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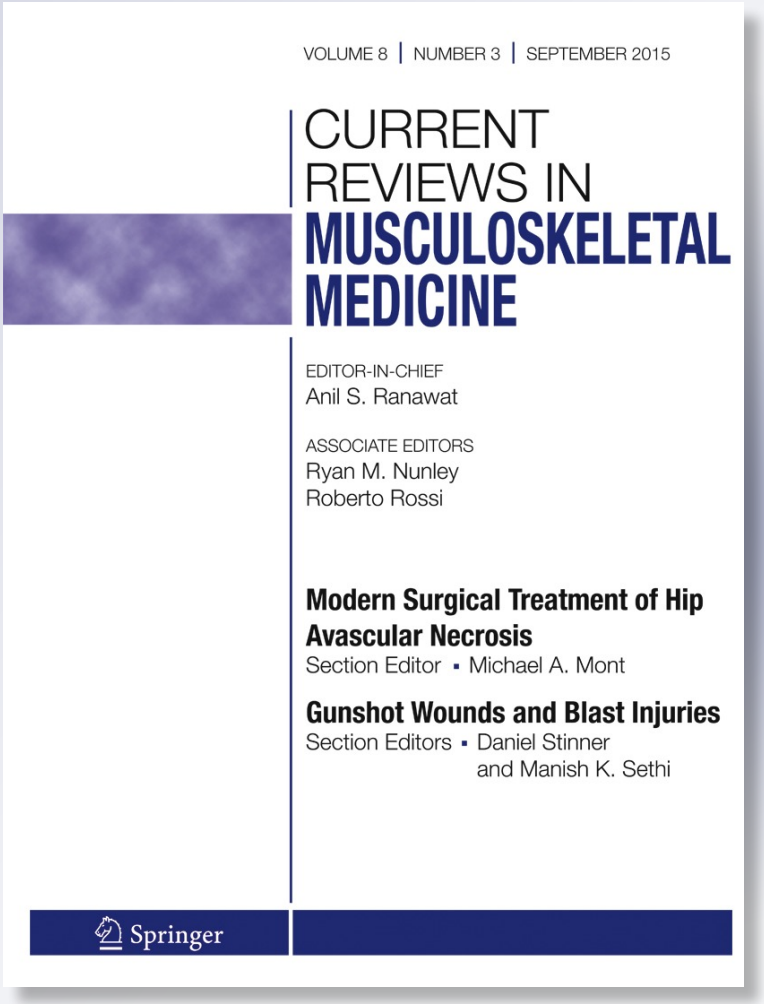

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GUNSHOT WOUNDS AND BLAST INJURIES (D STINNER AND MK SETHI, SECTION EDITORS)

2014 Fort Hood, Texas, mass casualty incident: reviews and perspectives

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Abstract On April 2, 2014, in Fort Hood, Texas, an active shooter incident occurred where four active duty soldiers were tragically killed. Active shooter incidents are becoming alarmingly more frequent over the last decade in the USA. The authors provide a detailed account of the events that occurred within the hospital and an evaluation of the triage decisions made on that day. A detailed review of mass casualty preparedness and the general approach to triage processes are also described.

Keywords Mass casualty incident · Triage · Penetrating injury · Penetrating extremity injury · Active shooter · Fort Hood

Introduction

Injuries and fatalities as a result of firearms are a common occurrence in the USA. According to the Center for Disease Control and Prevention (CDC) in 2011, over 32,000 people lost their lives to suicide or homicide, with firearms as the mechanism of injury [1]. This equates to an average of just over 85 lives per day lost due to firearms. Additionally, shootings in public places have become increasingly common. Thirty school shootings occurred from January 2013 to January 2014 in the USA. As evidenced by the events at Virginia Polytechnic Institute in 2007; Sandy Hook Elementary in Newtown, Connecticut, in 2012; and the Aurora, Colorado, movie theatre in 2012, shootings may involve a large number of casualties. It is abundantly clear that preparation for these active shooter incidents is vital.

Mass casualty incidents (MCIs) are events in which the number of patients overwhelms immediate hospital resources and capabilities. On April 2, 2014, the military base located in Fort Hood, Texas, experienced its second mass casualty incident within a 5-year span. The first mass casualty incident occurred in November of 2009, when 13 people were killed and over 30 were wounded. During the most recent tragedy, 4 people were killed, including the gunman, and 12 others were severely wounded. It is understood that the culprit drove to three different buildings over an 8-min period and opened fire with a .45 caliber handgun, wounding active duty Army soldiers at each location.

