Original Publication

🔓 OPEN ACCESS

A Simulated Mass Casualty Incident Triage Exercise: SimWars

Suzanne Bentley, MD, MPH*, Laura Iavicoli, MD, Lorraine Boehm, MSN, CCRN-K, RN-BC, WCC, TNCC, George Agriantonis, MD, Barbara Dilos, MD, Julia LaMonica, MS, RN, ACNP-BC, Colleen Smith, MD, Lillian Wong, MD, Tania Lopez, MD, Anju Galer, MSN, APRN, ANP-BC, Stuart Kessle, MD

*Corresponding author: Bentleys@nychhc.org

Abstract

Introduction: This multipatient simulation exercise encompasses triage by hospital medical providers during a mass casualty incident (MCI) involving gas line explosion with building collapse. The SimWars format allows two teams to participate in identical simulations coupled with active audience observation, followed by facilitated group discussion. The exercise requires real-time knowledge application of MCI management and helps learners develop a framework for rapidly classifying and dispositioning MCI patients. **Methods**: Two teams of provider pairs completed MCI triage of 12 simulated patients in 8 minutes with an objective of quickly and accurately dispositioning within hospital bed availability. Participants included emergency medicine and surgery physicians, with active observation by mixed provider audiences. Observers completed a checklist per patient (category: urgent/emergent/not emergent, disposition: bed type/location). At simulation conclusion, a 45-minute facilitated discussion compared observers' self-assessment of MCI patient management with the simulation teams' decisions. Finally, an expert panel discussed management decisions and MCI triage pearls. **Results**: Team performances ($N = 4$) and audience responses ($N = 164$) were similar on seven of 12 patients, allowing robust discussion. Participants completed an evaluation at exercise conclusion; 37% reported good/excellent ability to accomplish MCI initial triage and disposition before this exercise compared to 100% after, a statistically significant 63% increase. All postsurvey respondents agreed or strongly agreed that the exercise would change their MCI clinical practice. **Discussion**: The two-team format allows comparison of how different teams handle MCI triage, and active observation allows comparison of audience and team decision making.

Keywords

Trauma, Interprofessional Education, Simulation, Surgery, Emergency Medicine, Triage, Communication Skills, Fire, Clinical Reasoning/Diagnostic Reasoning, Mass Casualty Incident

Appendices

A. Prebriefing for Simulation Participants.pptx

B. Overview Handout for Audience Participants.docx

C. Introduction Slides.pptx

D. Checklist for Audience and Facilitators.docx

E. Patient Information Handout for Audience.docx

F. Simulation Case Script.docx

G. Bedboard Slide.pptx

H. Facilitated Discussion Guide and Main Points .docx

All appendices are peer reviewed as integral parts of the Original Publication.

Educational Objectives

By the end of this activity, learners will be able to:

1. Triage multiple critical patients from a mass casualty incident (MCI), balancing efficiency of triage (speed of assessment) with effectiveness of triage (correctness of triage classification and disposition).

2. Disposition multiple critical patients from an MCI within the constraints of currently available hospital beds, while also balancing the desire to reserve high-acuity bed types (e.g., intensive care unit or operating room) for potential future patients versus the disposition needs of the present patients.

3. Discuss importance of MCI triage team communication, teamwork, and coordination to quickly and correctly accomplish the above objectives.

Introduction

A mass casualty incident (MCI) is an event that *overwhelms* the local health care system, with the number of casualties vastly *exceeding* local *resources* and capabilities in a short period of *time*.[1] Hospital surge capacity is defined as a hospital's ability to meet a sudden and unusual spike in demand for resources.

