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REVIEW ARTICLE

Orthopaedic triage during natural disasters and mass casualties: do scoring systems matter?

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Abstract Mass casualty events, either natural disasters or man-made, are associated with extremities injuries. The treating surgeon often faces a challenging decision: can the affected extremity be saved or amputated? The following article will present the author's view on the subject of triage and the use of scoring systems in the decision-making process whether to salvage or amputate an affected extremity. The author will analyse the existing scoring systems and emphasise significance of the regional factors: geographical, cultural and level of health care, as factors playing roles in this process.

Introduction

Over the last decade, more than 2.5 billion people have become casualties of natural disasters. Every year an estimated 1.2 million people are killed and over 50 million are injured in road accidents. More than 740,000 people die annually as a result of armed conflicts. Most of these deaths (490,000) occur outside war zones [1].

For healthcare systems and individual healthcare providers, the choice of the best, most efficient type of care represents a significant challenge. The casualties associated with these events are overwhelming due to large numbers of people being affected in rapid-onset disaster events, which differ from everyday pathology because of limited resources and other factors.

Over the years, there have been many attempts to quantify the severity of the injury sustained, to establish a protocol, a way to assist in the decision making process whether to salvage or to amputate the affected extremity, how to allocate and provide the best care to the injured and to allocate appropriately the resources available.

A variety of scoring systems have been developed to assist in this process, to make it more objective with a predictable outcome. Most of these systems are applied to the mangled extremity and are based on neurological, vascular, soft tissue and tendon conditions. There is no relationship to the other, more general and very important factors, that, in the opinion of the author, play an important role in the decision process when dealing with mass casualties. Among these factors are: level of healthcare in the given country or region, availability of medical expertise, dimension of the disaster, number of the wounded and local culture, among others.

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History

Triage, "to sort" in French, was introduced to the field of medicine by Baron Dominique Jean Larrey, a surgeon in Napoleon's army. The urgent care was provided first to those solders who where in the worst condition, regardless of their military rank. Larrey's system of care involved initial care of the wounded in the field and transport to the hospitals. It was at that time the ambulance was born.

In 1846 John Wilson, a British Naval Surgeon, advocated administration of care to those with life-threatening injuries while withholding immediate care from those who were either likely to die or those whose injuries could be treated later, doing the "greatest good for the greatest number."

During World War I, injured soldieries were brought and triaged at the central casualty collection points and subsequently transferred to the next more appropriate treatment facility.

World War II brought up a tiered approach when the injured were treated in the field by the medics and then transferred to the next level of care if it was needed.

The Korean and the Vietnam Wars demonstrated the significance of rapid triage and evacuation. Use of helicopters decreased the time from the injury to the definitive care to less than two hours, leading to significant improvement in the outcome.

Experience during military conflicts in the Middle East over the last two decades contributed to improvements of the medical care during mass casualty events that affected both the military and civilian populations.

Triage concepts

In mass casualties events, the triage process is very complex. After initial evaluation the injured are placed into a specific category based on the probability of survivorship and severity of injury.

The following categories of injured have been accepted:

Priority 1: immediate (red). Patients with critical injury, requiring minimal treatment time and resources, and after being treated have good prognosis for survival.

Example: massive haemorrhage that can be controlled with a simple procedure.

Priority 2: delayed (yellow). Patients with significant injury the care of which can be delayed without risk of significant subsequent morbidity.

Example: Isolated major long bone fracture.

Priority 3: minimal, nonurgent (green). Patients, also known as walking wounded, with injuries that can wait for treatment.

Example: sprains, abrasions, lacerations, small bones fractures.

Priority 4: expectant (black). Patients with injuries so severe that chance of survival is minimal.

Example: massive head injuries, third degree burns with 95 % body coverage.

Some patients, whose injuries are very severe so that they are not likely to survive, are considered for an additional category (blue). The decision about the care of these patients is very challenging and treatment priority is based on the resources available. In the events of significant number of casualties this (Blue) type of priority indicating often no treatment or transportation, while in the event when medical support is possible these patients require to be transferred, if possible, to a level 1 or 2 trauma center.

Those who are unresponsive, pulseless and not breathing are triaged as dead.

Triage of the patients with orthopaedic injuries

After a patient's category is established and the patient's life-threatening injuries are under control (based on ATLS protocol), secondary triage is performed and optimal care is provided for individual injuries.

In case of limited resources and overwhelming number of casualties, the so-called "minimal acceptable care" concept is implemented. An example of this is splinting of the long bone fractures.

Patients with multiple orthopaedic injuries and other associated injuries are treated differently than those with isolated extremity injuries.

Extremity scores

In an attempt to optimise care in patients with multiple or single orthopaedic injuries a variety of scoring systems have been introduced over the last several decades. This was especially important when extremity injury was so severe that either amputation or limb salvage was considered.

- *The Mangled Extremity Severity Score (MESS)* was developed by Johansen in 1990 [2]. Based on four components—degree of skeletal and soft tissue injury, severity of limb ischemia, patient age and systemic hypotention—when MESS was 7 or more predicted amputation had 100 % accuracy.
- *The Limb Salvage Index (LSI)* was introduced by Russel et al. in 1991 [3]. This index is based on seven components: injury to an artery, deep vein, nerve, bone, skin, and muscle as well as warm ischemia time. An LSI of 6 or more points indicates that the limb should be amputated.
- *The Predictive Salvage Index (PSI)* was developed by Howe et al. in 1987 [4]. The PSI components are: the level of arterial injury, the degree of bone injury, the degree of muscle injury, and the time to surgery. The threshold for limb amputation is a score of 8 or more points.
- *The NISSSA* was described by McNamara et al. in 1944 [5]. The nerve injury, ischemia, soft-tissue injury, skeletal injury, shock, and patient age make up this score. The threshold for limb amputation is a score of 11 or more points.
- *The Hanover Fracture Scale (HFS-98)* was developed in 1982 [6] and modified in 2001 [7]. The components of the HFS-98 are bone loss, skin injury, muscle injury, wound contamination, periosteal stripping, local circulation, systematic circulation, and nerve function. A score of 11 or more points is the threshold for limb amputation.

