An overview of the American trauma system

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ABSTRACT
The American trauma system is designed to provide an organized response to injury. It draws its foundations from lessons learned from America’s involvement in the wars of the 20th century as well as principles developed in urban community hospitals. Although run at the local and state government level, it is guided by national societies and has become a world class example. It also currently faces challenges with declining reimbursement and providing equal access to care for all Americans. Professional societies and legislative bodies are continuing to work together for fair and equitable solutions to these issues.

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Introduction

The American trauma system is designed to provide an organized response to injury. Traumatic injuries are responsible for 59% of all deaths for people aged 1–44 years in the US per data from the Center for Disease Control.1 Today’s trauma system in the US draws its foundations from the lessons learned during the wars of the early and mid twentieth century. During the first and second world wars, the transportation of a wounded soldier through successive echelons of care (from initial stabilization on the battlefield by soldiers with primitive medical training to transportation to aid stations or hospitals for definitive medical care) became the standard of care. Initial priority was given to the control of external hemorrhage, open fractures and pain. Wounded soldiers needing additional care were then transported to hospitals behind the frontlines for emergency surgery and further medical care. Due to mechanization, transportation through this progenitor trauma system accelerated and outcomes improved. In the Second World War, additional emphasis was placed on resuscitation and the treatment of shock with intravenous fluids and blood. With the development of the helicopter in the Korean and Vietnam Wars, grievously wounded men could be transported within minutes to a fully equipped hospital.2 They no longer were required to progress through the layers of progressive care outlined above.

Back in the US, civilian urban trauma centers had incorporated the systems pioneered during wartime and adapted them for the accidental injuries typically seen in peacetime. Within these urban trauma centers, considerable research and training contributed to improved outcomes for trauma patients but outside of these centers, trauma care at community hospital remained rudimentary. In 1966, the Committee on Shock and the Committee on Trauma of the Division of Medical Sciences of the National Academy of Sciences/National Research Council published their report, Accidental Death and Disability: The Neglected Disease of Modern Society, which advocated strong government leadership to develop standardized systems for trauma care as well as the funding for research and training to spread them throughout the nation.3 The National Highway Safety Act of 1966 provided funding from the US Congress to reduce mortality/morbidity from motor vehicle accidents, which is the leading source of traumatic injuries by far. In the early 1970’s, Illinois used its funding from Congress to develop the first statewide trauma system by extending principles pioneered at Cook County Hospital in Chicago, one of the first true trauma centers in the US.4

The American College of Surgeons, in 1976, published Optimal Hospital Resources for Care of the Seriously Injured, which provided criteria for categorizing hospitals based on the level of trauma care they could provide.5 Emphasis was placed on operating trauma centers within the context of regional trauma systems. The American College of Surgeons (ACS) does not directly designate trauma centers. They instead provide verification of resources outlined in their regularly updated Resources for Optimal Care of the Injured Patient.6 Verification is a voluntary process that involves peer review, a pre-review questionnaire, and a hospital visit. A hospital’s
verification status lasts 3 years. In many states in the US, state governments are responsible for designating trauma hospitals but local governments may also be involved.

**Current state of the American trauma system**

Care of the traumatically injured patient begins in the field with Emergency Medical Services personnel, who stabilize the patient for transportation to an appropriate trauma center. They are typically the first to triage the patient. Upon arrival to the hospital, further care is provided by a coordinated team of physicians and nursing staff; the composition and roles within this team depend on the level of trauma care provided by the hospital. The following is a synopsis of the 4 levels of trauma center criteria as stipulated by the ACS:

**Level I**

A Level I Trauma Center is a comprehensive regional resource that is a tertiary care facility central to the trauma system. A Level I Trauma Center is capable of providing total care for every aspect of injury — from prevention through rehabilitation. These centers generally serve large cities or population-dense areas. Elements of Level I Trauma Centers include:

- 24-h in-house coverage by general surgeons, and prompt availability of care in specialties such as orthopedic surgery, neurosurgery, anesthesiology, emergency medicine, radiology, internal medicine, plastic surgery, oral and maxillofacial, pediatric and critical care.
- Referral resource for communities in nearby regions.
- Provides leadership in prevention, public education to surrounding communities.
- Provides continuing education of the trauma team members.
- Incorporates a comprehensive quality assessment program.
- Operates an organized teaching and research effort to help direct new innovations in trauma care.
- Program for substance abuse screening and patient intervention.
- Meets minimum requirement for annual volume of severely injured patients.

**Level II**

A Level II Trauma Center is able to initiate definitive care for all injured patients. These centers either supplement the clinical activity of a nearby Level I center or serve as the lead trauma facility in less population-dense regions. Elements of Level II Trauma Centers include:

- 24-h immediate coverage by general surgeons, as well as coverage by the specialties of orthopedic surgery, neurosurgery, anesthesiology, emergency medicine, radiology and critical care.
- Tertiary care needs such as cardiac surgery, hemodialysis and microvascular surgery may be referred to a Level I Trauma Center.
- Provides trauma prevention and continuing education programs for staff.
- Incorporates a comprehensive quality assessment program.

**Level III**

A Level III Trauma Center has demonstrated an ability to provide prompt assessment, resuscitation, surgery, intensive care and stabilization of injured patients and emergency operations. These centers frequently treat patient who may require transfer to a higher level of care.

