Knowledge retention and usefulness of simulation exercises for disaster medicine - what do registrars know and think?

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A research report submitted to the Faculty of Health Sciences, University of Witwatersrand, Johannesburg in partial fulfilment of the requirements for the degree of Master of Medicine in Emergency Medicine

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Declaration

I, Laura Louise Cowling, declare that this work is original and contains no section copied in whole or in part from any other source, unless explicitly identified in quotation marks and with detailed, accurate referencing. I declare that this work has not been submitted to any other University for the purposes of a post graduate degree.

Dr L Cowling

Signed on this 21st Day of December 2021

Contribution Declaration

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

FACULTY OF HEALTH SCIENCES

Declaration: Student's contribution to article(s) and agreement of co-author(s)

I, Laura Louise Cowling, student number 302455 declare that this Thesis/Dissertation/Research Report is my own work and that I contributed adequately towards research findings published in the article(s) stated below which are included in my Thesis/Dissertation/Research Report .

Signature of Student: **Date:** **24/09/2021**

Name of Primary Supervisor: Dr Kylen Swartzberg

Signature of Primary Supervisor **30/09/21**

Agreement by co-authors: By signing this declaration, the co-authors listed below agree to the use of the article(s) by the student as part of his/her Thesis/Dissertation/Research Report. In cases where the student is not the 1st author of a published article, the primary supervisor must explain (under comments) why the student is entitled to use the paper for his/her degree purposes.

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N/A

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Dedication

To my parents who taught me to question everything, and to Alex who gave me the answers.

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Decision letter from journal

Manuscript Number: AFJEM-D-21-00019R2

Knowledge retention and usefulness of simulation exercises for disaster medicine - what do specialty trainees know and think?

Dear Dr Cowling,

Thank you for submitting your manuscript to African Journal of Emergency Medicine.

I am pleased to inform you that your manuscript has been accepted for publication.

My comments, and any reviewer comments, are below.

Your accepted manuscript will now be transferred to our production department. We will create a proof which you will be asked to check, and you will also be asked to complete a number of online forms required for publication. If we need additional information from you during the production process, we will contact you directly.

We appreciate you submitting your manuscript to African Journal of Emergency Medicine and hope you will consider us again for future submissions.

Kind regards,
Stevan Bruijns
Editor-in-Chief

African Journal of Emergency Medicine

Article as accepted by journal

Title

Knowledge retention and usefulness of simulation exercises for disaster medicine - what do Registrars know and what do they think?

Abstract

Introduction

Disaster medicine education is an important but often neglected part of Emergency Medicine (EM) registrars' curriculum. It is especially neglected in limited resource environments(1), which, owing to poor infrastructure generally, are more likely to be affected by disasters than better resourced environments. Disaster medicine cannot be taught solely in a classroom and various methods are required to teach practical concepts.

This study aims to look at Emergency registrars' perception of high-fidelity simulation and their needs with regards to Disaster Medicine Education.

Methods

This was a prospective cross-sectional cohort study involving 27 EM registrars from the University of the Witwatersrand, who, participated in a high-fidelity simulation and were given a questionnaire before and after the exercise. The questionnaire consisted of theory questions relating to disaster medicine as well as Emergency Registrar's perception and needs towards disaster medicine education.

Main results

High fidelity simulation does not increase theoretical knowledge of Disaster Medicine but it does increase perceived confidence. EM registrars seek yearly training, beginning in their first year and choose high fidelity simulation as their preferred method of training.

Conclusion

High fidelity simulation is crucial to increasing the confidence of EM registrars during their training. More research is needed to develop core competencies and methods of evaluating training.

Keywords

Disaster medicine, simulation, education

African relevance

- Low-middle income countries are affected disproportionately with disasters
- Disaster medicine education is an under researched field in developing nations
- Emergency medicine registrars and specialists are likely to be at the front line of a disaster response

Knowledge retention and usefulness of simulation exercises for disaster medicine - what do Registrars know and what do they think?

Introduction

Background/ Rationale

Disaster medicine

Disaster medicine is an important subject for doctors, particularly Emergency Medicine (hereafter EM) specialists who will often be the forefront of disaster incidents(2). It is also useful to develop other core competencies required by the EM physician such as communication, collaboration and management skills(3). Disaster medicine is an often-neglected area in the undergraduate and post graduate curricula of medical training (☐(4–6)). It is difficult for educators to prioritize education on an "low probability" event and a challenge to find teaching methods that increase the above-mentioned competencies as well as other skills needed for disaster management. Disaster medicine is also a neglected area of research in resource limited environments.

To the author's knowledge there are no studies relating to disaster medicine education in resource constrained environments. These environments are often hit hardest during disaster and are at great risk for future disasters. Climate change, urbanization and over population are factors which are likely to lead to an increase in severity and frequency of disasters and these may affect the developing world disproportionately(7).

Importance of disaster medicine training

It has been shown that medical professionals who have received training in disaster medicine are more willing to respond to a mass casualty incident (8). Additionally, uncoordinated responses by individuals who have not received training can hamper the response to a disaster(9)☐. In low income countries that already experience a low doctor to patient ratio it is imperative that all available medical staff are willing and trained to respond to a mass casualty or disaster incident. Regular and effective training is therefore imperative to ensure that when disaster strikes all available staff are prepared and willing to respond appropriately.

Simulation as training

The various methods used for teaching disaster medicine are lectures, low fidelity simulations, so called "tabletop" exercises, computerized simulations, and high fidelity, in-field simulations. Lectures may be

effective at imparting knowledge on theory but not necessarily practical skills that are useful in a disaster situation. There are studies proving that simulation-based learning is effective for teaching aspects of medical education(10), but few relating specifically to disaster medicine. It has been shown that although lectures are adequate at teaching theory, doctors feel more confident after simulations of disasters(11). High fidelity simulations have been shown to improve a personal sense of preparedness(12). Computerized simulations are an option but often the high development costs and limited technological reach make this approach impractical in poorly-resourced countries However, no studies have been done in a resource limited setting.

Evaluating disaster medicine training

High fidelity simulation is a costly and time-consuming exercise(13)☐. It therefore needs to be investigated as a method of disaster medicine training as to whether it improves confidence and EM registrars' perceptions of their skills. It is very difficult to assess disaster medicine educational tools as no standardized method of evaluation exists(14)☐. However, the Kirkpatrick model(15) is a well validated model that can be used to assess training methods. The Kirkpatrick model uses 4 levels to assess the efficacy of the intervention(15)☐ ☐. The first level is Reaction- how useful do the participants think the training exercise is. The second level is Learning which can be assessed using a pre and post test. The third level is Behavior and this component assesses whether the trainees use what they have learned in their daily work. The fourth level is Results and this evaluates whether the behavior assessed in level three results in actual improved outcomes. As disasters are rare in everyday practice, it is difficult to ascertain whether training has improved the relevant skills. The needs of EM registrars should also be investigated with regards to disaster medicine education so that the efforts into disaster training can be effective.

Methods

Survey

A sample population of 27 EM registrars from the University of Witwatersrand(Wits) took part in a disaster medicine simulation as part of their academic program. The registrars were given pre-reading(selected articles chosen by the educators) as well as a questionnaire to complete pre simulation. The questionnaire was designed by the researchers using the Kirkpatrick model as a framework.

Part A of the questionnaire(see Appendix B) included basic demographic information, Likert scale questions regarding attitude and perceptions of a mass casualty incident and a theoretical component with questions pertaining to disaster medicine curriculum. This questionnaire was answered in Google Forms in the week prior to the simulation. This part of the questionnaire assessed level 2(Learning) of the

Kirkpatrick model. Part A was administered pre and post simulation. Part B of the questionnaire was only answered post high fidelity simulation and contained specifics regarding the simulation and also the needs of the registrars with regards to a disaster medicine curriculum. This part of the questionnaire assessed level 1(reaction) of the Kirkpatrick model. In addition to using the Kirkpatrick model to develop the questionnaire, questions were included that assessed the registrars perceived needs pertaining to disaster medicine education which would aid in building a disaster medicine curriculum.

