

ORIGINAL RESEARCH

Evaluating nurses' preparedness in critical incidents

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ABSTRACT

Objective: This study aims to evaluate the preparedness and training of Canadian nurses in critical incidents.

Methods: *Design:* An observational cross-sectional survey through a self-administered web-based questionnaire. *Setting:* The questionnaire was shared with nurses working in emergency departments, intensive care units, and coronary care units at five hospitals affiliated with McGill University in Montreal (Quebec, Canada). *Participants:* In total, 145 nurses completed the questionnaire. It was sent through email to nurse managers and assistant nurse managers working in the emergency department, adult intensive care unit, and cardiac care unit at four academic hospitals. *Main Outcome Measured:* level of preparedness and skills of nurses to deal with critical incidents.

Results: Most nurses have not participated in a disaster management (code orange) simulation (64.8%, n = 94). Moreover, around half of them knew their specific role in such a simulation (49.6%, n = 72). The vast majority of participants (78.6%, n = 114) never took part in a real code orange scenario. On multiple logistic regression, having > 10 years of experience in nursing, having > 10 years of experience in critical care, participating in a code orange simulation, knowledge of roles and responsibilities during a code orange situation, and having knowledge of the department's code orange plan, were significantly associated with a higher level of preparedness.

Conclusions: This study shows a lack of nurses' preparedness in dealing with critical incidents based on their self-assessment. Confidence and knowledge of skills associated with BLS and ACLS were noted to be essential for a high level of preparedness.

Key Words: Nursing preparedness, Critical incidents, BLS, ACLS

1. BACKGROUND

The frequency of disasters, whether man-made or natural, is increasing worldwide.^[1-3] Disasters take place on average once a week somewhere in the world.^[4] With the high number of natural disasters taking place annually (around 150 per year), the recent COVID-19 pandemic and the surge in terrorist attacks like the Christchurch Mosque shooting, the disaster preparedness of medical systems became an international concern.^[5] These critical incidents, defined as disasters or any event involving death and destruction, result in numerous losses of human life and serious destruction

of properties and infrastructure.^[6] The resulting injuries can rapidly overwhelm the medical facilities.^[7] Therefore, trauma centers' response and the presence of established protocols in these centers are essential components of disaster preparedness. Specifically, in most Canadian hospitals, the emergency protocol for a disaster is the "code orange".^[8] When activated, it signals the need for medical services that are beyond the hospital's normal operations to ensure that the rapid increase in patients is met with the appropriate number of health personnel.^[9] However, worldwide studies, including in the United States and Canada, have shown that trauma

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centers' disaster preparedness is suboptimal.^[10] Many health professionals working in critical care and emergency feel like they are not ready for a crisis.^[11]

During critical incidents, such as natural disasters, it is vital to have individuals equipped with skills acquired through Advanced Cardiac Life Support (ACLS) and Basic Life Support (BLS) to ensure adequate response.^[12] BLS and ACLS provide essential skills that are used in management protocols dealing with mass casualty incidents.^[13,14] Despite their importance, these skills are a major weakness of some emergency medical response teams.^[15] Numbers-wise, nurses are the largest group of health professionals on a team called to deal with a critical incident.^[16,17] Several studies have shown that nurses' BLS and ACLS skills degrade faster than knowledge.^[18] Additionally, many papers have also found that nurses do not feel confident or prepared to deal with disasters.^[19]

In one of Australia's trauma centers, Corrigan et al. found that only 38% of participants attended a disaster drill simulation and 13% participated in a real-life disaster. The majority felt "not prepared" or "unsure" about their disaster preparedness.^[20] In Canada, a cross-sectional survey of level 1 trauma centers in 2009 showed that 43% had not conducted a recent disaster drill scenario.^[21] The recent increase in disasters worldwide led to changes in disaster policies, which highlighted the need to enhance nurses' competencies in critical incidents.^[22,23] To attain such disaster competencies, nurses require knowledge, skills and attitudes pertaining to disasters.^[24] Nevertheless, several studies showed a lack of disaster training in nursing curricula.^[25,26] To our knowledge, no Canadian studies have been performed to assess Canadian nursing preparedness in critical incidents. This study aims to assess the critical incident preparedness of nurses working in the McGill University Health Centre (MUHC), a major healthcare network in Montreal, Quebec, Canada.

