutional supports for frontline healthcare workers are listed in Table 3. Respondents most frequently indicated that their institution provides employee assistance programs, access to the Internet, and access to grief counseling. However, respondents reported that their institutions tend not to provide continuing education on emergency planning. In the event of a large-scale outbreak/disaster, the majority of respondents (range 62.2 to 67.1%) indicated that their institution does not provide childcare, eldercare, or petcare support; however for these questions approximately one-third of the respondents indicated that they did not know (or had no answer).

With respect to knowledge of institutional emergency plans, <50% of all respondents indicated that their institution has a formal emergency plan for a large-scale outbreak (yes = 44.6%; no = 15.3%). A nearly equal proportion of this sample of nurses (40.1%) did not know (or had no answer). Among those with a positive response, there was a tendency for respondents to indicate that they were familiar with the policies and procedures pertaining to their role in the emergency plan (mean score = 3.4 ±1.13). Of this sample, 9.1% of nurses indicated that they had participated in emergency drills for infectious disease outbreaks in their institution (90.3% stated "no", and 0.6% did not know or had no answer). With respect to a family emergency plan for a major outbreak or disaster, 24.0% of the respondents indicated that they had a plan, 73.0% reported having no plan, and 3.0% responded "don't know" or had no answer.

Mean response values for opinion statements regarding personal, institutional, and health system preparedness are listed in Table 4. Respondents reported feeling inadequately equipped and trained to work during an infectious disease outbreak (mean score = 2.52 ±1.21). However, responses were neutral regarding the existence of adequate institutional programs and policies to respond to a large-scale outbreak (mean score = 3.03 ±1.16). Nurses reported low confidence toward preparedness of Canadian healthcare institutions (mean score = 2.31 ±1.12). Similarly, they reported low levels of confidence that they would be protected during a large-scale infectious disease outbreak (mean score = 2.15 ±1.06). Correlation coefficients between responses to opinion statements and perceptions of preparedness for various attack/disaster scenarios are listed in Table 4. Moderate positive correlations were observed between perceptions of being adequately equipped and trained to respond to infectious disease outbreaks and perceptions of preparedness ($r = 0.51$ and $r = 0.45$, respectively). Opinion statements regarding the adequacy of equipment, institutional programs and policies, and confidence in the Canadian healthcare system to protect them during infectious disease outbreaks were more positively correlated with perceptions of preparedness for infectious disease out-

| Supply/Resource | Yes (%) | No (%) | Don't Know/No Answer (%) |
|---|---|---|---|
| Gloves | 72.1 | 11.0 | 17.0 |
| Gauze | 64.6 | 12.5 | 22.9 |
| Masks | 62.3 | 19.8 | 18.0 |
| Gowns | 51.2 | 28.6 | 20.3 |
| Bedding | 30.4 | 35.3 | 34.3 |
| Laundry Facilities | 29.9 | 34.0 | 36.1 |
| Ventilators | 18.5 | 59.0 | 22.5 |
| Isolation Facilities | 15.6 | 74.3 | 10.2 |
| Emergency Food and Water | 11.1 | 35.7 | 53.1 |



Table 2—Perceived institutional adequacy of supplies and resources in the event of a large-scale outbreak (percent)

| Supply/Resource | Yes | No | Don't Know/No Answer |
|---|---|---|---|
| Routine Supports | | | |
| Employee Assistance Program | 84.4 | 8.8 | 6.7 |
| Access to the Internet at work | 83.8 | 15.3 | 0.9 |
| Access to grief counseling as needed | 75.5 | 12.5 | 12.0 |
| Updates on global surveillance of infectious diseases | 35.9 | 53.4 | 10.7 |
| Continuing education on emergency planning | 29.6 | 59.8 | 10.6 |
| Supports in the event of a large-scale outbreak/disaster | | | |
| Childcare support | 4.8 | 62.2 | 33.0 |
| Eldercare support | 1.4 | 64.9 | 33.8 |
| Petcare support | 0.6 | 67.1 | 32.3 |



