Triage Performance of First-Year Medical Students Using a Multiple-Casualty Scenario, Paper Exercise

Robert F. Sapp, MD, MPH;[1] Jane H. Brice, MD, MPH;[2] J. Brent Myers, MD, MPH, FACEP;[3] Paul Hinchey, MD, MBA, EMT-P[4]

1. Resident Physician, Oregon Health and Science University, Portland, Oregon USA
2. Medical Director, Orange County EMS System, Hillsborough, North Carolina USA; Associate Professor, Department of Emergency Medicine, University of North Carolina School of Medicine, Chapel Hill, North Carolina USA
3. Medical Director, Wake County EMS System, Raleigh, North Carolina USA; Adjunct Assistant Professor, Department of Emergency Medicine, University of North Carolina School of Medicine, Chapel Hill, North Carolina USA
4. Assistant Medical Director, Wake County EMS System, Raleigh, North Carolina USA

Correspondence:
Jane H. Brice, MD, MPH
Department of Emergency Medicine
CB# 7594
University of North Carolina Hospitals
101 Manning Dr.
Chapel Hill, North Carolina 27599-7594 USA
E-mail: brice@med.unc.edu

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Abbreviations:
CAEP = Canadian Association of Emergency Physicians
EMS = emergency medical services
START = Simple Triage and Rapid Treatment
UNC = University of North Carolina

Abstract

Introduction: Large-scale events may overwhelm the capacity of even the most advanced emergency medical systems. When patient volume outweighs the number of available emergency medical services (EMS) providers, a mass-casualty incident may require the aid of non-medical volunteers. These individuals may be utilized to perform field disaster triage, lessening the burden on EMS personnel.

Objective: The purpose of this study was to evaluate the accuracy of triage decisions made by newly enrolled first-year medical students after receiving a brief educational intervention.

Methods: A total of 315 first-year medical students from two successive classes participated in START triage training and completed a paper-based triage exercise as part of orientation. This questionnaire consisted of 15 clinical scenarios providing brief but sufficient details for prioritization. Subjects assigned each scenario a triage category of Red, Yellow, Green, or Black, based on the START protocol and were allowed four minutes to complete the exercise. Participants from the Class of 2009 were provided with printed START reference cards, while those from the Class of 2008 were not. Two test types varying in the order of patient age values were created to determine whether patient age was a factor in triage assessment.

Results: The mean accuracy score of triage assignment by medical student volunteers after a brief START training session was 64.3%. The overall rate of over-triage was 17.8%, compared to an under-triage rate of 12.6%. There were no significant differences in triage accuracy between subjects with and without printed materials (63.9% vs. 64.6%, $p = 0.729$) or those completing the age-variant test types (64.4% vs. 64.1%, $p = 0.889$).

Conclusions: First-year medical students who received brief START training achieved triage accuracy scores similar to those of emergency physicians, registered nurses, and paramedics in previous studies. Observed rates of under- and over-triage suggest that a need exists for improving the accuracy of triage decisions made by medical and non-medical personnel. This study did not find that printed materials significantly improved triage accuracy, nor did it find that patient age affected the ability of participants to correctly assign triage categories. Future research might further evaluate disaster triage by non-medical volunteers.

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Introduction

With current international concern regarding terrorist attacks, disasters due to natural hazards, bioterrorism, and mass-casualty incidents, the ability of emergency medical systems to appropriately and rapidly respond to disaster situations is critical. Large-scale events, however, may overwhelm the capacity of even the most advanced emergency medical systems. As soon as the volume of patients and demand for medical care outweigh the available number of medical providers, a disaster may require the participation and aid of volunteer, non-medically trained citizens.

In the event of a disaster, the main priorities for patient care are triage, treatment, and transport. The most important medical function during a mass-casualty incident may be the accurate identification of patients who will benefit substantially from early intervention or transport.[1] *Triage* has been defined as the sorting of medical conditions into different categories to achieve a true priority of care,[2] seeking to prioritize victims based on severity, and maximize available medical resources. Prehospital medical providers typically perform triage of disaster victims in the field and make decisions as to which patients to treat on-scene and which to transport immediately to a nearby hospital or other medical facility.

