Trends and Challenges in Paediatric Trauma and Emergencies

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Trauma is a significant cause of mortality and morbidity in children, especially in the developed countries.[1,2] Before the 1960s, there were no organised child care services and protocols for paediatric emergency. Gradually, with the development of trauma centres and paediatric advanced life support, there has been a steady reduction in the mortality of paediatric emergency and trauma patients. With time, there have been consistent developments in the management of trauma in children in the domains of prevention, prehospital care, intrahospital care, postoperative management and rehabilitation.

Though paediatric trauma has such devastating effects, the good thing is the potential of a remarkable recovery in this patient subgroup. Optimal and complete recovery in paediatric trauma is a multistep process of which resuscitation is the first component. Though the children have increased physiological reserve, aggressive and rapid resuscitation is important in younger children because of increased metabolic demand. In children, trauma-related deaths are often caused by respiratory, cardiac, or central nervous system problems that lead to metabolic changes. Injured adults and children are usually similar, but younger children show more obvious physical changes. Sick children with critical signs must be identified and prioritized because most child emergency deaths occur in the first 24 hours. In 2005, WHO released guidelines for treating paediatric emergencies, which were revised in 2016. The updated guidelines tell us to treat any child showing these signs or symptoms as a paediatric emergency :

- Obstructed or absent breathing
- Severe respiratory distress
- Central cyanosis
- Signs of shock (cold extremities with capillary refill time > 3 sec and weak and fast pulse)
- Coma or seriously reduced level of consciousness
- Seizures
- In a child with diarrhoea, any two signs of severe dehydration: lethargy or unconsciousness, sunken eyes, very slow return of skin after pinching

Characteristics of paediatric trauma

Paediatric trauma patients have certain characteristics that differentiate it form their adult counterparts.[3] Most injuries in paediatric patients result from blunt trauma that can be managed non-surgically. Head injury is the most common cause of death in paediatric trauma patients, closely followed by hypotension. With chest trauma, rib fractures are not very likely in the paediatric age group due to the cartilaginous nature of the ribs and therefore, more force gets absorbed by the thoracic contents, resulting in pulmonary or cardiac contusion or tension pneumothorax. In paediatric patients, significant blood loss can occur before clinical signs of hypotension and tachycardia manifest. Ligamentous injury to the spine is more common in the paediatric age group and may be the only finding in spinal trauma. Last but not the least, there are long-term complex psychological ramifications of trauma on paediatric patients that need to be integrated in the care of such patients.

Recent advances in understanding the pathophysiology of paediatric trauma

Understanding the pathophysiological changes that happen after major trauma are pivotal to creating treatment protocols directed to the care of injured. Central nervous system responds to systemic injury by secretion of neuroendocrine factors like cortisol, renin, aldosterone, insulin, glucagon, antidiuretic hormone and catecholamines. While the balanced secretion of these neuroendocrine factors is protective, excess or deficient quantity has deleterious effects and the effects are both time-limited and variable. Therefore, the longer the trauma gets untreated, the more complex and long-lasting is the effect of these neuroendocrine factors. With recent advancements of understanding the pathophysiology following trauma at cellular levels, the concept of ABC in resuscitation has placed more stress on the airway, breathing and circulation. Regarding the airway and breathing, there is evidence in support of

early intubation for correcting oxygen delivery and blood saturation. Regarding the circulation, emphasis has been laid on early fluid resuscitation with the ringer's lactate and blood products and limited use of albumin in first 24 hours of trauma as that may be deleterious. Adequate fluid resuscitation and correction of acidosis remain the primary goals of resuscitation of paediatric patients in shock. As catecholamines get secreted in shock as part of the neuroendocrine response, selective use of norepinephrine and dopamine, along with resuscitation proves to be beneficial. Ongoing blood loss reduces oxygenation, and this, coupled with acidosis, can have an influence on cardiac mortality in the paediatric age group more than the adults. Therefore, adequate circulation and ventilation are of paramount importance in reducing cellular damage because of anaerobic metabolism and organ dysfunction. In severe shock, however, even if the resuscitation is started early and aggressively, there can be cellular damage because of the reperfusion. With poor oxygenation, there is a generation of cytotoxic free oxygen radicals. In addition, there is production of cytokines prostaglandins, leukotrienes, and platelet-activating factor that has a negative impact on the cell membranes and results in systemic inflammatory response syndrome. The latter is thought to cause the deleterious cardiac effects in shock, and research is ongoing to identify the therapeutic targets for each of these. A protein intake of 1.5 to 3.0 g/kg in 24 hours is suitable in the early stages of injury, along with just enough nonprotein calories to meet metabolic demands.[4]

Triaging

Triaging is an ongoing process in paediatric emergency and trauma services as the clinical condition of a child can deteriorate rapidly. New methods and computer programs are needed to help medical responders detect unstable patients before they become dangerously low on blood pressure. Reducing under and over-triage would improve the effectiveness of the trauma system, cut morbidity and mortality, and reduce the total cost of trauma treatment. Feature extraction algorithms and machine learning can identify how much central blood volume has been lost. Identifying trauma patients at high risk of haemorrhagic shock early can help intervene quickly, prioritize treatment, and improve outcomes.

