Casualty Collection in Mass-Casualty Incidents: A Better Method for Finding Proverbial Needles in a Haystack

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The authors do not have any financial relationship with the producers or sellers of glow sticks.

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Abbreviations:
EMS = emergency medical services
MCI = mass-casualty incident
START = Simple Triage and Rapid Treatment

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Abstract

Introduction: Mass-casualty incidents (MCIs) are on the rise. The ability to locate, identify, and triage patients quickly and efficiently results in better patient outcomes. Poor lighting due to time of day, inclement weather, and power outages can make locating patients difficult. Efficient methods of locating patients allow for quicker transport to definitive care.

Objective: The objective of this study was to evaluate the methods currently used in mass-casualty collection, and to determine whether the use of the Simple Triage and Rapid Treatment (START) triage tag system can be improved by using easily discernable tags (glow sticks) in conjunction with the standard triage tags.

Methods: Numerous drills were performed utilizing the START triage method. In Trial A, patients were identified with the triage tags only. In Trial B, patients were identified using triage tags and glow sticks. Four rounds of triage drills were performed in low ambient light for each Trial, and the differences in casualty collection times were compared.

Results: Casualty relocation and collection times were considerably shorter in the trials that utilized both the glow sticks and triage tags. An average of 2.58 minutes (31.75%) were saved during the casualty collections. In addition, fewer patient errors occurred during the trials in which the glow sticks were used. Between the four rounds, an average of four patient errors occurred during the trials that utilized the triage tags. However, there was an average of only one patient error for the drills when participants utilized both the triage tags and the glow sticks.

Conclusions: The use of the highly visible glow sticks, in conjunction with the START triage tags, allowed for more rapid and accurate casualty collection in suboptimal lighting. The use of the glow sticks made it easier to relocate previously triaged patients and arrange for expeditious transport to definitive care. In addition, the glow sticks reduced the number of patient errors. Most importantly, there was a significant reduction in the number of patients that initially were triaged via the START method, but were overlooked during casualty collection and transport.

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Introduction

The purpose of this study was to analyze the methods currently used to triage, collect casualties, and transport victims of mass-casualty incidents (MCIs). During MCIs, the number of patients and the severity of their injuries exceed the capabilities of the facility and staff.[1] Patients who sustain major injuries and have the greatest chance of survival using the least amount of time, equipment, supplies, and personnel are managed first.[2]

One of the biggest challenges in managing a MCI is relaying important patient information. Although communication is the cornerstone of any properly management incident response, generally, it is the first aspect of the response to fail. It is important for mutual aid and receiving facilities to know

3	Severe difficulty breathing, chest sinks in on inspiration	Resp > 30 Radial pulse present Awake	Immediate

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Figure 1—Example of patient information printed on 3 x 5 inch cards: Triage level is printed on the reverse side of the card for emergency medical services crew clarification

the number and severity of the injured victims, the probable casualty collection times, and the available ambulances and hospitals. An analysis of the World Trade Center MCI suggested that a "lack of communication probably resulted in more problems than all other factors combined".[3]

Most US emergency medical services (EMS) systems employ a standard triage tag in conjunction with the Simple Triage and Rapid Treatment (START) triage system.[1] The START system evaluates the respiratory, circulatory, and neurological functions of victims and classifies them in one of four categories: (1) immediate; (2) delayed; (3) minor; and (4) deceased/non-salvageable. In this system, initial triage takes priority over emergency treatments in the field setting. Emergency care administered by triage teams is restricted to opening the airway, controlling severe hemorrhage and elevating the lower extremities of the injured. Chan *et al* noted that triage tags have well-known limitations, "...the tags are not weather resistant and are easily marred or destroyed. After the World Trade Center collapse on 11 September 2001, the vast majority of patients, even those transported by ambulance, arrived at emergency departments without triage tags".[4]

Numerous studies on alternative methods of patient identification in MCIs have been performed. Third-generation wireless Internet, global positioning devices, bar-coding, and "smart dog" tags have been analyzed. The majority of these systems attempt to aid in the identification and tracking of each particular patient. No studies on the actual method of locating patients in the field and methods with which to improve casualty collection have been performed.

Due to the magnitude of MCIs, auditing the performance, tactics, and ultimate disposition of patients only can be performed retrospectively. While the scenarios and patients are not real, drills still provide important training tools. It is neither feasible nor ethical to take time away from a true MCI to provide feedback or attempt newer, unproven ways of patient identification, triaging, and casualty collection.

Methods

The purpose of this project was to compare the casualty collection times between two trials, Trial A and B. In Trial A, four drills were conducted using only the START triage tags, and in Trial B, four drills were conducted using both the START triage tags and glow sticks in the corresponding triage color. The scenario depicted in Appendices A and B were used for all drills: a shooting at a local high school with an unknown number of victims. The scene is secure, but the lighting is suboptimal.