During a mass-casualty incident, volunteers may be asked to aid medical personnel in various capacities, such as assisting in patient transport, patient check-in and identification, or even in the initial triage of incoming patients to a medical facility or in the field. However, to serve in the role of patient triage and achieve the goal of prioritization, non-medically trained volunteers must be able to perform triage decisions with an acceptable level of accuracy. Previous studies have shown that physicians and nurses triaged standardized patient scenarios with a mean accuracy of 65%, while paramedics achieved a slightly lower accuracy of 59%.[3,4] Ideally, disaster volunteers would achieve triage results just as accurately as trained professionals in order to adequately prioritize patients during crises. In fact, if volunteers perform triage incorrectly, they actually may hinder attempts to mitigate disaster outcomes, and ultimately, may lead to greater harm than good.[5]

Poor sensitivity in designating triage assignments, commonly referred to as under-triage, may lead to severe or even life-threatening injuries being missed in patients who initially appear to have a less urgent triage priority. On the other hand, poor specificity of triage assignment, also known as over-triage, may result in a situation in which many patients with non-severe injuries are classified as urgent medical priority. Large numbers of patients with less emergent medical needs who are prioritized for immediate medical attention, might increase the burden placed on limited emergency medical resources, causing patients with more severe injuries to be overlooked or turned away.

In order to limit negative outcomes resulting from over- and under-triage, methods useful in aiding volunteers with the decision-making process and to increase triage accuracy may be of great benefit in disaster scenarios. A study by Kilner and Hall showed that printed decision-support materials significantly improved the accuracy of triage decisions made by police firearms officers with no medical training beyond basic first-aid classes.[6] Additional studies noted that brief educational interventions for prehospital providers using the START (Simple Triage and Rapid Treatment) or JumpSTART methods led to significant increases in triage accuracy.[7,8] However, the effectiveness of these brief educational interventions has yet to be evaluated for non-medical volunteers.

The purpose of this study was to evaluate the accuracy of triage decisions made by educated, but non-medically-trained volunteers, namely first-year medical students on the first day of medical school orientation, using a paper-based, multiple-casualty scenario exercise following a brief educational training session. In addition, this study examined the effect of printed triage decision-making tools to determine whether such support materials improved overall performance in triage assignment, by non-medical volunteers.

Methods

Study Design

This study was a non-randomized, cross-sectional, observational study designed to evaluate the performance of medical triage by newly enrolled, first-year medical students. A paper-based triage exercise was designed involving 15 individual clinical scenarios for which brief but sufficient details for priority assignment were provided. This questionnaire was administered to a total of 315 first-year medical students at the University of North Carolina (UNC) School of Medicine on the first day of medical school orientation as part of a tabletop disaster exercise dealing with medical triage and the Incident Command System. For each patient scenario, participants were instructed to assign the appropriate triage level based on the Simple Triage and Rapid Treatment (START) triage protocol, which classifies patients into one of four triage categories: Red (emergent priority), Yellow (urgent priority), Green (delayed priority), and Black (dead). A pilot evaluation of the instrument was completed by emergency medicine resident physicians and paramedics at the University of North Carolina at Chapel Hill prior to its use in this research study. The Institutional Review Board of the University of North Carolina approved this research study.

Study Setting and Participants

In order to select a study population fairly representative of well educated, but non-medically trained volunteers, participants were recruited from a convenience sample of 315 first-year medical students at the University of North Carolina School of Medicine in Chapel Hill, North Carolina on the first day of medical school orientation. These students all had completed undergraduate study, but had yet to receive any training in medical school classes. A total of 160 students from the UNC School of Medicine class of 2008 and 155 students from the class of 2009 were recruited in two successive years to participate in this research study as part of class activities on medical school orientation day.

Study subjects initially were given two brief educational lectures in a large-group classroom setting by emergency medicine faculty at the UNC School of Medicine who also

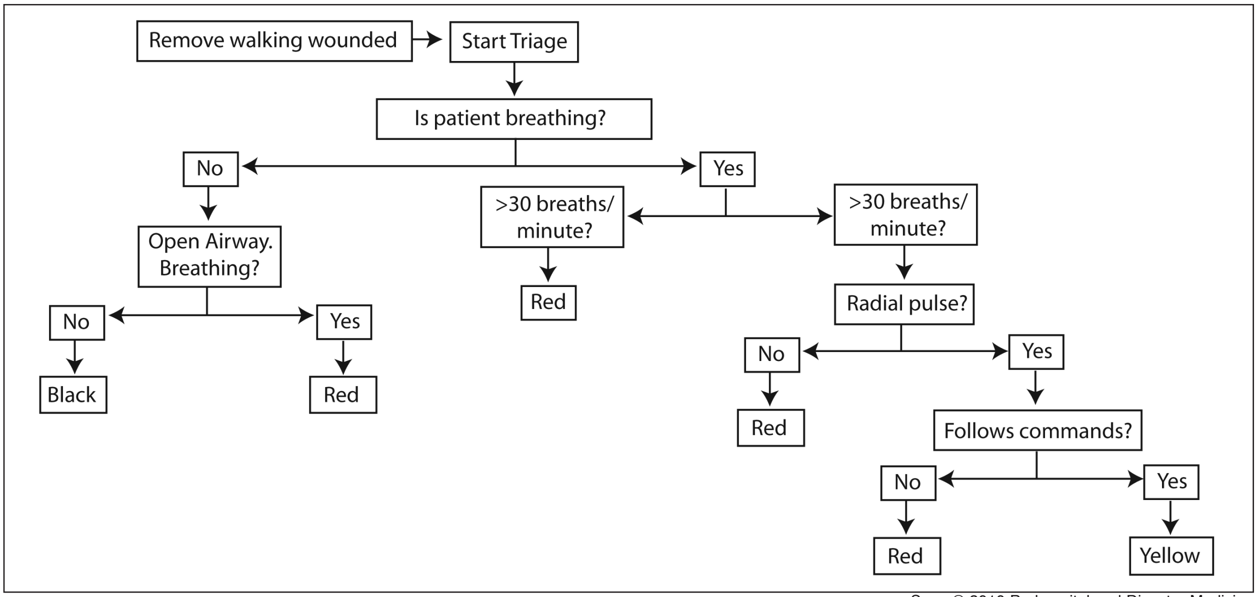

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Figure 1—START Triage algorithm

serve as emergency medical services (EMS) Medical Directors. The first 10-minute lecture informed students about the details and health risks of sarin gas exposure, a potential bioterrorism agent, which served as the basis of the tabletop disaster exercise on orientation day. The second brief, five-minute lecture dealt with the various aspects of disaster management, including disaster triage. This lecture specifically detailed the START triage algorithm and the specific criteria for each categorical designation, as well as describing the components of the Incident Command System at UNC Hospitals. As the START protocol is the most widely-used triage methodology in the United States and is prevalent in the literature,[9,10] the training and questionnaire was based on this system.

Participants from the medical school class of 2008 received the brief introductory lecture detailing triage assessment and the START protocol, but were not given any printed support materials or additional resources. On the other hand, participants from the medical school class of 2009 were provided with a decision-making support card listing the START triage algorithm and the criteria for each categorical designation (Figure 1), in addition to receiving the identical large-group educational intervention.

Next, the first-year medical school class of each successive school year was broken down into 20 groups of eight students each, which were pre-determined prior to orientation day by the administration of the UNC School of Medicine. Each study facilitator was assigned to four groups of students in order to administer the tabletop disaster exercise and the triage questionnaire. This session involved a simulated sarin gas exposure generating approximately 300 casualties in the field, requiring students to perform disaster triage and activate the Incident Command System. Each facilitator was instructed to administer the 15-scenario triage questionnaire without providing any additional information or help to students and to serve as timekeepers for the triage exercise. Participants were given the paper-based triage questionnaire and were allowed exactly four minutes to complete the entire written triage exercise, at which point, the facilitator terminated the triage exercise and collected each questionnaire. This limited time period was selected in order to simulate the rapid decision-making necessary for performing triage in a mass-casualty disaster situation, providing slightly more than 15 seconds per scenario for the completion of patient evaluation and triage assignment.

Survey Content and Administration

The 15-scenario clinical triage questionnaire was developed by EMS Medical Directors and Emergency Medicine faculty at the UNC School of Medicine. Patient scenarios were selected to include an equal balance of triage levels and to provide clear-cut answers that would directly fit the START triage criteria. Background information on patient age, clinical symptoms, vital signs (respiration rate, pulse rate, capillary refill, etc.), and mode of arrival to the medical facility were provided for each clinical scenario. These individual scenarios involved a range of medical and traumatic presentations not inherently linked with sarin gas exposure. The correct triage assignment for each patient scenario was determined *a priori* by clinical consensus between three emergency medicine/EMS physicians at UNC Hospitals who had received direct disaster management training and have direct disaster response roles in the region. Four patient scenarios were designated as triage "Red", four were "Yellow", four were "Green", and three were "Black". The exercise included scenarios involving an array of patients between 25 and 63 years of age, and was designed to fit onto one page for ease in administration. The complete triage questionnaire is in Appendix A.

Two variations of the triage questionnaire were created prior to study administration: Test Type A consisted of patient scenarios organized from the youngest patient age to oldest patient age (25 to 63 years of age), while Test Type

B was created by inverting the order of patient age data on the page while maintaining a consistent order of patient scenarios. This was intended to determine whether patient age was a factor in triage assessment. A pilot evaluation of the two variants of the study instrument was completed by emergency medicine resident physicians and paramedics at UNC prior to its use in the study.

Subjects were given one of the two questionnaire types at random and were required to complete the exercise without assistance from other participants or from the study facilitators. Students in the medical school class of 2008 were not allowed to use any outside resources while completing this questionnaire, while students in the medical school class of 2009 were allowed to refer to the START triage card provided.

Each student was given exactly four minutes to complete the triage exercise, at which point, the study facilitators collected all questionnaires. The strict time limit was designed to provide slightly more than 15 seconds per triage scenario, most effectively assessing the ability of volunteer subjects to make rapid triage decisions in the field during a disaster. Due to the significant time limitations imposed, some students were unable to complete the entire triage questionnaire before the time limit had expired and the exercises were collected. Any unfinished scenarios were left blank and recorded as incorrect answers.

Data Processing

After collecting 315 triage questionnaires, data from each completed exercise were entered into a spreadsheet in Microsoft Excel 2002 (Microsoft, Inc., Redmond, WA). *A priori*, all cases were assigned a correct triage level by a consensus decision of three emergency medicine/EMS physicians at UNC Hospitals, and each questionnaire was scored against this consensus answer key. Each individual patient scenario was scored as correct, incorrect over-triaged, or incorrect under-triaged in the Excel spreadsheet. The answer key for Type-A exercises was adjusted to correct for the inverted question order of the Type-B questionnaire, and each individual answer sheet was scored against the respective answer key.

The created spreadsheet was imported into the Statistical Package for the Social Sciences (SPSS) for Windows statistical program, Version 14.0 (SPSS, Inc., Chicago, IL). New variables were created for each of the 15 triage questions to record whether the correct triage assignment was made for each scenario. The triage accuracy score for each individual participant was determined by calculating the sum of the values for the 15 "correct score" variables and dividing this total by 15, the number of possible correct answers on the written exercise. The overall mean triage accuracy score was calculated by totaling the 315 individual accuracy scores for each participant and dividing the sum by the total number of participants.

Then, separate spreadsheets were created to compare the data from Test A with Test B, and to assess the rates of over-triage and under-triage. Mean accuracy scores for each subgroup were calculated using the criteria above, allowing for further subgroup comparisons. Independent sample *t*-tests were performed to determine the differences in mean of the triage accuracy scores between the various subject groups. A *p*-value of less than 0.05 was considered to be statistically significant.

Results

A total of 315 students completed the written triage exercise, 160 students from the class of 2008 and 155 from the class of 2009. The study participants comprised 100% and 97% of the total class size of the UNC School of Medicine classes of 2008 and 2009, respectively. The overall mean accuracy score of triage assignment by medical student volunteers after a brief START triage training session was 64.3% (Table 1). The mean accuracy score achieved by subjects from the class of 2008 was 63.9 ±17.3% compared to a mean accuracy score of 64.6 ±17.9% in participants from the class of 2009 (two-tailed $p = 0.729$). The overall mean rate of under-triage (assigning a less severe triage category than that suggested by the START criteria) was 12.6 ±19.58%. The overall rate of over-triage (assigning a more severe triage category than that suggested by the START criteria) was 17.8 ±16.9%.

An additional comparison of Test Types A and B, differing by the order in which patient ages ranging from 25 to 63 years were assigned to the clinical scenarios, revealed a mean overall accuracy value of 64.4 ±16.73% for test type A (n = 161) and a mean accuracy score of 64.1 ±18.39% for test type B (n = 154), $p = 0.889$.

Discussion

The results of this research study indicate that newly enrolled, first-year medical student volunteers with no formal training in medical school were able to perform a paper-based triage assessment with a mean accuracy score of 64.3% after receiving a brief START training session. This overall triage accuracy score was comparable to that achieved by emergency medical physicians and registered nurses (65% accuracy) and better than that achieved by paramedics (59% accuracy) on a 20-question written triage exercise in the 2002 Kilner study.[7] Pediatric emergency physicians performed triage on a 55-scenario questionnaire with a mean accuracy score of 53.5% in a study by Bergeron and Gouin, while registered nurses scored a mean accuracy of 64.2%.[8] The first-year medical students evaluated in this study performed disaster triage with better accuracy than that seen in certified prehospital EMS providers (41.1% accuracy score) on a similar written exercise.[11] In addition, the medical student volunteers achieved this level of triage accuracy under rigorous time limitations imposed to simulate the rapid decision-making necessary in the field.

The overall rate of under-triage (assigning a less severe triage category than that suggested by the START criteria) was 12.6%. The Canadian Association of Emergency Physicians (CAEP) has suggested targeting rates of under-triage <5% for field triage and transport decisions.[12] The under-triage value achieved by medical students was substantially greater than the CAEP target, suggesting that potentially life-threatening conditions might be missed by medical student volunteers while performing triage in a mass-casualty situation. As unanswered scenarios were scored as blank responses and counted as under-triage, the strict time limitations of this study may have led to an increase in the rates of under-triage above the CAEP target value.

Overall Medical Student Triage Accuracy	64.3	***p*-value**
Class of 2008 Triage Accuracy	63.9 ±17.25	0.729
Class of 2009 Triage Accuracy	64.6 ±17.88	
Test Type A Triage Accuracy	64.4 ±16.73	0.889
Test Type B Triage Accuracy	64.1 ±18.39	
Overall rate of Under-triage	12.6	
Overall Rate of Over-triage	17.82	

Table 1—Medical student triage performance results

The overall rate of over-triage (assigning a more severe triage category than that suggested by the START criteria) was 17.8%, falling within the CAEP recommended target of <50% over-triage.[12] This value suggests that the study participants avoided drastically overburdening the EMS system with over-triaged patients, but potentially at the cost of allowing serious injuries to go unrecognized and untreated. Research has placed the relationship between over-triage and patient mortality in mass-casualty incidents into question,[13] lending credence to the generous target levels set by the CAEP and the results achieved by medical students in this study.

Despite being provided with a printed triage decision-making tool detailing the START protocol, students in the class of 2009 did not achieve accuracy values that were significantly better than were those of the class of 2008. The lack of statistical significance observed in the difference between the two medical school classes may place into question the additional value of printed support materials after an educational intervention already has been provided. Alternatively, differences in pre-existing medical knowledge or ability to perform triage between the two classes may account for the discrepancies in triage accuracy observed, although there was no reason to believe that this was so.

Several studies showed that educational training with the START triage system, the pediatric JumpSTART system, or Internet modules helped to improve the triage accuracy of prehospital medical providers.[7,8,14] While there are several different triage protocols in use today, including the newer methodology SALT, START triage was selected based on its widespread use and its prevalence in the literature.[9,10] This study utilized an initial 10-minute lecture on the START triage protocol in a large-group setting prior to the administration of the clinical questionnaire. The acceptable level of triage accuracy achieved by the participants in this study on a written exercise suggests that even a short 5–10-minute lecture may be sufficient and effective in training educated, non-medical volunteers for triage duties during a crisis situation. As the duration of time in which benefits are maintained from triage educational sessions is unclear, this study supports the effectiveness of providing brief training sessions to volunteers with or without previous triage education.

The lack of a statistically significant difference in the accuracy values observed in participants completing Test Type A and those completing Test Type B may suggest that patient ages in the varying clinical scenarios did not have a substantial effect on the ability of medical student volunteers to correctly triage patients on the clinical questionnaire. The clinical scenarios used in this exercise involved patients ranging in age from 25–63 years old, so this study evaluated adult triage, but did not address the evaluation of pediatric or geriatric patients. The effect of patient age potentially may have a greater effect on triage performance in real-world situations, as non-medical volunteers may consider children or the elderly to be of greater urgency in receiving medical care, while young adults might be assumed to be healthier overall and of lesser severity.

The study results indicate that first-year medical student volunteers performed triage decisions on a paper-based, clinical exercise at a level of performance that was similar to that observed in emergency medicine physicians, registered nurses, and ambulance paramedics. The extent to which scores on triage exercises consisting of written patient scenarios correspond to scores on simulated patients or real-life mass-casualty incidents has not been fully evaluated, so the actual clinical performance of medical triage by first-year medical students may vary from these results during a mass-casualty situation.

As this study involved a written triage exercise and utilized a novel triage questionnaire, there are limitations on the comparisons between the current results and other studies in the literature. However, the favorable scores attained on the written exercise suggest the possibility that medical student volunteers who receive an educational intervention actually might perform triage in the field as accurately as would other responding emergency personnel. Though no target goal for triage accuracy has been established as the "gold standard", the level of triage performance by first-year medical students may be considered to be sufficient for use during large-scale disasters if the written scores translate to triage performance in the field. Future research should evaluate the link between triage performed on paper-based exercises and triage performed in the field.

The results of this study suggest that medical students may be of help during a disaster through performing basic triage in a hospital facility or in the field. Without additional education and training and protective equipment, it would be inappropriate to send medical students to a disaster scene. However, in such a mass-casualty incident, these volunteers might serve in hospital triage in a secure location to address the numerous patients arriving by personal transportation rather than by EMS, thereby freeing up essential personnel in the emergency department. As medical students are a ready source of personnel and already are at the hospital, they may be able to assist with triage after receiving a brief training session and printed materials.

This study evaluated triage decisions made by a specific group of potential disaster volunteers—medical students This is an eager, hard-working, and easily trainable population that likely would be willing to volunteer to assist medical professionals during a disaster. Triage may be a potential function performed by these student volunteers during large-scale emergencies, so a study designed to evaluate this particular group may be of great benefit to future disaster preparedness programs. It is clear that additional training would be required before sending volunteers into the field, such as education on field operations, the Incident Command System, safety, hazardous materials, etc. However, with the proper education and training, these individuals may serve as an essential source of labor. Future studies might examine the triage performance of other non-medical volunteers, such as undergraduate, graduate, or professional students, a potentially enormous resource pool in a disaster scenario.

Another limitation of this study was that biographical information was not collected on medical student participants prior to administration of the START training and the triage questionnaire. Some individuals entering the UNC School of Medicine previously may have worked as emergency medical technicians or registered nurses and received some education and training in triage assessment through courses or field work. As data on previous medical training and triage experience were not collected, it is more problematic to generalize the results observed in the study group to the overall population of educated, but non-medically-trained citizens across the country. With more extensive data, if these students were comparable to other potential volunteers. Future studies might evaluate other potential confounding variables and may obtain biographical data on study participants in order to better assess the external validity of the results.