AAMC

While many types of events can call upon such capacity, none is more time sensitive or potentially consequential than a large-scale MCI.[2] Recent news reveals that unfortunately these events are no longer rare occurrences, and medical providers and hospitals everywhere must be prepared for sudden, unexpected, massive influxes of patients, some with critical injuries.[2] With increasingly overcrowded emergency departments (EDs) leaving little margin for error, hospitals must be prepared to immediately and expertly implement an MCI plan to rapidly transition from normal operations to crisis standards of care. Real-world MCIs usually occur without notice and require decision making in a chaotic, information-poor environment.[2] The definitions of an MCI depend on the resources of the admitting institutions; however, it is clear the outcomes depend on preparedness, of which one crucial aspect is correct and timely triage during the MCI.[1]

MCIs are low-frequency but very high-stakes events and represent a challenging area of medical care. There is rarely a single correct management strategy, and decisions must be made quickly and with limited information. This simulated exercise encompasses triage during an MCI gas line explosion with building collapse causing major fire in the hospital vicinity. The exercise is designed to teach and reinforce the skills of rapid and accurate triage in an MCI through hands-on, real-time application of MCI triage knowledge via simulation. The SimWars format of two (or more) teams participating in the identical simulated MCI triage exercise is coupled with active audience participation to allow for inclusion of a larger learner group than could be accommodated in simulation alone. Active audience observation and participation are encouraged through use of a checklist for triage and disposition decisions by the audience in real time during the simulation cases, allowing critical thinking and active learning. This comparative design is utilized to maximize learning and provide enhanced group discussion, with objectives geared toward development of a best-practices conceptual framework for classifying and dispositioning MCI patients. The overarching objective is to offer a unique educational platform for MCI education in order to allow for increased application of MCI triage knowledge in real time through simulation with a large group of learners.

The target audience is those interested in learning about or involved in the care of critically injured trauma patients, such as victims of MCI, and encompasses a mix of actively practicing physicians, physician assistants (PAs), nurse practitioners (NPs), nursing staff, emergency medical service (EMS) personnel, medical and nursing students, pharmacists, and respiratory therapists. The purpose of this MCI exercise is to compare and contrast medical decision making by the different simulation teams and audience participants, composed of the provider types listed above, in order to provide all participants with the opportunity to apply knowledge to simulated MCI scenarios. The exercise has been designed to link theory to practice, expose learners to a high-fidelity MCI situation, and further increase and improve learners' confidence and abilities in performing MCI triage. Those with limited prior education on MCI triage are able to follow along with the scenario, make their best possible decisions on the checklist, compare their decisions to those of experts, learn tenets of MCI triage during facilitated discussion, and ask questions. The audience includes in-hospital providers who care for MCI patients, as well as EMS personnel, who benefit from an exercise of this type since knowledge of next steps after their hospital transport allows them to help in-hospital teams efficiently make next-step decisions (e.g., EMS personnel can inform the triage physician of their assessment of the level of urgency). While trauma simulations are commonplace and simulation exercises involving more than one patient at a time have been published, none to date have evaluated the rapid-fire triage of multiple patients from an MCI, such as in this exercise.[3-5]

The curricular design of this multipatient MCI triage SimWars includes careful consideration of adult learning principles, most notably, active participation and facilitation of schema development. For this reason, we have selected simulation with adjunctive active observation and participation by all observers. Undergraduate and graduate medical and nursing education is rapidly adopting simulation as a modality to bridge the gap between the theory and actual practice of medicine[6,7] and especially recognizes simulation for its value in teaching high-stakes, infrequently occurring case types, such as MCIs.

Simulation additionally allows for the practice of teamwork and communication in patient management,[8,9] all while offering a safe space for learners to develop and apply medical knowledge and skills without risk of harm to live patients.[10] Studies to date show that observation of simulation and hands-on participation offer similar learning outcomes and levels of engagement.[11,12] Different studies report increased observer engagement and role satisfaction of observers when provided with tools to enhance participation, leading to our development and use of audience handouts (e.g., the checklist as utilized for this exercise).[11]

