Introduction to the Academic Symposium to Evaluate Evidence Regarding the Efficacy of Trauma Systems

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The Academic Symposium to Evaluate Evidence Regarding the Efficacy of Trauma Systems was held at Skamania Lodge in Stevenson, Washington, on July 17 to 18, 1998. This symposium was held near the banks of the Columbia River by design. The river gorge was the very passage blazed by the courageous Lewis and Clark expedition, the purpose of which was to systematically map a course through uncharted territory to the Pacific Ocean.

The "Skamania Symposium" brought together trauma care experts interested in the investigation of formal systems to optimize the delivery of timely and appropriate trauma care. Although much work had been previously accomplished, the purpose of the Skamania Symposium was to systematically review the published literature to quantify our current understanding of trauma system effectiveness and chart a course ensuring that future research endeavors would build on current knowledge and expand traditional methods used in trauma system assessment.

OBJECTIVES OF THE SKAMANIA SYMPOSIUM

Two initial objectives provided the foundation for the Skamania Conference. The first objective was to conduct a comprehensive, systematic review of the peer-reviewed literature to identify evidence regarding the effectiveness of trauma systems in North America. This goal was accomplished, and the resulting literature was divided into three categories, based on the study design chosen to assess patient outcomes: preventable death studies, by using a medical record review to judge the suitability of patient outcomes, based on the opinions of a panel of experts; trauma registry-based studies, relying on detailed information collected on patients treated in trauma centers and compared with a standard population; population-based studies, examining outcomes among a sample of all injured patients in a region. These extensive reviews were organized into preliminary evidence tables and published.¹

The second objective was to organize a symposium that would convene a group of trauma care experts to critically appraise the published evidence regarding trauma system effectiveness. After expert evaluation and consensus opinion, the preliminary evidence tables would be refined to provide evidence-based conclusions regarding trauma system efficacy, and a research agenda would be formulated to augment and fill deficiencies in current knowledge. This research agenda would be energized by a prioritized list of action items that would bring to bear the necessary resources to address the agenda. This second objective was accomplished during deliberations at the Skamania Conference. The purpose of this supplement to the Journal of Trauma: Injury, Infection and Critical Care is to convey the research findings and "future course" mapped during the conference.

As a prerequisite to the material presented in this supplement, some thought should be given to what
attributes of a systematic approach to health care would constitute a "trauma system." The remainder of this article is dedicated to characterizing structural attributes of health care delivery that, when aggregated, represent the concept of a trauma system.

CHARACTERISTICS OF A TRAUMA SYSTEM

Trauma systems are based on the concept that optimal care is delivered to injured patients when preconceived processes and resources are coordinated into an organizational plan. A trauma system must enable providers to respond immediately to calls for assistance and establish in advance priorities, personnel responsibilities, and allocation of resources. A comprehensive trauma system guarantees that a patient undergoes rehabilitation during recovery. Over the past 3 decades, as trauma systems have been established and functioned in a variety of circumstances, several descriptions of the essential characteristics of a trauma system have been published. Several authors and organizations have proposed characteristics to include when planning a trauma system. These published descriptions can be studied in chronologic order to aid in our understanding of how current ideas regarding trauma systems relate to previous experiences.

Illinois Criteria, 1971

A novel description by Boyd et al. of the characteristics of the Illinois trauma system was published in 1973. The statewide trauma system described by Boyd et al. incorporated both rural and urban communities. Boyd et al. proposed that hospitals be categorized as trauma centers according to a ranking scheme. Hospitals were categorized into three levels of capability based on established criteria for equipment, resources, and personnel. The state was divided into regions, and one hospital in each region was identified as the premier trauma center with the greatest acute care capabilities. Physicians and surgeons who practiced medicine in small and medium trauma centers located in rural communities provided care within their capabilities. Interhospital transfer to the trauma center best able to provide the required care was implicitly expected for the system to work effectively. Participation of public, nonmedical community leaders, including the state governor, was essential to the planning of regional systems within the Illinois Trauma Program.

Boyd et al. considered active communication between prehospital care providers, physicians, and surgeons in hospitals, and among trauma centers to be a high priority. Emerging technology made direct linkage between ambulances and hospitals-and between trauma centers-practical and affordable. Improved communication between ambulances and hospitals suggested ample forewarning of incoming patients; emergency department staff could be poised and ready to respond with full capability at patient arrival. Major advances in ambulance design occurred during the early phase of the Illinois Trauma Program implementation, and emergency transportation vehicles were distributed statewide. Boyd et al. emphasized special training for all providers caring for injured patients. Individuals were expected to be knowledgeable regarding their specific tasks and trained to participate as members of a coordinated team. Boyd et al. also envisioned new personnel to serve in the trauma system: emergency medical technicians, trauma nurse coordinators, and "traumatologists." A final component of the Illinois Trauma System was a computerized registry of patient information. Such a database was advocated as an essential tool to monitor quality of care and determine where to make improvements. These five criteria-categorization of hospitals, use of improved communications technology, enhanced design of ambulances for safe transportation of injured patients, special training of health professionals, and system evaluation by using trauma registries-were developed as components of a "controlled systems approach" by Boyd and colleagues with the vision that a coordinated trauma system would save lives. The Illinois Trauma Program's design, implementation,
and impact on survival of injured patients was described in the medical literature, and such scholarship carried a seminal influence on development of future trauma systems.\textsuperscript{2-5}