The patient base for all of the drills consisted of 18 patients triaged as: five immediate, five delayed, four

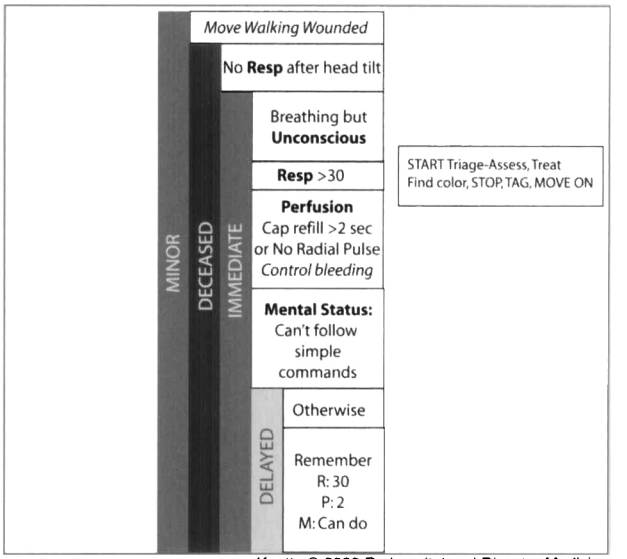

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Figure 2—Card given to each emergency medical services provider participating in the casualty collection project

deceased/non-salvageable, and four minor, or walking wounded patients. The patients were designated by plain paper bags with the patient information printed on a 3 x 5 inch card placed in the bag (Figure 1). A triage tag and a glow stick (Trial B only) also were placed in the bags. The triage level of the patients was written on the back of the 3 x 5 inch card. The patients were scattered randomly throughout the scenario. Ambient lighting in all of the patient locations was reduced uniformly so that the patients could not be seen without the aid of the flashlight provided.

All EMS crews participating in the study were briefed on the START triage system prior to the drills. Each crew or member was given a START triage card to assist them with the triage. The EMS crews were not advised of the total number of patients involved in the study or the severity of injuries (immediate, delayed, minor, or deceased). Emergency medical services crews for Trials A and B were sequestered from each other and were not informed of triage times, or location of patients, etc.

The EMS crews were instructed to locate a patient, perform a START assessment, confirm their triage level with the level already written on the card, and place the triage tag with the appropriate level designated on the bag. When the crew was unable to locate any more patients, they reported to the Incident Commander. The Incident Commander then advised them to relocate all of the immediate-level patients and bring them, individually, to the Incident Commander. Once all of the immediate-level patients were transported to the Incident Commander, the crews were advised to relocate and transport all of the delayed-level patients, followed by the minor, followed by the deceased/non-salvageable patients. Trial B was performed by a different EMS crew and was performed in the same manner with one exception: in addition to placing the triage tag on the patient, the crew also placed the activated, corresponding glow stick.

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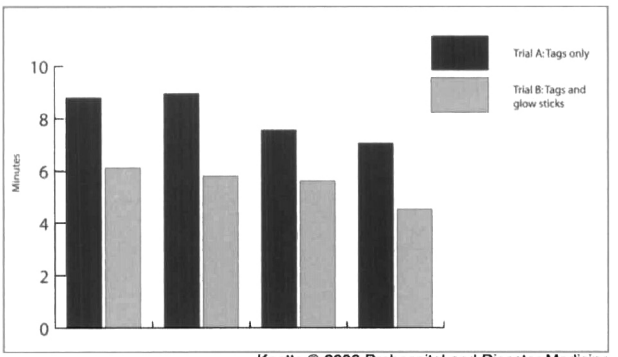

Figure 3—Comparison of casualty collection times between A and B trials

The casualty collection time is calculated using the following equation:

Time to locate/apply triage tags/glow sticks on all patients - Time to relocate/transport patients to Incident Commander Collection = Casualty Collection Time

The casualty collection times were compared between Trials A and B, rather than the total time it took for each team to perform the drill. By comparing casualty collection times only, a comparison could be made as to whether the glow sticks allowed for quicker patient relocation and transport.

Results

The use of the glow sticks, in addition to the triage tags, saved valuable time in relocating patients and transporting them to the Incident Commander (Figure 3). The time saved between the drills conducted for each trial was an average of 2.58 minutes (Table 1). The average casualty collection time was reduced by almost one-third (31.75%). Emergency medical services crews expressed the opinion that the glow sticks were "much more visible than the standard triage tags."

During the course of this project, it also was noted that there were more patient errors (e.g., less severely injured patients being transported prior to more severely injured patients) in all of the Trial A drills when compared with the Trial B drills (Table 2). There were significantly more *catastrophic errors* (patients missing altogether) in the Trial A drills: four patients were not relocated after the initial triage. In comparison, only one patient was not relocated after the initial triage in all of the Trial B drills combined.

Discussion

The results of this study demonstrate that more visible means of patient identification at the scene of a MCI can facilitate for more rapid casualty collection. Increasing the rate at which a patient can be relocated after the initial triage and transported to definitive care can reduce morbidity and mortality.[1] Not only did the glow sticks make relocating patients less problematic, it also contributed to fewer patient errors. During MCIs in which inclement weather, poor lighting conditions, and power outages are the status quo, glow sticks may prove helpful.

A major limitation of this study is that only a total of four limited drills were performed for each of the two trials. Ideally, several hundred mass-casualty triage drills could be performed in order to obtain statistically significant numbers. Performing such a great number of drills is not feasible, due to the time involved for the on-call personnel. Each round of drills requires at least two EMS crews and a number of patients to perform the drill.

The use of glow sticks also has a number of limitations. They are to be used as a guide only. Over-reliance on the glow sticks could result in catastrophic patient errors. The absence of glow sticks on a mass-casualty field should not necessarily exclude the presence of more patients. The key to appropriate triage and casualty collection always will be founded on good communication and record keeping. Also, the shelf life of glow sticks is unknown: will they tolerate sitting in the EMS truck during a long Michigan winter or hot Arizona summer? Still, the glow sticks tolerate wet conditions, have a sturdy cord that is attached to patients, and are not easily lost due to the very nature of their increased visibility.

A MCI is defined by the fact that the required resources to handle the incident far exceed the available resources, and is defined by destruction or ineffective community support that requires outside forces to be brought in. In a rural area, a large MCI could result in a disaster. The same event may be defined as an MCI in an urban area. Due to the additional space required and the cost-per-unit of glow sticks, this method is unlikely to succeed in a major disaster such as the World Trade Center attacks or Oklahoma City bombing. The question that must be answered in any study is whether or not the product being studied would alter one's medical practice. In certain situations, the use of glow sticks for more visible patient identification could be used to ensure decreased morbidity and mortality in a MCI due to easier patient identification allowing for more rapid extracation of the patient from the incident, thus, allowing for faster delivery to a hospital for definitive care. Locating patients in a tractor-trailer accident on a dark highway, patients involved in a high school shooting with a power outage, and other local MCIs certainly could benefit from this practice. Bob Cesario of the Independence Fire Department said that during the trial, he felt that the use of the glow sticks would have an added benefit in multiple vehicle accidents. Glow sticks corresponding to the number and severity of patients still entrapped in the vehicles could be determined quickly by placing the corresponding glow sticks on the windshield of the vehicle, thus allowing for more selective extrication. Incidents involving multiple casualties in a darkened environment, such as during nightfall or during a power outage, are examples of events when the use of glow sticks could prove to be advantageous for rapid patient identification and extrication. Victims in large areas of dispersement could be identified more easily with the use of glow sticks, particularly in low light.

Round	Trial	Triage of All Patients Completed (minutes)	Patients Re-Located and Taken to Incident Commander (minutes)	Time to Collect and Transport Patients: Casualty Collection (minutes)	Errors	Time Saved between Trials A and B (minutes)
I	A	11.93	20.73	8.8	5	2.68
	B	12.35	18.47	6.12	1	
II	A	12.22	21.17	8.95	4	3.15
	B	12.45	18.25	5.80	2	
III	A	11.22	18.78	7.56	4	1.95
	B	10.97	16.58	5.61	1	
IV	A	12.30	19.35	7.05	3	2.52
	B	10.92	15.45	4.54	0	

Table 1—Data collection times Rounds IA through IVB

Trial	Total Errors Committed	Errors Committed
Trial IA: tag only	5	2 Immediate-level patients were transported after a Minor level patient 1 Immediate-level patient was transported after a Delayed-level patient 2 patients were not relocated (after the initial triage)
Trial IB: tag and glow stick	1	1 Immediate-level patient was transported after a Delayed-level patient
Trial IIA: tag only	4	3 Immediate-level patients were transported after a Delayed-level patient 1 patient not relocated (after the initial triage)
Trial IIB: tag and glow stick	2	1 Immediate-level patient was transported after a Minor-level patient 1 patient not relocated (after the initial triage)
Trial IIIA: tag only	4	2 Immediate-level patients were transported after a Minor-level patient 1 Delayed-level patient was transported after a Deceased patient 1 patient not relocated (after the initial triage)
Trial IIIB: tag and glow stick	1	1 Minor-level patient was transported after a Deceased patient
Trial IVA: tag only	3	1 Immediate-level patient was transported after a Deceased patient 2 Immediate-level patients were transported after a Minor-patient
Trial IVB: tag and glow stick	0	No errors

Table 2—Trials of tags vs. tag/glow stick combination and errors committed

Conclusions

In this study, glow sticks not only allowed for shorter casualty collection times, but also reduced the number of patient errors. Glow sticks can be a valuable additional resource in the management of MCIs.