2. METHODS

2.1 Study design

Our study is an observational cross-sectional survey through self-administered web-based questionnaires constructed with a secure and encrypted platform LimeSurvey (v3).^[17] The questionnaire was developed based on previously published surveys.^[17] Feedback from trauma two surgeons, three nurse clinicians, and two nurse educators with more than 10 years of experience in trauma and critical care was received to ensure clarity and relevance.^[17,28] Similar to other studies, a 5-point Likert scale was used to rate the survey items, ranging from 1 = not relevant to 5 = relevant.^[29] The reviewers had two weeks to review the items; four items were deemed not relevant by the majority of the reviewers and therefore

deleted. The McGill University Faculty of Medicine and Health Sciences Institutional Review Board approved the study (IRB Review Number: A04-E25-20B (20-04-050)).

2.2 Survey content

The survey was developed in French and English and divided into two sections. In the first section, general demographic, respondents were asked to provide basic demographic and employment information.^[30] The second section included essential nursing activities (13 activities) performed during critical incidents as per the ACLS and BLS curriculum and critical incidents and simulation experience.^[31-36]

Respondents were asked to rate each activity based on their level of self-perceived preparedness. The rating was done using a five-point Likert scale with the responses "not at all prepared (1 point)", "not prepared (2 points)", "neutral (3 points)", "prepared (4 points)", "very well prepared (5 points)", in line with other published surveys, such as the Emergency Preparedness Information Questionnaire, assessing nurses' preparedness and comfort.^[34,37-39] In the second section, education, respondents were asked to indicate if they received BLS and/or ACLS certifications.^[34] Moreover, respondents were asked about their participation in past simulations or real experiences associated with critical incidents, such as mass casualties. They also indicated whether they knew their role in a disaster scenario and if they were aware of disaster management protocols in their institution.^[40,41]

2.3 Nursing preparedness score (NPS)

Similar to the score computed by Noguchi et al., a nurse preparedness score (NPS) was calculated based on the items included in the self-perceived level of preparedness found in the second section of the survey.^[38] All 13 items included correspond to essential trauma and critical care skills outlined in the Basic Life Support (BLS) and Advanced Cardiovascular Life Support (ACLS) courses, and the practical experience of the survey reviewers. The maximum possible score was 65, given that all items were rated at 5 on the Likert scale. On the flip side, if all items were rated 1, the minimum possible score was 13. Additionally, in line with Noguchi et al., two categories of respondents were determined based on the NPS: a high level of preparedness if the score was equal or above the median, and a low level of preparedness if the score was below the median.^[38] Despite being in line with Noguchi et al., the items corresponding to skills outlined in BLS and ACLS courses, and items validated by experts, no statistical analysis was done on the survey for reliability and validity.

2.4 Survey dissemination

Between October 2020 and April 2021, inclusively, the questionnaire was sent through email to Nurse Managers (NM)

and Assistant Nurse Managers (ANM) working in the Emergency Department (ED), Adult Intensive Care Unit (ICU), and Cardiac Care Unit (CCU) at four hospitals affiliated with the MUHC (Royal Victoria Hospital, Montreal General Hospital, Jewish General Hospital, St. Mary's Hospital). The questionnaire was then disseminated through email by the NMs and ANMs to a convenience sample of nurses, all of whom were working in their respective departments as they were more likely to care for critically ill patients.^[42] Respondents were informed that their participation was completely anonymous and voluntary, and instructed to fill it once. All data was secured on a password-protected file that was only accessible by the lead authors. Missing data was excluded from the study.

2.5 Endpoints and covariates

The primary endpoint of this study is the level of preparedness (high or low) based on the NPS. General demographics, experience in resuscitation, number of years of experience in nursing, number of formal training in trauma care, participation in a mass casualty simulation, and knowledge of institution-specific protocols were included as covariates.

