INTRODUCTION

The magnitude of traumatic injury as a public health problem is enormous. In terms of years of productive life lost, prolonged or permanent disability, and cost, it is now recognized as one of the most important threats to public health and safety in the United States. As such, the prevention of traumatic injury and the provision of trauma care must be regarded as essential public services central to the mission of public health agencies.

In the broadest sense, the goal of a system of healthcare is to decrease the risks and the burden of disease to individuals and to society. For a trauma system, this requires a group of related injury-oriented facilities, personnel, and organizational entities operating in an organized, coordinated manner, typically within a defined geographic area. Achieving the goal of reducing the burden of injury requires a spectrum of activity incorporating, but extending well beyond specialized trauma medical care. While the definitive treatment of life or limb threatening physical injury largely rests with the surgical specialties, the view of traumatic injury as purely a surgical problem has given way to a more system-based perspective. In this revised paradigm, surgical care may be more accurately viewed as a single, albeit critical, element in an integrated system of ‘disease management’ for traumatic injury that spans the continuum from prevention to rehabilitation and primary care.

The resources for the optimal care of the injured patient discussed in this book are largely those related to specialized acute care facilities in the continuum of trauma care, and the standards set forth are essential to the assurance of high quality acute care within a trauma system. While the term trauma center is used to denote these specialized, often higher-volume facilities providing care to more severely injured patients, most acute care facilities within a trauma system regularly provide care to victims of more minor traumatic injury. These same “non-trauma center” facilities will also occasionally receive more severely injured patients and are an important element in an “inclusive” trauma system. As opposed to an “exclusive” system which incorporates only specialized centers as the providers of acute trauma care, the “inclusive” system, conceptualized in 1990 (table 1), acts to match patient care needs to the capability of receiving centers. (figure 2)
Utilizing this approach makes the best use of available resources, matches patient needs to level of care, engages all acute care facilities in the management of the acutely injured patient, avoids over-burdening the specialized trauma centers with large number of patients with more minor injuries, and helps improve surge capacity in the event of mass casualty events.

![Figure 2: The ‘inclusive’ trauma system utilizes the full spectrum of acute care facilities to provide trauma care](image)

**Trauma System Components & Functions: The Public Health Model**

The history of trauma system development is a study in the expansion of the scope of practice from which specialized trauma care is delivered: from individual surgical practitioners to clinical departments to organized acute care facilities, to multi-disciplinary, multi-institutional programs to integrated state and regional systems. As the scope of activity for the provision of trauma services has expanded, so has the need for better integration of trauma care into a larger public health framework. This framework views traumatic injury as a ‘disease’ which can either be prevented or managed in a way that reduces severity and improves ultimate outcome. The public health approach incorporates steps remarkably similar to an institutional performance improvement process: a) identify a problem [disease or injury] based on available data  

b) design and implement a corrective action [prevention or intervention]  

c) reevaluate subsequent data to assess the effect of the intervention on outcome. These steps translate into what are referred to as the ‘core functions’ of public health:

- **Assessment:** The regular and systematic collection and analysis of injury-related
information from a variety of sources to determine the status of the problem including resources related to it, causative factors, and the identification of potential opportunities for intervention.

- **Policy Development**: Driven by assessment, and resulting in comprehensive policies and standards designed to meet the overall goals of a trauma system and improve outcomes.

- **Assurance**: The evaluation & monitoring of system components, resources, organization, processes, and adherence to policies and standards in order to help ensure the provision of necessary services.

These ‘core functions’ describe, in broad terms, what a trauma system does, rather than what it is, or what elements it includes. The trauma system itself consists of a variety of discrete components, interacting in an organized, predetermined manner, to perform these core functions and accomplish defined goals. The discrete components of an inclusive trauma system are defined in the Health Resources Services Administration’s Model Trauma Care System Plan, (ref) and reflected in the ACS Committee on Trauma document for Trauma Systems Consultation (ref). A summary of these components is outlined in table 2.

In order to perform the three core functions of public health, a trauma system must specify how the various components listed in table 2 operate and interact to achieve specific goals. The revised HRSA document “Model Trauma System Planning and Evaluation”, will contain a detailed set of functional “benchmarks” for a trauma system essentially describing what a trauma system does in addition to what a trauma system is. An abbreviated list of these functional benchmarks are listed in table 3. In this functional model of a trauma system, assessments are performed to monitor the burden of injury, and match system resources to the needs for prevention and treatment. Policies are developed related to this assessment designed to improve outcome through the establishment of process and resource-based standards, through public and individual education, and through community collaboration. Assurance is accomplished through monitoring, evaluation, and the enforcement of system performance standards and established system policies.
## ADMINISTRATIVE COMPONENTS

| Leadership | • Lead Agency providing oversight and administration to activities of the trauma system  
• Trauma System Advisory Committee to guide planning & review system performance  
• Trauma Medical Leadership |

| System Development | • Formal trauma plan for the state / region  
• System guidelines & standards  
• Process to build collaborative constituency for trauma care |

| Legislation | • Agency authority to develop and/or approve regional trauma plans  
• Authority to implement regional / State trauma plan, establish or adopt guidelines for care, and designate specialized definitive care facilities.  
• To provide a sustainable source of funding for the trauma system and to support trauma care |

| Finances | • Established process for trauma system financial analysis & reporting |