Other simulated MCI exercises, such as that by Ko et al.,[13] have been conducted; however, our format is unique and allows for learning to occur for a broader and larger audience. The unique SimWars format coupled with active audience participation has not been reported thus far in the literature. The consecutive arrival of 12 patients in only 8 minutes in the same session allows learners to experience what it might feel like to participate in triage during an actual MCI. Rather than have only those performing the exercise gain experience and knowledge, an entire audience of active participants can benefit. They mentally perform the same tasks that the participating teams perform and are able to compare and contrast their decisions with those of the teams. The entire group then participates in and learns from facilitated discussion with an expert panel. Furthermore, comparing multiple teams' performances with audience case assessment allows for robust and far more extensive discussion than would be elicited from either a single simulation case or a single team or learner completing the sequence of patients.

This SimWars MCI exercise was initially implemented during a hospital-wide trauma conference with an audience comprising physicians of multiple disciplines and levels of training, PAs, NPs, nurses, and EMS personnel. It may be implemented for any size audience of any provider types or as a stand-alone MCI simulation exercise for single providers or teams.

Methods

Summary of Simulated MCI Scenario

Each team participated in treating an identical set of simulated MCI patients, with identical objectives. These objectives were to triage each patient in rapid succession and to assign a clinical acuity level and disposition type within the confines of bed availability within the hospital. The audience members participated in the exercise twice, with the opportunity to reflect on and change their medical decision making during the second case based on new insights from the first.

Learner Description

The exercise consisted of two teams of two medical providers each comprising a possible combination of emergency medicine (EM) or surgery attendings, residents, midlevel providers (PAs, NPs), and EMS personnel. Teams were composed of one EM resident and one surgery resident physician. The exercise was designed to take place in front of an audience, with active audience participation.

Prebriefing

Both teams and the audience were informed ahead of time that while this was SimWars, meaning there were two teams each performing the same set of scenarios without watching the other team's performance, there would not be a winning team (although the exercise could optionally be conducted with election of a winner). As with many clinical scenarios, during an MCI, there was no right or wrong answer, and providers were expected to act quickly and to the best of their abilities. The SimWars format was utilized to allow comparison of how two different teams handled the MCI and to permit comparison of personal decision making by audience members with that of the teams.

Simulation team prebriefing: Prior to the day of the event, two participating teams were selected and their consent to participate obtained. The teams were prebriefed on concepts regarding participation in a simulation (Appendix A) and informed they would be participating in an MCI event without information provision as to type of MCI or expected number of patients. Participants were offered the chance to ask any questions.

Audience prebriefing: Upon arriving at the MCI exercise and prior to the start of the simulation, the audience members were introduced to the SimWars format, informed about what they would see, informed of the participating teams' roles, briefed on their audience role as active observers (Appendices B & C), introduced to the objectives and scoring checklist (Appendix D), provided with an overview of the simulated patients they would be observing (Appendix E), and offered the chance to ask questions.

Audience and Participant Introduction
Introductory material was conveyed to the audience and participants (Appendix C). The scenario began with an EMS notification to the ED emergency phone from emergency medical dispatch that there had been a gas line explosion in the area and the fire department–emergency medical services had activated a Level C MCI in the area. By definition, this meant the ED could receive up to nine critical and 70 noncritical patients. The charge nurse was notified to contact appropriate administration and activate the hospital external disaster plan. Twelve patients arrived over 8 minutes. The pairs of providers were tasked with working together to triage the rapidly arriving patients quickly but correctly and within the resources available at the hospital (e.g., number of available critical care or operating room beds). The scenario ended when all patients had been dispositioned to areas in the hospital or 8 minutes had elapsed.

The patients comprised high-fidelity simulation manikins and standardized patient actors. Each patient was assigned a number corresponding to an overview of the patients that was provided to audience members prior to the start of the exercise so they could more easily follow along (Appendix E). The participating team members did not have this information (e.g., vital signs) unless they specifically requested it during the exercise and were tasked with rapidly assessing the patients in real time to make a triage categorization and disposition decision. There was an embedded participant working with the team, in this case, a nurse. The embedded participant was an actor following a script (Appendix F) in order to standardize what information was provided to the team when asked (e.g., provision of vital signs or prompted explanation of an injury). The EMS role was also played by an embedded participant, who wheeled patients to the team and provided scripted patient information (e.g., injury type and overview of each patient; Appendix F).