Table 3—Perceived institutional supports available for front-line workers (percent)

| | Mean ±SD | Radiological attack | Nuclear attack/ accident | Biological weapons attack | Chemical weapons attack | Chemical accidents | Natural disaster | Infectious disease outbreak |
|---|---|---|---|---|---|---|---|---|
| Do you feel adequately equipped to work during an infectious disease outbreak? | 2.52 ±1.21 | 0.21 | 0.22 | 0.25 | 0.23 | 0.29 | 0.37 | 0.51 |
| Are you adequately trained to deal with infectious disease outbreaks? | 1.78 ±1.22 | 0.17 | 0.17 | 0.23 | 0.19 | 0.23 | 0.27 | 0.45 |
| Does your institution have adequate programs and policies to respond to a large-scale outbreak? | 3.03 ±1.16 | 0.22 | 0.24 | 0.25 | 0.27 | 0.25 | 0.30 | 0.34 |
| In general, since the 2003 SARS outbreak, do you feel confident that Canadian health care institutions are prepared for future outbreaks? | 2.31 ±1.12 | 0.20 | 0.19 | 0.24 | 0.22 | 0.18 | 0.22 | 0.32 |
| As a healthcare professional, do you feel confident that the Canadian healthcare system will protect you during a large-scale infectious disease outbreak? | 2.15 ±1.06 | 0.23 | 0.23 | 0.26 | 0.26 | 0.18 | 0.25 | 0.32 |



Table 4—Correlation coefficients between opinion statements and perceived level of preparedness to respond to a variety of attack/disaster scenarios (SARS = severe acute respiratory syndrome)
Note: All correlation coefficients are significant at the $p < 0.001$ level. Response scale for opinion statements reflects 5-point Likert scale ranging from 1 = not at all to 5 = very much.



https://doi.org/10.1017/S1049023X00024043 Published online by Cambridge University Press

breaks (range: $r = 0.32$ to $r = 0.34$) than other disasters due to natural hazards and aggressive attacks (range: $r = 0.18$ to $r = 0.30$).

## Discussion

Overall, the results of the current survey demonstrate that Canadian nurses who work in emergency departments and/or intensive care units do not feel adequately prepared to respond to a variety of disaster scenarios. In particular, perceptions of preparedness were low for CBRN scenarios, with the lowest confidence reported for radiological and nuclear attacks. Studies with nurses and other healthcare workers in the US also have found low levels of knowledge and confidence to respond to bioterrorism scenarios.[9–11] Given the malicious intent and negative socio-political outcomes of CBRN events, these types of disasters are quite distinct from naturally occurring infectious disease outbreaks or other nature-related disasters.[12] According to Hall *et al*,[12] political agendas, revenge, or punishment all may serve as motivation behind CBRN terrorist acts. Furthermore, terrorism has several aims, including the desire to coerce a target audience through inflicting fear and damage, and to disrupt feelings of security and social infrastructure.[13]

To date, CBRN attacks have been rare in Canada, whereas Canadian nurses routinely are exposed to a variety of infectious disease outbreak scenarios. The most serious outbreak in recent history was the 2003 SARS epidemic. In the current study, the influence of previous outbreak experience was found to exert an influence on nurses' perceptions of preparedness. This finding suggests that exposure to outbreaks of either known infectious agents (e.g., clostridium difficile) or unknown agents (e.g., SARS) helps to enhance nurses' sense of preparedness for large-scale infectious disease outbreaks.

