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Role of General Surgeons in Pediatric Trauma Management in Developing Countries: Challenges, Competencies and the way forward with Example Case Report

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ABSTRACT

Background

Pediatric trauma remains a leading cause of morbidity and mortality in low- and middle-income countries (LMICs), where specialized pediatric surgical services are often scarce. In many such settings, general surgeons serve as the primary providers for injured children. This review examines the epidemiology of pediatric trauma in developing countries, the critical role played by general surgeons, the unique physiologic and anatomic considerations in children, challenges faced in resource-limited environments, and proposes strategies to strengthen pediatric trauma care via empowering general surgeons through training, system adaptation, and collaborative care models.

Severe blunt abdominal trauma with associated renal vascular injury is rare in infants and carries significant morbidity. Early recognition and prompt multidisciplinary management are critical for survival and organ preservation.

Case Summary

We report the case of an 8-month-old male infant who sustained multisystem injuries following a road traffic accident involving an e-rickshaw. The child presented with altered sensorium and excessive crying. Neuroimaging revealed microhemorrhages consistent with diffuse axonal injury. Abdominal imaging demonstrated Grade III liver laceration and Grade IV right renal injury with renal artery narrowing, renal vein thrombosis, and extensive renal infarction. The child required blood transfusion, intensive monitoring, and referral for tertiary-level pediatric nephrology and trauma care.

Keywords: Pediatric Trauma; Renal Vascular Injury; Diffuse Axonal Injury; Blunt Abdominal Trauma; Case Report; Care Guidelines

INTRODUCTION

Trauma has emerged as a predominant cause of death and disability in children globally, especially as improvements in infectious disease control have reduced other causes of childhood mortality [1]. Low and middle-income countries (LMICs) bear a disproportionately high burden: over 90–95% of childhood injury deaths occur in LMICs [2].

In many developing nations, there is a severe shortage of specialized pediatric surgeons, particularly outside major urban centers. As a result, general surgeons often function as the first and sometimes only surgeons available to manage acute pediatric trauma. Given the differences in anatomy, physiology, injury pattern, and resource constraints, this role demands specific competencies and adaptive strategies.

Blunt abdominal trauma in infants is uncommon but potentially life-threatening due to limited physiological reserves and difficulty in clinical assessment. Renal injuries account for approximately 10–20% of pediatric abdominal trauma, with high-grade renal vascular injuries being particularly rare in infants. Associated traumatic brain injury further complicates management and prognosis. We present a rare case of an infant with combined diffuse axonal injury, high-grade renal vascular trauma, and hepatic injury following a road traffic accident, emphasizing early diagnosis, stabilization, and multidisciplinary care.

Epidemiology & Patterns of Pediatric Trauma in LMICs

- The majority of childhood injuries including road traffic accidents (RTAs), falls, burns, and domestic accidents are unintentional [1].
- A prospective study in a low-resource hospital setting reported that among children admitted under 12 years, trauma (including burns) constituted about one-third (≈ 33%) of pediatric surgical admissions [3].
- Blunt trauma predominates; in many series, blunt abdominal trauma is the most common presentation requiring surgical assessment [4].
- In a recent cohort, nearly half of pediatric trauma patients had moderate to severe trauma per pediatric trauma scoring, and more than half were managed conservatively [5].

These data highlight that pediatric trauma comprises a substantial portion of surgical burden in LMICs a burden often shouldered by general surgeons.

Why General Surgeons Are Central in Pediatric Trauma Management in LMICs

Workforce Distribution & Shortage of Pediatric Surgeons

Given the limited number and unequal distribution of pediatric surgical specialists, most district and rural hospitals rely on general surgeons for emergency surgical care. In such settings, general surgeons become the frontline responders in cases pertaining to pediatric trauma.

Spectrum of Injuries Requiring Immediate Intervention

In many pediatric trauma cases such as blunt abdominal trauma, hollow-viscus perforations, splenic or hepatic injuries, thoracic injuries, polytrauma, burns, soft tissue injuries the time window for lifesaving intervention is narrow as per standard guidelines. As the more time elapses risk of morbidity and mortality increases. General surgeons with broad trauma training may be the only available operative source at crucial moments.

Limited Pre-hospital and Referral Systems

Many LMICs lack robust pre-hospital trauma care, timely ambulance services, and organized referral pathways. Consequently, children often present directly to the nearest hospital, which may not have pediatric-specific services making general surgeons essential for initial stabilization and definitive management in view of scale of injury & morbidity with risk of life in hand [1].

Pediatric-Specific Considerations: What General Surgeons Must Know

Children are not "small adults" Several physiological and anatomical differences make pediatric trauma management distinct from that of adult trauma management:

- **Compensatory mechanisms and sudden decompensation:** Children may maintain normal vital signs until sudden collapse as compensation mechanisms provided by their body are not mature enough.
- **Thermoregulation:** Children are prone to hypothermia as subcutaneous fat layer and thermoregulation center in hypothalamus are not mature. These mentioned mechanisms are important during trauma resuscitation and surgery.
- **Fluid and blood volume management:** Trauma resuscitation requires pediatric-specific dosing and careful monitoring, which will require timely intervention and strict monitoring by a Pediatrician.
- **Anatomic vulnerability:** Thin abdominal and thoracic walls, lax abdominal muscles make intra-abdominal or thoracic organ injury more likely even after "minor" external trauma.
- **Healing and long-term sequelae:** Children have higher potential for growth-related deformities, developmental impact, and need for long-term follow-up.