One of the most successful scores, the Ganga Hospital Score, was developed by Rajasekaran et al. in 1994 [8]. The authors based their score on four components: covering structures: skin and fascia; skeletal structures: bone and joints; functional issues: musculutendinous; and nerve units; comorbid conditions.

The score was validated in 109 consecutive GA type III A and type III B open tibia fractures. The Ganga score was easy to apply and found to be reliable in prognosis for limb salvage and outcome measures in type III-A and III-B open injuries of the tibia.

While low scores in any of the scales are used to predict successful limb-salvage potential, the high scores do not have adequate sensitivity to predict amputation.

These scores assess limbs with combined orthopaedic and vascular injuries and were found to have poor prediction of Gastillo–Anderson type III B injuries [9].

Discussion

Mass casualties from recent natural, military, and terrorist disasters present a serious treatment challenge to civilian medical communities all over the world. In the 2010 Haitian earthquake, more than 50 % of the injuries were to extremities and a high percentage of those were crush injuries. Crush injuries, crush syndrome, delayed presentation of the injured, amputations, and infections overwhelmed the region's medical community.

Over the years, there were multiple attempts to come up with objective ways to triage affected patients and more specifically those with extremity injuries. An appropriate scoring system would guide surgeons as to which extremity to amputate and which to salvage. Timely decisions would save not just a limb but affect life and lives of many during mass casualty events.

These score systems had different weaknesses: retrospective design, small numbers, length of the follow up, clinical bias, and more. They did not take into consideration local community healthcare systems, manpower, local culture, dimension of the disaster event or medical/surgical expertise. What would be accepted in one region would not necessarily be so in another.

As an example, the Lower Extremity Assessment Project, or LEAP study, has shown that the advantages to early amputation may not be as great as previously thought [10]. The self-reported health status was not significantly different at two-years following injury between the amputation and reconstruction groups. These results were particularly surprising because most patients treated by amputation had achieved maximum improvement two years post-injury, whereas reconstructed limbs often required additional procedures to achieve union or soft tissue coverage. The results from the LEAP study have also shown that the most important overall predictors of outcome, regardless of treatment strategy, include low level of education and poor socio-economic status.

Conclusion

It is obvious that scoring systems are helpful, but it is still the treating surgeon's clinical judgment that makes the ultimate decision in this very important process of triage during mass casualties events.

Given the current geopolitical situation, it is very likely that surgeons will continue to be confronted with these complex decisions: limb-salvage versus amputation, saving limb or saving life. As a rule, the decision to amputate should be seen not as a failure of treatment but as a life-saving, function-preserving operation.

Technical, cultural, facilities, and surgical skill factors should all play significant roles in the decision-making process when amputation is considered. Given what we have learned to date, a staged approach to amputation should be implemented whenever possible to minimise the risk of local and systemic infection. Since field amputation is an evolving medical skillset that will inevitably grow with the increasing incidence of disaster, education in its purposes, techniques, planning, and approaches should be of critical importance to all orthopaedic surgeons. International collaboration and availability and exchange of information will further assist us in developing a more objective approach in some of the most challenging and changing human life decisions.

References

1. Geneva Declaration Secretariat (2008) Global burden of armed violence full report. www.genevadeclaration.org. Accessed 1 July 2013
2. Helfet DL, Howey T, Sanders R, Johansen K (1990) Limb salvage versus amputation: preliminary results of the mangles extremity severity score. Clin Orthop 256:80–86
3. Russell WL, Sailors DM, Whittle TB, Fisher DF Jr, Burns RP (1991) Limb salvage versus traumatic amputation: a decision based on a seven-part predictive index. Ann Surg 213:473–481
4. Howe HR Jr, Poole GV Jr, Hansen KJ et al (1987) Salvage of lower extremities following combined orthopedic and vascular trauma: a predictive salvage index. Am Surg 53:205–208
5. McNamara MG, Heckman JD, Corley EG (1994) Severe open fractures of the lower extremity: a retrospective evaluation of the Mangled Extremity Severity Score (MESS). J Orthop Trauma 8:81–87
6. Tscherne H, Oestern HJ (1982) A new classification of soft-tissue damage in open and closed fractures (author's transl). Unfallheilkunde 85:111–115
7. Seekamp A, Kontopp H, Tscherne H (2001) Hannover fracture scale '98: reevaluation and new prospects for an established score system. Unfallchirurg 104:601–610 [in German]
8. Rajasekaran S, Naresh Babu J, Dheenadhayalan J, Shetty AP, Sundararajan SR, Kumar M, Rajasabapathy (2006) A score for predicting salvage and outcome in Gustilo type IIIA and type IIIB open tibial fractures. J Bone Joint Surg (B) 88-B:1351–1360
9. Wolfson N (2010) Orthopaedic infection in the crush injuries: my Haiti experience. Poster, Musculoskeletal Infection Society Annual Meeting, Los Angeles, USA
10. Bosse MJ, MacKenzie EJ, Kellam JF et al (2001) A prospective evaluation of the clinical utility of the lower-extremity injury severity scores. J Bone Joint Surg [Am] 83-A:3–14