

Principles of Primary Survey and Resuscitation in Cases of Pediatric Trauma

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Abstract- Trauma is a common cause of death and disability in children. Proper approach to pediatric trauma involves adherence to ABCDE sequence in the primary survey and resuscitation in order to promptly recognize and manage immediately life threatening conditions. This readily reviewed sequence includes A: establishment and maintenance of a patent airway while maintaining cervical spine immobilization; B: evaluation of breathing, ventilation and oxygenation, immediate treatment of tension pneumothorax, open pneumothorax and massive hemothorax; C: evaluation and treatment of circulatory compromise and shock; D: Disability and Neurologic Status, assessment of signs of increased intracranial pressure and impending cerebral herniation; and E: Exposure while preventing hypothermia. Implementing these assessment and management priorities can result in more favorable outcomes.

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Introduction

Trauma is one of the leading causes of mortality and morbidity in children (1,2). In seriously injured patients, it is vital to rapidly assess the injuries and promptly institute life-preserving treatments (3). This can be best fulfilled by following Advanced Trauma Life Support (ATLS) protocols with immediate implementation of “ABCDE” and continuous reevaluation of the adequacy of resuscitation efforts (4). Adherence to ATLS protocol is associated with more favorable management outcomes (5); a decline in mortality and morbidity of trauma patients was observed after the introduction of ATLS (6,7).

Children are not miniature adults; their anatomy, physiology and even injury mechanisms differ from adults. The unique characteristics of pediatric patients should be taken into consideration during the assessment and management of injuries. However, the principles and priorities are the same and follow similar ATLS sequences as adults (2,3).

There is evidence suggesting that initial assessment

and resuscitation priorities are not yet adequately appreciated by some physicians (8). By simulation of some clinical cases of pediatric trauma, we aimed to review in brief the principles of primary survey and resuscitation, and also demonstrate how failure to maintain a systematic approach can cause early life-threatening conditions to be easily missed.

Materials and Methods

The following three cases are simulated cases of pediatric trauma.

Case 1

An eight-year-old boy was hit by a car while he was riding his bike without wearing a helmet. He was unconscious when the Emergency Medical Service (EMS) arrived. His cervical spine was immobilized. An endotracheal tube was inserted, and bag ventilation initiated as the patient had shallow breathing. He was then transferred to the nearest hospital.

Upon arrival in the emergency department (ED), his

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vital signs were as follows: PR= 135/min, BP= 75/50mmHg, O₂sat=90% (with 100% Oxygen) and ventilated at a rate of 20/min.

While Doctor A was evaluating airway and ventilation, 2 large bore IV lines were placed and immediate infusion of 20 cc/kg warm isotonic crystalloid initiated after obtaining a blood sample for lab tests.

Doctor A noticed decreased breath sounds in the left hemithorax. He attributed this to inappropriate endotracheal tube placement, and speculated that paramedics might have failed to appreciate relatively short trachea in children resulting in right mainstem bronchial intubation. A calorimetric CO₂ detector was attached to the tube, which confirmed the presence of CO₂ in the exhaled air. Doctor A insisted that this finding does not rule out right bronchial intubation and ordered to obtain an immediate AP chest X-ray film.

Further assessments revealed a GCS score of 5 (E=1, V=2, M=2), normal pupillary responses, bruises over the left flank and severe deformity of the left thigh. While the team was waiting for the chest X-ray examination to be obtained, the patient suddenly developed cardiac arrest and all resuscitation efforts were unsuccessful. The patient was pronounced dead 45 minutes after the initiation of resuscitation.

Case 2

A 5-year-old girl was brought to the ED on a back board with full spinal precautions. According to EMS reports, the girl had been a rear seat occupant restrained by a lap belt during a head-on automobile collision. Upon impact, the girl's body was flexed forward, but the belt prevented ejection from the seat. No trauma to the head had occurred.

Vital signs were normal except for heart rate that was higher than the normal limit for age (PR = 142/min, Respiratory Rate (RR) = 20/min, BP = 95/60 mmHg, O₂ Sat = 99%). The child was obviously scared by the ED environment and was screaming, calling her mother and shouting for help. Spinal immobilization was maintained, and nasal O₂ was administered. There were no signs of the ventilation compromise. A 20 gauge IV catheter was introduced, and blood samples were obtained.

The GCS score was 15. Pupils were equal in size and reactive to light, and no lateralizing signs were noted. The body was fully exposed, and room temperature was adjusted to prevent hypothermia. A minor bruising was noticed just above the umbilicus. The abdomen was slightly distended. Gastric and urinary catheters were

placed. Lateral cervical, chest and pelvic X-ray examination did not show any abnormality. No further pathology was found during secondary assessment. However, due to agitation and apprehension of the patient abdominal examination was inconclusive.

After a while, the child quieted down and seemed to be tired and sleepy after making all the efforts. Less than an hour later, the patient was reevaluated. Heart rate was 155/min while the blood pressure had dropped to 70/50mmHg. The GCS was 8, and urinary output was less than 10 ml/hour.

Case 3

A young woman rushed into the ED carrying her 9-month-old daughter. The infant was unconscious and had a bump on the left side of the skull. The mother explained that a few hours earlier his 5-year-old son had thrown a heavy toy car towards the infant because she was crying and made noise. After that, the patient had experienced several episodes of vomiting and on the way to the hospital became unconscious. She denied any other trauma to the infant.

The patient was immediately intubated and adequate ventilation and oxygenation was established. Appropriate IV fluid was administered. The GCS incorporating pediatric verbal score was eight. The pupils were symmetric and responsive. The anterior fontanelle was slightly bulged. In response to a painful stimulus, withdrawal was noted in the left side while right extremities abnormally extended (decerebrate posturing). The on-call neurosurgeon was informed for consultation. Exposure of the body revealed 3-4 areas of new and old bruising on the trunk and thigh.