Therefore, general surgeons need specialized knowledge and skills beyond standard adult trauma protocols along with teamwork with support from specialized staff and Pediatrician.

Evidence of Outcomes: General Surgeons and Pediatric Trauma

While there is no universal registry distinguishing outcomes by surgeon type (pediatric vs general), several studies show:

- In LMICs, resource-adapted trauma care provided by generalists can yield acceptable outcomes when protocols are followed [1].
- In a cohort of pediatric abdominal injuries, there is no consensus on optimal management even among different surgeons, highlighting variability in practice and the need for standardization [6].
- Over the last decades, a trend toward non-operative management of stable blunt abdominal trauma in children has emerged worldwide a paradigm that general surgeons must adopt, balancing resource constraints and patient safety [7].

These findings suggest that, with proper decision-making and resource adaptation, general surgeons can manage many pediatric trauma cases effectively.

Challenges Faced by General Surgeons in LMICs

Despite their essential role, general surgeons face significant obstacles:

- Insufficient pediatric-specific trauma training: A recent systematic review found that among trauma patients in LMICs, only a small fraction can provide dedicated pediatric trauma training [8].
- Resource limitations: Lack of pediatric ICU beds, pediatric anesthesia expertise, limited imaging (ultrasound, CT), blood bank limitations, and deficient post-operative care infrastructure.
- Delayed presentation: Many children present late due to lack of pre-hospital transport, poor referral networks, and socio-economic barriers increasing morbidity and mortality [3].
- Lack of standardized protocols: Variability in management practices, particularly regarding when to opt for operative vs

non-operative treatment, results in inconsistent outcomes [6].

- Medicolegal and ethical concerns: Operating on children without pediatric surgical backup may raise parental or institutional concerns, consent issues, and long-term follow-up responsibilities.

Strategies to Strengthen Pediatric Trauma Care via General Surgeons

To optimize pediatric trauma outcomes in resource-limited settings, we propose the following strategies:

Incorporate Pediatric Trauma Modules into General Surgery Training

Surgical residency programs should include mandatory pediatric trauma training and rotations, including pediatric ATLS-like protocols adapted for children. This would help in providing a better pediatric insight to general surgeons.

Standardize Protocols & Guidelines

Develop national/regional resource-adapted guidelines for pediatric trauma including triage, blunt abdominal trauma management, burn care, transfusion protocols, stabilization, and referral criteria. Inconsistent treatment protocols not only increases morbidity and mortality ratios but also makes it difficult to carry on the care given. Standardized protocol will help a lot clearly.

Use of Telemedicine and Tele-mentoring

In this era of technology, telemedicine has proved a boon in healthcare industry already. Using this technological advancement specially in remote or district hospitals, general surgeons can seek real-time guidance from pediatric surgery specialists in tertiary centers to optimize decision-making.

Strengthen Pre-hospital and Referral Systems

Implement low-cost pre-hospital first-responder training (e.g., lay first-responder models) to improve early stabilization and transport in pediatric trauma cases. This aligns with global efforts to expand essential emergency and surgical care worldwide [9].

Data Collection and Trauma Registries

Create pediatric trauma registries in district hospitals to track injury patterns, outcomes, complications, and follow-up data that can guide policy, resource allocation, and training needs.

Collaboration between General Surgeons & Pediatric Surgeons

Foster a collaborative model: general surgeons handle initial emergency and life-saving interventions; pediatric surgeons provide guidance, follow-up, and definitive care when feasible.

Future Directions & Research Needs

- Studies comparing outcomes of pediatric trauma managed by general surgeons versus pediatric surgeons in LMIC settings.
- Evaluation of training interventions (e.g., pediatric trauma courses, simulation-based training) for general surgeons and impact on morbidity/mortality.
- Development of cost-effective tele-medicine networks for pediatric trauma support.
- Research on long-term outcomes (growth, development, complications) in children operated by general surgeons.
- Implementation and analysis of pediatric trauma registries to generate local data for tailored guidelines.

CASE PRESENTATION

Example from a District-Level Hospital in India: Demonstrating the Critical Role of Pediatrician–General Surgeon Collaboration in Trauma

We report the case of an 8-month-old male infant who sustained multisystem injuries following a road traffic accident involving an e-rickshaw. The child presented with altered sensorium and excessive crying. Neuroimaging revealed microhemorrhages consistent with diffuse axonal injury. Abdominal imaging demonstrated Grade III liver laceration and Grade IV right renal injury with renal artery narrowing, renal vein thrombosis, and extensive renal infarction. The child required blood transfusion, intensive monitoring, and referral for tertiary-level pediatric nephrology and trauma care.

