



Management of Pediatric Trauma

COMMITTEE ON PEDIATRIC EMERGENCY MEDICINE, COUNCIL ON INJURY, VIOLENCE, AND POISON PREVENTION, SECTION ON CRITICAL CARE, SECTION ON ORTHOPAEDICS, SECTION ON SURGERY, SECTION ON TRANSPORT MEDICINE, PEDIATRIC TRAUMA SOCIETY, AND SOCIETY OF TRAUMA NURSES, PEDIATRIC COMMITTEE

Injury is still the number 1 killer of children ages 1 to 18 years in the United States (<http://www.cdc.gov/nchs/fastats/children.htm>). Children who sustain injuries with resulting disabilities incur significant costs not only for their health care but also for productivity lost to the economy. The families of children who survive childhood injury with disability face years of emotional and financial hardship, along with a significant societal burden. The entire process of managing childhood injury is enormously complex and varies by region. Only the comprehensive cooperation of a broadly diverse trauma team will have a significant effect on improving the care of injured children.

INTRODUCTION

Unintentional and intentional injury and homicide cause more deaths in children and adolescents ages 1 to 18 years than all other causes combined.¹ Deaths caused by injuries, intentional or unintentional, account for more years of potential life lost under 18 years than sudden unexplained infant death, cancer, and infectious diseases combined. It is estimated that 1 in 4 children sustain an unintentional injury requiring medical care each year.² The direct cost of childhood injury is >\$50 billion annually.³ Survivors of childhood trauma may suffer lifelong disability and require long-term skilled care. Improving outcomes for the injured child requires an approach that recognizes childhood injury as a significant public health problem. Additional topics related to the injured child can be found in other publications from the American Academy of Pediatrics (AAP).⁴⁻⁹ These publications complement and enhance our understanding of managing pediatric trauma.

TRAUMA SYSTEMS

Children are injured in a wide variety of geographic locations, and the involvement of local and regional centers is paramount to optimizing care for injured children. A pediatric trauma system functions best as a part of the inclusive emergency medical services (EMS), trauma system, and disaster response system at the local, regional, state, and

abstract

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national levels. The inclusive trauma system is defined as one in which all EMS providers, physicians, other caregivers, and hospitals participate in the care of injured patients. Regional adult trauma centers and regional pediatric trauma centers are the central components of such a system. These systems allow for prompt communication, earlier recognition of critical injuries, and continuing education for trauma and emergency care providers. An inclusive trauma system ranges from hospitals capable of initial stabilization to those that provide comprehensive trauma care. As was noted in the Institute of Medicine's report "Emergency Care for Children: Growing Pains,"¹⁰ within any given EMS or trauma system, it is likely that not all hospitals will be completely equipped with appropriate pediatric resuscitation equipment or medications.^{10,11} There may also be significant variability in pediatric training and experience among physicians and nurses working in hospital emergency departments (EDs).^{12,13} However, pediatric readiness, including administrative support, quality improvement, education, equipment, supplies, medication, and continuing education, is important for all hospitals.

Approximately 80% of US children live within 50 miles of a level I or II trauma center. However, in many less populated states, the percentage of children living within 50 miles of a trauma center is much lower.¹⁴ An estimated 17.4 million children do not have access to a pediatric trauma center within 60 minutes.^{15,16} When the trauma system extends over a large geographic area, the outlying hospitals of the system must be able to undertake the stabilization and initial management of the injured child or children who present to the hospital. Optimally, each trauma system will also define the age range of the pediatric patient on the basis

of specific hospital and trauma team resources that are available.

When a regional pediatric referral center is available within the trauma system, the most severely injured children may be transported to a facility with a level I or II pediatric trauma designation.¹⁷ Trauma system administrators are key stakeholders to facilitate ways in which all hospitals with EDs may be required to evaluate and resuscitate injured children.^{4,5,7,10} A mass casualty event, such as a tornado strike on 1 hospital in a system, highlights the need for such readiness. It has been recommended that a physician and nurse coordinator for pediatric emergency care be identified in each facility, with pediatric-specific policies, procedures, equipment, a quality-improvement process, and guidelines for care established.^{7,10} These guidelines are outlined in the AAP/American College of Emergency Physicians/Emergency Nurses Association joint policy statement "Guidelines for Care of Children in the Emergency Department."⁷ In addition, the Emergency Medical Services for Children performance measures that assess a state's operational capacity to provide pediatric emergency care are important adjuncts to managing a trauma system.¹⁷

Protocols for field and hospital triage, treatment, and transfer of victims of pediatric trauma are an important part of any trauma system.¹⁸ Transfer recommendations and toolkits are available from many states and regional systems as well as from national organizations.^{19,20} Ideally, the quality of care that is provided within the system is continuously evaluated by the trauma system administration through performance improvement processes. Benchmarking care by using risk-adjusted data is important for the ongoing improvement in pediatric care and system delivery models. The outcomes for pediatric

trauma patients can be compared with available benchmarks such as the National Trauma Data Bank,²¹ and information shared with specific providers so that an optimal environment for quality improvement in pediatric trauma care is promoted. The American College of Surgeons (ACS) has initiated a Pediatric Trauma Quality Improvement Project that will provide participating hospitals with additional pediatric specific benchmarking data.²²

PREHOSPITAL PEDIATRIC TRAUMA CARE

Prehospital providers may not be as familiar with effective pediatric emergency care as they are with the care provided to adults,²³ because most prehospital providers are infrequently exposed to critically ill or injured children. Lack of experience with pediatric trauma patients is typically addressed by continuing education efforts for EMS providers through established courses supported by the AAP and the National Association of Emergency Medical Technicians or by practical experience in a children's hospital. Online and remote training may be an effective and reasonable alternative in largely rural states.²⁴ State and national certifying and licensing bodies can ensure that adequate continuing education units are obtained in pediatric trauma management by prehospital providers to maintain proficiency. No matter how continuing education is accomplished, mechanisms for assessing knowledge and skill retention and continuous evaluation of performance are crucial for prehospital personnel. The method for maintaining skills may include continuous evaluation of performance or collaboration with a pediatric health care system that provides opportunities to maintain and expand on pediatric acute care knowledge and skills. New projects

that use simulation show promising results.²⁵ Direct feedback to field providers is an essential component for continual improvement in any trauma system to improve outcomes for injured children. This feedback can be provided by the receiving facility by using real-time reviews, case review presentations, or feedback to the referring prehospital agency.

There is a relative lack of data regarding the best practices for pediatric resuscitation in out-of-hospital traumatic cardiac arrest, including fluid administration, cervical spine stabilization, and airway management of children. The Broselow system does provide useful information for early resuscitation, and there are new recommendations for termination of resuscitation in the field.²⁶ Comprehensive support for research in this area needs to come from regional, state, and national organizations. Current examples of research support include the federally funded Emergency Medical Services for Children program,²⁷ the Pediatric Emergency Care Applied Research Network,²⁸ the Pediatric Emergency Research Network,²⁹ and the American Pediatric Surgical Association Outcomes and Clinical Trials Center.³⁰

TRAUMA CENTERS

It has been shown that younger and more seriously injured children have improved outcomes at a trauma center within a children's hospital or at a trauma center that integrates pediatric and adult trauma services.^{14,31-34} Data suggest that the presence of a pediatric trauma center within a state was associated with lower pediatric injury mortality rates.³⁵ The requirements for a hospital trauma program that cares for children vary by state. The most comprehensive description of the various levels of pediatric trauma care is provided

by the ACS "Optimal Care of the Injured Patient" document.³⁶ The ability to provide a broad range of pediatric services, including the presence of providers trained in pediatric emergency medicine, pediatric medical subspecialties and surgical specialties, pediatric anesthesiology, pediatric critical care, traumatic stress and substance abuse counseling, pediatric rehabilitation, and other specialized trauma care, is important. Nurses with demonstrated competency in the care of pediatric trauma patients are an important aspect of care as well.

Management of the injured child requires special considerations. Issues that are unique to children include reducing diagnostic radiation exposure, family presence during resuscitation,³⁷ the availability of child life specialists, fluid and electrolyte management, and blood transfusions, to name a few. Careful consideration of diagnostic radiation for trauma evaluation is always of primary importance because of the radiation dose that is often delivered.³⁸ Pediatric protocols for imaging and diagnostic testing³⁹ and a child- and family-centered environment of care for injured individuals and in mass casualty events^{8,40} are important resources to proactively have in place at all hospitals, including pediatric and non-children's hospital trauma centers. Specific guidelines for implementing and facilitating family presence during pediatric trauma care are useful to facilitate safety and efficacy of family presence within a hospital.⁸ Specific pain management protocols could allow the injured child timely control of pain. Competency and ability to provide a full range of pediatric pain strategies for children, including systemic analgesics, regional and local pain control options, and distraction techniques, are essential components for pediatric trauma care.⁸ Pain management is important from

the time of injury and throughout the care continuum, including rehabilitation.

Continuing trauma education for hospital providers and trauma nurses is important and can be accomplished by current certification in the Advanced Trauma Life Support course from the ACS and courses in trauma nursing supported by the Society of Trauma Nurses and the Emergency Nurses Association.⁸ Some trauma centers may not have the resources to care for all of the injured children within their referral region at any given time, especially in less populated states. Thus, the most seriously injured children may need to be stabilized in regional referral centers and transported to tertiary facilities with these resources. Pediatric critical care transport teams are often the best resource for such transfers.⁴¹ Hospitals that seek regional or state designation or verification as a pediatric trauma center through the verification process of the ACS or similar state trauma designation processes are examples of facilities that have made an extraordinary effort to provide resources to care for injured children.

A well-equipped and staffed pediatric intensive care unit (PICU) is another essential component of a pediatric trauma center. PICUs offer a setting with the necessary monitoring devices, equipment, medications, and technology to support physiologic function and are staffed with professionals with the expertise to apply them to the pediatric patient. Data show that the availability of PICU beds within a region may improve survival in pediatric trauma.³⁴ Pediatric critical care physicians, surgeons, and anesthesiologists trained in the care of injured children working together are needed for optimal care of severely injured and unstable patients in the ICU setting. In addition to critically injured children, stable patients with the potential

for deterioration may also require the specialized services of a PICU. Pediatric trauma care specialists, especially those with critical care training, are in short supply and are distributed irregularly in the population, thus endangering the nationwide delivery of pediatric trauma care.⁴² Furthermore, the presence of experienced PICU nursing and allied health care personnel supports the environment necessary for frequent monitoring and assessment of injured children. Moreover, pediatric trauma care continues on inpatient floors. Once the child is stable and the possibility of rapid deterioration is decreased, a comprehensive evaluation of the child's physical function and psychological needs, pain management, and the rehabilitation process generally begins while still in the inpatient setting.

REHABILITATION AND THE MEDICAL HOME

It is the goal of a comprehensive trauma system to reintegrate the child into his or her community and to his or her primary care medical home. The availability of rehabilitation resources for pediatric patients is a vital component of pediatric trauma care. Returning the child to full, age-appropriate function, with the ability to reach his or her maximum adult potential, is the ultimate goal after injury. Early rehabilitation is especially crucial for those children suffering neurologic injuries. Physical, occupational, cognitive, speech, and play therapy, as well as psychological and social support, are all essential elements of a comprehensive rehabilitation effort for the injured child and his or her family. It is important to address acute stress and posttraumatic stress reactions in trauma patients.⁴³ In particular, crisis intervention and ongoing support can be offered to youth who are injured through interpersonal violence, because

they are especially at risk of repeat, violent injuries and psychosocial trauma. Some examples of support organizations are the National Network of Hospital-Based Violence Intervention Programs (www.nnhvip.org) and the National Child Traumatic Stress Network (www.nctsn.org).

PERFORMANCE IMPROVEMENT

The presence of active and effective performance improvement committees, with issues focused toward pediatrics, is an integral component for trauma centers. In any trauma center, these activities also include attention to patient safety. Periodic review of trauma care by the providers of that care is the process that is most likely to improve patient outcomes in any hospital. Trauma care review is facilitated by a comprehensive trauma registry that has ties with national databases so that outcomes can be benchmarked for improved quality of care. Mandatory systematic child death review processes are recommended to identify emerging trends and higher level risk factors for which interventions can be developed and evaluated. The ACS suggests that every facility that provides care for injured children have a quality-improvement process that leads to focused continuing education.³⁶

Another unique aspect related to pediatric trauma care is the need for increased awareness for signs of potential child abuse.⁴⁴ Pediatric trauma center personnel need to be aware of state reporting requirements within their jurisdiction and remain vigilant to facilitate early detection of abuse and neglect. This is best accomplished by using a protocol or screening to detect child abuse in the ED that cares for children. It is the responsibility of all pediatric providers to be educated regarding the early detection, diagnosis, and

management of inflicted injuries. Community hospitals with limited pediatric services can identify resources for specialized child protection teams in their regional referral areas. Cooperation and collaboration between referring providers and hospital-based child protection teams are important for the management of cases of suspected abuse and neglect.

INJURY PREVENTION

Injury prevention is the cornerstone to any discussion concerning pediatric trauma. Injury-prevention initiatives do work.⁴⁵ For example, the Safe Kids program has been instrumental in decreasing deaths attributable to trauma. However, these initiatives are not promoted equally across the United States, often because of limited resources. There are methods to identify and refine the approach to injury-prevention initiatives that are specific to individual regions.⁴⁶ Trauma programs can use data from the trauma registry to identify high-risk injury-prevention needs. Injury-prevention activities can be identified by using local data and may focus on such things as fall prevention, alcohol and drug abuse recognition and intervention, child passenger safety, bike safety, water safety, and other regionally appropriate activities as endorsed by the Injury Free Coalition for Kids (www.injuryfree.org). Ideally EMS providers, hospitals, EDs, and trauma centers have injury-prevention content and information as well as activities incorporated into patient and staff education and as part of community-based injury-prevention programs. Primary care providers are encouraged to emphasize individual and community safety and injury-prevention programs such as The Injury Prevention Program from the AAP.⁴⁷

PEDIATRIC DISASTER PREPAREDNESS AND SURGE

Disaster preparedness in the United States has improved significantly in the years since Hurricane Katrina. Hospital accreditation programs such as The Joint Commission have strengthened their disaster preparedness requirements. Children have unique needs for care in mass casualty incidents, especially if chemical, biological, or nuclear events occur. Along with physiologic considerations, triage, identification, decontamination, tracking, and reunification are all issues that must be considered during mass casualty events. A process for recruiting pediatric health care professionals when a surge response is needed is often included in any disaster plan. One model includes a calling tree within the various departments and sections to recruit providers for a surge response.

States and regions (facilitated by federal partners) can review current emergency operations and devise appropriate plans to address the population-based needs of infants and children in large-scale disasters. Action at the state, regional, and federal levels addresses legal, operational, and information systems to provide effective pediatric mass critical care through the following: (1) pre-disaster/mass casualty planning, management, and assessment with input from child health professionals; (2) close cooperation, agreements, public-private partnerships, and unique delivery systems; and (3) use of existing public health data to assess pediatric populations at risk and to model graded response plans on the basis of increasing patient volume and acuity.⁴⁸

Ideally, attending to the psychological needs of injured children is considered in any such event. Although the needs of children in disasters can be anticipated, the capability of a trauma system to meet

these needs will remain in question until the nation achieves an optimal level of emergency readiness for children on a daily basis.⁴⁹

RECOMMENDATIONS

1. The unique needs of injured children need to be integrated specifically into trauma systems and disaster planning at the local, state, regional, and national levels.
2. Every state should identify appropriate facilities with the resources to care for injured children and establish continuous monitoring processes for care delivered to injured children. These facilities are especially important for the youngest and most severely injured children.
3. Evaluation and management of the injured child should begin with the providers at the bedside who have basic competency in pediatric trauma care.
4. Prehospital and hospital providers should make every effort to stay current in the emergency management of injured children. In addition, providers should actively participate in and cultivate an injury-prevention program within their service area to ultimately reduce the rate of children injured.
5. Pediatric providers should be familiar with the pediatric trauma services in their region and how to integrate the available services into their practice. Hospital-based providers who are not at regional pediatric centers should be able to evaluate, stabilize, and transfer acutely injured children.
6. Pediatric injury management should include an integrated public health approach from prevention through prehospital care, to emergency and acute hospital care, to rehabilitation and long-term follow-up, as indicated, for stress reactions associated with the injury.
7. Qualified pediatric critical care transport teams should be used when available in the interfacility transport of critically injured children.
8. Interfacility transfer agreements should be in place to facilitate rapid acceptance and transport of critically injured children to a facility with the appropriate level of care.
9. National organizations with a special interest in pediatric trauma, such as the AAP, the ACS, the American College of Emergency Physicians, the American Academy of Emergency Medicine, the Emergency Nurses Association, the Pediatric Trauma Society, the American Pediatric Surgery Association, the Pediatric Orthopaedic Society of North America, the American Pediatric Surgical Nurses Association, and the Society of Trauma Nurses, should collaborate to advocate for a higher quality of care across the nation.
10. Evidence-based protocols for the management of the injured child can be developed for essential aspects of care, including prehospital, acute resuscitation, and postdischarge through rehabilitation.
11. Research including data collection for best practices in isolated trauma and mass casualty events specifically addressing the needs of children should be supported.
12. State and federal financial support for research, advocacy, education, and trauma system development and maintenance must be provided.

13. Steps should be taken to increase the number of trainees in specialties that care for injured children to address key subspecialty service shortages in pediatric trauma care. Strategies should include increased funding for graduate medical education and appropriate reimbursement for pediatric trauma specialists.
14. Direct, constructive feedback to field providers and referring hospitals should occur from the pediatric trauma center to allow for continued education and improved pediatric care.
15. All health care providers should be aware that injured children and their families should be evaluated and referred for stress reactions related to injury.
16. All health care providers should be alert to signs of potential abuse when evaluating injured children and should report concerns to the appropriate authorities.

LEAD AUTHORS

David W. Tuggle, MD, FAAP, FACS
Sally K. Snow, RN, BSN, CPEN, FAEN

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ABBREVIATIONS

AAP: American Academy of Pediatrics
ACS: American College of Surgeons
ED: emergency department
EMS: emergency medical services
PICU: pediatric intensive care unit

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