The registrars then participated in a high-fidelity simulation exercise in conjunction with the University of Johannesburg Department of Emergency Medical Care. A structural collapse scenario was simulated with actors playing the role of patients. The simulation costs were reduced by using a number of strategies. Firstly, emergency care students were used as volunteers for moulage. Secondly, through inter-facility collaboration with UJ, who provided rescue equipment and personal protective equipment, and WITS, who assisted with planning and provided catering. UJ also has a long standing relationship with City of Johannesburg Emergency Management Services(COJEMS), who own the site where the simulation took place.

The registrars were assigned to roles (command and control, rescuer, triage, and treatment). These roles did however change during the exercise to reflect the dynamic environment of a disaster. The simulation lasted approximately 3 hours. After the simulation, a debriefing was held. Six months after the exercise the registrars were given Part A and B of the questionnaire. This questionnaire was answered on hard copy to ensure maximum response rate.

Data analysis

Statistical analyses were conducted in R software (version 4.00; www.R-project.org). Test for data normality were done using the Shapiro–Wilk test and examining Q-Q plots. All data in this study were non-normal and appropriate non-parametric analyses were conducted, including Wilcoxon matched pairs for data collected pre- and post-simulation, chi-squared contingency table analyses and Pearson's chi-squared analyses. Tests were two-tailed, and model significance set at 0.05.

Results

A total of 27 Emergency Medicine registrars took part in this study, 26 of whom completed the questionnaire pre-simulation and post-simulation and one who participated in the pre-simulation only, indicating a response rate of 98%.

Theory

Registrars scored a median of 22 (out of a total of 25) in both the pre- and post-simulation MCQ questions, which did not differ significantly from chance (Wilcoxon test, p=0.898). Thus level 2(learning) of the Kirkpatrick model was not significantly influenced by high fidelity simulation.

Improving skills

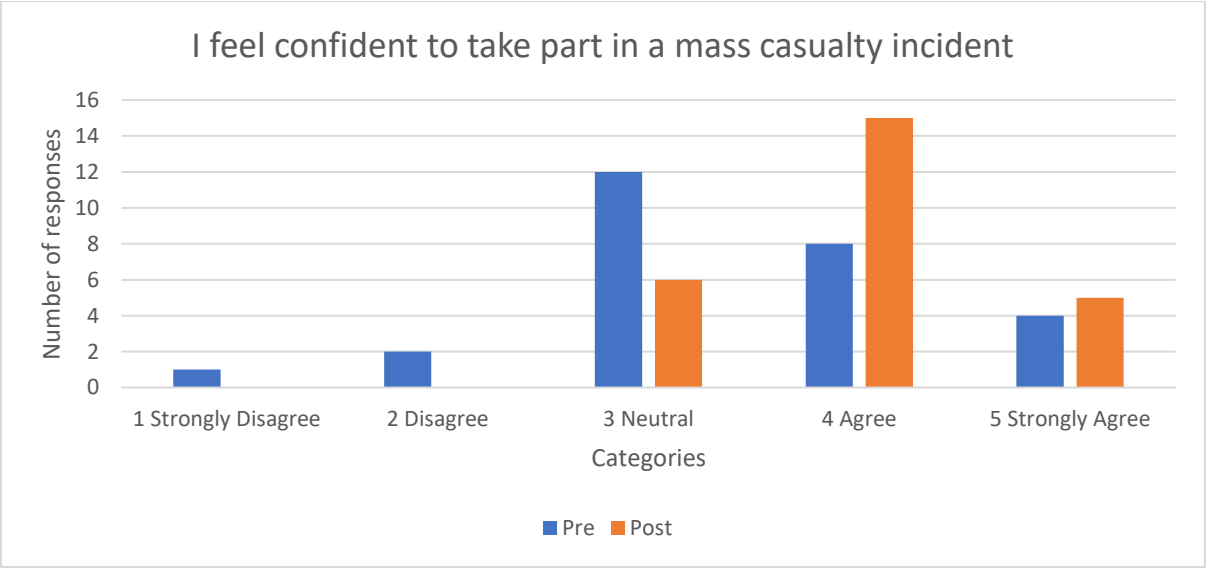

Figure 1. Usefulness to improving confidence of registrars in taking part in a mass casualty incident

Registrars were asked about their confidence in managing a structural collapse scenario in five areas. Pre simulation, the most common response was “not confident” for the role of command and control, “not confident” for rescuer, “slightly confident” for triage and “slightly confident” for safety. Post simulation, the most common response was “slightly confident” for command and control, “confident” for rescuer, “confident” for triage and “mostly confident” for safety. Therefore, the registrars felt a subjective improvement in their confidence and thus a positive impression of the training exercise(Kirkpatrick level 1, Reaction).

Educational needs

Importance of training for registrars

Significantly more registrars agreed that the simulation training increased their knowledge ($p< 0.001$) and confidence($p<0.001$). Thus, the registrars showed a positive reaction (Kirkpatrick level 1) to the high fidelity

simulation. Significantly more registrars strongly agreed that simulation training was important in their curriculum ($p<0.001$) and mentioned that insufficient time was spent in disaster training ($p<0.001$).

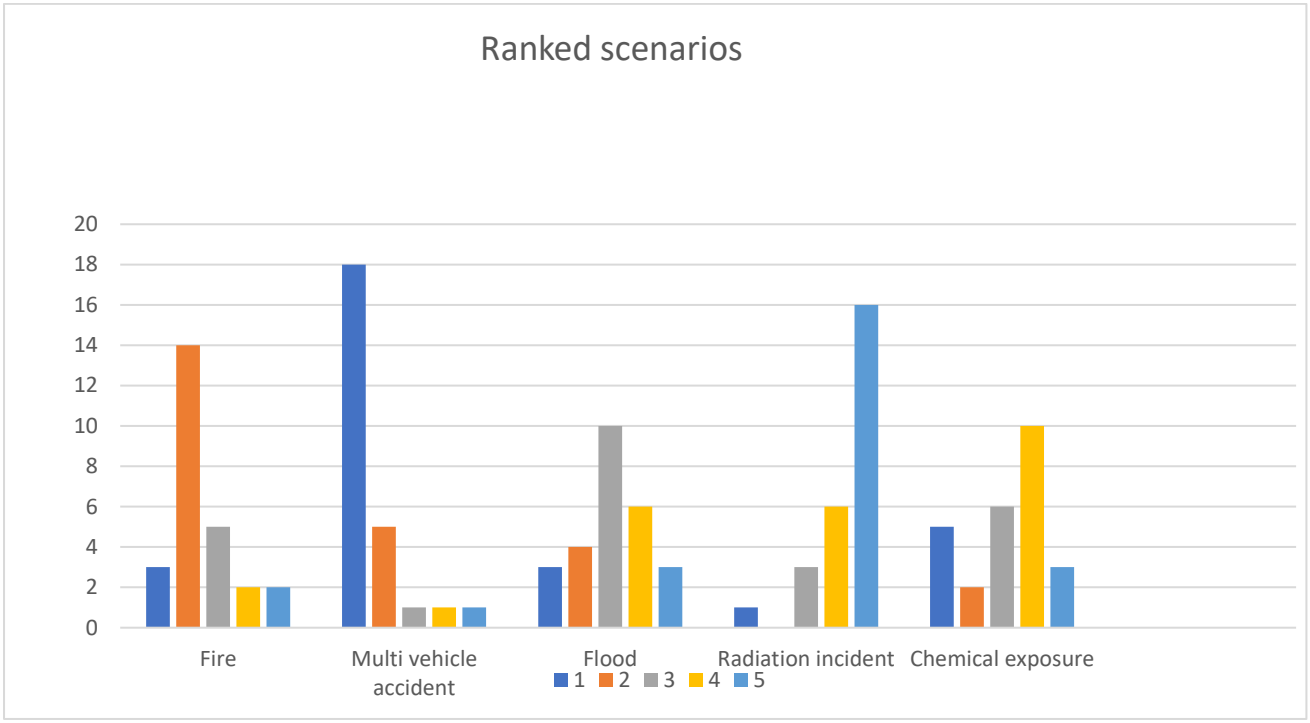

Figure 2 Responses to "which scenarios would you like to practice in a simulation?" (1 being most like to experience and 5 being least)

