



Caring for the injured child in settings of limited resource



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ABSTRACT

Children represent the most vulnerable members of our global society, a truth that is magnified when they are physically wounded. In much of the developed world, society has responded by offering protection in the form of law, injury prevention guidelines, and effective trauma systems to provide care for the injured child. Much of our world, though, remains afflicted by poverty and a lack of protective measures. As the globe becomes smaller by way of ease of travel and technology, surgeons are increasingly able to meet these children where they live and in doing so offer their hands and voices to care and protect these young ones. This article is intended as an overview of current issues in pediatric trauma care in the developing world as well as to offer some tips for the volunteer surgeon who may be involved in the care of the injured child in a setting of limited resource availability.

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Introduction

Every year around the globe, it is estimated that 1 million children are killed as a result of injury and violence. Tens of millions are treated for wounds, many of whom survive with some form of lifelong disability.¹ The burden is highest amongst the poor, with more than 95% of all childhood injury deaths occurring in low- and middle-income countries (LMICs). In an era of increasing urbanization of the developing world, pediatric trauma will continue to rise and is predicted to be the number one leading cause of death and disability worldwide by the year 2020.² Despite these staggering statistics, pediatric trauma care remains underappreciated throughout the developing world. Funding for research and development of trauma systems for children lags far behind other diseases, and makes up less than 1% of the international financial assistance given to LMICs.^{3,4}

It has been proven in the US and Europe that a motivated society can respond to a call for prevention of childhood injury with real improvements in safety. Mortality from injury in these high-income countries has been roughly halved in the 3 decades since Dr. Haller's seminal report in *J Am Med Assoc*.^{2,5,6} This improvement in childhood safety in the developed world has been due to multi-faceted injury prevention measures as well as the development of trauma systems that prioritize care of the wounded child from the point of injury through successful rehabilitation. Throughout the majority of the global south, children continue to live in higher-risk environments with less supervision and family resources, in countries with little investment in their safety.⁷

Despite the massive roadblocks, there is hope that the plight of the injured child in the developing world can improve. Awareness is increasing and surgeons in LMICs are leading the push to effect a change in political will to value child safety.⁸ Funding initiatives of groups such as the Fogarty International Center of the National Institute of Health are seeking to produce data that can guide proper trauma system development.⁹ Pediatric surgeons in the developed world must advocate for injury prevention, speak out against violence, and partner with our global colleagues to develop strong pediatric trauma systems.

Unintentional injuries

"Safety and security don't just happen, they are the result of collective consensus and public investment. We owe our children, the most vulnerable citizens in our society, a life free of violence and fear."—Nelson Mandela

Almost 90% of childhood injuries are unintentional and they are the leading cause of death for children over the age of 5 years in LMIC. The epidemiology is evolving as a result of modernization and the increasing movement of the populace to large poorly planned urban areas. These changes have placed the vulnerable child in proximity to a host of risks, including motor vehicles, heights, fire, and toxic substances.^{1,6}

Road traffic injuries (RTI)

Motor vehicle crashes, particularly those involving pedestrians, are the primary source of childhood injury in most LMICs. Transportation systems have been improved but poorly planned over the last 2 decades, leading to high-speed vehicles and small

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children on foot sharing the same roadway. Preventative measures addressing roadway design, speed control, and personal protective equipment are being addressed by groups such as the United Nations Road Safety Collaboration and the Global Road Safety Partnership, but the impact is predicted to continue to rise in the near future.¹⁰

Prehospital care systems are sparse, leading to delayed presentation and a mortality rate of greater than 50% in some countries of sub-Saharan Africa.⁷ Work is underway to improve initial trauma care, including measures that train commercial drivers to provide basic trauma life support in Ghana,¹¹ scoop and run program with taxi drivers in Uganda,¹² and training laypersons to provide basic prehospital care in Iraq,¹³ and initial hemorrhage control in Cambodia.¹⁴ These programs have promise and highlight the need to adapt interventions to meet the local societal needs rather than copying the practices of HICs. Until a mature prehospital care system is developed, however, the surgeon attending to children who suffer from road traffic injuries in the LMICs will be challenged with the insult of delayed wounds as well as a lack of technology to diagnosis and treat.

The majority of injuries will be blunt, with identical anatomy and physiology to children all over the world, so trust your training and instinct when evaluating these patients. The initial resuscitation is standard, but will likely be limited by supplies at hand. Creativity may be in order for minor procedures such as intubation, chest tubes and peritoneal lavage, as properly sized non-drug consumables such as tubes and lines are often not available.⁴ A careful inventory of personnel and physical resources in the casualty ward and the operating theater is essential to allowing the surgeon to make the best decisions when a traumatized child arrives.