Carl R. Darnall Army Medical Center (CRDAMC) is located on the military base in Fort Hood, Texas, and was within 2 miles of the scenes of the shooting. It is a level III trauma center and also serves as a teaching hospital. Beginning at 1620 hours, 18 patients arrived over the following 2 h with gunshot wounds or injuries related to the events that day. Fortunately, all of the physicians that responded to the incident have completed the military's Combat Care Casualty Course and are Advanced Trauma Life Support certified. Additionally, there was numerous active duty staff that have been deployed and deeply involved with MCIs in both Afghanistan and Iraq.

Within the first 20 min of the incident, two patients arrived in the midst of cardiopulmonary resuscitation. Both of those patients had gunshot wounds to the chest, and both expired

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after intense efforts at resuscitation. Two patients arrived with gunshot wounds to the neck. Four out of the 13 patients who suffered gunshot wounds sustained penetrating wounds to the extremities. The authors' experience coincides with the data and observations of Peleg et al., where the incidence of orthopedic-related injuries due to violence from terrorist acts or war was higher when compared to other services such as thoracic surgery, general surgery, or neurosurgery [2]. See Table 1 below for a description of patient injuries and arrival time to the ED.

The authors set out to describe their initial reactions and observations relating to the events of the April 2, 2014 MCI. A review of general MCI preparedness topics, principles of gunshot wound triage, and initial evaluation and treatment principles from an orthopedic surgery perspective is also discussed.

The April 2 Fort Hood mass casualty incident

Primary triage: evaluation of emergency department response

As the active shooter incident evolved, there were multiple scenes and multiple victims. The distribution of victims and dilution of prehospital resources impacted the ability of emergency medical service (EMS) to perform accurate primary triage and make decisions regarding transport. Consequently, patients may or may not have been appropriately triaged when they arrived at the emergency department. Also, some of the highest acuity patients arrived relatively later in the incident, due to self-transport of the mobile, lower acuity victims. During both mass shooting events at Fort Hood, in 2009 and 2014, the first patients to arrive at the hospital were not transported by EMS agencies but rather by private vehicle.

The location of the triage area for CRDAMC is at the entrance doors of the ambulance bay. This is designed to prevent non-immediate patients from going through the emergency department. During the beginning of the incident, only one doctor and one nurse were in the triage area. Unexpectedly, as a consequence of the massive hospital response, the triage area and the immediate treatment area were inundated with excess personnel. During an active shooter incident, this can become dangerous for hospital personnel, with a relative lack of security outside the hospital. Future efforts will be made to improve crowd control and security at the emergency department entrance to ensure accurate patient triage and the safety of both patients and medical providers.

An under-triage rate of 5 % was noted when evaluating the initial response. One patient out of 18 was inappropriately triaged as delayed when they should have been triaged as an immediate patient. The physicians in the delayed treatment area rapidly identified the oversight during their trauma assessment. Likely, a significant distracting injury to the patient's arm obscured his much more serious and penetrating splenic injury. This patient's case reinforces the importance of ongoing triage and re-assessment throughout the initial response. The hospital system needs to be prepared for rapid movement of patients from lower acuity areas to higher acuity areas. In this instance, the system worked well; the patient's life-threatening injury was expediently diagnosed, and the patient was stabilized pending surgical treatment.

It should also be noted that two patients were arguably over-triaged. These two patients arrived with CPR in progress early in the course of the shooting response. By definition, these patients should likely have been triaged as expectant. At the time of their arrival, there was no knowledge of the expected number of incoming casualties. Both of these patients received a full Advanced Trauma Life Support (ATLS) evaluation and subsequent treatment, to include ED thoracotomies on both. Neither patient survived their injuries.