Fluid management

Fluid management starts with prehospital care and needs vascular access which can be challenging in the prehospital setting.[5] It has been found that the prehospital care of the children is severely deficient as compared to the adults.[6] As a result, children are often at a higher risk of adverse events due to hypovolemia from treatable causes prior to their admission to the emergency department. Physiology and age-related changes in the paediatric population need further research to determine the optimal fluid and volume of resuscitation, including balanced resuscitation with FFPs and PRBC or whole blood. It has been found that overhydration is common up to 12% in the resuscitation of non-haemorrhagic paediatric trauma patients, and this results in overhydration-related complications such as pleural effusion and ascites.[7]

Massive transfusion

Massive transfusion is a strategy found beneficial in critically bleeding adult patients with trauma; however, the benefit for the paediatric age group is not well established.[8,9] Though studies have appeared on the benefit of large volume of blood products transfusion in the paediatric age group, most of these studies are retrospective in nature and the strength of evidence is very low.[10] Diab et al. defined massive transfusion in children as a replacement of > 50% total blood volume in 3 hours, > 100% total blood volume in 24 hours or replacement for ongoing blood loss > 10 total blood volume/minute.[10] Further, some authors suggest that >40 ml/Kg transfusion of blood products during the first day could identify critically ill paediatric patients at increased risk of death.[11]

Other important areas of active research ongoing in paediatric emergency resuscitation are transfusion protocols and permissive resuscitation, including low-volume resuscitation. Yet, more research is needed to reach a consensus.

Coagulopathy and tranexamic acid

Trauma-induced coagulopathy is a common challenge encountered in polytrauma adult and paediatric patients.[12] Trauma-induced coagulopathy in paediatric population contributes to the increased morbidity, mortality, length of hospital and ICU stay.[13,14] The major factor responsible for coagulopathy is the activation of coagulation cascade and subsequent acidosis, haemodilution and coagulation factor consumption resulting in disseminated intravascular coagulation.[12] It is widely believed that the underlying processes of coagulopathy differ in the adult and the paediatric age group. In the paediatric age group, coagulopathy occurs secondary to mechanisms of acute traumatic coagulopathy due to activation of protein C, glycocalyx shedding, and Weibel Palade body degradation and iatrogenic coagulopathy a=secondary to haemodilution, hypothermia and coagulation factor depletion.[15] The safety and efficacy of tranexamic acid is well established in adults; however, in paediatric population, it is established for cardiac, spinal and craniofacial surgeries.[16-18]

Point of care ultrasound (POCUS)

POCUS use and training are widespread in paediatric emergency medicine.[19,20] In a range of clinical situations that occur in both PICU and PEM settings, including respiratory distress and failure, abdominal trauma, cardiovascular dysfunction, elevated intracranial pressure, and procedural guidance, POCUS offers diagnostic and therapeutic potential.[21] Future research on the POCUS guidelines will improve the outcome sin the critically ill paediatric patients. Respiratory illness is currently the most serious diagnosis in paediatric emergency patients requiring ICU admission, and POCUS includes evolution of pneumonia, pleural effusion and pneumothorax.[22]

Focused assessment with sonography in trauma

Focussed assessment with sonography (FAST) and e-FAST (extended FAST)examinations are rapid diagnostic methods to identify injury to a vital structure, including hemoperitoneum, hemopericardium, haemothorax and pneumothorax. FAST can reliably detect hemoperitoneum and direct emergency trauma treatments. The use of CT scans is still common, yet it is still insufficient to rule out IAI in youngsters. FAST may eventually assist in reducing CT use since many paediatric solid organ injuries are treated nonoperatively. [23] Serial ultrasound tests and contrast-enhanced ultrasound may be used in future research to detect and track clinically significant intraabdominal injury throughout the PEM and PICU trauma treatment spectrum.

Simulation in training

Simulation for improving the training of paediatric emergency providers has been used in neonatal resuscitation, paediatric advanced life support, procedural skills training, and resource management training.[24] More development is needed in the simulation-based resuscitation training and the e-learning platform could offer better opportunities in training options.

Conclusions

Nelson Mandela stated, " Our children are the rock on which our future will be built, our greatest asset as a nation. They will be the leaders of our country, the creators of our national wealth, those who care for and protect our people."

The extent to which paediatric emergency care is prioritized depends on the context and protocols of each location. Those involved in paediatric emergency services strive to better the outcomes for sick and injured children. Some countries have comprehensive paediatric emergency care, while others have very limited resources. Prime Minister Narendra Modi stated that " We must generate more awareness about hundreds of children who are unable to survive due to lack of primary healthcare facilities."

One of the major cause responsible for this is a lack of dissemination of knowledge and skill. Not enough doctors specialize in paediatric emergencies, so there's not enough knowledge about how to care for children in emergencies. Only focusing on their primary specialty may limit the paediatric emergency specialists' knowledge of paediatric care. [25] It can encompass the community setting that does not have basic organised medical care to state-of-the-art paediatric emergency departments in tertiary care centres specialising in paediatric trauma and emergency or from an individual child to a subgroup of the population in cases of man-made and natural disasters.

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