Differences in perceptions of CBRN scenarios were recently highlighted in a large-scale telephone survey of Canadians in the general population.[14] Perceptions of CBRN terrorism varied, with nuclear terrorism receiving the highest ratings in terms of severity and personal impact, and the lowest ratings in terms of perceived ability to cope should such an attack occur. Radiological and nuclear attacks as risk issues have long been associated with high levels of dread and as such require specialized risk management efforts.[15–17] Recent studies in the US also have highlighted differences in risk communication initiatives required across different terrorism scenarios.[15,18–20]

Based on the current findings and other studies of healthcare workers, it appears that preparedness planning for CBRN scenarios (radiological and nuclear attacks in particular) requires additional specific training efforts to enhance perceptions of preparedness.[9,21,22] Increasing preparedness for attack scenarios, through specific planning and training efforts, also may improve general preparedness for multiple health hazard scenarios.[23,24]

In this study, a variety of demographic factors were found to exert an influence on nurses' perceptions of preparedness. In particular, women, part-time nurses, and nurses with no previous outbreak experience, and specifically with no experience in the SARS outbreak, reported lower levels of preparedness than did men, full-time nurses, and nurses with outbreak experience. Indeed, perceptions of preparedness may reflect a variety of personal and system-level factors.

Demographic differences in risk perceptions are well established.[16,25–27] Studies of risk perception around the world, including terrorism risk perceptions, have shown that women tend to report higher levels of perceived risk and worry than do men.[14,27–29] A recent study in Canada found that while women reported having thoughts about engaging in a variety of terrorism preparedness behaviors more frequently than did men, women also engaged in preparedness behaviors less frequently than did men.[30] Although the precise factors responsible for lower levels of preparedness among women are unclear, a complex interplay of risk and worry may be partially responsible, likely in conjunction with a variety of other social or psychological factors including family responsibilities (see below). It is clear however, that gender differences in perceived preparedness among nurses require further examination, and the perceived inadequacy of training and support programs reflect such needs.

Previous outbreak experience (particularly with SARS), as well as full-time work, were associated with greater levels of preparedness in this study. A plausible explanation is that greater experience may lead to increased confidence and mastery. In the risk perception literature, higher levels of knowledge and familiarity with the hazard typically are associated with lower levels of perceived risk.[31,32] During the SARS outbreak, part-time hospital staff reportedly experienced higher levels of emotional distress than did full-time staff.[33] Full-time employment may facilitate enhanced confidence for preparedness and response by accumulation of more experience. Initiatives drawing upon the experience of nurses with significant outbreak or disaster exposure may represent a useful training approach.[34]

The findings from this study show that region of employment also was related to perceptions of preparedness. Nurses employed in Ontario and Quebec reported the highest levels of preparedness. Although the reasons for this finding are unclear, healthcare systems in Canada are organized by province, and as such resources, working conditions, training opportunities, and other salient factors related to management and preparedness may differ accordingly.[35] Previous studies have shown that risk perceptions in Canada vary by region.[16] The differences in preparedness observed in this study also may reflect differential perceptions regarding the threat of such disasters and attacks by region. Efforts to increase perceptions of preparedness are needed across Canada, perhaps particularly so among those regions with the lowest perceived preparedness ratings.

Although concerns regarding family and children were salient in previous studies of the psychosocial effects of the SARS outbreak on healthcare workers,[2,33] perceptions of preparedness did not differ according to whether the respondent had dependent children. There was a tendency for single nurses to report slightly higher levels of preparedness than married nurses across all types of disasters, which may reflect the need for the protection of family or difficulties associated with dual-role conflict.[36,37]

The majority of respondents reported that their institution offers no family care supports in the event of a large-scale outbreak or disaster. Further examination of the specific, family-related supports required by nurses and their dissemination is required.[37,38]

As with Canadian nurses, low levels of terrorism-related preparedness also were recently reported among Canadians in the general population.[30] Respondents in a recent general population telephone survey reported that they have thought about and have actually engaged in terrorism-related preparedness behaviors to a small extent. The low levels of preparedness reported among members of the general public may be related to the fact that they also reported beliefs that terrorism posed a low risk to Canadians.[27,39] Another recent risk perception study in Canada indicated that flu epidemics were perceived as posing a low risk to the health of Canadians.[16] However, no analogous information was collected in the current survey.