Bed availability was displayed on a screen and updated in real time during the exercise, showing locations available in the hospital (Appendix G). As with a real MCI, the participating providers did not know ahead of time what to expect or what types or severity of patients they would encounter, so they had to work to balance quick triage with correct triage and anticipate bed utilization to the best of their ability.

To reiterate, audience members were encouraged to think critically about how they would assess, triage, and disposition each patient by following along and completing the provided checklist (Appendix D) for each patient. The audience members were also encouraged to reflect on whether their decisions matched those of the teams, as well as why or why not, and on what information they had that the teams did not obtain that changed their decision, if any.

MCI Simulation Exercise
The scenario was designed to represent institution-specific, usual proceedings but can (and should) be easily modifiable to another institution's policy and procedures or standards.

Environment:

- Lab setup: auditorium, simulation center, ED, or any large open space—matched to audience size.
- Patient setup:
  ○ High-fidelity simulators (HFSs) as available, but not required. In this scenario, the HFS was not turned on due to low-yield value in a loud, large auditorium. If the scenario is to be done with smaller audiences, HFSs can be utilized as fully intended. Alternatively, low-fidelity manikins (e.g., simple CPR torso) or a even printed card of patient demographics on a stretcher or

wheelchair can be utilized. For this exercise, the HFS adult manikin was utilized as four of the 12 patients (patient numbers 4, 6, 9, and 11), the HFS child manikin was utilized once, the HFS female/birthing manikin was utilized once (as a nongravid female simulated patient), the simple CPR torso was utilized twice, and the remaining four patients were simulated by live actors.

- Standardized patients.
- Moulage/clothes/wig: blood, ecchymosis, burns, dirt, and debris. Alternatively, the patient description can be verbalized by the embedded EMS participant arriving with the patients (e.g., no actual moulage but the EMS might state, "He has significant soot around the mouth and facial burns" or "A large area of ecchymosis is present on his left flank").

Props: Vital signs were printed and handed to participating teams or alternatively were verbalized by the embedded EMS participant.

Actors:

- Simulation director or someone to introduce the concept and provide safe-simulation introduction (e.g., confidentiality, safe container rules, requests that participants suspend disbelief).
- Simulation operators or personnel to coordinate HFS or standardized patient release to the team (i.e., a staging manager).
- Content experts for facilitated discussion (in this scenario, a combination of simulation experts and ED and surgery attending physicians).
- Embedded participants (in this example, a nurse and an EMS).
- Embedded ED attending, administrative director on call, and/or bedboard personnel to provide bed numbers when requested.

MCI simulation exercise flow:

- Case narrative introduction (Appendix C).
- Two previously identified and prebriefed simulation teams. Team 2 was blinded to the exercise while Team 1 performed.
- After completion of the exercise by Team 1, the expert judges facilitated discussion and gave comments and pearls to Team 1 and the audience.
- After completion of the exercise by Team 2, the expert judges again facilitated discussion and gave comments and pearls to Team 2 and the audience.

Expert Facilitated Discussion
The exercise concluded with a group discussion facilitated by an expert panel (a senior ED attending physician, a senior trauma surgery attending, a critical care attending faculty member, and the medical director of the hospital simulation center) utilizing the PEARLS framework for debriefing,[14,15] which emphasized discussion of differences in Team 1 versus Team 2 performance followed by a summary of best practices and expert MCI triage pearls (Appendix H).

