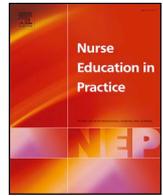




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Original research

Essential evidence-based introductory bioterrorism content for practicing nurses

Manu Sharma^{a,*}, Jane K. Dixon^b, Eileen J. Carter^{c,d}, Ruth McCorkle^b^a *NewYork-Presbyterian Hospital-Columbia, University Irving Medical Center, 177 Fort Washington Ave., New York, NY, 10032, USA*^b *Yale University School of Nursing, 400 West Campus Drive, Orange, CT, 06477, USA*^c *Columbia University School of Nursing, 560 West 168th St., New York, NY, 10032, USA*^d *NewYork-Presbyterian Hospital, 560 W. 168th St., Room 609, NY, NY, 10032, USA*

A B S T R A C T

Bioterrorism content is too often absent from nursing education post-licensure. According to the Centers for Disease Control and Prevention (CDC), bioterrorism is defined as “the deliberate release of viruses, bacteria, or other germs (agents) used to cause illness or death in people, animals, or plants.” The purpose of this scholarly work was to develop and pilot a curriculum on introductory bioterrorism concepts for practicing nurses. A literature search and a review of available resources elucidated pertinent content items on bioterrorism and its associated precautions for nurses. Next, two rounds of expert panel consisting of five members rated the identified content and provided comments to validate the curriculum's content. Based on the results, content items were expanded into a curriculum that was piloted as a four hour in person educational session and nurses in attendance were invited to participate in pre-test and post-test questions. They were also asked for their perceptions of the educational session's usefulness and influence on patient care in case of a bioterrorism event. All respondents strongly agreed that the information presented would be useful to them and would influence their patient care in a bioterrorism event. Further refinement, evaluation, and implementation of the developed curriculum are recommended.

1. Introduction

The Centers of Disease Control and Prevention [CDC, 2006](#) defines bioterrorism as “the deliberate release of viruses, bacteria, or other germs (agents) used to cause illness or death in people, animals, or plants.” The CDC organizes potential bioterrorism agents into three categories (A, B, or C) based on their potential impact. Category A agents (high priority) include *Bacillus anthracis* (anthrax), *Clostridium botulinum* toxin (botulism), *Yersinia pestis* (plague), variola major (smallpox), *Francisella tularensis* (tularemia), and filoviruses (viral hemorrhagic fevers such as Ebola and Marburg). The [CDC \(2014\)](#) classifies Ebola virus disease (EVD) as a Category A agent, due to its high transmission, mortality, “public health impact”, and requirement of “special action for public health preparedness.” One factor that determines if an agent receives a high priority classification is whether or not it is highly infectious. [Passi et al. \(2015\)](#) noted that with EVD, the generation of aerosols is possible and contributes to its classification as a potential bioterrorism agent.

Although the 2014 advent of EVD to the U.S.A. was not a bioterrorism event, it nonetheless demonstrated the current state of nursing preparedness for a handful of cases of a potential bioterrorism agent. In the U.S.A., two out of four laboratory confirmed cases were nurses who had assumed care of an EVD patient. This statistic

highlights practicing nurses' need for nursing education on the topic of infection control practice for a highly infectious organism, which is also a potential bioterrorism agent. Not only are some potential bioterrorism agents innately highly infectious, but also other potential bioterrorism agents can be made highly infectious at their dissemination sites through the use of certain dispersal methods. Guidelines exist from various sources to assist nurses, along with other healthcare workers, in properly donning (putting on) and doffing (removing) Personal Protective Equipment (PPE) when in contact with highly infectious disease agents such as EVD. According to the [Occupational Safety and Health Administration \(OSHA\)](#), PPE is equipment worn in order to reduce exposure to workplace hazards that could result in harm or disease.

A nursing union, National Nurses United, administered a non-scientific Ebola survey that highlighted the need for PPE education for practicing nurses when assuming care of patient with a highly infectious potential bioterrorism agent, such as EVD. The timing of the survey was after the first of two nurses at Texas Presbyterian Hospital tested positive for EVD. According to [National Nurses United \(2014\)](#), there were 2000 nurse respondents and 85% reported that their hospital did not provide formal education on EVD with specifically the ability to participate and ask questions. Although there may be bias risk in this survey, the fact that so many nurse respondents reported a lack

* Corresponding author. 177 Fort Washington Ave., New York, NY, 10032, USA.