Initial response: an orthopedic perspective

After notification of a potential MCI and while initial triage was being performed on multiple scenes and the emergency room, all orthopedic providers and staff gathered in our clinic to assess our personnel assets. The details of mass casualty incident response have been discussed briefly as part of the in-processing done at our facility and is routinely practiced by the ED and the EMS, but this does not include surgical services. The orthopedic providers present during notification split to the emergency room, operating room, and delayed care areas to determine where our services could best be utilized. Our hospital had recently changed over from pagers to cell phones, and we encountered significant difficulty obtaining access to the cell phone tower secondary to the amount of cell phone activity as the base locked down. Text messaging was quickly noted to be the most accessible and reliable way to communicate. All who sustained orthopedic injuries were placed in the delayed care area after initial triage or were transferred to other hospitals to allow for space for incoming injured patients. Prioritizations for radiographs were appropriately given to those injured patients that were triaged to the immediate category in the emergency department and operating room. The exact number of injured patients was difficult to assess as conflicting numbers were being communicated and the location of the perpetrator was attempting to be ascertained. Tracking patients from the emergency department to the delayed or minimal category area was difficult as the mass casualty tracking number was not always easily available. Therefore, as patients were being evaluated in the emergency department, we obtained the mass casualty number and patient name.

Table 1 Timeline of patient arrival, major injuries, and triage category

Patient number	Arrival time	Injuries	Triage category
1	1625	Intraocular foreign body with ruptured globe	Delayed
2	1625	GSW (neck and arm)	Immediate
3	1630	GSW (abdomen, CPR in progress)	Immediate
4	1642	GSW (chest)	Immediate
5	1642	GSW (neck)	Immediate
6	1644	GSW (chest and flank)	Immediate
7	1644	GSW (chest, CPR in progress)	Immediate
8	1645	GSW (arm)	Delayed
9	1645	GSW (abdomen)	Immediate
10	1650	GSW (chest and arm)	Immediate
11	1659	GSW (back)	Immediate
12	1705	GSW (arm and abdomen)	Delayed
13	1710	GSW (back)	Immediate
14	1738	GSW (abdomen)	Immediate
15	1830	Lacerations (upper extremities)	Delayed
16	1835	Acute stress reaction	Delayed
17	1839	Acute stress reaction and closed head injury without LOC	Delayed
18	1850	Lacerations (upper extremities)	Delayed

GSW gunshot wound

Upon transfer to the delayed care area, all patients were re-evaluated with primary and secondary surveys using ATLS principles. Orthopedic providers performed or assisted with this survey in those previously noted to have orthopedic injuries upon arrival. The necessity of tourniquets applied at the scene and radiographs was assessed as part of the secondary survey. All open wounds were re-assessed and covered with wet-to-dry dressings. Patients with crepitus and deformity were provisionally stabilized with splints. All patients in the delayed category vital signs were continuously re-assessed. As part of this re-assessment, one of the injured patients with a gunshot wound to his upper arm was noted to have a splenic injury caused by the same bullet which was initially not appreciated and whose vital signs were noted to decompensate over time. As with all injuries resulting from a low velocity firearm, we irrigated wounds, started antibiotics per protocol, and placed definitive splints as required. If surgery was needed to stabilize fractures, informed consent was obtained for surgical intervention the following day. The only wound that was taken to the operating room on the day of injury was the individual whose vital signs decompensated who was taken secondary to a concomitant exploratory laparotomy and splenectomy.

Review of mass casualty incidents

Epidemiology

A study published in 2014 by Schenk et al. revealed that, in 2010, there were just under 10 million EMS calls in the USA, and just under 10,000 of them were later categorized as a MCI [3]. This 0.1 % incidence is an all-encompassing number that includes patients that were involved in electrocutions, motor vehicle accidents, traumatic injuries of all types, toxicological exposures, house fires, etc. More specifically, in 2014, the Federal Bureau of Investigation (FBI) did an active shooter study with the goal of better preparing governmental agencies and law enforcement with prevention and response measures to these incidents. Their results showed that from the years 2000 to 2013, there were 160 active shooter incidents in the USA. A total of 1043 casualties were accounted for, and 486 of those were killed during the incident. The FBI data shows an increasing trend of these incidents over the past 14 years, from 6.4 incidents annually in the first 7 years to 16.4 incidents per year in the last 7 years. Additionally, a concern from both a law enforcement and patient perspective is that three of the shooters carried and/or used improvised explosive devices in addition to shooting at victims. The data also states that 70 % of the locations used for the acts of violence were places of either education or commerce [4].

