Triage for the neurosurgeon

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Triage for the neurosurgeon is a misnomer. The neurosurgeon’s role within a mass-casualty situation is one of a subspecialist surgeon instead of a triage officer. Unfortunately because of the events of September 11, 2001, civilian neurosurgeons and other medical specialists have been questioning their role within a mass-casualty situation or, worse, a situation created by biological, chemical, or nuclear weapons. There is no single triage system used exclusively within the United States, and different systems have differing sensitivities, specificities, and labeling methods. The purpose of this article is to discuss varying aspects of triage for both military personnel and civilians and suggest how the neurosurgeon may help shape this process within his or her community. Furthermore, the effects of biological, chemical, and nuclear weapons will be discussed in relation to the triage system.

KEY WORDS • triage • mass casualty • disaster medicine • nuclear, biological, chemical warfare

The title for this article is somewhat of a misnomer. If the neurosurgeon is performing general triage in a mass-casualty situation, something is gravely wrong. For the general neurosurgeon, understanding the principles of triage, why decisions are made and where he or she fits into the system is beneficial and essential for the effective treatment of the neurologically injured. As a limited medical asset, neurosurgeons can best serve patients by performing triage and subsequent surgery in head- and spine-injured victims and not by trying to perform general triage of all patients in a mass-casualty situation. In light of the events of September 11, 2001, many within the medical field have more fully analyzed their roles within a mass-casualty situation both in regard to blast- and missile-induced wounds from terrorist acts and potential acts of biochemical terrorism. In their examination of 220 terrorist bombing incidents, Frykberg and Tepas indicated that biochemistry was a factor in 20% of the incidents.15 In their examination of 220 terrorist bombing incidents, Frykberg and Tepas indicated that biochemistry was a factor in 20% of the incidents.15

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Napoleon’s army, Larrey developed a system to evaluate rapidly the wounded and evacuate salvageable patients needing the most urgent care. He instituted these principles while battle was still in progress and triaged without regard to rank. Principles of triage were further practiced during the American Civil War and World War I. In World War II the United States Army Medical Corps developed a tiered triage system. Portable field hospitals were used, and medics initiated treatment in the field. This system is credited with contributing to the survival of more patients with abdominal wounds in World War II than any other single factor. During the Korean War, the military began using the four-tiered triage system described in the Military Triage section of this paper. This system led to a significant improvement in survival of patients who sustained casualties. As transportation methods improved, time from injury to treatment decreased significantly, and correspondingly mortality rates also improved. In World War II time from injury to definitive treatment was approximately 12 to 18 hours. This interval decreased to fewer than 2 hours during the Vietnam War largely because patients could be transported by helicopter.3 Kennedy and associates indicated that mortality rates decreased from 4.7 to 1%, in part, due to the advances in rapid triage and transport.

Ultimately the goal of triage is to ensure that the available medical resources are used to treat the greatest number of patients in need of those resources. In standard triage patients at either end of the extremes of care should be identified. Resources can then be diverted from those whose death is imminent or who will recover regardless of care to those who are critically ill.14 After an attack involving WMD, the number of cases will likely overwhelm the resources of area hospitals. In a study performed by Wetter and associates,16 they found that the majority of urban and rural Pacific Northwest emergency departments

Abbreviations used in this paper: EMT = emergency medical technician; ER = emergency room; GCS = Glasgow Coma Scale; WMD = weapons of mass destruction.
would have difficulty responding to the effects of a biochemical attack. In a questionnaire emergency department officials were asked about their capabilities after a sarin gas attack or an anthrax exposure affecting 50 patients. Questions addressed the supply of medications, availability of indoor isolation rooms, water containment systems, and personal protective equipment. Only 29% of hospitals stocked enough atropine to treat 50 chemical casualties, and no hospital had enough pralidoxime. Sixty-four percent of hospitals had enough ciprofloxacin to treat 50 anthrax cases for 2 days. Twenty-one percent of hospitals had isolated ventilation units and water containment systems while 25% had no systems. In light of these statistics, the hypothetical situation proposed by Kaufmann and associates is even more disturbing. These authors estimated that if anthrax spores were released up-wind of large suburban area, approximately 50,000 cases of anthrax contamination would occur, resulting in 32,000 deaths. This defines the mass-casualty situation in which the number of casualties quickly overwhelms the available resources. Resources must be allocated to provide the best care to the most patients possible, with the knowledge that some patients will receive no care. This scenario is in contrast to a multiple-casualty situation in which resources are available to treat the large number of patients involved.