E-mail addresses: mas9403@nyp.org (M. Sharma), Jane.Dixon@yale.edu (J.K. Dixon), Eic9019@nyp.org (E.J. Carter), Ruth.McCorkle@yale.edu (R. McCorkle).

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of education on PPE for a highly infectious potential bioterrorism agent such as EVD, must be addressed.

Results from surveys demonstrated that a majority of nurses lack exposure to bioterrorism education in the U.S.A. A study, which utilized a survey instrument, by [Rebmann and Mohr \(2010\)](#) revealed that 60% (n = 284) of post-licensure nurse respondents reported never receiving formal education on bioterrorism (p.72). In another survey by [Katz et al. \(2006\)](#), only 20% (n = 29) of post-licensure nurse respondents acknowledged obtaining bioterrorism education. [De Felice et al. \(2008\)](#) administered a questionnaire that revealed a bioterrorism knowledge deficit among nurses in Italy. Both a lack of education and a knowledge deficit exist among nurses regarding bioterrorism.

A lack of policy at the national level coupled with a lack of standardization of nursing continuing education requirements at the state level contribute to the current state of bioterrorism education for practicing nurses. According to Lippincott NursingCenter®, nursing continuing education requirements are in fact mandated at the state level and not at the federal level. This results in a lack of standardization of nursing continuing education post-licensure; individual states possess the autonomy to set their own requirements. Prior to licensure renewal, only nurses in Nevada, one out of fifty states, are currently required to obtain a one-time only bioterrorism education of four contact hours.

[Carter and Gaskins \(2010\)](#) partnered with a local public health department and created a bioterrorism clinical simulation experience to incorporate basic bioterrorism information into a nursing school curriculum. It is important to note that this sort of bioterrorism content exposure to nursing students was the exception and not the norm. The content areas included the Strategic National Stockpile (SNS), pandemic Influenza response, signs and symptoms of biological agents, treatment modalities for biological agents, and a simulation involving assuming care of a small pox patient.

[Shadel et al. \(2001\)](#) utilized focus groups to identify twenty-six content items in bioterrorism preparedness education for healthcare and public health workers. Some of the most frequent content items included infection prevention and control concepts, epidemiology of potential bioterrorism agents, development of emergency preparedness plans, and education of healthcare and public health workers to increase awareness of the bioterrorism threat. This work provided elucidation of content items for bioterrorism education but was not specific to nursing education.

If another potential bioterrorism agent that is highly infectious presented in the current healthcare setting, it would yet again likely jeopardize nurse safety and welfare. According to [Fayer and Watson \(2015\)](#), registered nurses comprise the largest occupation among healthcare professionals; hence, they will most definitely be involved in the healthcare team response to a bioterrorism event. Thus, there is need for development and implementation of an introductory curriculum for nurses that includes dual content – both introductory concepts of bioterrorism and correct use of PPE. Such a curriculum will enhance nurse safety and strengthen preparedness.

1.1. Purpose and aims

The purpose of the work described was to develop and pilot test an educational curriculum comprising of introductory bioterrorism concepts for practicing nurses. The work preceded through a series of distinct processes: a literature search and review of resources to identify introductory bioterrorism concepts and its associated precautions, the development of an introductory curriculum based on this evidence, two rounds of expert panel validation of the curriculum, implementation of the curriculum in a pilot educational session, pre-test and post-test questions to assess efficacy of the educational session, and an evaluation by practicing nurses. These processes further reflect the [Satterfield et al. \(2009\)](#) transdisciplinary evidence based model. This model entails shared decision making from the “best available research evidence,”

experts, and population, which in this case is nurses, within an external framework of environment, organizational context, and constraints (p.382). Essentially, this report brings what [Satterfield et al. \(2009\)](#) described as decision making to all levels; namely, the evidence, end users (nurses), and experts (p.382). This comprehensive framework, which is similar to the methodology utilized for content development, requires nursing decision-making. Inclusion of nurses, the end users, in this process empowers nurses to have their voices heard and directly influence nursing bioterrorism education that is developed specifically for them.