The majority of nurses in the current survey reported they had no family emergency plan in place in the event of a large-scale outbreak or disaster, and fewer than 10% of the nurses had participated in emergency drills for infectious disease outbreaks in their institution. Given the need for family supports and previous studies showing benefits of training drills for enhancing healthcare worker knowledge,[24] the imperative for personal planning and regular participation in emergency response drills appears to be critical for effective preparedness and response.[38,40]

The findings from this study show an extensive lack of awareness of institutional emergency plans, and lack of access to continuing education on emergency planning and infection control. This finding underscores the need to further examine training programs and stockpiling of supplies for disasters. A survey of healthcare workers in the US reported that the majority of workers were unsure of their hospital's level of preparation in the event of a terrorist attack.[41] Further research to define preparedness in the context of nursing and to delineate the most effective and efficient methods for training of healthcare workers is needed.[24,42,43]

Respondents here reported only moderate levels of confidence in Canadian healthcare institutions to respond to future outbreaks. Similarly, in another study, members of the Canadian general population perceived institutions at all levels, including hospitals and healthcare services, as being only moderately prepared for terrorism.[30] Although the specific reasons for these findings are unknown, preparedness and coordination of all parts of the health system requires a complex interplay of multiple, hierarchical players with efficient and effective communication and organizational requirements. Transparency of institutional and health system authorities fosters trust and may prove an important component of preparedness planning at any level.[30,44]

Opinion statements regarding the adequacy of equipment, institutional programs and policies, and confidence in the Canadian healthcare system to protect them during infectious disease outbreaks were more strongly correlated with perceptions of preparedness for infectious disease outbreaks as well as other disaster and attack scenarios, and may point to specific opportunities to strengthen preparedness perceptions. Future analyses will examine the complex relationships between survey constructs and how they may cluster.

The demographics of this sample of nurses are representative of the Canadian nursing workforce. The current survey included 90% women, and based on reports from the Canadian Institute of Health Information, 94% of nurses in Canada are women.[45] The majority of respondents in this survey worked in an urban area (81.6%), and despite Canada's vast rural geography, this is representative of the wider Canadian healthcare workforce, 83% of whom work in urban areas.[46]

The mean values for the ages of the nurses was not collected in this survey; instead age was determined as a categorical variable, dividing the sample into three age cohorts, which were similarly represented in this survey (34% <35 years old; 32% were 36–45-years-old; and 33% >45 years old). The age categories were divided differently in the CIHI report on the regulated nursing workforce in Canada,[45] however, they reported that 78% of nurses were >35 years of age, whereas in this study 65% of the nurses were >35 years of age. The high proportion of nurses >35 years of age in both surveys is consistent with the aging healthcare workforce, which is well-documented in the literature.[46]

Several limitations of this study should be considered. The low response rate observed compared with the total Canadian population of nurses may have introduced bias into the results, particularly as the sample is self-selected for online participation. However the sample was broadly representative of the nursing population in Canada by region. Differences in perception by region may reflect language-based differences in responses. Surveys were translated from English to French and evaluated by bilingual researchers for equivalency of terms. In addition, the survey did not assess actual levels of knowledge for recognition or treatment of specific CBRN diseases/symptoms, nor did it assess the specific elements of disasters that the nurses perceived they were unprepared for. And the question regarding adequate supplies of equipment was presented as a list without differentiation of specific types of equipment (e.g., type of mask). Lastly, no information was collected regarding willingness or motivation for training, or the nature of training that nurses desire.

## Conclusions

Nurses have played and will continue to play key roles in emergency response.[47] This study found that nurses perceived themselves and Canadian institutions as under-prepared for a large-scale disaster. Further training of nurses is required, taking into account the unique characteristics of different types of disasters. Future research should further examine potential, gender-based differences in perceptions of preparedness for such disasters, and the implications of such differences on training needs. Studies assessing how perceptions of preparedness change over time also are required in order to gauge how perceptions may vary as new events unfold. Tracking of perceptions of preparedness over time also will facilitate evaluation of the effectiveness of modern emergency response training programs.

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https://doi.org/10.1017/S1049023X00024043 Published online by Cambridge University Press