Weapons of mass destruction attacks also require efforts to ensure the safety of medical and rescue personnel. Careful staging of patient arrival and decontamination must be preplanned. The process by which an individual patient is decontaminated should ideally take 15 to 30 minutes. If a hospital is situated within a “contaminated region,” medical personnel should initiate standard treatment for the particular inciting agent and then transfer the patient to a region where decontamination and follow-up treatment can be provided. Unfortunately, in a mass-casualty situation involving chemical or nuclear agents, it cannot always be assumed that the hospital designated to treat these casualties is not itself within a contaminated area. Preplanning within a medical region must deal with contingency plans. Furthermore, planning must assume that all patients exposed to a WMD attack will need to undergo decontamination and treatment (that is, atropine injections for even mild nerve gas exposure). These are significantly larger numbers of patients than the 10 to 15% severely injured casualty case load that would be expected to require care after a terrorist attack.

MILITARY TRIAGE

Classic military triage is based on a series of guidelines known as the conventional North American Treaty Organization triage classification. The “immediate” category includes patients who are to be treated first and include those with the following injuries: airway obstruction, cardiorespiratory failure, significant external hemorrhage, shock, sucking chest wound, and partial- or full-thickness burns of the face and neck. These patients have life-threatening injuries that can be treated with minimal use of resources. The “delayed” category includes patients with the following types of injuries: open thoracic wound, penetrating abdominal wound, severe eye injury, avascular limb, fractures, and partial- or full-thickness burns not involving the face, neck, or perineum. A delay in treatment of up to 6 to 8 hours will not substantially alter outcome. The “minimal” category includes patients with the following injuries: minor lacerations, contusions, sprains, superficial burns, and partial-thickness burns of less than 20% of body surface area. These patients will not suffer significant morbidity even if no further medical intervention is performed. The “expectant” category includes patients in whom there are signs of impending death or those with treatable injuries requiring a vast expenditure of resources. This includes patients with head injury and a GCS score lower than 8, partial- or full-thickness burns affecting greater than 85% of body surface area, or multisystem trauma. Unfortunately, this category must exist when there are inadequate resources to treat all patients, such as during wartime and in situations involving mass casualties.

A system is likewise designed for the evacuation of victims. The tiers include the following: 1) “Urgent” evacuation patients cannot be treated or stabilized at their current treatment facility and must be evacuated within 2 hours. These patients have nonsurgery-related head injuries or partial- or full-thickness burns to the face or neck. 2) “Urgent-surgical” evacuation patients are those with potentially survivable injuries who need surgery in fewer than 2 hours. Injuries in this category include open chest and abdominal wounds, uncontrollable bleeding, head injuries requiring surgery, or avascular limbs. 3) “Priority” evacuation patients are those requiring treatment in fewer than 4 hours. Patients with closed-chest and abdominal injuries, spine injuries, open fractures, and partial- or full-thickness burns of the hands, feet, or genitalia are included in this category. 4) “Routine” evacuation patients are those who will not suffer medical deterioration within the subsequent 24 hours or are those who are “expectant.” This group includes patients with closed fractures, psychiatric cases not treatable at the facility, and those with irreparable and irreversible injuries. 5) “Convenience” evacuation is for those personnel who require evacuation but are not currently ill.

In addition to the aforementioned tenets of standard military triage system is the concept of reverse triage. Reverse triage is used within a military setting when the situation demands that soldiers be returned to combat as rapidly as possible. In this environment, soldiers with minimal injuries are treated first and then returned to activity before more seriously wounded patients are managed.

In the military, corpsmen have extensive triage and evacuation training. Physicians working with these corpsmen must understand the triage system and work within it as a coordinated team. Military medical personnel expect that not all patients will be treated if resources do not permit. In the civilian community this may be a difficult concept to accept. Trauma hospitals routinely expend maximum resources on cases in which the expected outcome is dismal. Medicolegal and societal considerations have created a standard by which no less is expected. In a mass-casualty situation, this system must be modified.