2. Methods

2.1. Literature review

Evidence of introductory bioterrorism concepts for nurses was collected from course materials from [Johns Hopkins University \(2010\)](#) Masters of Science program's Biodefense concentration, the Centers for Disease Control and Prevention (CDC) website, and a general literature search. The CDC is an authority on health threats to the U.S.A. population and represents the gold standard source of advice for healthcare providers due to its use of science and evidence-based principles, as well as its critical role in responding to these health threats. Keywords utilized included the following: nurs*, nursing, nurse, healthcare worker, HCW, education, curriculum, in-service, training, Ebola, bioterror*, anthrax, infectious, personal protective equipment, PPE, safety, occupational safety, and preparedness. Articles were catalogued by year, design/methods, strengths, limitations, results/conclusions, biological agent, mode of transmission, type of PPE, and pertinent notes. The following databases were searched: CINAHL, Cochrane Library, Global Health, Grey Lit, Ovid Embase, Ovid Medline, Pub Med, and Scopus. Additional literature from reference lists as well as sources suggested by professors, colleagues, and authors were also included. The exclusion terms limited articles to English with any date of publication. Thirty-eight articles were found to be relevant and were subsequently reviewed.

2.2. Expert panel, round 1

After a review of the evidence, a list of items was developed to include in the curriculum, pending agreement by expert panel. Two rounds of review by expert panel were conducted: experts were contacted independently of one another and were given a rating form to complete. In both rounds, five experts rated the identified curriculum items developed by importance and relevance. Six items of content for the curriculum were rated for relevance (“1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, and 4 = highly relevant”) and also importance (1 = not important, 2 = somewhat important, 3 = quite important, and 4 = highly important) with the goal to achieve an Item Content Validity Index (I-CVI) by item of 0.78 ([Polit and Beck, 2012](#), p. 358). Importance was rated in addition to relevance in order to distinguish between items more finely and to prioritize the items. I-CVIs were calculated for each item based on numerator data, consisting of the sum of the number of experts rating in agreement on importance, and denominator data, consisting of the sum of the experts (e.g. if five experts rated bioterrorism definition as moderately or very important then the numerator would be five divided by five yielding an I-CVI of 1.0). The same method was used to calculate I-CVIs for relevance. The rating form was designed to also elicit comments by the experts at the item level, as well as allowing for additional comments.

In the first round, three out of the five experts' educational backgrounds included nursing. All five experts possessed professional experience related to bioterrorism preparedness. All experts selected for the expert panel met at least one of the following criteria: testifying before Congress on the subject matter, professional work experience pertaining to bioterrorism response, service on a committee, taskforce,

or council related to bioterrorism, publication of scholarly work on bioterrorism, and Certification in Infection Prevention and Control (CIC).

2.3. Expert panel, round 2

A second round of expert review was conducted the same way as the first round in order to obtain ratings of relevance and importance with one slight modification to an item; namely the word “brief” was added to “history of bioterrorism.” Sub items were added at this round as a method of clarification of the items, and in response to experts’ comments in the first round. In the second round of expert panel, one of the original experts did not respond, so an alternate expert was recruited in order to have five experts in the second round. This resulted in one less bioterrorism expert on the panel with a professional nursing background.

2.4. Piloting of curriculum with pre-test and post-test

The curriculum was implemented as a pilot to 11 inpatient nurses at a large urban academic tertiary medical center to test the content and process of teaching the content including the pre-test post-test evaluation. Nurses were recruited through sharing a hospital-approved continuing education flyer on paper, electronically, and through word of mouth. The format was a four-hour, in-person education session that included the use of word cloud via audience response technology, PowerPoint presentation, a case study, a PPE demonstration, and allotted time for questions. The case study, adapted from Henderson, Inglesby, & O’Toole (2002), highlighted the clinical presentation and management of anthrax. For content items and sub items included in the piloted curriculum, see Table 1. Curriculum items and sub items were expanded upon using several external and internal resources ranging from the CDC website, literature review, hospital website, and other pertinent sources.

The project was conducted with institutional review board approval. Audience response technology was utilized to obtain pre-test and post-test data from nurses’ responses to questions before and after education was presented on introductory bioterrorism concepts. Audience response technology enables real time audience participation via a handheld device or computer. This innovative and engaging technology has the ability to capture data. Inclusion criteria for participation in this pre-test and post-test study included practicing nurses of the large urban academic tertiary medical center. Exclusion criteria included those who were unable to attend the educational session for the entire portion that covered the knowledge questions: specifically, the first two hours. Only the pre-test and post-test data of nurses who met these criteria were included in the analysis.