Before emergency medical systems can consider the potential utilization of non-EMS providers in a disaster triage capacity, additional research must be completed. Future studies might address the feasibility of mobilizing and training volunteer providers in time for their triage to be clinically effective during a mass-casualty incident, as in the case of labor services like the Medical Reserve Corps or the National Disaster Medical System. Additionally, methods of maintaining and rapidly accessing the pool of potential volunteer labor during disasters must be developed and studied, as Incident Command must be able to access these resources for them to be of benefit during an emergency. Research must address the exact education and training necessary for volunteers prior to serving in a disaster situation, involving just-in-time training as well as any prerequisite education.

Conclusions

The results of this study indicate that newly-enrolled first-year medical students who received a brief START triage educational session performed triage assessments on a 15-question written exercise with a mean accuracy score of 64.3%, a value similar to that achieved by emergency medical providers and registered nurses in previous studies. Errors were made by the student participants in both under-triage and over-triage, suggesting that a need exists for methods of further improving triage decisions by medical and non-medical personnel. This study did not find that printed START triage cards improved medical student triage accuracy, although previous studies showed marked benefits of similar using a decision-making tools. Further research might address the performance of triage by medical students or other graduate/undergraduate students using simulated patient-actors to better assess the potential for these students to serve in the capacity of field triage during a disaster.

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Appendix—Triage questionnaire

	Triage Scenarios
R Y G B	25 y/o male appears alert c/o headache and cough after assisting someone from scene. Denies trauma. R 18
R Y G B	32 y/o c/o is unable to walk due to severe weakness, sweating and uncontrolled diarrhea. No visible trauma. Cap refill <2 sec, R 12
R Y G B	33y/o male asthmatic alert c/o shortness of breath after running from scene. Vital signs R 24
R Y G B	34 y/o female alert c/o severe R leg pain with a fractured lower leg with bone sticking out of the skin after being pushed down approx 6 stairs. Bleeding appears to be minor. Denies other complaint. Cap refill <2 sec, radial pulse palpable. R 26.
R Y G B	38y/o confused male who initially c/o severe shortness of breath and crushing chest pain but became unresponsive in the ambulance. CPR in progress by EMS on arrival at hospital.
R Y G B	40y/o female is confused, falling repeatedly and unable to stand. Is unable to follow simple commands. Cap refill <2sec, good radial pulse. R 14
R Y G B	44 y/o male having seizure that stops on arrival at the hospital. He is unresponsive,There is a bruise on his forehead. Cap refill <2 sec, good radial pulse. R 14
R Y G B	45y/o male is walking alert c/o right wrist pain after fall. Evident deformity of R wrist. No visible bleeding.Vital signs R 20
R Y G B	48y/o alert male with large cuts on thigh after putting his leg through a glass door. He is unable to stand. There is visible muscle and tendon with controllable bleeding. Cap refill <2 sec, good radial pulse. R 18
R Y G B	51y/o male unresponsive in drivers seat of car at hospital entrance. He has no visible trauma. His face is blue and he is not breathing. Cap refill >2 sec, barely palpable radial pulse. R O after opening his airway.
R Y G B	55 y/o alert male c/o headache, slurred speech and blurry vision. Falls repeatedly on standing but has no visible trauma. Cap refill < 2 sec, good radial pulse. R 14.
R Y G B	56 y/o female alert, c/o shortness of breath, chest tightness, blurry vision, drooling and weakness. Cap refill <2 sec, good radial pulse. R 36
R Y G B	56 y/o female unresponsive according to EMS she, " Just stopped breathing!" No visible trauma. Cap refill <2 sec, weak radial pulse. R 0 after opening her airway.
R Y G B	60 y/o female police officer presents after driving herself to hospital. She was the first arriving officer and aided the wounded. She is alert c/o generalized weakness, wet with sweat, and drooling. No visible trauma R 14
R Y G B	63 y/o female face down unresponsive. Her face is blue and she does not appear to be breathing.There is no visible trauma. Cap refill <2 sec, good radial pulse. R 0, Begins breathing spontaneously after opening her airway.