## CLINICAL COMPONENTS

| Injury Prevention | • Overall system plan to promote injury control  
• System wide injury control coalition. |

| Human resources | • There is sufficient workforce resources to allow coordinated operation of the trauma system  
• Process for evaluating adequacy of human resources  
• Educational programs sufficient to ensure adequate and ongoing trauma-related education |

| Prehospital care | • Identified agency responsible for prehospital care, continuing education, quality improvement, etc.  
• Standardized certification  
• Ambulance and non-transporting medical unite guidelines  
• Communications systems integrated with EMS & disaster preparedness |

| Definitive Care Facilities | • Specifically designated acute care facilities to provide acute trauma care  
• Designation process using established standards for acute trauma facilities  
• Established transfer agreements facilitating access to specialized trauma centers  
• Acute care facilities are integrated by the trauma plan into an inclusive system of care  
• Rehabilitation facilities to provide post-acute care |

| Information Systems | • System-wide information system allowing the timely collection and analysis of patient-related data |

| Evaluation | • System-wide structures that allow monitoring of system performance, including compliance with standards and improvement opportunities. |

| All Hazards Preparedness | • Disaster Preparedness capability that integrates prehospital and hospital response with the EMS system.  
• Involves private and public sectors in planned response.  
• Includes a performance improvement component |

| Research | • Active research programs ideally linked to specific problems identified by prevention, quality improvement, or clinical efforts within the system. |

Table 2. Basic components of a trauma system
### Assessment
- A thorough description of the epidemiology of injury within the system has been formulated using both population-based data and clinical databases.
- A trauma management information system has been developed and implemented, and is used to periodically assess the ‘burden of injury’ within the region and trauma system performance.
- A complete assessment of resources necessary for the function of the trauma system has been completed and is regularly updated.
- An assessment of the trauma system’s disaster/emergency preparedness has been completed including coordination with the public health and EMS systems and the emergency management agency.
- The trauma system regularly assesses and monitors its value to its constituents in terms of cost/benefit analysis and societal investment.

### Policy Development
- Comprehensive statutory authority and administrative rules exist and are used effectively to maintain trauma system leadership and trauma system infrastructure, planning, oversight, and future development.
- Trauma system leadership acts to establish, maintain, and constantly evaluate and improve a comprehensive trauma system in cooperation with medical, professional, governmental, and citizen organizations.
- Public policy incorporates guidelines, rules, and standards set by professional organizations or government agencies for the purpose of improving trauma system performance.
- Public policy development is guided by data related to trauma system performance.
- The formal trauma plan is used to integrate the trauma system with EMS, public health, emergency preparedness, and emergency management.
- The system effectively utilizes its resources, including financial support and infrastructure, to conduct ongoing system planning, implementation, and maintenance.
- The lead agency informs and educates State/regional/local constituencies and policy makers to foster collaboration and cooperation for system enhancement and injury control.

### Assurance
- The trauma management information system (MIS) is used to facilitate ongoing assurance of system performance and outcomes and provides a basis for continuously improving the trauma system.
- The trauma system is supported by an EMS system that includes communication, medical oversight, prehospital triage, and transportation; and integrated with the public heath system.
- Acute care facilities function as a resource-efficient, inclusive network, meeting required standards and providing resources for the optimal care of all injured patients.
- The lead agency, in cooperation with other agencies and organizations, uses analytical tools to monitor the performance of population-based prevention programs and the delivery of trauma care services.
- The lead agency ensures that the trauma system demonstrates prevention and medical outreach activities within its defined service area.
- The lead agency ensures that each hospital works continuously to improve the quality of trauma care as measured by patient outcomes.
- The lead agency ensures that adequate rehabilitation facilities have been integrated into the trauma system and that these resources are made available to all populations requiring them.
- The financial aspects of the trauma systems are integrated into the overall quality improvement system to assure ongoing “fine-tuning” and cost-effectiveness.
- The lead agency acts to ensure a well trained and competent workforce.
- The lead trauma authority acts to protect the public welfare by enforcing various laws, rules, and regulations as they pertain to trauma system components and the system overall.