Three types of questions were asked – 1) three questions concerning demographic characteristics, 2) eight questions designed to reflect knowledge and 3) two perception questions regarding the participant’s evaluation of program usefulness and potential influence as displayed in Table 2. These perception questions were similar to those used by Cordasco et al. (2015) –level of agreement (strongly agree (1.0), agree (0.75), disagree (0.50), or strongly disagree (0.25)) with the statements that “the information would be useful to me” and “the information would influence my patient care” in a bioterrorism event (Cordasco et al., p.S90). A paper evaluation form was also available for nurses to complete for the educational program.

3. Results

3.1. Expert panel, round 1

Quantitative results from the expert panel (round 1) included the I-CVI results. An I-CVI of 0.78 or greater was obtained for both importance and relevance in the following items: bioterrorism definition,

Table 1
Results of expert panel round 1, round 2, and decision of inclusion in curriculum.

Item	Expert Panel Round 1				Expert Panel Round 2				Inclusion in curriculum	
	Importance		Relevance		Importance		Relevance		Rating	I-CVI
	Rating	I-CVI	Rating	I-CVI	Rating	I-CVI	Rating	I-CVI		
Bioterrorism definition	2,3,4,4,4	0.80	2,3,4,4,4	0.80	3,3,3,4,4	1.0	3,3,4,4,4	1.0	Yes	
History of bioterrorism	2,4,4,4,4	0.80	3,3,4,4,4	1.0	2,2,3,4,4	0.6	3,3,3,4,4	1.0	Yes	
CDC category (A) agents’ clinical manifestations	1,4,4,4,4	0.80	1,2,4,4,4	0.60	1,1,4,4,4	0.6	2,2,4,4,4	0.6	Yes, D	
CDC category (A) agents’ treatment modalities	2,2,3,3,4	0.6	2,2,3,4,4	0.6	1,2,3,4,4	0.6	1,2,4,4,4	0.6	Yes, D	
Strategic National Stockpile (SNS)	1,2,3,4	-	2,2,2,4	-	2,2,3,3,4	0.6	1,2,2,4,4	0.4	Yes, D	
Strategic National Stockpile (SNS)					1,2,2,3,4	0.4	1,2,3,3	-	No	
Nursing implications	4,4,4,4	-	4,4,4,4	-	4,4,4,4,4	1.0	3,4,4,4,4	1.0	Yes	
Nursing implications					4,4,4,4,4	1.0	4,4,4,4,4	1.0	Yes	
Nursing implications					1,3,4,4,4	0.80	3,3,4,4,4	1.0	Yes	
Nursing implications					2,4,4	-	3,4,4	-	No	

Note: the use of “D” in the inclusion in curriculum column indicates that the content was deemphasized.

Table 2
Pre-test and post-test questions.

	Pre-test Questions	Post-test Questions	Corresponding answer choices
KNOWLEDGE	1. “Bioterrorism is the deliberate release of viruses, bacteria, or other germs (agents) used to cause illness or death in ____” (CDC, 2006)	Same wording	A People B Animals C Plants D All of the above*
	2. Anthrax is a _____.	Same wording	A Bacteria* B Virus C Fungus D Toxin
	3. Variola major (smallpox) is a _____.	Same wording	A Bacteria B Virus* C Fungus D Toxin
	4. Current treatment modalities for anthrax include all the following EXCEPT:	Same wording	A antibiotics B antitoxins C vaccination D antifungals*
	5. The clinical manifestation of all skin lesions being in the same phase at the same time is consistent with	Same wording	A Varicella B Smallpox* C Tularemia D Plague
	6. In a large scale bioterrorism event, the pharmacy most likely able to provide sufficient treatment will be the:	Same wording	A Urban hospital's pharmacy B National Satellite Pharmacy for Defense C Strategic National Stockpile* D Compounding pharmacy
	7. The current recommendations for isolation precautions for nurses taking care of a patient with Ebola virus disease (EVD) are:	Same wording	A Special Plus Contact B Droplet and Contact C Contact D Airborne, Droplet, and Contact*
	8. The current recommendations for isolation precautions for nurses taking care of a patient with Small Pox are:	Same wording	A Special Plus Contact B Droplet and Contact C Contact D Airborne and Contact*
PERCEPTION	9. Regarding the following statement: bioterrorism information would be useful to me in a bioterrorism event	Regarding the following statement: the information presented would be useful to me in a bioterrorism event	A I strongly agree B I agree C I disagree D I strongly disagree
	10. Regarding the following statement: bioterrorism information would influence my patient care in a bioterrorism event	Regarding the following statement: the information presented would influence my patient care in a bioterrorism event	A I strongly agree B I agree C I disagree D I strongly disagree