Evaluation
During exercise: There was a checklist (Appendix D) used by the audience members that allowed them to participate from their seats and complete assessment of the following items:

- Overall teamwork and communication of the triage teams.
- MCI management of each individual patient:
    - Rapid assessment of circulation, breathing, airway, and injuries.
    - Correct triage and whether the correct category was verbalized: emergent, urgent, or not urgent.
    - Appropriate disposition for each patient, taking bed availability into account.

In addition, each audience member was asked to choose his or her own acuity level and disposition and compare them to the decisions made by Team 1 and Team 2. This checklist aligned with the previously stated objectives.

Postexercise evaluation: Following SimWars, participants and audience were asked to complete an evaluation of the simulation exercise itself in order to assess whether the exercise met the objectives, whether the handouts were useful for guiding audience participation and engagement, and whether the audience experienced a learning curve from participation alongside Team 1 versus Team 2 for ability to accomplish initial triage and disposition during an MCI.

Results

There were four team members who participated directly in managing the simulations (two teams of two: one EM resident physician and one surgery resident physician per team) and 164 audience members who participated and completed the postexercise evaluation. Of these 164 audience participants, there was a combination of attending and resident physicians and nurses from the EM and surgery departments (90%), EMS personnel (5%), and hospital administrators (5%). Participants applied tenets of MCI triage knowledge to the simulated patients to identify their category of clinical acuity and disposition within hospital bed availability.

Comparing the two teams' decisions to each other and to those of the audience members provoked robust facilitated discussion of MCI triage. The discussion revealed that the teams' performances and audience responses were similar for seven of 12 patients but were quite varied for the other five, a result that occupied the bulk of the discussion led by the expert panel.

Participants (164 audience participants plus four simulation participants) completed a voluntary evaluation of the SimWars exercise with response options on a 4-point Likert-like scale (1 = *Poor/Strongly Disagree,* 2 = *Fair/Disagree,* 3 = *Good/Agree,* 4 = *Excellent/Strongly Agree*; see the Table).

Table. Postevaluation

Evaluation Questions	Agree/Strongly Agree
SimWars met stated objectives.	100%
SimWars would change my clinical practice caring for MCI victims in the future.	100%
Handouts/supporting materials were useful.	97%
Scenario debriefings/facilitated discussion after each team's participation were educational.	94%
Expert panel summary at conclusion of the scenarios was educational.	100%

Abbreviation: MCI, mass casualty incident.

Thirty-seven percent reported good/excellent ability to accomplish initial triage and disposition of an MCI before this exercise, followed by 100% reporting good/excellent ability after the exercise, a statistically significant 63% increase. Additionally, free-text comments about the simulated MCI exercise included comments such as "excellent," "like real life, brought it home," "speed and amount of patients arriving was tremendous," "it was great to watch the triage of patients," "I believe that the SimWars and presentation was excellent," and "it really made me think."

Discussion

This is a novel simulation MCI triage exercise that does not appear to have been previously published in the literature. It was very well received, and postevaluations were very positive. The exercise can be tailored to desired size of simulation group and/or audience. As implemented, the format demonstrated great educational benefits for a wide range of provider types. The results indicate that the simulation participants, as well as the active observers in the audience, were able to learn from the activity and that it increased self-reported comfort with ability to perform MCI triage. Several evaluation respondents requested more in-depth discussion about each MCI patient by the expert panel, which emphasizes that

this exercise can be expanded/contracted based on audience, time available, and specific learning objectives.

The expert facilitated discussion and exploration of the teams' decisions for managing each of the 12 patients offers great opportunity for discussion and can be broken down into more-/less-detailed discussion of the pros and cons of balancing speed and accuracy for each disposition, based on allotted time for exercise completion.

Studies to date show that observation of simulation (vs. active participation) should not be underestimated as an important opportunity to enhance and expand the experience of simulation-based education.[12] Some studies suggest that learning outcomes in observer roles are as good as (or sometimes better than) hands-on roles in simulation.[11] Different studies report increased observer engagement and role satisfaction by observers when provided with observer tools to enhance participation. With this in mind, we developed the audience handouts (e.g., the checklist) so observers could more actively participate rather than passively watching the simulation.[11] While hands-on participation may remain the preferred method for many participants, observation of simulation appears to be a viable, beneficial educational tool allowing inclusion of a significantly larger group at one time than would ever be possible otherwise.