In the diagnosis of injuries computed tomography is not likely an option, but many hospitals do have plain x-ray and ultrasound, often with very skilled technicians.¹⁵ With suspected truncal hemorrhage, early direct surgical control is the safest option. Damage control principles should be followed, and laparotomy can be performed under ketamine anesthesia for initial hemorrhage control. This procedure can often be taught to the house officer or other non-surgeon who will be responsible for initial trauma care in the rural setting.¹⁶

As with any poly-traumatized child after blunt wounding, extremity injuries are common. External fixation and traction splints are very useful—the general surgeon who will be attending to injured children in the developing world would be well served by working with an orthopedist to learn basic casting and fixation principles. Unfortunately, many children with extremity injuries are treated by traditional healers or “bone-setters”, which leads to an increased proportion of osteomyelitis and nonfunctional extremities.¹⁷ Amputations are often required, but with socially disastrous implications, so they should be performed with careful counseling of the family.

Falls

These injuries have been supplanted by RTIs as the leading cause of injury related death and disability, but are still the most common type of injury seen in children.¹ Death and disability from falls primarily occurs due to closed head injuries, which are difficult to diagnosis and treat with an absence of diagnostic tools and trained neurosurgical specialists. Careful attention to the post-resuscitation pediatric Glasgow coma score and pupillary exam is key, as they are most closely linked to outcome. If CT is not available, ultrasound can be used in the young child to evaluate for intracranial hemorrhage; otherwise the surgeon must rely on clinical exam for lateralizing signs. Trauma craniotomy can be

performed with a series of burr holes and a Gigli saw, but long-term outcomes of severe head injury in the developing world are very poor so compassionate care should be considered in the child with GCS score less than 8 after medical management.¹⁸

Burns

There are approximately 200,000 fire-related deaths per year globally, with over 90% of these occurring in LMICs and half of them occurring in Southeast Asia alone.¹⁹ Children are the overwhelming preponderance of victims, with the mean age of all burned patients around 10 years old and the highest incidence in infants and toddlers less than 5.^{20,19} The majority of burns occur at home due to scalds or open cooking fires, with a very low incidence of the inhalation injuries which are more often seen in the confined multi-story living quarters of HICs.

Even in otherwise healthy children, mortality rate with burns over 50% total body surface area in LMICs approaches 100% and should probably be treated with compassionate care rather than aggressive surgical treatment. In the child who suffers from malnutrition or HIV, the lethal burn area is far less. Death in smaller burns often occurs in a delayed fashion due to sepsis, and disability from contracture is a likely outcome for the survivors.²⁰ For these reasons, burn prevention is the most important tool to protect children, but effective burn care can still have a huge impact.

Burns less than 15–20% should be considered for aggressive early excision and grafting, which can speed up recovery and minimize cost.²¹ Blood loss in larger burns is not well tolerated, so careful wound care is needed with either silver based solutions or alternatives such as natural honey gauze. Ketamine anesthesia can be useful to allow for thorough wound cleansing every few days. A simple Z-plasty can be life-changing for the child with significant disability from a burn contracture.²²

Toxic injury

A variety of toxic ingestions may present in curious children, but the most notable is the caustic burn to the esophagus. This is now extremely rare in the developed world, but a source of lifelong complications in children of LMICs. Soap is often manufactured in the home by traditional methods utilizing alkaline solution stored in soda bottles or glass jars, which is mistaken for water by the child.²³ The presentation to health care is sometimes delayed up to 1 month, and marked by drooling and inability to swallow solids or liquids.²⁴ A flexible or rigid endoscope can be used to evaluate the degree of injury, and a nasogastric tube is placed across the esophagus with mild-moderate injury to minimize stricture. With severe injury, gastrostomy is performed to allow for nutrition and retrograde access, but long-term patency requires multiple dilations and has a low success rate.²⁴ In my experience, a small silastic tube (discarded VP shunt or broviac catheter) across the esophagus greatly aids recovery and facilitates wire placement for Savary dilations.

Injuries in conflict zones

“If we are to teach real peace in this world, and if we are to carry on a real war against war, we shall have to begin with the children.”—Mahatma Gandhi

Whether forced into roles as active combatants or exposed to conflict by proximity, children have always been the most vulnerable population in times of war. This is increasingly truer as the battlefield has become largely urban with loosely defined and

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