Note: For knowledge questions (1–8), correct answer is indicated by asterisk (*).

history of bioterrorism. Regarding CDC category (A) agents' clinical manifestations an I-CVI of 0.78 or greater was obtained for importance but not for relevance. An I-CVI of less than 0.78 was obtained for the item CDC category (A) agents' treatment modalities for both dimensions. One expert did not rate both the Strategic National Stockpile and nursing implications. For comprehensive results of the first round of the expert panel, see Table 1.

In addition to I-CVIs, the expert panel round 1 yielded qualitative data. One expert from the first round commented on the item bioterrorism definition as not being as important as communicating the general concept of bioterrorism. Regarding CDC category A agents' clinical manifestations, one comment stated that a bioterrorism event warrants real time information and education regarding this item, whereas another expert perceived nurses as unlikely to ever see a bioterrorism case patient. One expert commented on the inability to rate items and suggested further clarification of the following items: Strategic National Stockpile (SNS) and nursing implications. Two experts recommended both PPE and infection control practice as important items to be included in the curriculum for nurses. One expert commented that nurses should be aware of an emergency action plan and another advocated for nurses to be taught how to access CDC website resources. All comments were carefully considered in the redesign of the rating instrument for expert panel, round 2.

3.2. Expert panel, round 2

Based on the comments from the first round of expert panel, the rating form was redesigned. The most significant difference was that the expert panel round 2 rating form added a column for sub items next to all items; this modification was an attempt to provide clarity for the experts and further reflect the experts' comments. The item SNS was divided up into two sub items (existence of SNS and possible role of SNS for nurses, and what might be in it or lacking). Another key change consisted of dividing up the item nursing implications into the following four sub items: namely, infection prevention and control basic concepts, PPE practice for highly infectious disease, emergency action plan, and CDC and additional resources.

Validation of content was obtained by I-CVI results of 0.78 or greater in both importance and relevance in the following items and sub items: bioterrorism definition (general concept) and nursing implications (infection prevention and control basic concepts, PPE practice for highly infectious disease (e.g EVD), and emergency action plan). Validation also occurred for relevance but not importance in the following items and sub items: brief history of bioterrorism (brief overview of history) and CDC category (A) agents' clinical manifestations (signs and symptoms of these agents). For comprehensive results of the second round of the expert panel, see Table 1.

The experts' comments provided qualitative findings. Two experts wrote comments regarding the importance of the item and sub item brief history of bioterrorism (brief overview of history); one noted that, due to the time lapse from the last bioterrorism event, presentation of this information can raise awareness on bioterrorism and a second acknowledged that this content provides context and reinforces that bioterrorism occurrence is rare. The item and sub item CDC category A agents' clinical manifestations (signs and symptoms of these agents) received three ratings of very important. However, two experts deemed it not important at all and one commented that Registered Nurses (RNs) will not be diagnosing and a second described the challenge to weaponize these agents and the low probability of encountering such pathogens. In contrast, two experts wrote of the importance of this item and sub item; one expert commented that this is probably the most important item and sub item on the rating form. In rating the item and sub item CDC Category A agents' treatment modalities, treatment options and possibly prophylaxis, one expert commented that RNs will not be treating patients and suggested that it may be more beneficial to discuss gaps in treatment and prophylaxis and the limitations of science and medicine. Four of five experts wrote, in response to the Strategic National Stockpile (what may be contained in it or lacking), either there is no way of validating the true contents due to its clandestine nature or its contents are fluid. Three experts commented on nursing implications (emergency action plan); one wrote that this may inspire nurse involvement, a second noted that dissemination of this information to nurses is necessary for the successful implementation of the plan, a third suggested while nurses may be educated about what is needed for a plan they often do not have enough influence to improve planning. In response to nursing implications (CDC and additional resources), one expert commented that this content required further clarity while a second wrote about industry's possible influence on the CDC. Another expert commented on the importance of utilizing the local health department as a key resource during a bioterrorism event.