<table>
<thead>
<tr>
<th>Table 3. Specific functional benchmarks of a trauma system related to the three core functions of public health</th>
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<td>(from “Model Trauma System Planning and Evaluation” (ref)</td>
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THE DEVELOPMENT AND EVALUATION OF STATE & REGIONAL TRAUMA SYSTEMS

The principal underpinning of a regional system of trauma care is the recognition, on the part of public officials and of the general population, that major injury is a manageable public health problem amenable to primary (preventing the event), secondary (reducing the degree of injury resulting from the event), and tertiary (optimizing outcome from the injury once it occurs) prevention. Enhancing this recognition requires overcoming several commonly held views on traumatic injury involving the incidence of major injury (“it won’t happen to me”), the availability of optimal trauma care (“If I am injured, I’ll be well taken care of by my local hospital.”), and preventability.

A recent Harris Poll conducted for the Coalition for American Trauma Care (March 2005) revealed that most Americans are not aware that injury is the leading cause of death for children and young adults, but felt that having a nearby trauma center, once its function was described, was as important as having Police and Fire Departments. In addition, the poll reflected the perceived importance of trauma systems to most Americans, once such as system was described. This poll suggests an inherent appreciation of the need for systems of emergency care, but also suggested a need for public education about the role of trauma centers and trauma systems.

Steps in the Development and Organization of a Trauma System

Based on the 2002 National Assessment of State Trauma System Development (HRSA, ref), 38 of the 50 states in the U.S. had at least one critical element in place for a trauma system. The majority of states continue to work actively to enhance existing systems. While differences in regional politics, populations, and economics preclude a formulaic or prescriptive approach to trauma system development, there are several essential elements involved in the process, and a general sequence that is applicable to many regions. The following is a brief description of several of the key steps in trauma system development:

Public education and support is an essential foundation providing the basis for enacting legislation that establishes the structure of the system, including a lead agency, the authority of that lead agency, and funding to support the enterprise. Often this is coupled with legislative education by the professional community and advocacy by community interest groups.

A needs assessment study compliments public education and developing public support by
establishing the magnitude of the ‘burden of injury’ in a community, and the need for improved trauma care. In doing this, resources available within the region are compared to the anticipated needs of a trauma system, thereby defining the “gap” that exists between the two. The “gap analysis” may be used by public health planners to identify specific deficiencies and develop feasible solutions for the system.

**Enabling legislation** for system development is sought based on the established needs of the trauma system. This legislation is essential to establish a lead agency with the authority to operate the system, develop and enforce standards, designate specialized facilities, and ensure the provision of essential services. Public and professional collaboration is sought through a strong advisory body composed of health care, medical, and public representatives.

**Development of a Trauma Plan** by the lead agency (authority) is necessary to provide an overall blueprint for the design, implementation, and ongoing development of the state/regional system of trauma care. Such a plan may outline the organizational structures, system components, basis for system standards, specific objectives of the system, and a means of evaluating and improving system performance. The trauma plan is typically developed by the lead agency in conjunction with the appropriate professional and community advisory groups through a state/regional trauma advisory committee.

**Standards for optimal care** are typically set by the lead authority in conjunction with health and medical professionals. These standards may apply to any element in the trauma system, and often involve the adoption of standards developed by national organizations or agencies. Perhaps the most widely utilized standards for are those developed by the American College of Surgeons Committee on Trauma, contained within this document “Resources for Optimal Care of the Injured Patient”. Other examples of national standards for trauma system elements include those of the Commission for the Accreditation of Medical Transport Systems (CAMTS).

**Evaluation, verification, and designation of trauma centers** involves an assessment of the trauma centers (evaluation) within a trauma system to ensure that they meet the standards set by the lead agency (verification). The verification process may be internal, conducted by the lead agency, or external, conducted by an organization or agency authorized by the lead agency. Verification then allows the lead agency, depending on the specific regulations, to designate acute care facilities or other components of the trauma system. This designation process often allows exclusivity, and reflects the lead agency’s authority to exclude and even limit non-designated facilities or system components from provider care within the system. It is fundamental to the development of a system
that the number of designated higher level trauma centers be limited to those necessary for the patient population at risk for major injury. Ultimately, it is the responsibility of the lead agency to regulate the quality and consistency of the various components of the trauma system through the designation and verification process.

**Trauma system evaluation and performance improvement** requires a defined program based on an state or region-wide trauma registry, a system-wide medical audit process, and an appropriate committee structure with broad based membership. The purpose of this program is to ensure that the various elements of the trauma system are, in fact, operating in an organized, coordinated manner that improves overall outcomes from traumatic injury. These system performance improvement (PI) activities should complement or ideally be integrated with the PI programs of pre-hospital care, acute care facilities, and rehabilitation facilities.

While the lead agency maintains the authority and responsibility for trauma system oversight, it often depends on the system-wide trauma committee(s) for peer review and system evaluation. (Table 4) These committees may be distinct, or combined with a separate ‘closed session’ for confidential peer review.