Current issues

At the onset of an active shooter incident, a complex array of services and resources must be activated. The mandatory nature of a multi-service approach is primarily for benefit of the casualties involved in the incident. In 2013, the American College of Surgeons and the FBI worked together to convene two meetings in Hartford, Connecticut, in an attempt to develop and solidify a nationally recognized approach for increasing survivability in mass casualty shootings. Now known as the Hartford Consensus, this is a set of recommendations that was compiled by subject matter experts in various fields including those from the military, fire, law enforcement, prehospital, and medicine. The ultimate aim of this committee in increasing survivability is hemorrhage control. Decreased mortality from the use of tourniquets is a broadly accepted practice for preventing deaths in the setting of penetrating injuries. This is due to evidence accumulated specifically from the Iraqi military campaigns [5]. At the Hartford Consensus, the acronym THREAT was coined and it stands for the following: Threat suppression, Hemorrhage control, Rapid Extrication to safety, Assessment by medical providers, and Transport to definitive care [6]. This approach has since been accepted and widely presented nationwide by the US Fire Administration and the US Department of Homeland Security.

The authors are in overt agreement with the notion of a national policy that focuses on the training of police, EMS, and fire departments on the initial stabilization of casualties using tourniquets. What is more complex to standardize is the transparent readiness and response of EMS and the receiving hospital in the midst of any violent tragedy. Jenkins et al. [7] evaluated multiple instruments, all of which are designed to assess for thoroughness of hospital emergency preparedness. The group compared nine different emergency preparedness tools, most of which were developed by a governmental agency, to a relatively newly developed national standard, the National Incident Management System (NIMS). NIMS is a nationwide template developed in 2004 by the US Department of Homeland Security, which outlines the guidelines and resources to ensure a systematic approach by departments and agencies at all levels to be adequately prepared for a multitude of disasters. NIMS elements include preparedness, communication, information management, and command. They showed that no current instrument exists to ensure comprehensive hospital preparedness by meeting all of the NIMS criteria.

It has also been noted that a nationally accepted triage system is lacking. The potential problem with this fact is the miscommunication that could occur in the midst of a crisis due to the inconsistency of triage processes, triage tagging, and overall nomenclature. The logistics of managing a MCI that is both effective for patient care and mindful of resource utilization requires a collective understanding of triage systems, patient sorting, lifesaving medical interventions, and patient assessment. Currently, there is a movement by the CDC and a SALT (Sort, Assess, Lifesaving interventions, Treatment/Triage) workgroup to push for a nationally standardized triage method and triage system. This workgroup concluded that, as of 2013, there are no triage systems currently used by any EMS, which has been validated by scientific evidence to suggest its national adoption [8]. In light of this conclusion, this workgroup, along with national governmental and non-governmental agencies alike, created the model uniform core criteria for mass casualty triage. These criteria highlight the core components that a triage system should contain to meet nationally accepted standards. Creating this system allows the flexibility of each EMS and hospital service to use existing systems, but modifying them only minimally to ensure that they meet the core criteria set out in the national standards.

Review of triage

Triage system overview

Prehospital triage is a challenging task. The prehospital provider must attempt to triage every patient appropriately and, in many situations, simultaneously evacuate them to a higher level of care. These circumstances often lead to either over-triage or under-triage. Over-triage implies that a minimal patient will be categorized as delayed or a delayed patient as immediate. If this is not corrected, the higher acuity treatment areas may be overwhelmed with lower acuity patients, leaving a higher acuity patient to wait and possibly worsen during that period of time. Under-triage leads to a situation where patients receive an inappropriate lower triage category. This also encompasses patients who are in the immediate category but are categorized as expectant. Obviously, mis-triage in either direction can lead to increased morbidity and/or mortality. It also places increased stresses on a medical system that is already stressed in a mass casualty situation. Though there is a possibility for over- or under-triage by EMS in the prehospital stage, re-triage is initiated to identify any deterioration in patient status or an incorrectly assigned triage category upon hospital arrival and beyond.

Simple Triage and Rapid Transport (START) is a triage tool designed for all mass casualty events. The START triage method is commonly used throughout the USA and has been since the early 1980s. The system is based on a progression of questions concerning the ability to walk, respiratory rate, peripheral circulatory perfusion, and mental status. However, START fails to adequately address exsanguinating hemorrhage and tactical considerations that may be relevant during mass shooting events. SMART Triage was developed to more specifically address hemorrhage control. Fort Hood Emergency Medical Services are trained in the use of SMART Triage, which is also what the Central Texas region's EMS agencies have adopted. SALT Triage, mentioned previously, is a newer triage system with a focus on early lifesaving interventions to include hemorrhage control, tourniquet application, chest decompression, and auto-injector antidotes. See Table 2 for comparison of the triage methods. Incorrectly triaging patients can be detrimental, but research shows respectable results for EMS services complying with protocols. A study performed by Fitzharris et al. evaluated the adherence and accuracy of EMS triage protocols in over 57,000 patients. They found that the protocol was correctly followed 74 % of the time [9]. This system is currently used the by the emergency department at Carl R. Darnall Army Medical Center.

Orthopedic evaluation and extremity triage principles

After initial triage, patients should be evaluated with a primary and secondary survey according to the principles of Advanced Trauma Life Support for doctors. Orthopedic injuries associated with severe hemorrhage may be diagnosed and emergently treated during the primary survey with the application of pressure, packing, or the placement of the tourniquet. Absent distal pulses may indicate a vascular injury and must be further investigated. Signs and symptoms of compartment syndrome may also be noted on the primary or secondary survey. The diagnosis of a major arterial injury and/or a

Table 2 Types of triage systems

Type of triage system	Brief description
SALT (Sort, Assess, Lifesaving interventions, Treatment/Triage)	This method globally sorts patients based on their initial ability to ambulate. Lifesaving interventions are then initiated, for example tourniquets and/or chest decompression. After this, patients are triaged as minimal, immediate, and expectant based on pulse, RR, and MS
START (Simple Triage and Rapid Transport)	Walking wounded patients are asked to move to a designated location and are deemed as minor. Each non-ambulatory patient is then evaluated in the order of respiration>perfusion>mental status
SMART Triage	Almost identical to START in its algorithm, except there is an increased focus on controlling hemorrhage for the patients which have abnormal perfusion or altered mental status

RR respiratory rate, *MS* mental status

compartment syndrome should be clearly communicated with key surgical trauma coordinators/physicians as these injuries may represent life- or limb-threatening wounds requiring urgent surgical intervention. If known, the type of weapon used should be recorded. High-energy injuries caused by rifles or shotguns often require operative treatment and antibiotics, while low-energy injuries caused by handguns may not [10]. Other injuries, such as fractures or soft tissue wounds, should also be documented during the secondary survey.

The importance of hemorrhage control has been widely recognized by the civilian and military medical communities. Tourniquet use has been clearly demonstrated to improve survival for patients with major limb trauma [5]. Improper use of a tourniquet has been associated with morbidity and mortality [11]. A tourniquet may be placed in the prehospital setting prior to evaluation of the wound by the emergency physician, general surgeon, or orthopedic surgeon. Indicated tourniquets should be assessed for proper placement and effective hemorrhage control. Inappropriately placed tourniquets should be removed in a controlled setting to prevent potential complications associated with tourniquet use [12]. Pressure dressings or bandages may then be placed as indicated.

After completion of the primary and secondary survey, wounds may be temporized before definitive treatment. Gunshot wounds associated with significant soft tissue injury or fracture should be irrigated, dressed, and splinted. Superficial low-energy wounds may be treated with a temporary soft dressing. Antibiotics may be given per hospital/department protocol. Radiographs should be obtained when possible. Each patient's demographic information and pertinent diagnoses should be recorded to allow for patient disposition. Clear communication is paramount to the assessment, treatment, and disposition of patients in mass casualty incidents.

Conclusion

Gunshot wounds are a major source of morbidity and mortality in the USA. Mass casualty incidents caused by firearms occur with alarming frequency. Fort Hood has experienced two such events, and valuable lessons regarding triage and treatment have been learned. Patients should be systematically sorted according to an agreed upon algorithm. Ongoing patient re-assessment is critical to ensuring accurate categorization and expedient care. Initial orthopedic surgery evaluation should follow ATLS principles with focused attention on limb perfusion, hemorrhage control, and fracture stabilization. The hospital response to MCI should be planned, practiced, and reviewed by all involved personnel to ensure effective patient evaluation and treatment.

Compliance with Ethics Guidelines

Conflict of Interest Joshua J. Strommen, Scott M. Waterman, Christopher A. Mitchell, and Brian F. Grogan declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

Disclaimer This article solely expresses the opinions of the authors and does not reflect the opinions of the US Army, the Department of Defense, or the US Government.

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