2.6 Statistical analysis

Baseline demographics were presented. Univariate analysis and logistic regression analysis were performed to identify variables associated with a higher level of preparedness. All statistical analyses were performed using Stata 16.1 (Stata Corp LLC, TX, USA). All p-values were two-sided, and the significance threshold was set at $p = .05$.

3. RESULTS

A total of 145 nurses completed the online survey. The general demographics are presented in Table 1. Most of them were women ($n = 123, 84.8\%$), between 31- 40 years of age ($n = 49, 33.8\%$), and working in the ED ($n = 112, 77.8\%$). Almost an equal number of participants had below ($n = 78, 53.7\%$) or above ($n = 67, 42.2\%$) 10 years of experience in nursing. Regarding experience in the critical care setting, the majority had between 1-10 years of experience ($n = 82, 56.6\%$) and 11-20 years ($n = 42, 29.0\%$). Almost all nurses ($n = 134, 92.4\%$) have participated in the obligatory continuing education activities required by their professional order. Only 51 participants (35.2%) had previously participated in a code orange simulation and among those, only ($n = 16, 31.4\%$) had taken part in one in the last two years. Eighty-four (57.9%) of nurses completed both BLS and ACLS courses.

The mean Likert scale score of each nursing activity in critical care settings is shown in Table 2. Starting blood transfusion ($M = 4.81, SD = +/- 0.40$), performing CPR ($M = 4.48,$

$SD = +/- .67$), and determining the Glasgow Coma Score ($M = 4.58, SD = +/- .57$) were the three skills most highly rated by participating nurses. Inversely, ensuring intraosseous (IO) access ($M = 2.91, SD = +/- 1.29$) was the skill that nurses felt the least prepared to perform.

Table 1. General demographics of the study population

		N (%)
Age	20-30 years	46 (31.7)
	31-40 years	49 (33.8)
	41-50 years	35 (24.1)
	51-60 years	14 (9.7)
	> 60 years	1 (0.7)
Gender	Female	123 (84.8)
	Male	22 (15.2)
Department	Adult Intensive Care Unit	15 (10.4)
	Coronary care unit	17 (11.8)
	Emergency Department	112 (77.8)
Years of experience in nursing	< 1 year	5 (3.4)
	1-10 years	73 (50.3)
	11-20 years	42 (29.0)
	21-30 years	18 (12.4)
	>30 years	7 (4.8)
Years of experience in critical care setting	< 1 year	8 (5.5)
	1-10 years	82 (56.6)
	11- 20 years	40 (27.6)
	21-30 years	11 (7.6)
	>30 years	4 (2.8)
Mandatory educational requirements	No	11 (7.6)
	Yes	134 (92.4)
Participation in a real code orange	No	114 (78.6)
	Yes	31 (21.4)
Participation in a code orange simulation	No	94 (64.8)
	Yes	51 (35.2)
Last code orange simulation	>2 years	31 (66)
	1 year - 2 years	16 (34)
Knowledge of roles and responsibilities during code orange	No	72 (49.7)
	Yes	73 (50.3)
Knowledge of institutional protocol	No	65 (44.8)
	Yes	80 (55.2)
BLS only	Yes	51 (35.2)
ACLS only	Yes	6 (4.1)
ACLS and BLS	Yes	84 (57.9)

The median NPS score of the responders was 52, with a minimum of 23 and a maximum of 65. In total, 72 nurses were included in the low-level preparedness group, as their NPS score was below the median score of the entire group and 73 nurses were included in the high-level preparedness group. Age, sex, experience in resuscitation settings, number of years of experience in nursing, number of experiences in critical care, participation in a code orange simulation, knowledge of individual's role in such a simulation, knowledge of

hospital protocols during code orange, participation in real-life code orange, and completion of life support courses were significantly associated with a higher level of preparedness. Table 3.

Table 2. The mean level of self-reported preparedness for each nursing activity in critical settings

Trauma Skill	Mean	SD	Median
Evaluating airway	4.34	.63	4
Jaw thrust maneuver	3.74	1.10	4
Chin lift maneuver	4.05	.89	4
Inserting NPA	3.64	1.19	4
Inserting OPA	3.51	1.20	4
Ambu Mask ventilation	4.21	.85	4
Ensuring IO access	2.91	1.29	3
Starting blood transfusion	4.81	.40	5
Setting a Level 1 Rapid Infuser	3.28	1.39	4
Performing CPR	4.48	.67	5
Using AED	4.20	.91	4
Evaluating GCS	4.58	.57	5
Triaging patients	3.54	1.50	4

Notes. NPA: Nasopharyngeal airway, OPA: Oropharyngeal airway, IO: Intraosseous, CPR: Cardiopulmonary resuscitation, AED: Advanced Electronic Device, GCS: Glasgow Coma Scale.

Variables found to be significant in the univariate analysis were included in the multiple logistic regression. Being in the age groups 30-40 (OR 3.12, CI 1.33-7.32, $p < .001$) and 41-50 (OR 5.54, CI 2.12-14.46, $p < .001$) were associated with higher levels of NPS. Moreover, being a male (OR 3.09, CI 1.13-8.42, $p = .028$), having > 10 years of experience in nursing (OR 3.59, CI 1.6-8.03, $p < .001$), having > 10 years of experience in critical care (OR 2.93, CI 1.33-6.49), participating in a code orange simulation (OR 4.26, CI 2.03-8.95, $p < .001$), knowledge of roles and responsibilities during a code orange situation (OR 3.61, CI 1.82-7.16, $p < .001$), and knowing the department's code orange plan (OR 2.4, CI 1.23-4.69, $p < .001$) were significant predictors of having a high NPS (see Table 4).

4. DISCUSSION

There is an increasing trend in critical incidents, whether natural or man-made, happening worldwide. Major terror attacks, accidents, fires, and natural disasters have been on the rise.^[43] Specifically, per the Ecological Threat Register, the world witnessed a tenfold increase in the number of natural disasters since the 1960s.^[44] Due to extreme weather related to climate change, such disasters are expected to continue to rise.^[45] During critical incidents, the priority is to provide the utmost support to victims and treat them.^[46] Nurses, as the front-line healthcare workers, play a vital role in responding

to such incidents.^[47] As such, our study assessed the comfort level of nurses in carrying out activities usually performed in critical incidents. Many of those activities are taught in BLS and ACLS courses and are within the nurses' scope of practice.^[48] Almost half of respondents were deemed to have low preparedness associated with those activities; 49.7% of nurses had a low NPS, while 50.3% had a high NPS. This concerning finding is in line with previous papers that highlighted a lack of both skills and knowledge of BLS and ACLS among nurses.^[49-51]

BLS and ACLS skills aside, this study also assessed training in critical incidents. Since it is tough to predict or control such incidents, knowledge, and training (like disaster drills) are considered the most practical methods to enhance preparedness.^[52] Although designing and implementing drills are time and resource-consuming, they are considered the cornerstone of disaster preparedness.^[53] These drills provide valuable information on what works and what does not in critical incidents.^[54] They allow for the assessment of performance and the refining of procedures.^[55,56] Those drills can play a critical role in improving disaster preparedness and understanding among nurses.^[57] In our study, participating in a code orange simulation, knowledge of roles and responsibilities during a code orange situation, and having knowledge of the department's code orange plan were associated with higher levels of nursing preparedness. This is in line with findings that participating in drills relating to disaster management and evaluation improved nurses' skills and knowledge in critical incidents.^[58,59] Therefore, periodic disaster drills are strongly recommended since they are necessary to prepare nurses.^[60] Despite that, Gomez et al. found that less than half of trauma centers in Canada had conducted a disaster drill.^[21] Canadian nurses have expressed a low level of confidence in the Canadian healthcare institutions' resources and preparedness to deal with critical incidents.^[61] In Australia, a trauma center also found that only 38% of survey respondents participated in a disaster drill.^[20] These findings are consistent with our study, as only 35.2% of nurses participated in a code orange simulation despite its importance.

On an individual level, most nurses believe they are not prepared for disasters.^[20,62] Many of them do not feel confident in their knowledge and skills in dealing with major disasters.^[30] This comes as no surprise since most nursing curricula lack knowledge and training in disaster.^[63,64] Such is the case for curricula in nursing schools and continuous education at work.^[65] In a previous study, it was found that less than most respondents had moderate knowledge of disaster preparedness.^[66]

Table 3. Univariate analysis of factors associated with a high level of preparedness

	High (N = 73) n (%)	Low (N = 72) n (%)	Total (N = 145)	p value
Age (years)				.004
20-30	13 (17.8)	33 (45.8)	46 (31.7)	
30-40	27 (37)	22 (30.6)	49 (33.8)	
41-50	24 (32.9)	11 (15.3)	35 (24.1)	
51-60	8 (11.0)	6.0 (8.3)	14 (9.7)	
> 60	1.0 (1.4)	0 (0)	1 (0.7)	
Sex				.023
Man	16 (21.9)	6 (8.3)	22 (15.2)	
Woman	57 (78.1)	66 (91.7)	123 (84.8)	
Title				.368
Advanced Practice Nurse	2 (2.7)	0 (0)	2 (1.4)	
Assistant Nurse Manager	6 (8.2)	3 (4.2)	9 (6.2)	
Nurse	19 (26)	21.0 (29.2)	40 (27.6)	
Nurse Clinician	41 (56.2)	45 (62.5)	86 (59.3)	
Nursing Practice Development Educator	4 (5.5)	1 (1.4)	5 (3.4)	
Other	1.0 (1.4)	2 (2.8)	3 (2.1)	
Department				.071
Adult Intensive Care Unit	4 (5.5)	11 (15.3)	15 (10.3)	
Coronary Care Unit	6 (8.2)	11 (15.3)	17 (11.7)	
Emergency Department	62 (84.9)	50 (69.4)	112 (77.2)	
Other departments	1 (1.4)	0 (0.0)	1 (0.7)	
Years of experience				.002
< 1 year	0 (0)	5 (6.9)	5 (3.4)	
1-10	28 (38.4)	45 (62.5)	73 (50.3)	
11-20	29 (39.7)	13 (18.1)	42 (29.0)	
21-30	11 (15.1)	7 (9.7)	18 (12.4)	
>30	5 (6.8)	2 (2.8)	7 (4.8)	
Years in critical care setting				< .001
< 1 year	0 (0)	8 (11.1)	8 (5.5)	
1-10	34 (46.6)	48 (66.7)	82 (56.6)	
11-20	27 (37.0)	13 (18.1)	40 (27.6)	
21-30	9 (12.3)	2 (2.8)	11 (7.6)	
> 30	3 (4.1)	1 (1.4)	4 (2.8)	
Obligatory continuing education activities				.736
No	5 (6.8)	6 (8.3)	11 (7.6)	
Yes	68 (93.2)	66 (91.7)	134 (92.4)	
Life support course(s) completed				.004
Both	53 (72.6)	31 (43.1)	84 (57.9)	
BLS	16 (21.9)	35 (48.6)	51 (35.2)	
ACLS	2 (2.7)	4 (5.6)	6 (4.1)	
Non	2 (2.7)	2 (2.8)	4 (2.8)	
Code orange simulation				< .001
No	36 (49.3)	58 (80.6)	94 (64.8)	
Yes	37 (50.7)	14 (19.4)	51 (35.2)	
Last code orange simulation				.853
1 year - 2 years	12 (33.3)	4 (36.4)	16 (34.0)	
> 2 years	24 (66.7)	7 (63.6)	31 (66)	
Knowledge of role in code orange				< .001
No	25 (34.2)	47 (65.3)	72 (49.7)	
Yes	48 (65.8)	25 (34.7)	73 (50.3)	
Knowledge of department code orange plan				.01
No	25 (34.2)	40 (55.6)	65 (44.8)	
Yes	48 (65.8)	32 (44.4)	80 (55.2)	
Participation in real code orange				.003
No	50 (68.5)	64 (88.9)	114 (78.6)	
Yes	23 (31.5)	8 (11.1)	31 (21.4)	

Table 4. Logistic regression of the factors associated with a high level of preparedness

Predictor	Estimate	SE	p	Odds ratio	Lower CI	Upper CI
Age						
30-40	1.14	.44	.009	3.12	1.33	7.32
41-50	1.71	.49	< .001	5.54	2.12	14.46
51-60	1.22	.63	.054	3.38	0.98	11.67
Sex						
Man	1.13	.51	.028	3.09	1.13	8.42
Years of experience in nursing						
> 10 years	1.28	.41	.002	3.59	1.60	8.03
Years in critical care setting						
>10 years	1.08	.41	.008	2.93	1.33	6.49
Life support course(s) completed						
Both	.54	1.03	.601	1.71	0.23	12.75
BLS	-.78	1.04	.454	0.46	0.06	3.54
ALS	-.69	1.32	.600	0.50	0.04	6.68
Participation in code orange simulation						
Yes	1.45	.38	< .001	4.26	2.03	8.95
Knowledge of roles and responsibilities during code orange						
Yes	1.28	.35	< .001	3.61	1.82	7.16
Knowledge of department code orange plan						
Yes	.88	.34	.011	2.40	1.23	4.69
Participation in real code orange						
Yes	1.30	.45	2.88	.004	3.68	1.52

Moreover, even if education is received, the number of hours focused on nurses’ role in a critical incident is inadequate.^[67] This is congruent with our findings, as only 50.3% of respondents knew of their specific role in a disaster simulation and only 55.2% knew where to locate their department’s code orange plan. As such, it is important to ensure that nursing education relating to critical incidents addresses their roles as they have the biggest potential to take an active one during such times.^[68] Nurses can play a vital role in critical incident preparedness, recovery, and evaluation.^[69] Therefore, there is an opportunity to expand on educational initiatives relating to critical incidents among nurses.^[70,71]

Lastly, our study found that having worked over 10 years, whether in nursing as a general or specifically in critical care settings, was associated with a higher level of preparedness. This is in agreement with the literature which indicates that nurses’ readiness is associated with emergency and intensive care experience within a hospital setting.^[72] Previous research also found that nurses’ experience, averaging around 11 years, was positively associated with a more efficient response in a critical incident scene as it occurs.^[73] Additionally, in comparison to less experienced nurses, other studies highlighted that experienced nurses are more likely to be

ready to deal with critical incidents and feel more confident than their colleagues in responding to them.^[16] Limitations and future directions

Our study has several limitations. Firstly, the sample size is small given the large number of nurses working at the MUHC.^[74] As such, the respondents may not be representative of the nursing population in the hospital network. Secondly, the respondents were only from one hospital network and one city. Thus, the results may not be applicable to other cities and provinces in Canada. Finally, certain skills that could be associated with nursing preparedness in critical incidents were not explored beyond those acquired in BLS and ACLS. Such important skills may impact the NPS assigned to respondents. Future papers should look into nursing preparedness in rural areas and compare the findings with those in major cities and academic centers.

5. CONCLUSION

Despite the crucial role of nurses in disasters, few research studies have investigated nurses’ preparedness in critical incidents in North America. As frontline workers, many nurses feel unprepared to face a major disaster.^[75] Our findings underscore the need to expand on disaster preparedness by

addressing gaps present in emergency response associated with critical incidents and nursing. Specifically, by emphasizing BLS/ACLS skills in nursing curricula, implementing disaster drills and simulations more frequently, and engaging nurses in hospitals' disaster response policies and plans. Such actions are imperative to ensure that nurses are best equipped to deal with emergencies.

The Canadian Disaster Database suggests that an all-hazards plan should be available to deal with any critical incident, whether natural or terrorism-related.^[21] Despite that, our study showed a lack of nursing preparedness in BLS/ACLS activities and disaster response simulations and drills. It also highlighted that the completion of life support courses was associated with higher nursing preparedness.

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AUTHORS CONTRIBUTIONS

Shafic Abdulkarim: Conceptualization, visualization, original draft writing. Ammar Saed Aldien: Second draft writing, review, editing. Anudari Zorigtbaatar: Methodology, formal analysis. Natasha Dupuis: Investigation. Josee Larocque: Investigation. Tarek Razek: Supervision.

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The authors declare that they have no known competing

interests.

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DATA SHARING STATEMENT

No additional data are available.

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