**External review and assessment of the trauma system** are essential components for more mature systems, and are often desirable for systems in the early stages of development. A number of indicators and guidelines for trauma system development have been used as a means of assessing the “completeness” of a given system. Studies by West et.al., Bazzoli et.al. and Bass et.al. have used a relatively small set of system development indicators to gauge development. (ref) A more recent analysis of national trauma system development by HRSA used an expanded set of 62 indicators of system development, including elements related to disaster preparedness. (ref) A greatly expanded set of benchmarks and indicators, coupled with scoring criteria will be incorporated into the revised HRSA document “Model Trauma System Planning & Evaluation” to allow more detailed assessment of state trauma systems throughout the United States. (ref, Table 3)

In 1996, as a means for further assisting the development of state and regional trauma systems, the ACS Committee on Trauma initiated the a program for trauma system consultation. Unlike trauma center verification, this program is purely consultative in nature and designed to be

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<tr>
<th>Trauma Advisory (TAC) or Regional Advisory (RAC) Committee / Council</th>
<th>Trauma Medical Audit Committee</th>
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<tr>
<td>• Review, development of system policies including designation &amp; verification</td>
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<td>• Operational guidelines Trauma system planning &amp; development</td>
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<td>• Trauma system funding</td>
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<td>• System performance improvement</td>
<td>• External peer review of individual cases: all trauma-related specialties</td>
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<td>• System-related management guidelines &amp; protocols</td>
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<td></td>
<td>• External review of PI processes for pre-hospital care and trauma centers.</td>
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Table 4. Examples of the functions of system-wide trauma committees
applied to a trauma system at any state of development. The ACS-COT consultative process for a trauma system involves a site visit by a multidisciplinary team over a period of 3-4 days, and a comprehensive analysis of all the components and the functionality of the state/regional system. The outline and pre-survey questionnaire for an ACS-COT trauma system consultation are included in the ACS document “Consultation for Trauma Systems” (8).

ROLE OF DESIGNATED TRAUMA CENTERS IN THE DEVELOPMENT OF REGIONAL TRAUMA SYSTEMS

As the scope of activity for the provision of trauma care has expanded from single centers to multi-faceted systems, it has become increasingly important that trauma centers be effectively engaged in all aspects of trauma system planning, implementation, and evaluation. Trauma centers are a key element in a system and the focal point for treatment. Trauma centers typically contribute administrative leadership, medical leadership, and academic expertise to a state/regional system. Lead trauma facilities in a given region (Level I or II), in collaboration with the lead agency, have the additional challenge of engaging all other acute care facilities, designated centers as well as non-trauma hospitals, in the performance improvement process for an inclusive trauma system.

Meaningful participation in state/regional trauma system planning, development, and operation is essential for all designated facilities within a region. This participation will be dependent on local administrative structures, politics, and the state of trauma system development. Examples of participation by trauma center staff include:

- Participation in state/regional trauma advisory committees
- Leadership in state/regional medical audit committees
- Regular collaboration with State COT, EMS or other agencies to promote development of state/regional system
- Participation in media and legislative education to promote and develop trauma systems
- Participation in state/regional trauma needs assessment, or injury surveillance,
- Participation in the development of a state/regional trauma plan or state trauma registry
- The provision of technical assistance and education to regional hospitals and providers for the purposes of improving system performance

THREATS TO TRAUMA SYSTEM DEVELOPMENT

Despite the enormous burden of injury from traumatic injury that exists in the United States,
and the increasing recognition that trauma centers and trauma systems of care are an essential public health service, the survival of these centers and systems are by no means guaranteed. Trauma care is expensive, resource intensive, and demands a substantial degree of commitment from a broad spectrum of health care professionals and administrators. The 2002 National Assessment of State Trauma System Development (HRSA, ref) identified the top three threats to trauma systems as: 1) inadequate system (including trauma centers) financing  2) the inability to recruit and retain trauma physicians and nurses,  3) the apparent lack of support (public & other) for the trauma system. Compounding these threats are the additional problems of: a) medical malpractice premium increases in some states, particularly for high risk specialties such as neurosurgery, b) the relaxation of EMTALA regulations and the adverse impact on sub-specialists availability, c) the increasing trend for non-designated center to refer or transfer the majority of injured patients, regardless of level of care required, to designated facilities thus increasing the resource and in some cases financial burden to these designated facilities. Solutions to these problems will likely require the cultivation of stronger public support for trauma centers and systems, the establishment of secure financial support via legislation-based fees or taxes (e.g. property, vehicular, insurance, healthcare, etc) and appropriately directed medical liability reform.

BIBLIOGRAPHY

1. Model Trauma System Planning and Evaluation: Integration of the Public Health and Trauma Care Systems for Improved Injury Outcomes. U.S. Department of Health & Human Services, [Draft, 2005]

Notes: