Virtual Simulation-Enhanced Triage Training for Iraqi Medical Personnel

Paul N. Kizakevich[a], Andrew Culwell[a], Robert Furberg[a],
Don Gemeinhardt[a], Susan Grantlin[a], Rob Hubal[a],
Allison Stafford[a], COL R. Todd Dombroski[b]
[a]*RTI International, Research Triangle Park, NC*
[b]*U.S. Army Medical Corps*

Abstract. Triage, establishing the priority of care among casualties in disaster management, is generally practiced using constructive tabletop or live exercises. Actual disasters involving multiple casualties occur rarely, offering little opportunity for gaining experience and competency assessment. Further, when they do occur, response needs to be rapid and well-learned. In the Iraqi medical education environment where the need for triage training is immediate, but the ability to stage practice exercises is nearly impossible, the blending of didactic learning with simulation-based triage offers an alternative training methodology.

Keywords: Triage, simulation, virtual patients, disaster medicine

1. Introduction

As part of a U.S. Agency for International Development (USAID) project to enhance medical training in Iraq, we were asked to design and deliver a "Train-the Trainer" curriculum in trauma triage. Mass casualty triage is the process of establishing the priority of care among multiple casualties to rationally allocate the use of limited resources. Like most time-sensitive, high-stakes cognitive skills that are rarely used, triage requires regular practice to maintain proficiency and confidence in decision-making. Actual disasters, such as explosions, hurricanes, or toxic exposures, occur so rarely that there is little opportunity for gaining experience. Constructive tabletop simulations are abstract mental exercises without direct patient interaction. The expense of obtaining, training, and moulaging multiple actors for live training exercises usually forces triage training to be incorporated into collective training exercises designed for the entire disaster response infrastructure. To provide an alternative methodology, including individual self-paced learning, we developed a blended didactic and simulation-based curriculum in multiple-casualty triage.

2. Methods

2.1. Virtual Patient Simulation

The triage simulation was developed by leveraging several virtual reality systems developed for medical care training, including trauma, bioterrorism, and chemical agent casualties, called Sim-Patient™. The patient is an animated 3D character situated in a 3D scene (Figure 1). The simulation includes 3D visual models of the full range of medical devices available to the student, including bandages, drugs, and monitoring devices. The student can navigate and survey the scene, as well as interact (e.g., take a pulse) and converse with the virtual patient.

Figure 1. Single casualty in Sim-Patient trauma patient simulator.

Simulated patients have been developed for trauma, bioterrorism, and chemical casualties [1, 2] as well as mentally disturbed individuals and pediatric patients [3, 4]. The simulated patient can be configured for a practice session with a variety of injuries and will exhibit appropriate signs and symptoms that change with the evolving condition of the patient over time. Animations such as vomiting, tearing, coughing, seizure, and convulsions relate to physiological status and interventions. The patients have dynamic facial expression, gestures, body movement, and can portray anger, fright, confusion, or other emotions or behaviors based on cognitive, emotional, physiological, and pathological models.

The effects of various treatments are simulated by a physiological model. The physiological simulation integrates real-time cardiovascular, respiratory, and pharmacokinetic models. A supervisory layer provides overall control of the simulation, controls the BODY™ physiology model (Advanced Simulation Corporation, Point Roberts, WA).

All of these add to the realism of the training by requiring that the student integrate knowledge of diagnostic processes with the search for and recognition of visual and audible symptoms, visual reinforcement of monitoring and treatment devices, and awareness of the changes in patient conditions over time. The dynamic visuals and audio increase the emotional involvement of the student.

2.2. Multiple-Casualty Triage Simulation

Sim-Patient was enhanced to support multiple-casualty scenarios. Each casualty has its own injury models, physiological simulation, and signs and symptoms that reflect changing physiological conditions. Figure 2 shows a multiple-casualty scenario in an urban environment, showing what might result from the explosion of an improvised explosive device (IED). Color-coded tags are used to triage each casualty, thereby designating the victim's priority of care. The triage tags are used within a four-level classification system (Immediate, Delayed, Minor, and Expectant) consistent with the Simple Triage and Rapid Treatment (START) triage method. Developed in the 1980's by the Newport Beach (CA) Fire Department and Hoag Memorial Hospital for use by civilian responders in the aftermath of earthquakes [5], the START method is universally recognized as a highly accessible and easy to use algorithmic approach to performing primary disaster triage [6]. Though START triage has come under attack in recent years, a retrospective review of over 1100 trauma patients triaged by different algorithms suggests that START triage is still a sensitive tool for predicting critical injuries [7].

Figure 2. Triage Simulation Trainer, showing multiple trauma casualties. Note the tabs, toolbar resources, START triage tags, and transport management buttons.

2.3. Scenario Definition for Triage Training

Scenarios were initially developed for training U.S. military physicians in triage and initial care consistent with IED-related injuries. These scenarios provide an evolving medical situation with graphically intense casualties including amputations, penetrations, massive burns, chest wounds, blunt trauma. Since the medical conditions were dynamic, conducting triage for these patients was not a deterministic process. How the caregiver moves about and selects individual casualties would affect the 'correct' triage assessment. For example, while evaluating casualty "A", casualty "B" might deteriorate, evolving from an "Immediate" to an "Expectant" state. While this represents a realistic, evolving casualty situation, training scenarios with unstable patients may detract from effective learning and make it difficult to assess student performance.