Limitations
A realistic, potential disadvantage or limitation to performing such a robust exercise is the time and resources necessary to implement it. This exercise was conducted utilizing HFSs and live-actor volunteers in full moulage, which took several hours of preparation and hard work to coordinate. The same exercise, however, could be done on a smaller scale with lower technology/resources and far less effort, such as through inclusion of each patient as a description on a PowerPoint slide displayed on-screen for a large audience or by substituting descriptive cards attached to empty stretchers. The observers would then be able to use the same checklist to make their own decisions, followed by similar facilitated discussion. Two teams could still be used if desired, with each team's decisions verbalized to the audience. The observers could then compare and contrast their decisions with those of the teams, just as occurred with the format utilized above.

An additional limitation concerns time provided for each participating team (8 minutes for 12 patients), which may not mimic real-life MCI triage decisions based on volume and timing of arriving patients. The time allotted can be expanded based on objectives and time available to conduct the exercise; however, both teams in our exercise completed intake of all 12 patients in the 8-minute time frame.

While postexercise evaluations revealed that this exercise met stated objectives and generally increased provider confidence with MCI triage, these evaluations were limited to participant perceptions only, without objective assessment of improvement. In the future, postexercise testing (e.g., written test or utilization of additional simulation cases) could be considered for more robust evaluation of outcomes.

Suzanne Bentley, MD, MPH: Medical Director, Simulation Center, NYC Health + Hospitals/Elmhurst; Attending Physician, Emergency Medicine, NYC Health + Hospitals/Elmhurst; Associate Professor, Emergency Medicine and Medical Education, Icahn School of Medicine at Mount Sinai

Laura Iavicoli, MD: Associate Director, Emergency Department, NYC Health + Hospitals/Elmhurst; Director, Emergency Medical Services/Emergency Management, NYC Health + Hospitals/Elmhurst; Assistant Professor, Emergency Medicine, Icahn School of Medicine at Mount Sinai

Lorraine Boehm, MSN, CCRN-K, RN-BC, WCC, TNCC: Simulation Specialist, Simulation Center, NYC Health + Hospitals/Elmhurst; Senior Nurse Educator, NYC Health + Hospitals/Elmhurst

George Agriantonis, MD: Director, Trauma, NYC Health + Hospitals/Elmhurst; Assistant Professor, Surgery, Icahn School of Medicine at Mount Sinai

Barbara Dilos, MD: Director, Anesthesia, NYC Health + Hospitals/Elmhurst

Julia LaMonica, MS, RN, ACNP-BC: Associate Nurse Practitioner, Emergency Medicine, NYC Health + Hospitals/Elmhurst

Colleen Smith, MD: Assistant Program Director, Emergency Medicine Residency, NYC Health + Hospitals/Elmhurst; Attending Physician, Emergency Medicine, NYC Health + Hospitals/Elmhurst; Assistant Professor, Emergency Medicine, Icahn School of Medicine at Mount Sinai

Lillian Wong, MD: Attending Physician, Emergency Medicine, NYC Health + Hospitals/Elmhurst; Assistant Professor, Emergency Medicine, Icahn School of Medicine at Mount Sinai

Tania Lopez, MD: Assistant Program Director, Pediatric Residency, NYC Health + Hospitals/Elmhurst; Attending Physician, Pediatrics, NYC Health + Hospitals/Elmhurst

Anju Galer, MSN, APRN, ANP-BC: Trauma Program Manager, NYC Health + Hospitals/Elmhurst