Patient Information

An 8-month-old male infant with no known comorbidities was brought to the Emergency Department on 9 September 2025 with an alleged history of being struck by an e-rickshaw. According to caregivers, the child became drowsy immediately after the incident and had persistent excessive crying. There was no prior history of trauma, bleeding disorders, or chronic illness.

Clinical Findings

On presentation, the child appeared irritable with intermittent drowsiness. Vital parameters were monitored, and initial examination raised concern for head injury and abdominal trauma. The abdomen was distended and tender, prompting urgent imaging. No external bleeding was noted.

Timeline

Time Point	Clinical Events
Day 0	Road traffic accident involving e-rickshaw
Same day	Emergency assessment and stabilization
Day 0	NCCT head and USG whole abdomen performed
Day 0	CECT whole abdomen conducted
Day 0–1	PRBC transfusion and ICU monitoring
Day 1	Referral to tertiary care center

Diagnostic Assessment

Neuroimaging

NCCT Head revealed three microhemorrhages in the left frontal lobe at the gray–white matter junction, consistent with diffuse axonal injury, without mass effect or extra-axial hemorrhage.

Abdominal Imaging

Initial USG whole abdomen showed:

- Right renal contusion with mild perinephric collection
- Mild hemoperitoneum
- Internal echoes in the urinary bladder
- Mild right pleural collection

Subsequent CECT whole abdomen revealed:

- 36 × 34 mm liver laceration in segment VI (AAST Grade III)
- AAST Grade IV right renal injury with:
  - Renal ischemia
  - Right renal vein thrombosis
  - Severe narrowing of the right renal artery
  - Non-enhancing infarcted upper and lower renal poles
- Mild perirenal collection
- Moderate hemoperitoneum
- Moderate right pleural collection

Fracture of the posterior aspect of the right 9th rib

Laboratory Investigations

Serial hematological evaluation demonstrated a progressive fall in hemoglobin levels, indicating ongoing blood loss.

Pediatric Trauma Score (PTS) Assessment

The Pediatric Trauma Score was calculated at presentation based on initial clinical findings:

Parameter	Finding	Score
Weight	<10 kg	+1
Airway	Patent	+2
Systolic BP	Maintained	+2
CNS Status	Drowsy / altered sensorium	+1
Open wounds	None	+2
Skeletal injury	Rib fracture	+1

Table 2: Total Pediatric Trauma Score: 9

However, considering significant internal organ injury (high-grade renal and hepatic trauma and evolving hemodynamic compromise, the effective trauma burden was consistent with severe pediatric trauma, warranting ICU admission and tertiary referral. A PTS close to the critical threshold highlights the importance of vigilance even when initial vital parameters appear stable.

Therapeutic Intervention

The child underwent immediate stabilization and resuscitation. In view of falling hemoglobin, one unit of packed red blood cells (PRBCs was transfused. Multidisciplinary consultation involving pediatrics, general surgery, and radiology was undertaken. The child was admitted to the Intensive Care Unit (ICU) for close monitoring.

Follow-up and Outcomes

Recognizing the severity of renal vascular injury and multisystem trauma, the treating Pediatrician and General Surgeon ensured prompt stabilization, appropriate imaging, and early referral. After review of CECT findings, the child was referred to Dr. Ram Manohar Lohia Hospital and PGIMER, New Delhi, for specialized pediatric nephrology and trauma care, ensuring continuation of tertiary-level management.

DISCUSSION

High-grade renal injuries with associated vascular compromise are uncommon in infants and often pose diagnostic and therapeutic challenges. Diffuse axonal injury, even in the absence of mass lesions, signifies significant acceleration–deceleration forces. This case underscores the importance of maintaining a high index of suspicion, early use of advanced imaging, and timely multidisciplinary intervention. Early recognition and stabilization at a secondary care center played a pivotal role in preventing further deterioration and enabling safe transfer.

PATIENT PERSPECTIVE

The patient was an infant and unable to express personal perspectives. The caregivers were informed at each stage of diagnosis and management and consented to referral for higher-level care.

Informed Consent

Written informed consent was obtained from the patient's legal guardians for publication of this case report and accompanying clinical details, in accordance with ethical standards.

CONCLUSION

This case illustrates a rare and severe presentation of pediatric blunt trauma involving renal vascular injury, hepatic laceration,

and diffuse axonal injury. Prompt assessment, early imaging, stabilization, and timely referral are crucial in achieving favorable outcomes in complex pediatric trauma cases. This case highlights the importance of early imaging, prompt stabilization, and timely referral in pediatric blunt trauma, particularly when renal vascular injuries are suspected. Early coordinated intervention can prevent deterioration and improve outcomes even in complex multisystem traumaIn. developing countries, general surgeons play an indispensable role in the management of pediatric trauma. Their broad surgical skill set, combined with adaptive use of available resources, often makes the difference between life and death for many children. However, to maximize safety and outcomes, there is an urgent need to strengthen training, standardize protocols, build referral and support networks, and invest in data-driven system improvements. Empowering general surgeons through structured pediatric trauma education and support can significantly reduce the burden of injury-related morbidity and mortality in the pediatric population across resource-limited settings.

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