To address this issue, we modified the simulator to provide casualties with stable physiological conditions according to defined triage learning objectives. Based on an analysis of the START algorithm, we identified seven assessment paths that might be followed before arriving at a triage determination (Figure 3). The Minor, Expectant, and Delayed categories each have a single path to triage classification. The Immediate triage tag category has four assessment paths, depending upon different critical conditions (i.e., airway, breathing, circulatory, and mental impairment).

To support triage training, 32 casualties were created with a spectrum of injuries and physiological conditions covering all of the 7 pathways. Eight scenarios were developed, with different mechanisms of injury, and 4 casualties were assigned to each scenario. One scenario was reserved for learning how to use the simulator, and the remaining seven configured for learning and practicing the START triage algorithm. These cases were designed to ensure that each path through the START triage algorithm is practiced at least 3 times by each trainee.

2.4. Student Feedback and After-Action Review

The simulation tracks the student's actions and compares them against the correct protocol path (Figure 3). At the end of each scenario, a chart presented the expected START-path (left pane) and the actions taken by the student (right pane) for each casualty in the scenario. For example, one of the first actions a first responder should take is to ask out loud for all 'ambulatory' casualties to walk to a separate area. These are the "walking well" and according to START can be tagged as Minor. Farther down the flowchart, the first responder should assess mental status, normally by asking the casualty to respond to simple commands. If the casualty is able to respond then the casualty is tagged as Delayed, otherwise the injured should be tagged as Immediate. A summary of the relevant physiological parameters are displayed for further guidance and review (bottom).

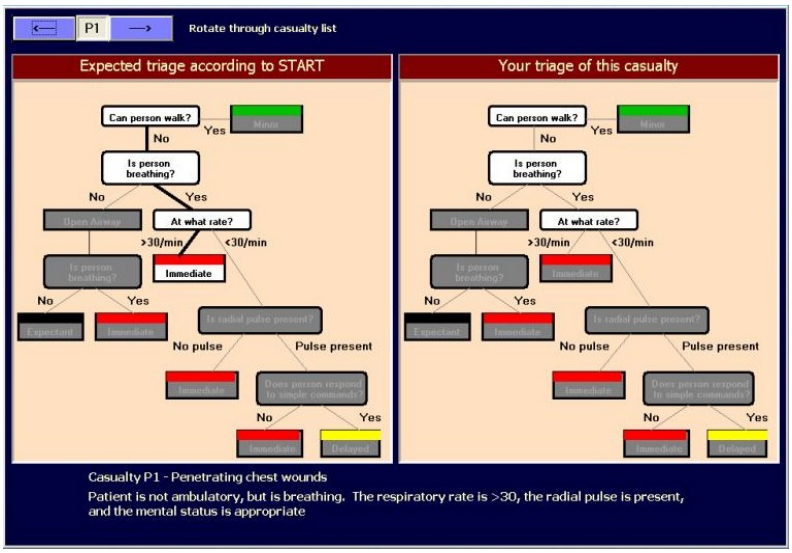

Figure 3. START algorithm used as an AAR. For stable casualties, the expected triage assessment (left) and the student's ongoing assessment (right) are presented and compared.

2.5. Triage Course Curriculum and Delivery

A comprehensive set of learning modules was developed comprising prehospital trauma care, the START triage methodology, how to use the Sim-Patient simulator, and how to employ Sim-Patient for training others. The latter module supported the Train-the-Trainer objective of the overall USAID program for Training Model Primary Providers (TMPP) The learning modules were developed in Microsoft PowerPoint format, and with annotated learning objectives and teaching points.

Twenty-two graphics-intensive laptop computers were configured with the Sim-Patient software and delivered to the Iraqi Ministry of Health (MOH) for use in the triage course, and subsequent turn-over to the planned Centers of Excellence for training of other medical personnel. In cooperation with the MOH, select physicians were recruited to attend one of two 2-day short courses on triage and using the Sim-Patient triage simulator. The two courses were conducted in July of 2006.

3. Results

Thirty-one physicians, identified by the MOH, participated in the blended didactic and simulation-based triage curriculum. Participants evaluated the curriculum using a questionnaire comprising qualitative measures (Likert-scale: strongly disagree=1 to strongly agree=5), and requested comments. The physicians were not followed after their participation, so assessment of transfer of learning was not possible. Summary statistics were developed for the qualitative measures and comments as follows:

Table 1. Qualitative measures of didactic presentation and simulation..

Category	Mean	Std. Dev.
Didactic Course & Presenter	4.36	0.43
Simulation Realism & Navigation	4.40	0.20
Simulation Content & Responsiveness	4.42	0.04
Simulation Learning Content	4.41	0.20
Overall	**4.38**	**0.36**

Table 2. Distribution of participant comments across all course elements.

Category	Count (%)	Pos/Neg (%)
Positive	56 (52%)	56 (93%)
Negative	5 (4%)	5 (7%)
Descriptive	4 (5%)	
Suggestive	43 (40%)	

4. Conclusions

A curriculum has been developed blending didactic training and case-based simulation for START triage training. The course has been given to a group of physicians with the goal of improving prehospital and emergency trauma care throughout Iraq. The participants' evaluations have been overwhelmingly favorable, with expressions of appreciation for the course and for being introduced to the START triage methodology. Several mentioned that they had been unaware of any formal trauma triage methodology. It has been suggested that this training, if made readily available to the first responders in Iraq, would make an immediate and measurable impact on the survivability of casualties in the field.

5. References

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