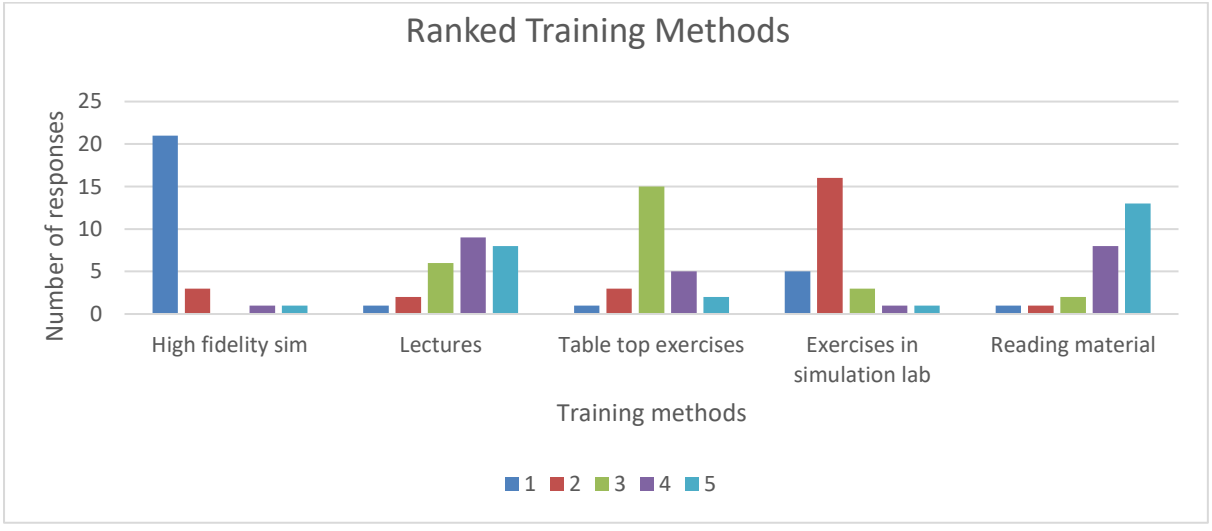

Figure 3. Ranked preferential teaching methods with 1 being most important and 5 being least.

Most (58%) of EM registrars think that Disaster medicine training should begin in the first year, with 23% believing it should start in second year. The majority (68%) prefer yearly training, and 19% believe it should be done every 6 months. Only 12% believe it should be done every two years.

Teaching perceptions of registrars

For improving knowledge, significantly more registrars maintained that pre-reading ($p < 0.001$), briefing ($p < 0.001$), simulation ($p < 0.001$) and debriefing ($p < 0.001$) were all very useful. A pre-test was regarded by most to be somewhat useful ($p < 0.001$). None of registrars mentioned that any training aspect was completely useless.

For improving confidence, significantly more registrars maintained pre-reading ($p < 0.001$) was useful. Briefing ($p < 0.001$), simulation ($p < 0.001$) and debriefing ($p < 0.001$) were all considered very useful.

Registrars were asked about their preference for combination of methods for simulation. Most preferred High-fidelity simulation and Exercises in simulation laboratory, although their preference did not differ significantly by chance ($p = 0.76$)

Methods	Number of responses
High fidelity simulation and Exercises in simulation laboratory	11
High fidelity simulation and Lectures	10
High fidelity simulation and Tabletop exercises	3
Lectures and Exercises in the simulation laboratory	2

Limitations

The limitations of this study are that it includes a small number of registrars from a single training centre. The second questionnaire was administered 6 months after the event and the duration between the exercise and the questionnaire might affect the answers. The registrars were not evaluated during their performance and thus only report a subjective improvement. The simulation was only done on a single scenario. The high fidelity nature of the simulation made it difficult for observers to evaluate the registrars performance.

Discussion

Disaster medicine education is not well studied in resource limited environments(1) as most research on this topic is done in the United States and Europe(16). Disaster medicine curricula lack robust research,

standardized evaluation and competency driven goals(17). There are also very few studies that evaluate high fidelity simulation for disaster medicine education.

The above study shows that high fidelity simulation, while a costly and resource intense effort, improves the self-reported knowledge and confidence of EM registrars in a resource limited setting. It also shows that high fidelity simulation can be undertaken in low resource environments, with collaboration with other departments and use of existing training facilities which helps to keep within budget. However, a simulation does not increase theoretical knowledge of disaster medicine and thus didactic lectures/pre reading must be used to improve theoretical knowledge.

The perceived confidence of the registrars improved post simulation. The simulation was very useful in improving their perceived skill sets in the different areas of disaster management (command and control, triage etc). This is important as even though the registrars did not participate in every role in the simulation, they all felt an increase in skill across the various roles. A similar study of medical interns by Ngo et al(18), studying high fidelity simulation produced comparable results.

All improvement of skills and knowledge by participants are self-reported and were not objectively measured by monitoring of performance or marking. This is a common finding with disaster medicine research(16,18) and may be an important measure of improvement for future studies on high fidelity simulations in disaster medicine education.

Studies have also used the Kirkpatrick model to assess disaster medicine education(16). Using the Kirkpatrick model, we can see that the study evaluates level 1 and level 2. Reaction(level 1) was assessed and it was found to be perceived as very useful for the registrars. Level two is learning and there was no difference in the theory component however the participants did perceive an improvement in skills. A more robust way to assess level 2 would be to record or observe the participants and develop a mark sheet or rubric for basic skill competencies. This study did not evaluate level 3(Transfer), which is similar to other disaster medicine studies(16) and level 4(Results) can only be assessed during a disaster event.

The specifics of the simulation were also examined in this study. Interestingly, the participants found that the briefing, simulation, and debriefings were all useful. This is important information for the development of a disaster curriculum for South African registrars.

The study also shows that most registrars feel that too little time is spent on disaster medicine education, which is in line with other studies(19,20). Similar to studies in Europe, participants favoured road traffic accidents as the scenario for future simulations(21). The EM registrars feel that teaching should occur annually and most picked high-fidelity simulation as the most useful teaching method. This can assist those involved with EM registrar training to develop a curriculum that meets the needs of the registrars.

Conclusion

High fidelity simulation is a valuable tool for disaster medicine education in a resource limited setting. It is a neglected part of the curriculum of EM registrars and standardized curricula need to be developed. This study has assessed the needs of EM registrars and thus can aid developing future training for them.

Dissemination of Results

Results from this study were shared with the registrars who participated as well as the educators involved with developing the academic curriculum for the registrars.

Authors contribution

Authors contributed as follow to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content

LC contributed 70%, KS 20 % and AG 10%.

All authors approved the version to be published and agreed to be accountable for all aspects of the work

Declaration of competing interests

The authors declare no conflicts of interest.

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Appendices

QUESTIONNAIRE PART A

Demographic information

1. Age in years:

2. Current level of study:

3. Previous experience with mass casualty incidents

If yes: how many

4. Previous formal training with disaster medicine/mass casualty incidents

If yes: please specify

On a scale of 1-5, with 1 being strongly disagree and 5 being strongly agree please answer the following questions

	1 Strongly disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly agree
1. I feel confident to take part in a mass casualty incident(MCI)					
2. I am clear about the various roles during a MCI					
3. I am willing to respond to a MCI					

4. My previous training has prepared me for a MCI
5. In service training has prepared me well for managing a MCI

Please choose the most correct answer.

1. During an adult mass casualty incident, the following triage score can be used:

a) The Emergency Severity Index

b) South African Triage Score

c) JumpSTART

d) Sieve and Sort

2. What are the three phases of disaster management?

a) preparation, response, recovery

b) evacuation, rebuilding, rebranding

c) preparation, planning, perception

d) planning, evacuation, recovery

3. A victim appears quite still when you get to them. You shake the victim and shout. They do not respond. What do you do next?

a) Go to the next person

b) Open their airway

c) Shout again

d) Tag them dead

4. A victim is moaning. What do you do next?

a) Count respirations for 15 seconds

b) Open their airway

c) Ask them why they are moaning

d) Check their capillary refill

5. Which do you *not* do during triage?

a) CPR

b) Intubate a patient who is gasping

c) Remove wet clothing

d) All of the above

6. The safety officer should not:

a) Dictate to other services what to do to protect themselves

b) Ensure that all hazards are identified that may harm the rescuers

c) Let any member of staff onto the scene without appropriate PPE.

d) Worry about the ambient temperature and weather conditions.