CIVILIAN TRIAGE SYSTEMS

Numerous triage systems and grading indices of trauma have been advocated to manage mass-casualty situations.
Goals of the systems are to quickly identify wounded individuals who would most likely benefit from rapid medical attention, while not expending valuable resources on those for whom there is little hope of recovery. An effective system would not significantly “under-” or “overtriage” patients. Undertriage implies insufficient sensitivity in a system to identify the critically injured. This results in potentially greater morbidity or mortality because of a low-level triage assignment. In overtriage patients who do not require immediate treatment receive it, thus detracting from those who legitimately required treatment. This is more likely to occur than undertriage; however, it is not without detriment. In reports of terrorist bombing incidents, Frykberg and Tepas found an overall overtriage rate of 59% and an undertriage rate of 0.05%. The overtriage rate was found to be inversely related to the critical mortality rate. Judgments in triage, however, often err on the side of overtriage to avoid the possibility of undertriage. The Revised Trauma Score for Triage was used by the military in Desert Storm because of its higher sensitivity rate than other indices.

Patients who have sustained severe injuries can expect the best survival chances if treated in facilities that are dedicated to trauma (Level I and II centers). Patients who have sustained less threatening injuries should be treated at community hospitals to avoid overwhelming trauma facilities. Most scoring systems available can be correctly used to identify patients who will live or die, but they do not accurately categorize the extent of injuries. It is estimated that between 6 and 25% of patients in a mass-casualty incident will require urgent treatment within 12 hours. Table 1 lists the different triage scoring systems currently used.

Triage systems may be divided into those based on physiological parameters and those based on mechanism of injury and anatomical factors. Physiology-based triage systems have been used to manage patients with current clinical instability and have been favored over anatomy-based systems. Anatomy- and mechanism of injury-based systems are used to identify those patients who have potential for clinical deterioration and require surgery. No system has thus been found for the accurate triage of the trauma victim. Experienced EMTs without a scoring system can just as accurately predict mortality as physicians by using the triage-revised Trauma Score, the Prehospital Index, and the Circulation, Respiration, Abdominal findings, Motor/Speech scale. In a prospective trial conducted by Fries and associates, the Trauma Triage Rule scale combined with EMT judgment had greater predictive value in identifying seriously wounded patients than the application of one without the other. Garner and associates retrospectively reviewed four trauma classification schemes (CareFlight, Simple Triage and Rapid Treatment, modified Simple Triage and Rapid Treatment, and Triage Sieve). They found that the motor component of the GCS and systolic blood pressure were the strongest physiological predictors associated with critical injury. Sensitivity and specificity were 72.6 and 96.2%, respectively, for GCS motor scores less than 6, and 30.4 and 99.2%, respectively, for systolic blood pressure less than 80 mm Hg. Simple Triage and Rapid Treatment and its modified version had sensitivity values of 85 and 84%, respectively, whereas specificity values were 86 and 91%, respectively. The Triage Sieve had the lowest sensitivity at 45%. CareFlight had an 82% sensitivity and a 96% specificity.

In addition to the specific difficulties inherent in most of the triage models, the inability of medical personnel to reach the hospital during a mass-casualty event may significantly alter the efficacy of any well-devised triage system. Added strains may occur if medical personnel leave the hospital to assist their families.

Different triage systems have different identifying labels, but typically three categories are used. 1) “Priority One” or “Emergency” (the color red): patients require immediate treatment. 2) “Priority Two” or “Urgent” (the color yellow): delay in care may occur for a limited time without significant mortality. 3) “Priority Three” or “Non-urgent” (the color green): patients in the first two categories may be treated before patients in the third category are addressed.

It is difficult in the civilian community to designate an expectant category (color black). All medical personnel find it distasteful to designate a patient expectant who, outside of a mass-casualty situation, would otherwise be