Elements of Level III Trauma Centers include:

- 24-h immediate coverage by emergency medicine physicians and the prompt availability of general surgeons and anesthesiologists.
- Incorporates a comprehensive quality assessment program
- Has developed transfer agreements for patients requiring more comprehensive care at a Level I or Level II Trauma Center.
- Provides back-up care for rural and community hospitals.
- Offers continued education of the nursing and allied health personnel or the trauma team.
- Involved with prevention efforts and must have an active outreach program for its referring communities.

**Level IV**

A Level IV Trauma Center has demonstrated an ability to provide advanced trauma life support (ATLS) prior to transfer of patients to a higher level trauma center. It provides evaluation, stabilization, and diagnostic capabilities for injured patients. These are usually located in rural areas and provide supplemental care.

Elements of Level IV Trauma Centers include:

- Basic emergency department facilities to implement ATLS protocols and 24-h laboratory coverage. Available trauma nurse(s) and physicians available upon patient arrival.
- May provide surgery and critical-care services if available.
- Has developed transfer agreements for patients requiring more comprehensive care at a Level I or Level II Trauma Center.
- Incorporates a comprehensive quality assessment program
- Involved with prevention efforts and must have an active outreach program for its referring communities.

Field triage criteria, which decide where a patient should be transported after their injury by ambulance services, are typically defined by local authorities with guidance from national expert panels. Trauma activation criteria, calling for either full trauma activation or limited trauma activation, are similarly defined locally. The designation of trauma centers has a significant impact on care patients receive. Recent data shows that mortality from trauma was 7.6% in designated centers versus 9.5 in undesignated centers with the significance improving to 10.4% versus 13.8% one year after hospital discharge. Overall, since the 1960's, mortality and morbidity from traumatic injuries has significantly decreased.

Yet, the American trauma system is not without its flaws. As noted previously, there was no standardized establishment of an American trauma system by the federal government. Due to this, there are significant lapses in access to trauma care with almost 50 million Americans unable to reach a level I and II center within 60 min. Although 47 states and the District of Columbia have ratified mutual aid agreements for trauma patient, only 31 states have set protocols for these transfers and special permissions are required for out-of-state ambulances. In contrast, trauma centers appeared to be heavily concentrated in the Northeastern US with about 40 million Americans having access to 20 or more trauma centers within an hour. Much has been written about these disparities but without a strong interstate body to mandate redistribution of resources, it will be difficult to enact a positive change in the foreseeable future. Currently, professional societies are attempting to advocate for this change with calls for a national inventory of trauma centers to assess need and waste within the national system.
A second looming issue for the American trauma system is cost containment. Federal funding for emergency medical services dwindled in the 1980’s due to cuts in the US Congressional budget. Smaller federal funding programs were established in the 1990’s but were generally seen as unsuccessful. Generally declining health care reimbursements and the advent of fixed payments have significantly affected trauma centers in particular which typically provide more expensive care due to their nature of involving more advanced facilities and more specialists. Trauma centers, functioning as the tertiary care center for a region, also tend to provide non-reimbursed care to indigent populations unable to afford medical care. Many for-profit hospitals have voluntarily shed their trauma center designation to improve their profitability while regional governments have continued to bail out local trauma centers in financial straits.

The American trauma system is comprised of several independent regional trauma systems run by state and local governments. It has a robust history with significant contributions to society at large and certainly is worthy of being called “world-class”. It does, however, need to find ways to successfully adapt to the era of capitated payments as well as address serious inequities present in its current iteration. These changes will require the ongoing advocacy of professional medical societies and cooperation from the federal government.

References
1. Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. Web-based Injury Statistics Query and Reporting System (WISQARS) Fatal Injury Data. 2018. https://webappa.cdc.gov/sasweb/ncipc/mortrate.html.
2. Mullins R. A historical perspective of trauma system development in the United States. J Trauma. 1999;47:S8–S14.
3. National Academy of Sciences, National Research Committee on Trauma, National Academy of Sciences, National Research Council Committee on Shock. Accidental Death and Disability: The Neglected Disease of Modern Society. Washington (DC): National Academies Press (US); 1966. https://www.nap.edu/read/9978/chapter/1.
4. Boyd D. Trauma systems origins in the United States. J Trauma Nurs. 2010;17:126–134. https://doi.org/10.1097/JTN.0b013e3181f4382.
5. American College of Surgeons. Optimal hospital resources for care of the seriously injured. Bull Am Coll Surg. 1976;61:15–22.
6. Committee on Trauma. American College of Surgeons. Resources for Optimal Care of the Injured Patient; 2014. Chicago: https://www.facs.org/-/media/quality%20programs/trauma/erc%20resources/resources%20for%20optimal%20care.ashx.
7. MacKenzie E, Hoyt DB, Sacra JC, et al. National inventory of hospital trauma centers. JAMA. 2003;289:1515–1522.
8. Sasser S, Hunt RC, Sugerman D, et al. Guidelines for field triage of injured patients: recommendations of the national expert panel on field triage, 2011. MMWR Recomm Rep. 2012;61:1–20.
9. Trunkey DD. The emerging crisis in trauma care: a history and definition of the problem. Clin Neurosurg. 2007;54:200–205.
10. Branas CC, MacKenzie EJ, Williams JC, et al. Access to trauma centers in the United States. JAMA. 2005;293:2626–2633.