7. All these statements concerning triage are true, EXCEPT:

a) The aim of triage is to do the most for the most number of patients

b) Triage remains the sole responsibility of the EMS service

c)Triage is a dynamic process and the patient's colour code may be altered

d) It is important that one triage system is adopted so that all the relevant services use the same system

8. Pick the one true statement about the tiers of command:

a) Gold command is responsible for on-scene operational decisions

b) Bronze commanders are sectional heads responsible for operational teams

c) Silver commanders should ideally function as separate command structures

d) Gold command may involve international organisations

9. A major incident is defined as:

a) More than 100 casualties
b) An incident requiring military intervention
c) An incident caused by a natural disaster
d) An incident that overwhelms local resources

10. With regards to patient handover, the "M" in the MIST acronym stands for:

a) Mechanism of injury
b) My call sign
c) Male or female
d) Medical history

11. Which category do the walking wounded fit into initially?

a) Dead
b) Delayed
c) Immediate
d) Urgent

12. The following are initial tasks that the first unit on the scene should do EXCEPT:

a) Make a thorough assessment of the situation

b) Wait for the most senior ranked officer to set up command.

c) Assign arriving personnel to different positions with which they are familiar.

d) Take responsibility for all functions of the Incident Command System.

13. A victim has a capillary refill of 4 seconds. What do you do next?

a) Open their airway
b) Check capillary refill again
c) Tag immediate and treat for shock
d) Tag delayed and treat for shock

14. Choose the one incorrect statement pertaining to transport of casualties from the scene of a major incident:

a) It is a critical component that requires careful planning and coordination.

b) Various organisations, such as a private EMS, may be able to transport patients and should take instructions only from their own control centres

c) Fire and law enforcement agencies may assist with the transport of patients out of the bronze zone
d) Patients triaged Green or P3 still require transportation to a health facility

15. As regards equipment requirement for a major incident, all of the following are true, EXCEPT:

a) Equipment pre-planning is paramount to an effective response.

b) The wearing of PPE, while important, should not delay the response to getting to the patients.

c) Checking of safety equipment remains the responsibility of the individual who will be wearing it.

d) The type of equipment required may vary depending on the nature of the incident.

16. During a paediatric mass casualty incident, the following triage score can be used:

a) The Emergency Severity Index

b) START

c) JumpSTART

d) South African Triage Score

17. Which is most important?

a) Your safety

b) The safety of the team

c) The victim's safety

d) Whether the victim lives or not

18. The phonetic alphabet:

a) Is local to South Africa

b) Uses words only and not numbers

c) Is an effective way to spell words over a radio

d) Cannot be used by the fire service

19. Triage labels should have the following characteristics:

a) Be highly visible

b) Be waterproof but still allow for the documentation of essential clinical notes on the label

c) Have a simple means whereby the label can be attached to the patient

d) All of the above

20. The surge capacity of a hospital refers to:

a) Capacity to coordinate the triage of patients effectively

b) The ability of a hospital to expand its normal services rapidly to meet the increase in demand

c) The ability of a hospital to discharge patients to lower levels of care

d) Capacity to coordinate resources through effective pre-planning

21. With regards to communication using the METHANE mnemonic, the “A” stands for

a) Access to scene

b) Ambulance required

c) Analgesia

d) Adult triage sieve score

22. Safety is paramount to ensure

a) Staff are prevented from getting infectious illness

b) Safety of self, scene and survivor

c) Biohazards are dispersed in the community

d) Staff are maximally utilised on the scene until they burn out

23. With regards to CSCATTT, the “A” stands for

a) Activity

b) Assessment

c) Ambulance

d) Authority

24. The following are examples of man made disasters, EXCEPT

a) Flood

b) Train accident

d) Oil spill

25. With regards to Command and Control, pick the most correct statement

a) It is the first priority

b) It is assumed by multiple individuals

c) Command is established in a bottom up fashion

d) Horizontal communication is employed in each service

PART B

1. How much knowledge have you retained since the simulation exercise?

<25%	
25-50%	
50-75%	
>75%	

2. Select the role/s you participated in during the simulation exercise:

Command and control
Rescuer
Triage
Treatment team
Safety

3. Before the simulation how confident were you in managing a structural collapse scenario in the following areas?

	Not confident	Slightly confident	Confident	Mostly confident	Very confident
Command and control					
Rescue					
Triage					
Treatment					
Safety					

4. After the simulation how confident were you in managing a structural collapse scenario in the following areas?

	Not confident	Slightly confident	Confident	Mostly confident	Very confident
Command and control					
Rescue					
Triage					
Treatment					
Safety					

5. How much did the simulation exercise change your **confidence** in managing a structural collapse scenario?

Decreased	Nil change	Slight increase	Moderately increased	Greatly increased

6. How much did the simulation change your **knowledge** in a structural collapse scenario?

Decreased	Nil change	Slight increase	Moderately increased	Greatly increased

7. How much did your activity in the specific role which you played increase your **knowledge** in that specific area?

Decreased	Nil change	Slight increase	Moderately increased	Greatly increased

8. How much did your activity in the specific role which you played increase your **confidence** in that specific area?

Decreased	Nil change	Slight increase	Moderately increased	Greatly increased

9. Not being part of a specific role compromises knowledge in that specific area

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

10. It is important to take part in each role during the simulation to increase **knowledge**

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

11. It is important to take part in each role during the simulation to increase **confidence**

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

12. Please rate the usefulness of the following in improving **knowledge** in disaster management

	Completely useless	Somewhat useless	Neutral	Somewhat useful	Very useful
Pre-reading					
Pre-test					
Briefing					
Simulation					
Debriefing					

13. Please rate the usefulness of the following in improving **confidence** in disaster management

	Completely useless	Somewhat useless	Neutral	Somewhat useful	Very useful
Pre-reading					
Pre-test					
Briefing					
Simulation					
Debriefing					

14. The pre-test should be done as a closed book test

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

15. The pre-test should be done as an open book test

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

16. The context of the simulation (structural collapse) was appropriate

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

17. During your emergency medicine training, which scenarios would you like to practice in a simulation?
Please rank the following from 1-5, with 1 being the one you would most like to experience and 5 being the least.

Fire	
Multi-vehicle accident	
Flood	
Radiation incident	
Chemical exposure	

18. Are their any other scenarios you would like to have in a simulation exercise? If yes, please specify.

19. When during registrar time should disaster simulation training occur?

1st year	
2nd year	
3rd year	

4th year	

Why?

_____

_____

20. How often should disaster simulation training be done?

Every 6 months	
Every year	
Every two years	
Never	

21. Disaster training is an important part of the curriculum for Emergency Medicine registrars

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

22. Enough time is spent on Disaster Medicine in the curriculum for Emergency Medicine registrars

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

23. The following methods are utilised as training methods for disaster medicine.
Please rank the following training methods from 1-5, with 1 being the most useful and 5 being the least.

High fidelity simulation	
Lectures	
Table top exercises	
Exercises in the simulation laboratory	
Reading material	

24. If you had to pick an ideal combination of two methods above, which would you pick(write down the numbers)?

1. High fidelity simulation	
2. Lectures	
3. Table top exercises	
4. Exercises in the simulation laboratory	
5. Reading material	

25. What would be your reason for not being willing to respond to an actual disaster?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Lack of knowledge					
Lack of confidence					
Lack of real life experience					
Lack of general preparedness					
Lack of simulation participation					

Appendices

Final protocol

TITLE: Knowledge retention and usefulness of simulation exercises for disaster medicine- what do Registrars know and what do they think?

Laura Cowling 302455 MBChB

Supervisors: Kylen Swartzburg (MBChB, FCEM (SA) MMED)

Anita Groenewald (MBChB, MSc(Emergency Med))

BACKGROUND

Disaster Medicine

Disaster medicine is a rapidly evolving field in Emergency Medicine, and has made significant progress in the modern world. The beginning of disaster medicine, as a formal concept, is thought to have developed from Heinrich Zangger's studies on civilian mine explosions in the early 20th century(1)☐. The exact history of disaster medicine is difficult to delineate as the very definition of disaster has changed significantly from its inception(1).☐

Zannger initially defined a disaster as "sudden, unpredictable tremendous forces, … especially of masses, speed, and high pressure"(1). His main area of interest was that of industrial accidents. Today, however, we have a broader definition of disaster which is an event that overwhelms local services and capabilities over a short period of time(2)☐. Therefore the definition depends largely on the availability and type of local resources. This broader definition encompasses all the categories of disaster.