**ACSCOT Criteria, 1976 to 1998**

Since 1913, members of the American College of Surgeons (ACS) have strived to improve the treatment of injured patients, and the ACS Committee on Trauma (ACSCOT) has fostered new ideas, disseminated information, and implemented programs focused on this goal. Members of ACSCOT developed the Advanced Trauma Life Support Program for physicians and have nurtured its growth into an internationally distributed education program. In addition, ACSCOT influenced the design of trauma systems through detailed descriptions of essential components in the document *Optimal Hospital Resources for Care of the Seriously Injured*. The first such document, published in 1976, contained descriptions of the organization, characteristics, and components of three tiers of trauma center commitment, by using the terms optimal, intermediate, and minimal (i.e., precursors to the terms Level I, II, and III). ACSCOT authors advocated linking trauma centers to form a coordinated network. In a trauma system, seriously injured patients may be initially resuscitated at a local trauma center, but should be transferred to the facility best able to provide comprehensive care for seriously injured patients in a region.\textsuperscript{6} Members of ACSCOT have altered and expanded the resource document through multiple editions. By 1999, with the revised title *Resources for Optimal Care of the Injured Patient*, authors from ACSCOT refined the description of trauma center characteristics and added a new category.\textsuperscript{7} Designation of Level IV trauma centers in remote rural areas reflect the committee's advocacy of inclusive trauma systems that encompass an entire state-from major metropolitan cities to remote rural communities. The COT also implemented a review program, the Consultation and Verification Program. Through site visits to hospitals and review of documents, investigators determined whether applicant institutions met published trauma center criteria. In summary, members of ACSCOT have made major contributions to the conceptual framework of contemporary trauma care as a public health care policy by advocating that trauma centers be linked in a network to form a trauma system and that such systems provide injured patients their best chance for survival and full recovery. The following key components of an "ideal" trauma system are proposed in the 1999 edition of *Resources for Optimal Care of the Injured Patient*.

**Administration**

A trauma system must be maintained by an administrative body with authority legislated by regional government. The policies of the trauma system's administration should be linked to published policies, such as outlined in *Resources for Optimal Care of the Injured Patient*. The administrative body designates trauma centers and limits the number of centers based on regional need. The administration must be allocated an appropriate budget to exercise its authority over the entire program-ranging from prehospital care to rehabilitation-and is held accountable for patient outcomes within the entire scope of the trauma system. Public support for program administration is an implicit concept for effective guidance of a trauma system.

**Access**

A trauma system must be designed to ensure injured patients have access to optimal care. Access starts with a timely response to a call for assistance, a process that depends on communication technology. Access is ensured by the practiced skill of scene responders and the resources available to them. A seriously injured patient's access to optimal care hinges on triage decisions made at the scene and on following guidelines identifying high-risk trauma patients. Access to proper care is both
a community and statewide issue. Statewide trauma systems promote timely interhospital transfer to tertiary trauma centers from lower level trauma centers through prearranged protocols. Thus, after optimal resuscitation in a Level IV trauma center, a seriously injured patient is transferred without impediment to a higher level trauma center.

Economic issues in an era of managed health care may prejudice access to optimal trauma care. Trauma system protocols should take precedence over managed care preferences to care for "covered" patients only in specified hospitals. The 1999 edition of Resources for Optimal Care of the Injured Patient condemns attempts to use managed care priorities to define access venues to optimal care for seriously injured patients. On the other hand, the document's authors emphasize that the cost-effectiveness of trauma systems must be demonstrated for these systems of care to be considered credible and beneficial health care policy.

**Trauma Centers**

Acute hospital care for seriously injured patients should be delivered in trauma centers. The resource document defines components determining categorization of the four proposed levels of care. The document describes the specific obligation of top-ranking regional trauma centers to provide leadership, particularly in education and administrative support. Trauma centers participating in a system minimizes duplication of trauma resources in a community by limiting the number of trauma centers based on need. Patients triaged to trauma centers should be repatriated to the care of their regular physicians, surgeons, and hospitals when appropriate.