One expert wrote additional comments that clinicians and Infection Control Practitioners will be in roles to analyze and report certain patterns to the Health Department. Some patterns were described as illnesses occurring around the same time or with a common geography, Influenza like illness outside of flu season, classic presentation of potential bioterrorism agents, previously healthy people with sudden acute illness, and suspected illnesses that are not endemic to the area with no travel history. The expert concluded that triage for infectious disease is essential, as it has associated risks of healthcare worker infection.

3.3. Pilot of curriculum with pre-test and post-test

Through substantial modification of the rating form in two rounds of expert panel and refinement of the curriculum content items based on experts' comments, the validated curriculum was deemed ready for implementation. Eleven practicing nurses attended the pilot educational session on introductory bioterrorism concepts for practicing nurses throughout the four-hour session. Four nurses participated in the pre-test and post-test through the use of audience response technology.

Pre-test and Post-test questions were divided into knowledge and perception questions. In the pre-test, the sample size varied per question and ranged from $n = 3$ to $n = 4$ respondents; eight knowledge questions received a mean correct score of 53.1%. In the post-test the sample size also varied per question from $n = 2$ to $n = 4$ depending on the question and the mean knowledge score correct was 74%. The correct scores per knowledge question ranged from 0% to 100% in the pre-test and 33.3%–100% in the post-test. The pre-test and post-test findings are summarized in Table 3.

Regarding perception questions prior to the educational session, 75% ($n = 3$) strongly agreed, and 25% ($n = 1$) agreed with the statement “bioterrorism information would be useful to me in a bioterrorism event” whereas 100% ($n = 4$) strong agreed with the statement

Table 3
Results of pre-test and post-test.

	Knowledge based	Perception or evaluation based
Pre-test	53.1% (425/800)	96.9%
Post-test	74% (591.6/800)	100%

Note: Sample size of respondents per question ranged from 3 to 4 in pre-test and 2 to 4 in post-test.

“bioterrorism information would influence my patient care in a bioterrorism event.” After the educational session, 100% of respondents strongly agreed with the statements that the bioterrorism “information presented would be useful to me” and “would influence my patient care” in a bioterrorism event.

4. Discussion

The results of both rounds of the expert panel informed the curriculum. It was unequivocal that the expert panel round 1 ratings proved both importance and relevance respectively among the curriculum items of bioterrorism definition (I-CVIs of 0.80, 0.80) and history of bioterrorism (I-CVIs of 0.80, 1.0). In round 2 the bioterrorism definition (general concept) was deemed both important and relevant while brief history of bioterrorism (brief overview of history) was rated with agreement in relevance only.

The item of CDC Category A agents' clinical manifestations was deemed important in round 1 (I-CVI 0.80) but not in the second round, in which two experts nonetheless affirmed its importance by their written comments. CDC Category A agents' treatment modalities did not achieve an I-CVI of 0.78 or greater in any round. This topic was de-emphasized in the curriculum while the items achieving a goal I-CVI were highlighted.

The item the Strategic National Stockpile and sub item (existence of SNS and possible role of SNS for nurses) did not sufficiently achieve agreement. However, comments from the experts elucidated the nursing role in administering contents from the SNS, affirmed the sub item's relevance for nurses, highlighted the supply chain issues in regards to possible shortages of medication, ventilators, and ICU beds, noted that the contents are fluid, and acknowledged that the contents are secretive and were not very helpful in the EVD and Zika epidemics. Due to the quantitative and qualitative results, SNS (existence of SNS and possible role of SNS for nurses) was greatly deemphasized but included in the curriculum. However, SNS (what may be in it or lacking) was omitted from the education as one expert refused to rate it acknowledging that it calls for speculation.

The nursing implications (infection prevention and control basic concepts, PPE practice for highly infectious disease, and emergency action plan) received agreement in importance and relevance and were included in the curriculum. Based on the comment about the reliability of resources, the nursing implications' sub item (CDC and additional resources) was omitted from the curriculum.

A logical first content item in such a curriculum should expose nurses to the concept of bioterrorism, enabling the nurses to differentiate between biocrime and biological warfare, as one expert recommended. Inclusion of a historical perspective on bioterrorism that highlights its occurrences dating back to the siege of Kaffa in 1346 (Wheelis, 2002) and spanning across centuries and continents to the recent 2001 Anthrax attacks in the U.S.A. (Johnson, 2005) could reinforce the reality of bioterrorism and aid nurses to better perceive their role and needs in such an event. Additionally, the historical information provides a glimpse at the varying levels of sophistication possible based on whether the perpetrator is an individual, group, or state, the greater impact from weaponization of agents, the concept of dissemination, and the significance of possessing basic knowledge on this subject matter due to the long history of bioterrorism. The CDC Category A, B, and C

Table 4
Final structure of piloted curriculum content.

Item	Sub-Item	Modalities
Bioterrorism definition	General concept	Word cloud (audience response technology), Lecture, PowerPoint presentation
History of bioterrorism	Brief overview of history	Lecture, PowerPoint presentation, Discussion
CDC category (A) agents' clinical manifestations and treatment modalities (Anthrax, Botulism, Plague Smallpox, Tularemia, Filoviruses)	Signs and symptoms of these agents	Lecture, PowerPoint presentation, Case study,
Strategic National Stockpile	Treatment options & possibly prophylaxis	Discussion
	Existence of SNS and possible role of SNS for nurses	Video
Nursing implications	Infection prevention & control basic concepts	Lecture, PowerPoint presentation, Hospital website
Nursing implications	PPE practice for highly infectious disease (e.g. EVD)	Demonstration
Nursing implications Questions and Answers	Emergency action plan (self, hospital, etc.)	Lecture, PowerPoint presentation, Discussion Discussion

agents pose threats as potential bioterrorism agents at different levels of impact. In some bioterrorism scenarios, the pharmacy that nurses now know will be replaced with the Strategic National Stockpile that hopefully will be able to dispense treatments to extremely large volumes of patients. Nurses equipped with bioterrorism knowledge can contribute to ameliorating the United States healthcare system's bioterrorism preparedness with a consideration for its implications for nurses, patients, and the general public.

This preparedness initiative manifests several important strengths. The curriculum development and evaluation was carried out via comprehensive and scholarly processes. These include a review of the evidence, two rounds of expert panel, and piloting with nurses, including structured evaluation via pre-test and post-test reflecting both knowledge of bioterrorism and perception of program usefulness and influence. There was a substantial modification to the curriculum contents through two rounds of expert panel, and the experts' comments truly enhanced the curriculum. This project provided an opportunity for exploration of the feasibility of implementation of such a curriculum in a large academic tertiary medical center. This same methodology of developing bioterrorism content in a curriculum for practicing nurses can be applied to introductory chemical, radiological, and nuclear preparedness content development, further ameliorating nursing preparedness efforts. For any of these various content areas of preparedness, occurrence of a relevant event (such as bioterrorism attack or radiation emergency) may trigger a sudden scaling up of educational programming across varied settings. When that occurs, it will be critical to have high quality curriculum, developed through rigorous process, available for widespread dissemination.

In two rounds of expert panel there were different proportions of nurses and non-nurses. The first round contained three out of five experts with nursing educational and professional experience whereas the second round consisted of only two out of five experts with such a background. The items history of bioterrorism and CDC category A agents' clinical manifestations received an I-CVI greater than 0.78 for importance in round 1 but not in round 2. This difference may be attributable to the varying ratios of nurses in the two rounds.

Nursing along with any other profession, is constantly changing. For example, the [Institute of Medicine \(2010\)](#) recommend in the *Future of Nursing* report that nursing education facilitate improved transitions to higher levels of education naming "master's, PhD, and doctor of nursing practice (DNP) degrees" among others (p.2). A further refinement of the curriculum contents will be necessary to reflect an increasingly educated nursing workforce with expanding roles and responsibilities.

A limitation of this work includes the sample size of participants in this pilot educational session. Factors for low nursing attendance could include the four-hour duration of this educational session, inefficient advertising, and an inadequate infrastructure or incentive in place for nurses to attend educational programs. A majority of nurses attended the session on paid time. In the future, it could be structured as two

hours or less to make it easier for nurses to be away from the unit. Modalities other than traditional in person education, such as online modules or a webinar, should be explored to test if more nurses are able to participate. Due to the time since the last bioterrorism event, some nurses may not prioritize this educational content over other nursing educational content available.

During the post-test, one respondent reported technical difficulty and perceived responding to the wrong questions due to the lag time on the device. This delay coupled with the small sample size most likely impacted the post-test mean correct score. The accuracy of audience responseware technology could potentially be a limitation. As well, there were two nurses who attended the session in its entirety but did not volunteer to answer the questions. Further elucidation of nurses' perception of testing via audience response technology could impact future design for pre-test, post-test, and evaluation.

The inclusion of such education within any organization also limits the material taught. In fact, the transmission-based precautions recommended for potential bioterrorism agents for the nurses were based on the organization's policies adapted from both the CDC guidelines and the literature. One nurse wrote on the paper evaluation form that a change in practice that will occur as a result of this program will be "... to be prepared [,] always wear proper PPE ...". This apparent appreciation for learning the process of PPE donning and doffing for a highly infectious potential bioterrorism agent such as EVD could manifest in one nurse consistently donning and doffing PPE correctly.

It will be critical to ensure stakeholder agreement with the validated curriculum. Nurses are stakeholders and should be involved in response plans for a bioterrorism attack. Nurses form an essential part of the healthcare response and will be unequivocally involved in a bioterrorism event. Without proper knowledge, the nurse could be at peril when assuming care of a patient with exposure to bioterrorism. Nurses evaluated the curriculum with consensus and strongly agreed with the educational session's perceived usefulness to nurses personally and its influence on patient care in a bioterrorism event.

In summary, this project resulted in a piloted curriculum whose final structure was denoted in [Table 4](#). Word cloud was used via audience response technology to visualize the audience's perception of the word bioterrorism. Next, bioterrorism was defined using the CDC definition. A brief history of bioterrorism was then presented via PowerPoint, lecture, and discussion. A case study, retrieved from [Henderson, Inglesby, & O'Toole \(2002\)](#), revealed the clinical manifestations and treatment course of a patient with Anthrax. It provided a real-life context that elucidated the needs for this one victim in order to allow nurses to comprehend what this could mean if this were to occur in large scale. CDC Category A agents' clinical manifestations and treatment modalities were taught via lecture, PowerPoint, and discussion. A brief video was played that explained what the CDC's SNS is. Infection prevention and control basic concepts were discussed followed by a demonstration of PPE for a highly infectious potential bioterrorism

agent such as EVD. Lastly emergency action plans at various levels was presented and the educational session concluded with time allotted for questions and answers.

4.1. Policy implications

According to Lippincott NursingCenter® (2018), post-licensure nursing continuing education requirements differ based on state policies as there are currently no federal mandates. The Texas Board of Nursing (n.d.), as cited in Jacobson et al. (2010), required nurses renewing their licenses in the state of Texas during a specific timeframe to obtain 2 contact hours pertaining to bioterrorism education. However, state policies are subject to change and according to Lippincott NursingCenter®, there no longer exists such a requirement. Implementation of mandatory continuing education requirements for licensure renewal in chemical, bioterrorism, radiological and nuclear preparedness would ensure that nurses receive exposure to bioterrorism content. According to Lippincott NursingCenter®, in the state of New York, where this pilot educational session occurred, there is no current requirement for practicing nurses to obtain continuing education hours in order to renew nursing licenses. Continuing education policy development, at the state level, could potentially target disaster preparedness nursing education and encompass introductory bioterrorism nursing content. Post-licensure nursing continuing education policy development can ensure nurses in fact receive bioterrorism education. Standardization of requirements is possible through policy implementation at the national level.

4.2. Future research

Research on refinement of the curriculum could further enhance future education. Additional research on implementation and evaluation of the educational intervention are necessary due to the small number of nurses that participated in the pilot educational session. More research regarding perceived barriers to receiving bioterrorism content post-licensure should also be explored in order to facilitate implementation of the curriculum in various settings.

5. Conclusion

This project served as a starting point for curriculum development, validation, and piloting at a large urban academic tertiary medical care center. The methodology utilized serves as a guide for nursing leaders and educators to develop introductory bioterrorism education for practicing nurses. The findings indicated that further investigation is needed regarding elucidation of essential introductory bioterrorism items and sub items in a curriculum for practicing nurses. This work also highlights the feasibility of equipping practicing nurses with this knowledge given the constraints at various levels. Post-licensure nursing continuing education mandates at the state level could significantly ameliorate the current state of bioterrorism education among nurses and have precedence. Further implementation and evaluation of an introductory bioterrorism curriculum for practicing nurses is recommended.

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Conflicts of interest

There are no conflicts of interest.

Ethical approval details

IRB approval was obtained from pertinent institutions.

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