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Appendix A—Information given to emergency medical services crews

Casualty Collection Research Project

This is a research project designed to evaluate the methods currently used in mass-casualty collection. The START (Simple Triage and Rapid Treatment) triage system will be utilized. The START system evaluates patient's respiratory, circucirculatory, and neurological function and categorizes them in one of four categories. In this system, initial triage takes priority over emergency treatments in the field setting. Emergency care administered by triage teams is restricted to opening the airway, controlling severe hemorrhage, and elevating patient's lower extremities. The categories are: Immediate, Delayed, Minor, and Deceased/Non Salvageable. The assignment of a triage level should take <60 seconds/patient. In inclement weather and other suboptimally lit environments, locating patients during both the triage and collection process can be difficult. In this study we will perform a drill whereby the patients will also be identified with glow sticks corresponding to their respective triage levels. It is hypothesized that using this more visible means of patient identification will allow for more rapid identification,collection, and ultimately, the transport of patients. The purpose of this study is to determine the advantages of the glow sticks in terms of greater ease locating patients and arranging for final disposition.

There is one proposed scenario: A shooting that takes place at a local high school. There are two rounds in each scenario. Round One involves triaging patients with the START system; Round Two uses the START system in addition to the glow sticks. The casualty collection times will be compared between the two rounds.

Triage Level	Color on Triage Tag	Corresponding Glow Stick
Immediate	Red	Red
Delayed	Yellow	Yellow
Minor	Green	Green
Deceased/Non-Salvageable	Black	Purple

Mass-Casualty Incident Scenario

Emergency medical services arrive at Lakeville High School: A 34-year-old male has entered the school grounds and shot multiple patients. The assailant has been shot and killed by SWAT officers, and your scene is secure. Power to the school is off, and there only ambient light is available. There are an unknown number of patients located in several rooms. You must perform the initial START triage assessment. Please use the following cards to assist you in triaging the patients. You will assign a tag to each patient in Trial A. Trial B will consist of the same number/triage level patients. In addition to placing the triage tags with these patients in Trial B, you also will use the glow stick that corresponds to the patient's triage level. After triaging all of the patients, you will carry each patient individually to the incident commander in the order of severity. For example, after triaging all of the patients, you will carry the patients individually starting with the "immediate" designations, followed by the "delayed," then "minor" and finally the "deceased" patients to the incident commander. The run times will be compared between the two trials.

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Appendix B—Patient scenarios (Cap = capillary; Resp = respirations; Sec = seconds)

Patient	Injury	Vitals	Triage Level
1	Compound fracture, left femur	Resp >30 Radial pulse absent Awake	Immediate
2	Bruising over abdomen, complaining of abdominal pain	Resp >30 Cap refill < 2 seconds Awake	Immediate
3	Severe difficulty breathing, chest sinks in on inspiration	Resp > 30 Radial pulse present Awake	Immediate
4	Bruise on forehead, blood in ears and nose	Resp < 30 Radial pulse present Unconscious	Immediate
5	Patient states she is diabetic, skin moist and clammy, feels shaky	Resp < 30 Cap refill > 2 sec Awake	Immediate
6	Sudden onset of chest pain with shortness of breath	Resp <30 Cap refill < 2 seconds Awake	Delayed
7	Impaled, 1-foot piece of shrapnel in right eye	Resp < 30 Radial pulse present Awake	Delayed
8	Female six months pregnant, broken left lower leg	Resp < 30 Cap refill < 2 sec Awake	Delayed
9	Impaled stick in right chest	Resp < 30 Cap refill < 2 sec Awake	Delayed
10	Blood in right eye	Resp <30 Cap refill <2 sec Awake	Delayed
11	No visible wounds	Resp none: open airway, still no respirations Radial pulse absent Unconscious	Deceased/Non-Salvageable
12	16-year-old, penetrating chest wound	Resp none: open airway, still no respirations Radial pulse absent Unconscious	Deceased/Non-Salvageable
13	Adult female, no visible wounds	Respirations none: open airway, still no respirations Radial pulse absent Unconscious	Deceased/Non-Salvageable
14	Torso injury; abdominal contents eviscerated	Resp none: open airway, still no respirations Radial pulse absent Unconscious	Deceased/Non-Salvageable
15	Abrasions to upper extremities	Resp <30 Radial pulse present Follows commands Ambulatory	Minor
16	32-year-old female, abrasions to back from falling debris	Resp <30 Radial pulse present Follows commands Ambulatory	Minor
17	Teen, knee sprain	Resp <30 Radial pulse present Follows commands Ambulatory	Minor
18	53-year-old male, no visible injuries	Resp <30 Radial pulse present Follows commands Ambulatory	Minor

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