<table>
<thead>
<tr>
<th>Scoring System</th>
<th>Parameter</th>
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<tbody>
<tr>
<td>Trauma Index</td>
<td>injury type, respiratory, cardiovascular, &amp; central nervous system</td>
</tr>
<tr>
<td>Triage Index</td>
<td>respiratory expansion, cap refill, GCS</td>
</tr>
<tr>
<td>Trauma Score</td>
<td>respiratory effort/rate, systolic BP, cap refill, GCS</td>
</tr>
<tr>
<td>Revised Trauma Score</td>
<td>GCS, systolic BP, &amp; respiratory rate</td>
</tr>
<tr>
<td>CRAMS scale</td>
<td>circulation, respiration, abdominal findings, motor/speech</td>
</tr>
<tr>
<td>Homebush Triage</td>
<td>based on modified Simple Triage &amp; Rapid Treatment (see below)</td>
</tr>
<tr>
<td>Prehospital Index</td>
<td>respiratory rate &amp; level of consciousness</td>
</tr>
<tr>
<td>CareFlight Triage</td>
<td>walking, obeys commands, radial pulse, respirations present or absent</td>
</tr>
<tr>
<td>Trauma Triage Rule</td>
<td>systolic BP ,5 mm Hg, motor GCS score ,5 &amp; penetrating trauma to head, neck, &amp; trunk</td>
</tr>
<tr>
<td>Triage Sieve</td>
<td>walking, breathing, respiratory rate, cap refill (widely used in the UK)</td>
</tr>
<tr>
<td>Simple Triage &amp; Rapid Treatment (cap refill) &amp; Modified Simple Triage &amp; Rapid Treatment (radial pulse)</td>
<td>walking, breathing, respiratory rate, radial pulse, obeys commands (used primarily in North America)</td>
</tr>
<tr>
<td>Revised Simple Triage &amp; Rapid Treatment (cap refill) &amp; Modified Simple Triage &amp; Rapid Treatment (radial pulse)</td>
<td>loss of limb/function cosmesis, mangled remains</td>
</tr>
<tr>
<td>neurpsychiatric triage</td>
<td>penetrating wounds to chest, abdomen, traumatic amputation, comorbid factors</td>
</tr>
<tr>
<td>anatomical factors</td>
<td>fall &gt;20 ft, ejection from vehicle, high-speed motor vehicle accident</td>
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* BP = blood pressure; cap = capillary; UK = United Kingdom.

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treated. According to Kennedy and associates,\textsuperscript{13} to avoid this problem, a triage category system called SuperG: START (simple triage and rapid transport system) was developed. This system added a “blue” category for patients whose chances of survival are small and require an extensive amount of medical treatment. These patients, in a nonmass-casualty situation, receive treatment after Priority One (red) patients and before Priority Two (yellow) patients. In a true mass-casualty situation, however, treatment of Priority Two (yellow) patients is more likely to yield a higher rate of success, and thus these patients should be treated before those considered code blue. An alternative to a triage tag system is geographic triage. Patients are triaged to the location of treatment based on their status.

Unfortunately, there are many different triage categories and scoring systems, of which none is perfect. If different triage categories exist within a region, patients will eventually be transported to a facility unfamiliar with their triage category. The best use of a system in a particular region depends on a coordinated triage approach undertaken by emergency personnel. Furthermore, the concept of a single person in command of a mass-casualty situation may be too overwhelming for just one individual. Hirshberg and associates\textsuperscript{10} have advocated the need for a dual command. One physician, an ER doctor, should be in charge of the overall medical and administrative operation of the emergency department, whereas a second physician, an ER or trauma surgeon should supervise the provision of trauma care. The following guidelines help maximize effectiveness in a mass-casualty situation: a single triage grading scale and category system should be used within a given geographic region; EMT/ER personnel and trauma surgeons routinely training with the designated regional system; a regional coordinator should manage the flow of patients and triage at a mass-casualty site; designated hospitals should treat severe trauma and others should manage the “walking wounded;” and appropriate threat assessment and preparation should be undertaken for WMD attacks and the potential effects on the medical system.

In a civilian mass-casualty situation, particularly following a WMD attack, subspecialists should help by knowing their specific role within that environment. Although a large civilian hospital has significantly more resources than a forward surgical unit in combat, in a WMD environment resources may be quickly overwhelmed. Even if a region depends on support from the National Disaster Medical System, there still must be a logical, coordinated response prior to the arrival of this support. Managing a mass-casualty situation requires coordination of efforts and a clear delineation of roles, which returns us to the point made in the introductory paragraph. A neurosurgeon running general triage is a poor allocation of resources. Coordination with the emergency medical system prior to an event, however, ensures that the triage and evacuation coordinators have considered the neurosurgeon’s input.

Finally, care for potentially contaminated patients requires proper facilities for decontamination. If any institution cannot perform this role and cannot supply caregivers with proper protective equipment, the entire system is at risk. In WMD scenarios the best defense is proper knowledge of what can be handled safely and efficiently in a coordinated matter.

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References


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