An important theme in the 1999 Resources for Optimal Care of the Injured Patient requires that in an inclusive trauma system the needs of "all injured patients must be addressed wherever they are injured and wherever they receive care." Historically, trauma systems may have been considered exclusive, meaning only the most seriously injured patients were necessarily covered by the system. This most recent resource document, supporting the ideas promulgated during the 1992 Centers for Disease Control Consensus Conference, advocates a broader scope and inclusion of care for all hospitalized injured patients.

**Rehabilitation**

Injury outcomes are usually measured as hospital survival, but the resource document states outcome should include survival rates in the months after hospital discharge. Trauma systems must include rehabilitation facilities and expertise. The completeness of injury recovery is a critical gauge of trauma care effectiveness, and an excellent measure is the timeliness of a patient's return to previous employment.

**Medical Audit**

A trauma system must actively evaluate its own performance. Self-monitoring of performance by using process variables is useful, but inspection and critique by external reviewers is a more credible and possibly more rigorous method to which trauma systems should be submitted. The verification of trauma centers by ACSCOT is a sterling example of an outside review program. The Verification/Consultation program of ACSCOT began in 1987 and had made more than 720 site visits by mid-1998.

Trauma system review should include measures of process efficiency, including response times and
frequency of overtriage and undertriage; resource inventory is also important. Death rates for injured citizens in a region are used as a criterion for trauma system evaluation. Linking data in trauma registries to prehospital care data and rehabilitation summaries will be a critical component of medical audits to evaluate seamless transitions of care within a trauma system.

Research Activities

A fully mature trauma system is obligated to evaluate the effectiveness of system components in terms of lives saved, morbidity avoided, and dollars spent. This level of research is defined as a responsibility of Level I trauma centers.

Prevention

Trauma systems must include active injury prevention programs based on education of those at risk, legislative initiatives to reduce risk factors, and research to identify ways to reduce injury occurrence. In support of inclusive trauma systems, prevention programs may be more effective if based on data elucidating injury mechanisms and characteristics on all injured patients.

Trauma System Guidelines, American College of Emergency Physicians

The American College of Emergency Physicians have prepared a detailed document, Guidelines for Trauma Care Systems, first published in 1988 and amended in 1992. This document shares the same essential criteria for a trauma system as developed by ACSCOT. The document also provides more detailed criteria for fully operationalizing prehospital care components in a trauma system.

Centers for Disease Control Consensus Conference, 1991

A fourth description of trauma system characteristics was produced after discussion and debate by a multidisciplinary group that met in 1991 at the request of the Center for Injury Control at the Centers for Disease Control and Prevention. The group prepared a document, "Position Paper on Trauma Care Systems," which emphasizes expanding the scope of trauma systems. As previously mentioned, trauma systems first intended to expeditiously serve seriously injured patients by means of triage to trauma centers. However, the concept of inclusive trauma systems proposes that systems influence the care of all hospitalized injured patients. More specifically, inclusive regional trauma systems should ensure optimal care to injured patients in rural areas where unique challenges exist for accomplishing optimal access to care. The document also states that to sustain trauma systems as a health care policy, coalitions in support of systems must include public officials and business leaders and health care professionals.

In summary, trauma systems represent an integrated and systematic structure designed to provide optimal care to injured patients from onset of injury through rehabilitation and return of ideal functioning. The degree to which trauma system effectiveness has been investigated varies based on phase of patient care (i.e., prehospital, hospital, rehabilitation), patient case mix (i.e., type and severity of injury), and geographic region (i.e., urban vs. rural). As mentioned earlier, an objective of the Skamania Symposium was to systematically evaluate existing evidence and provide recommendations that would enhance our ability to evaluate systems of organized care for traumatically injured patients.

Acknowledgments
The information provided in this supplement represents an amalgamation of effort and expertise demonstrated by the symposium participants. Each participant played an active role in the acquisition and refinement of the recommendations presented in this combined body of literature. A complete list of symposium participants is provided in Table 1. We also acknowledge the financial support provided by the Centers for Disease Control and Prevention, The National Highway Traffic Safety Administration, and the Departments of Emergency Medicine and General Surgery at Oregon Health Sciences University. Finally, we thank Dr. Jerris Hedges, Dr. Mark Helfand, Mr. William Worrall, and Mr. Eric Bixby for providing critical appraisals of submitted manuscripts.

### TABLE 1. Participants in the Academic Symposium to Evaluate Evidence Regarding the Efficacy of Trauma Systems

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<tr>
<th>Name</th>
<th>Institution</th>
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<tr>
<td>Mullins RJ, Mann NC</td>
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<td>Boyd DR, Dunea MM, Flashner BA</td>
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<td>Metzmaker CO, Fols R</td>
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<tr>
<td>Eastman AB, Schwab CW, Annest JL, et al</td>
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### REFERENCES


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