Discussion

Case 1

When the patient is intubated prior to transfer, as the initial assessment of the airway, it is important to make sure that the tube is in the appropriate position. As soon as end tidal CO₂ is detected, the esophageal placement of the tube is ruled out. In this case, overemphasis on the inappropriate placement of the endotracheal tube has distracted the team from a careful assessment of breathing (B in ABCDE sequence) including inspection and palpation of the neck and chest for tracheal deviation, asymmetric chest movement and signs of injury; and percussion for dullness or hyperresonance, which could give another clue to other important and immediately life threatening differential diagnosis of decreased breath sounds: tension pneumothorax.

Moreover, the tachycardia and hypotension indicate a shock state. Although hemorrhagic shock is the most common form of shock in severely injured patients, in rare occasions, shock has a different cause like cardiac tamponade, tension pneumothorax, spinal cord injury or myocardial contusion. Tachycardia, muffling of heart sounds, engorgement of cervical veins and hypotension that does not respond to crystalloid and blood administration are suggestive signs of cardiac tamponade. Tension pneumothorax can similarly present with distended neck veins and shock. Differentiation can be made by the findings of absent breath sounds and hyperresonance over the affected side in the latter condition.

Once clinically suspected, tension pneumothorax must be immediately decompressed by inserting a large caliber needle in the second intercostal space in the midclavicular line. Further placement of chest tube in the affected side is necessary. In case of cardiac tamponade, pericardial blood should be promptly evacuated. Subxyphoid pericardiocentesis can be both diagnostic and therapeutic, but its effect is temporary. Definitive treatment involves surgical pericardiectomy.

Case 2

Due to abundant physiological reserve and compensational mechanisms, children usually show few signs of hypovolemia even after considerable volume depletion. Tachycardia and poor skin perfusion might be the only key to early recognition of hypovolemic shock; systolic blood pressure is maintained in the normal range even in the presence of shock and start to decline only when more than 30% of the blood volume is lost. Thus, a high index of suspicion is necessary.

In the presence of tachycardia in a child that has sustained blunt (abdominal) trauma, it is important to be skeptical about the patient's hemodynamic stability and put emphasis on careful assessment of the circulation compromise and initiate resuscitation strategies (C in ABCDE sequence). The fact that the child is apparently doing well should not create an illusion of stable hemodynamics. Tachycardia does occur as a result of fear, anxiety or pain, but this attribution is not acceptable until other life threatening causes are carefully assessed and ruled out. In this case, bearing in mind the mechanism of injury and the high possibility of abdominal visceral injury and internal bleeding, other important signs of shock including delayed capillary refill, cool and pale extremities, skin mottling and weak peripheral pulses were not looked for, resulting in inadequate fluid resuscitation and precipitous

progression to a catastrophic decompensated shock state. Another evidence of hypovolemia was the secondary decrease in the level of consciousness indicating cerebral perfusion compromise, which was not appreciated and mistakenly interpreted as tiredness.

Case 3

In the case of head trauma, there should be an additional emphasis on prevention of secondary brain injury due to hypoxia or hypoperfusion (respectively B and C in ABCDE sequence). All patients should be continuously reassessed. Appropriate neurosurgical involvement should be considered from the beginning of the treatment.

Whenever there is a discrepancy between history and extent of physical injuries, the history of the injury should be viewed doubtfully, and child abuse should be considered. Some findings that are highly suggestive of child abuse include multicolored bruises, multiple old scars or contact burns, spiral fracture of long bones, retinal hemorrhages and multiple subdural hematomas.

Initial assessment consists of quick overall patient vital function evaluation, rapid primary survey and resuscitation, a more detailed secondary survey and initiation of definitive treatment. The primary survey and resuscitation process constitutes the ABCDEs:

Airway maintenance with cervical spine protection: establishment and maintenance of a patent airway by chin lift/ jaw thrust maneuvers, removal of secretions or foreign bodies, and insertion of oropharyngeal airway or establishment of definitive airway by means of intubation or surgical methods, if necessary. Cervical spine should be immobilized and maintained in a neutral position.

Breathing: ventilation and oxygenation: Inspection and palpation of the neck and chest wall for tracheal deviation, asymmetric chest movement and signs of injury; percussion for dullness or hyperresonance; auscultation of breath sounds. Tension pneumothorax should be alleviated by needle tracheostomy followed by chest tube insertion. Massive hemothorax also requires tube thoracostomy. Open pneumothorax should be sealed. All trauma patients should receive supplementary high concentration oxygen.

Circulation and shock: Evaluation of circulatory compromise (assessment of heart rate, peripheral pulses, mottling and coldness of extremities, capillary refill, urinary output), venous access, fluid resuscitation, blood replacement, controlling external bleeding and considering internal hemorrhage.

Disability: Neurologic Status: Evaluation of level of

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consciousness by GCS scale using pediatric verbal score for children younger than 4 years old. Assessment of pupils for size, equality, and reaction.

Exposure: Completely undressing, while preventing hypothermia (children are more susceptible to rapid heat loss).

Adjuncts to Primary Survey and Resuscitation:

ABG analysis

Pulse oxymetry

End Tidal CO₂ monitoring

ECG monitoring

Gastric and urinary catheterization

Lateral cervical, AP chest and AP pelvic X-ray examination

Conclusion:

In all cases of pediatric trauma, adherence to ABCDE sequence in rapid primary survey and resuscitation is essential. The importance of following a standard systematic approach to recognize and manage immediately life threatening conditions in trauma victims cannot be overemphasized. While implementing the same assessment and management priorities as adults, unique characteristics of pediatric patients should also be taken into account.

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