Increasing Severity of Disasters

The reasons for the increase and severity of mass casualty incidents are multiple. Firstly, the world's population is increasing and that population is increasingly moving towards urban centres(3)☐. This leads to overpopulation in cities and areas that were previously unpopulated being populated(3)☐. Secondly, one of the results of climate change, is more extreme weather conditions leading to an increase in natural disasters(4)☐. An increasing population and climate change also leads to fewer natural resources which

may lead to increasing conflict and thus an increase in the incidence of mass casualty events(4)☐. Thirdly, improvement in technology has led to mass transportation and an increase in sophistication in weapons of mass destruction leading to the possibility of larger destructive events (3)☐.

The impact of the disaster event extends far beyond the loss of life or number of casualties. The Great London Fire of 1666 only resulted in 6 official deaths but 80% of the buildings were destroyed(3)☐. The floods in Pakistan in 2010 killed approximately 1000 people but left 20 million homeless and susceptible to disease, starvation and death(3)☐. In as much as local resources become overwhelmed during a disaster, it is important to remember that "routine" medical conditions are still ongoing, for example maternal emergencies and neonatal care. The impact of a disaster event can far outweigh the initial event and therefore an adequate emergency response is vital to limit the consequences.

Disaster Readiness

An effective and efficient emergency response during a disaster is vital to limit loss of life, the duration of the disaster and to mitigate the consequences thereof(5)☐. A well trained and prepared emergency response system is rapidly able to gain control of the disaster scene, evaluate the type and number of casualties, appropriately allocate available resources and anticipate future problems(5)☐. Conversely, a poorly planned and executed emergency response can have disastrous effects on a population and area already under massive strain. The most recent example of this is the response to the Haitian Earthquake in January 2010(6)☐. The earthquake devastated the already crumbling infrastructure of Haiti and killed an estimated 250 000 people(6)☐. The response to this disaster was large, uncoordinated and largely ineffective. Over 400 Non Governmental Organisations registered to deliver health care during this time but a large proportion were inexperienced and lacked training in disaster medicine(6)☐. This meant that the volunteers used up vital resources (drinking water and food) whilst not providing health care to the

population of Haiti. Ineffective command and control leads to confusion, rumours and general chaos(6)☐. This example stresses the need of suitable training for disaster preparedness of appropriate individuals.

Disaster Medicine Education

Disaster medicine is also not a routine part of the undergraduate curriculum for medical degrees(7)☐. Research has shown that 51% of Emergency Medicine Residents in the US felt that “too little” time was spent on disaster medicine training(8)☐ and only 47% of interns received formal training in disaster preparedness(9)☐. There is also no worldwide standardisation of disaster medicine training and thus there is a wide variation in methods and outcomes(10)☐ The WHO guidelines on disaster preparedness recommend a sustained, widespread and updated training programme(11)☐

Evaluating training programmes is an important part of education. However, it has been shown in the literature that it is difficult to adequately evaluate the effectiveness and impact of disaster medicine training. A comprehensive literature review by Hsu et al found that the effectiveness of hospital disaster drills is difficult to determine(12)☐. The most effective methods of training responders to a disaster event were looked at in a 2002 Agency for Healthcare Research and Quality (AHRQ) evidence report(13)☐. The report found that there are:

- no published validated measures of preparedness
- few data that demonstrate the effectiveness of particular training interventions
- no studies evaluating educational programs for bioterrorism or other public health events in particular
- no studies addressing how to update and reinforce the training of clinicians in how to respond to mass casualty incidents

Thus it is difficult to scientifically and rigorously evaluate a simulation exercise for disaster management.

Although it is difficult to assess disaster medicine training programmes the Kirkpatrick model can be used to assess these type of exercises as an educational tool(14)☐. The Kirkpatrick model uses 4 levels to assess the efficacy of the intervention(14)☐. The first level is Reaction- how useful do the participants think the training exercise is. The second level is Learning which can be assessed using a pre and post test. The third level is Behaviour and this component assesses whether the trainees use what they have learned in their daily work. The fourth level is Results and this evaluates whether the behaviour assessed in level three results in actual improved outcomes.

Using the Kirkpatrick model to evaluate training for disaster medicine is essential to determine whether the training fulfils educational goals. Level 1 can be assessed using a questionnaire answered after the exercise while level 2 can be assessed using a pre and post test format. The third and fourth level can only be assessed in a real-life disaster event or a repeat simulation exercise.

As already mentioned there is a paucity of evidence regarding the best training method for disaster skills and preparedness. The current methods available are simulations, lectures, short courses, drills and “table top” exercises. In South Africa the options for formal courses are limited to a 5 day Disaster Medicine Course run by the University of Cape Town (15)☐,and H-MIMMS(Hospital Major Incident, Medical Management and Support) and MIMMS(Major Incident, Medical Management and support) courses, run by a small number of training institutions.

A study conducted by Behar et al compared didatic lectures only versus didatic lectures and simulation exercises in improving knowledge and disaster medicine preparedness(16)☐. They found that both lectures and simulation training improved knowledge but that simulation improved sense of comfort with

disaster topics(16)☐. Thus simulation exercises are important for increasing confidence around disaster medicine.

Bartley et al conducted a study on factual knowledge and perceptions around disaster medicine pre and post intervention(17)☐. The intervention had two components- a one hour lecture and an unplanned, compressed time simulation exercise which included a debriefing session(17)☐. A repeat test survey was done 4-6 months post intervention to reassess the factual knowledge and perceptions of disaster preparedness. The study showed that post intervention more people felt personally more prepared for a disaster and also had an improved sense of departmental preparedness(17)☐. 53% of people surveyed reported some degree of personal improvement post intervention(17)☐. And while the questionnaire used in the Bartley et al study is not applicable to our study, it does show that perceptions of skills in disaster medicine are improved by training.

Importance of training

Medical practitioners who have received recent training are the most willing and likely to respond to a mass casualty event(18)☐. Factors which are shown to decrease the willingness to respond include female gender and shorter times in service. However, adequate training negates these factors in respect to willingness to respond(18)☐. Those who have not received recent training are less likely to respond to a disaster(18)☐. Hospitals that conduct regular simulations show an improved response to a disaster, as shown with Thai hospitals in the Asian Tsunami of 2004(10)☐. Slepski surveyed medical professionals who had responded to a disaster event and found that the responders had not had a problem with implementing clinical skills but rather with the change in environment(19)☐. Thus simulations are important in order to develop the necessary adaptive skills for medical professionals during a disaster event and thus improve the response to an event.

The time cost and resources of a drill must be taken into account when deciding on whether it should form part of a standardised training programme for disaster preparedness. A simulated disaster exercise was run in June 2019 involving the registrars in emergency Medicine at Wots university. A pre-test questionnaire was completed. The aim of the this project is o assess both the reaction and learning (level 1 and 2 on the Kirkpatrick model) after the simulation exercise.

Objectives

Primary objectives:

1. To assess how useful the Emergency Medicine registrars perceive simulation training to be in improving confidence and knowledge in disaster medicine.

2. To assess the retention of knowledge amongst Emergency Medicine Registrars after a simulation exercise.

Secondary objectives:

1. To describe the demographics of the Emergency Medicine registrars who took part in the simulation exercises

2. To investigate whether Emergency Medicine registrars perceive their skills to improve with simulation training

3. To investigate the needs of Emergency Medicine registrars pertaining to simulation training for disaster medicine

4. To assess what methods of teaching the Emergency Medicine registrars perceive to be the most useful for disaster medicine training

Methodology

Study design: prospective cross sectional study

Study population and Sample

The study population is Emergency Medicine registrars at the University of Witwatersrand. The sample is those registrars (28 registrars out of 35 in total) who took part in the disaster simulation training exercise.