Stuart Kessle, MD: Director, Emergency Medicine, NYC Health + Hospitals/Elmhurst; Associate Professor, Emergency Medicine, Icahn School of Medicine at Mount Sinai; Vice Chairman, Emergency Medicine, Icahn School of Medicine at Mount Sinai

References

1. Ben-Ishay O, Mitaritonno M, Catena F, Sartelli M, Ansaloni L, Kluger Y. Mass casualty incidents—time to engage. *World J Emerg Surg*. 2016;11:8. https://doi.org/10.1186/s13017-016-0064-7

2. Waxman DA, Chan EW, Pillemer F, Smith TWJ, Abir M, Nelson C. Assessing and improving hospital mass-casualty preparedness: a no-notice exercise. *Prehosp Disaster Med*. 2017;32(6):662-666. https://doi.org/10.1017/S1049023X17006793

3. Capella J, Smith S, Philp A, et al. Teamwork training improves the clinical care of trauma patients. *J Surg Educ*. 2010;67(6):439-44 https://doi.org/10.1016/j.jsurg.2010.06.006

4. Hoff WS, Reilly PM, Rotondo MF, DiGiacomo JC, Schwab CW. The importance of the command-physician in trauma resuscitation. *J Trauma*. 1997;43(5):772-777. https://doi.org/10.1097/00005373-199711000-00007

5. Stahl K, Palileo A, Schulman CI, et al. Enhancing patient safety in the trauma/surgical intensive care unit. *J Trauma*. 2009;67(3):430-43 https://doi.org/10.1097/TA.0b013e3181acbe75

6. Motola I, Devine LA, Chung HS, Sullivan JE, Issenberg SB. Simulation in healthcare education: a best evidence practical guide. AMEE Guide No. 82. *Med Teach*. 2013;35(10):e1511-e1530. https://doi.org/10.3109/0142159X.2013.818632

7. Weller JM. Simulation in undergraduate medical education: bridging the gap between theory and practice. *Med Educ*. 2004;38(1):32-38. https://doi.org/10.1111/j.1365-2923.2004.01739.x

8. Lateef F. Simulation-based learning: just like the real thing. *J Emerg Trauma Shock*. 2010;3(4):348-352. https://doi.org/10.4103/0974-2700.70743

9. Volk MS. Improving team performance through simulation-based learning. *Otolaryngol Clin North Am*. 2017;50(5):967-987. https://doi.org/10.1016/j.otc.2017.05.008

10. Aboumatar HJ, Thompson D, Wu A, et al. Development and evaluation of a 3-day patient safety curriculum to advance knowledge, self-efficacy and system thinking among medical students. *BMJ Qual Saf*. 2012;21(5):416-422. https://doi.org/10.1136/bmjqs-2011-000463

11. Bullard MJ, Weekes AJ, Cordle RJ, et al. A mixed-methods comparison of participant and observer learner roles in simulation education. *AEM Educ Train*. 2019;3(1):20-32. https://doi.org/10.1002/aet2.10310

12. O'Regan S, Molloy E, Watterson L, Nestel D. Observer roles that optimise learning in healthcare simulation education: a systematic review. *Adv Sim (Lond)*. 2016;1:4. https://doi.org/10.1186/s41077-015-0004-8

13. Ko PY, Escobar SL, Wallus HJ, et al. Mass casualty triage and tagging scenario in the pre-hospital setting simulated event. *MedEdPORTAL*. 2012;8:9264. https://doi.org/10.15766/mep_2374-8265.9264

14. Eppich W, Cheng A. Promoting Excellence and Reflective Learning in Simulation (PEARLS): development and rationale for a blended approach to health care simulation debriefing. *Simul Healthc*. 2015;10(2):106-115. https://doi.org/10.1097/SIH.0000000000000072

15. Bajaj K, Meguerdichian M, Thoma B, Huang S, Eppich W, Cheng A. The PEARLS Healthcare Debriefing Tool.*Acad Med*. 2018;93(2):336. https://doi.org/10.1097/ACM.0000000000002035