Inclusion criteria: Emergency Medicine registrars who took part in the training exercise

Exclusion criteria: registrars who did not take part in the training exercise, registrars who decline to answer the questionnaire

Detailed description

The research will take place at the University of the Witwatersrand. The majority of the Emergency Medicine registrars took part in a disaster simulation training exercise on 5 June 2019. Prior to the exercise they received pre reading material that gave them theoretical knowledge about disaster medicine. They were also required to complete an online test prior to the training exercise, which tested their theoretical knowledge. The registrars had access to the pre reading and other resources to complete the test, thus it was essentially an “open book" test. The registrars then took part in the simulation exercise which was a simulated building collapse at the Rietfontein Fire Station. The simulation was planned in conjunction with the University of Johannesburg(UJ). UJ students took part as patient actors. The emergency medicine registrars had various pre assigned roles during the exercise: on scene triage, stabilisation, re triage, command and control or field treatment. The roles did change during the exercise to reflect the dynamic nature of a disaster incident.

A questionnaire will then be administered 6 months after the exercise during an academic meeting to ascertain what the registrars perceptions are regarding the most effective training method for mass casualty incident and their perception of their own skills during the simulation. Their theoretical knowledge will be tested by administering the same questionnaire as given for the “pre test” 6 months after the exercise.

Potential problems

The questionnaire will be administered months after the exercise and this might change the registrars perceptions of the training

There is a small study population as only those registrars who took part in the simulation exercise will be counted in the study

Variables

Independent: age, gender, level of education, previous experience of mass casualty incidents, previous training

Outcome: perceptions of skills, test scores pre and post intervention, assessment of simulation training

Data sheet

Two questionnaires- one on theoretical knowledge administered prior to the simulation and one that repeats the theory tests and also evaluates the perceptions and usefulness of the simulation exercise (Appendix 1).

Statistical Analysis

Pre and post test scores will be compared in order to assess knowledge retention using a paired t-test or a Wilcoxon matched pairs test for normally distributed and skewed numerical data respectively. Pre and post intervention confidence will be compared using a Sign test. The perceived use of different methods of teaching in increasing knowledge and confidence will be described using percentages. The responses to how the registrars feel disaster training should be implemented will be expressed as percentages.

Completed data collection sheets will be kept under safeguard by the investigator. Raw data will be captured and transferred from data collection sheets onto an electronic spreadsheet (Microsoft Excel, Microsoft Office 2012, Microsoft Corporation). All electronic data will be kept on a password protected computer. The original test and data will be received from the department once ethics is approved .

Ethics

An application for ethics clearance will be made to the Human Research Ethics Committee at the University of Witwatersrand

After Ethics approval the answers from the “pre test” will be accessed from Professor Motara(Head of Emergency Medicine division). Consent forms will be required and attached to the questionnaire. Permission for the registrars to partake in the study will also be sought from Professor Motara. Numbers will be assigned to registrars and this will be kept on a separate list accessed only by the investigator. This will be used to compare the theory test scores.

Timing

	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May
Preparing protocol	X	X	X									
Protocol assessment				X								
Ethics Application					X							
Data Collection					X	X						
Data Analysis							X	X	X			
Writing up-thesis										X	X	X

Funding

The study is self funded.

R1000- stationary

The simulation exercise was funded by the department of Emergency Medical Care of the University of Johannesburg.

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Protocol acceptance letter from department research committee

Dr Alison Bentley
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Pr:1493604

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6 October 2019

Attn: Faculty Postgraduate Committee and Human Research Ethics Committee

Re: **Protocol** by Dr Laura Cowling Student no: 302455

Dr Cowling presented her protocol to the divisions of Emergency Medicine Protocol committee and was advised to make changes to the satisfaction of the chair of the committee.

As chair of that committee I can confirm that she has made all the changes required for approval of her protocol.

Sincerely

Alison Bentley

Ethics certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Dr Cowling

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M191034

NAME: (Principal Investigator)	Dr Cowling
DEPARTMENT:	Emergency Medicine Helen Joseph Hospital
PROJECT TITLE:	Knowledge retention and usefulness of stimulation exercises for disaster medicine: what do registrars know and what do they think?
DATE CONSIDERED:	25/10/2019
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Anita Groenewald and Dr Kylen Swartzburg
APPROVED BY:	Dr. C Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	06/12/2019

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in October and will therefore be due in the month of October each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Letter from HOD

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

FACULTY OF HEALTH SCIENCES

Division of Emergency Medicine

Head,
Division of Emergency Medicine
University of the Witwatersrand
Feroza.motara@wits.ac.za

To who it may concern

I **Prof Feroza Motara** give **Dr Laura Cowling** permission to survey the Emergency Medicine Registrars who took part in the disaster simulation exercise on 5 June for purposes of your MMED.

FACULTY OF HEALTH SCIENCES WITS

FEROZA MOTARA
ACADEMIC HEAD
DIVISION OF EMERGENCY MEDICINE
DEPARTMENT OF FAMILY MEDICINE AND PRIMARY CARE
UNIVERSITY OF THE WITWATERSRAND

Date 6/10/19

SIGNATURE: _____

Prof Feroza Motara
Head,
Division of Emergency Medicine
University of the Witwatersrand

Signature.....

Faculty of Health Sciences. School of Clinical Medicine; Division of Emergency medicine; Physical Address:
Wits Medical School, 4th floor, Office No: 4B27, 7 York Road, Parktown, Johannesburg: Tel: +27 11 717 2539
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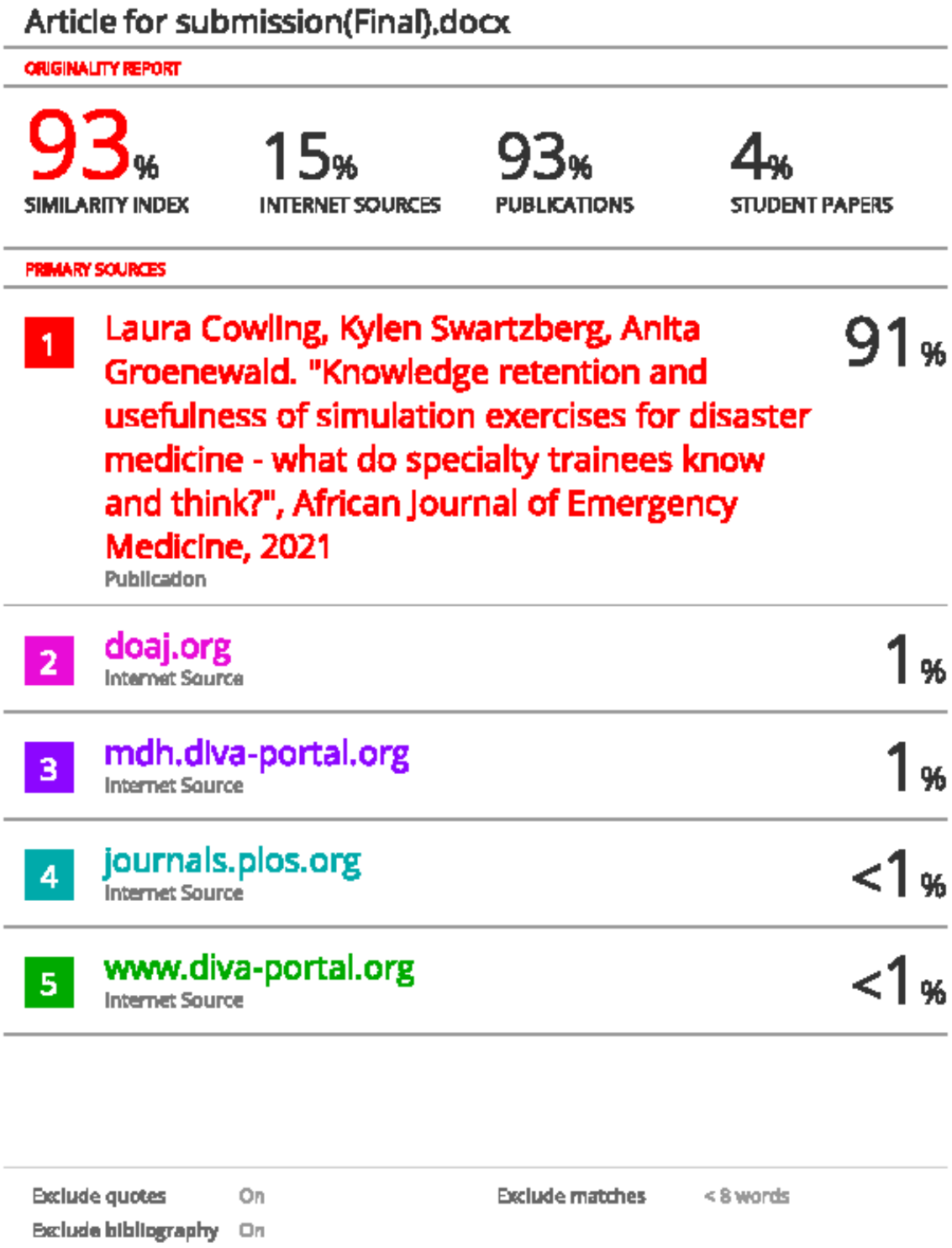

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Original article

Knowledge retention and usefulness of simulation exercises for disaster medicine - what do specialty trainees know and think?

Laura Cowling *, Kylen Swartzberg, Anita Groenewald

University of Witwatersrand, Department of Emergency Medicine, Parktown, Johannesburg, South Africa

ARTICLE INFO

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ABSTRACT

Introduction: Disaster medicine education is an important but often neglected part of Emergency Medicine (EM) specialty trainees' curriculum. It is especially neglected in limited resource environments (1), which, owing to poor infrastructure generally, are more likely to be affected by disasters than better resourced environments. Disaster medicine cannot be taught solely in a classroom and various methods are required to teach practical concepts. This study aims to look at Emergency specialty trainees' perception of high-fidelity simulation and their needs with regards to Disaster Medicine Education.

Methods: This was a prospective cross-sectional cohort study involving 27 EM specialty trainees from the University of the Witwatersrand, who, participated in a high-fidelity simulation and were given a questionnaire before and after the exercise. The questionnaire consisted of theory questions relating to disaster medicine as well as Emergency Specialty trainee's perception and needs towards disaster medicine education.

Results: High fidelity simulation does not increase theoretical knowledge of Disaster Medicine but it does increase perceived confidence. EM specialty trainees seek yearly training, beginning in their first year and choose high fidelity simulation as their preferred method of training.

Conclusion: High fidelity simulation is crucial to increasing the confidence of EM specialty trainees during their training. More research is needed to develop core competencies and methods of evaluating training.

African relevance

- Low-middle income countries are affected disproportionately with disasters
- Disaster medicine education is an under researched field in developing nations
- Emergency medicine specialty trainees and specialists are likely to be at the front line of a disaster response

Introduction

Disaster medicine is an important subject for doctors, particularly Emergency Medicine (EM) specialists who will often be the forefront of disaster incidents [2]. It is also useful to develop other core competencies required by the EM physician such as communication, collaboration and management skills [3]. Disaster medicine is an often-neglected area in the undergraduate and post graduate curricula of medical training [4–6]. It is difficult for educators to prioritise education on a "low probability" event and a challenge to find teaching methods that increase the above-mentioned competencies as well as other skills needed for disaster management. Disaster medicine is also a neglected area of research in resource limited environments.

To the author's knowledge there are no studies relating to disaster medicine education in resource constrained environments. These environments are often hit hardest during disaster and are at great risk for future disasters. Climate change, urbanisation and over population are factors which are likely to lead to an increase in severity and frequency of disasters and these may affect the developing world disproportionately [7].

It has been shown that medical professionals who have received training in disaster medicine are more willing to respond to a mass casualty incident [8]. Additionally, uncoordinated responses by individuals who have not received training can hamper the response to a disaster [9]. In low income countries that already experience a low doctor to patient ratio it is imperative that all available medical staff are willing and trained to respond to a mass casualty or disaster incident. Regular and effective training is therefore imperative to ensure that when disaster strikes all available staff are prepared and willing to

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respond appropriately.

The various methods used for teaching disaster medicine are lectures, low fidelity simulations, so called "tabletop" exercises, computerised simulations, and high fidelity, in-field simulations. Lectures may be effective at imparting knowledge on theory but not necessarily practical skills that are useful in a disaster situation. There are studies proving that simulation-based learning is effective for teaching aspects of medical education [10], but few relating specifically to disaster medicine. It has been shown that although lectures are adequate at teaching theory, doctors feel more confident after simulations of disasters [11]. High fidelity simulations have been shown to improve a personal sense of preparedness [12]. Computerised simulations are an option but often the high development costs and limited technological reach make this approach impractical in poorly-resourced countries However, no studies have been done in a resource limited setting.

High fidelity simulation is a costly and time-consuming exercise [13]. It therefore needs to be investigated as a method of disaster medicine training as to whether it improves confidence and EM specialty trainees' perceptions of their skills. It is very difficult to assess disaster medicine educational tools as no standardised method of evaluation exists [14]. However, the Kirkpatrick model [15] is a well validated model that can be used to assess training methods. The Kirkpatrick model uses 4 levels to assess the efficacy of the intervention [15] . The first level is Reaction- how useful do the participants think the training exercise is. The second level is Learning which can be assessed using a pre and post test. The third level is Behavior and this component assesses whether the trainees use what they have learned in their daily work. The fourth level is Results and this evaluates whether the behavior assessed in level three results in actual improved outcomes. As disasters are rare in everyday practice, it is difficult to ascertain whether training has improved the relevant skills. The needs of EM specialty trainees should also be investigated with regards to disaster medicine education so that the efforts into disaster training can be effective.

Methods

Survey

A sample population of 27 EM specialty trainees from the University of Witwatersrand (Wits) took part in a disaster medicine simulation as part of their academic program. The specialty trainees were given pre-reading (selected articles chosen by the educators) as well as a questionnaire to complete pre simulation. The questionnaire was designed by the researchers using the Kirkpatrick model as a framework.

Part A of the questionnaire (see Appendix B data supplement) included basic demographic information, Likert scale questions regarding attitude and perceptions of a mass casualty incident and a theoretical component with questions pertaining to disaster medicine curriculum. This questionnaire was answered in Google Forms in the week prior to the simulation. This part of the questionnaire assessed level 2 (Learning) of the Kirkpatrick model. Part A was administered pre and post simulation. Part B of the questionnaire was only answered post high-fidelity simulation and contained questions regarding the simulation and also the needs of the specialty trainees with regards to a disaster medicine curriculum. This part of the questionnaire assessed level 1 (reaction) of the Kirkpatrick model. In addition to using the Kirkpatrick model to develop the questionnaire, questions were included that assessed the specialty trainees perceived needs pertaining to disaster medicine education which would aid in building a disaster medicine curriculum.

The specialty trainees then participated in a high-fidelity simulation exercise in conjunction with the University of Johannesburg Department of Emergency Medical Care. A structural collapse scenario was simulated with actors playing the role of patients. The simulation costs were reduced by using a number of strategies. Firstly, emergency care students were used as volunteers for moulage. Secondly, through inter-faculty collaboration with UJ, who provided rescue equipment and personal protective equipment, and WITS, who assisted with planning and provided catering. UJ also has a long standing relationship with City of Johannesburg Emergency Management Services (COJEMS), who own the site where the simulation took place.

The specialty trainees were assigned to roles (command and control, rescuer, triage, and treatment). These roles did however change during the exercise to reflect the dynamic environment of a disaster. The simulation lasted approximately 3 h. After the simulation, a debriefing was held. Six months after the exercise the specialty trainees were given Part A and B of the questionnaire. This questionnaire was answered on hard copy to ensure maximum response rate.

Data analysis

Statistical analyses were conducted in R software (version 4.02; www.R-project.org). Test for data normality were done using the Shapiro–Wilk test and examining Q-Q plots. All data in this study were non-normal and appropriate non-parametric analyses were conducted, including Wilcoxon matched pairs for data collected pre- and post-simulation, chi-squared contingency table analyses and Pearson's chi-squared analyses. Tests were two-tailed, and ovoial significance set at 0.05.

Results

A total of 27 Emergency Medicine specialty trainees took part in the study, 26 of whom completed the questionnaire pre-simulation and post-simulation and one who participated in the pre-simulation only, indicating a response rate of 96%.

Theory

Specialty trainees scored a median of 22 (out of a total of 25) in both the pre- and post-simulation MCQ questions, which did not differ significantly from chance (Wilcoxon test, $p = 0.686$). Thus level 2 (learning) of the Kirkpatrick model was not significantly influenced by high fidelity simulation.

Improving skills

Specialty trainees were asked about their confidence in managing a structural collapse scenario in five areas. Pre simulation, the most common response was "not confident" for the role of command and control, "not confident" for rescuer, "slightly confident" for triage and "slightly confident" for safety. Post simulation, the most common response was "slightly confident" for command and control, "confident" for rescuer, "confident" for triage and "mostly confident" for safety. Therefore, the specialty trainees felt a subjective improvement in their confidence and thus a positive impression of the training exercise (Kirkpatrick level 1, Reaction). See Fig. 1.

Educational needs

Importance of training for specialty trainees

Significantly more specialty trainees agreed that the simulation training increased their knowledge ($p < 0.001$) and confidence ($p < 0.001$). Thus, the specialty trainees showed a positive reaction (Kirkpatrick level 1) to the high-fidelity simulation. Significantly more specialty trainees strongly agreed that simulation training was important in their curriculum ($p < 0.001$.) and mentioned that insufficient time was spent in disaster training ($p < 0.001$).

Most (59%) of EM specialty trainees think that Disaster medicine training should begin in the first year, with 33% believing it should start in second year. The majority (68%) prefer yearly training, and 19% believe it should be done every 6 months. Only 1.3% believe it should be

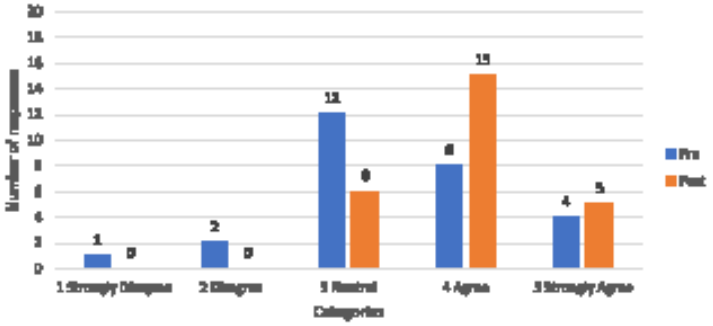

Fig. 1. Usefulness in improving confidence of specialty trainees in acting part in a mass casualty incident.

done every two years. See Figs. 2 and 3.

Teaching perceptions of specialty trainees

For improving knowledge, significantly more specialty trainees maintained that pre-reading ($p < 0.001$), briefing ($p < 0.001$), simulation ($p < 0.001$) and debriefing ($p < 0.001$) were all very useful. A pre-test was regarded by most to be somewhat useful ($p < 0.001$). None of the specialty trainees mentioned that any training aspect was completely useless.

For improving confidence, significantly more specialty trainees maintained pre-reading ($p < 0.001$) was useful. Briefing ($p < 0.001$), simulation ($p < 0.001$) and debriefing ($p < 0.001$) were all considered very useful.

Specialty trainees were asked about their preference for combination of methods for simulation. Most preferred High-fidelity simulation and Exercises in simulation laboratory, although their preference did not differ significantly by chance ($p = 0.76$). See Table 1.

Discussion

Disaster medicine education is not well studied in resource limited environments [1] as most research on this topic is done in the United States and Europe [16]. Disaster medicine curricula lack robust research, standardized evaluation and competency driven goals [17]. There are also very few studies that evaluate high fidelity simulation for disaster medicine education.

The above study shows that high fidelity simulation, while a costly and resource intense effort, improves the self-reported knowledge and confidence of SA specialty trainees in a resource limited setting. It also shows that high fidelity simulation can be undertaken in low resource environments, with collaboration with other departments and use of existing training facilities which helps to keep within budget. However, a simulation does not increase theoretical knowledge of disaster medicine and thus didactic lectures/pre reading must be used to improve theoretical knowledge.

The perceived confidence of the specialty trainees improved post simulation. The simulation was very useful in improving their perceived skill sets in the different areas of disaster management (command and control, triage etc). This is important as even though the specialty trainees did not participate in every role in the simulation, they all felt an increase in skill across the various roles. A similar study of medical interns by Ngo et al. [18], studying high fidelity simulation produced comparable results.

All improvement of skills and knowledge by participants are self-reported and were not objectively measured by monitoring of performance or marking. This is a common finding with disaster medicine research [16,18] and may be an important measure of improvement for future studies on high fidelity simulations in disaster medicine education.

Studies have also used the Kirkpatrick model to assess disaster medicine education [16]. Using the Kirkpatrick model, we can see that the study evaluates level 1 and level 2. Reaction (level 1) was assessed and it was found to be perceived as very useful for the specialty trainees. Level two is learning and there was no difference in the theory component; however the participants did perceive an improvement in skills. A more robust way to assess level 2 would be to record or observe the participants and develop a mark sheet or rubric for basic skill competencies. This study did not evaluate level 3 (Transfer), which is similar to other disaster medicine studies [16] and level 4 (Results) can only be assessed during a disaster event.

The specifics of the simulation were also examined in this study. Interestingly, the participants found that the briefing, simulation, and debriefings were all useful. This is important information for the development of a disaster curriculum for South African specialty trainees.

The study also shows that most specialty trainees feel that too little time is spent on disaster medicine education, which is in line with other

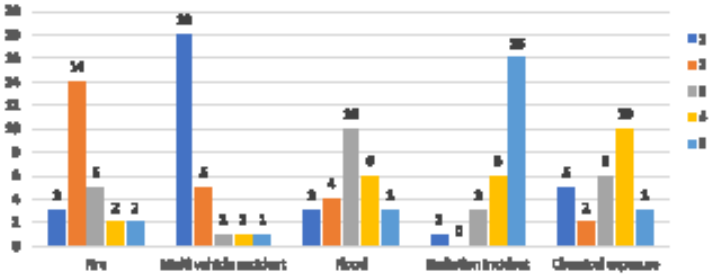

Fig. 2. Responses to "which scenarios would you like to practice in a simulation?" (1 being most likely to experience and 5 being least).

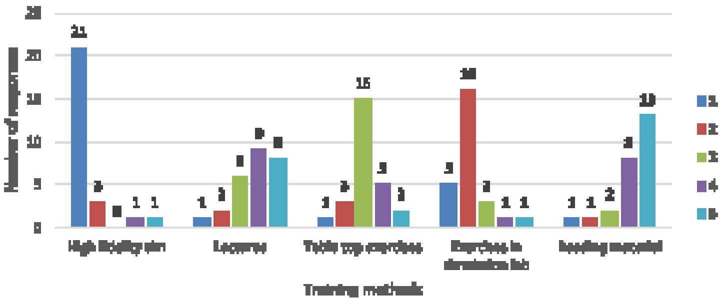

Fig. 3. Ranked preferential teaching methods with 1 being most important and 5 being least.

Table 1
Specialty trainees' preference for combination of methods for simulation.

Methods	Number of responses
High fidelity simulation and exercises in simulation laboratory	11
High fidelity simulation and lectures	18
High fidelity simulation and tabletop exercises	3
Lectures and exercises in the simulation laboratory	3

studies [19,20]. Similar to studies in Europe, participants favoured road traffic accidents as the scenario for future simulations [21]. The EM specialty trainees feel that teaching should occur annually and most picked high-fidelity simulation as the most useful teaching method. This can assist those involved with EM specialty training to develop a curriculum that meets the needs of the specialty trainees.

The limitations of this study are that it includes a small number of specialty trainees from a single training centre. The second questionnaire was administered 6 months after the event and the duration between the exercise and the questionnaire might affect the answers. The specialty trainees were not evaluated during their performance and thus only report a subjective improvement. The simulation was only done on a single scenario. The high-fidelity nature of the simulation made it difficult for observers to evaluate the specialty trainees performances.

Conclusion

High fidelity simulation is a valuable tool for disaster medicine education in a resource limited setting. It is a neglected part of the curriculum of EM specialty trainees and standardised curricula need to be developed. This study has assessed the needs of EM specialty trainees and thus can aid developing future training for them.

Dissemination of results

Results from this study were shared with the specialty trainees who participated as well as the educators involved with developing the academic curriculum for the specialty trainees.

CRediT authorship contribution statement

Authors contributed as follow to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: LC contributed 70%, EB 20% and AG 10%. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of competing interest

The authors declared no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.afjem.2021.08.001.

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