

Resuscitation of trauma patients- an overview

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Abstract

Trauma is a major cause of mortality worldwide. Majority of trauma deaths occurs within 24 hours of injury. Survival depends on timely resuscitation. Initial evaluation uses primary survey involving Airway maintenance, Breathing, Circulation, Disability and Exposure. In secondary survey, thorough head to toe examination is done. Initial resuscitation begins with 2 intravenous access and restricted volume replacement strategy. Controlling active bleeding, treating coagulopathy and transfusion of appropriate fluids is mandatory. Hypothermia should be treated with passive/ active peripheral warming and core warming. Ventilation strategy should be focussed to avoid hypoxaemia, hyperventilation and hypocapnia. Colloids (albumin, hydroxyethyl starches, dextrans, gelatins) and crystalloids (normal saline, ringer's lactate) are both used in resuscitation. For major blood volume loss, blood transfusion is recommended to maintain tissue oxygenation. Damage Control Resuscitation is the strategy for hemorrhagic shock management which requires large-volumes of blood product transfusion. Vasopressors maintain target arterial pressure in presence of myocardial dysfunction. For patients with expected massive haemorrhage, Plasma or Fibrinogen concentrate and RBC may be used. Head trauma severity is age specific. Sedation, analgesia and fluids should be started. Secondary injury from hypoxia, hypotension, hyperthermia or raised intracranial pressure should be avoided. After structured approach of airway, breathing, circulation and disability, definitive treatment of primary intracranial injury should be done. CT scan is done for moderate/ severe head trauma or if signs of basal skull fracture. Management of trauma patients is challenging and requires a multidisciplinary approach.

Keywords: Resuscitation, Coagulopathy, Head Trauma, Trauma

Introduction

Globally injuries cause nearly 40% of all child deaths [1]. Mortality in paediatric trauma patients is mainly due to traumatic brain injury and haemorrhage [2]. Since more than 50% of all trauma deaths occur within 24 h of injury [3], survival can be increased if time between trauma & admission to trauma centre is decreased. Ultimately survival depends upon good prehospital care, appropriate triage and effective resuscitation.

Initial evaluation: Initial evaluation uses primary survey including ABCDE: A is for Airway maintenance / access with control of the cervical spine; B is for Breathing; C is for Circulation with

external haemorrhage control; D is for Disability and neurological screening; and E is for Exposure/ Environmental control with thorough examination. In secondary survey, thorough head to toe examination is done. Prehospital care includes airway maintenance, ventilation, control of shock & external bleeding, proper immobilisation, immediate transport to nearest trauma centre. Tertiary survey includes re-examination and review of investigations to seek out any missed injuries.

Initial Resuscitation: Following survey resuscitation begins with intravenous (IV) Access. Two peripheral IV lines preferably largest catheters are mandatory. In cases of difficult iv access, after three attempts or 90 seconds in a child, intraosseous infusion may be considered [4].

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However, iv access must be secured after stabilisation since prolonged intraosseous line has complications like compartment syndrome, skin necrosis and osteomyelitis. During initial resuscitation, restricted volume replacement strategy is preferred. Studies have shown that uncontrolled bleeding after trauma is the commonest cause of preventable death among injured patients [3]. Hence controlling active bleeding, treating coagulopathy and transfusion of appropriate fluids is mandatory.

Hypothermia: Hypothermia worsens shock by increasing peripheral vasoconstriction, worsening acidosis and decreasing tissue oxygen delivery [5]. It is associated with hypotension, coagulopathy, altered platelet function, enzyme inhibition, fibrinolysis [6]. Methods of treating hypothermia include passive peripheral warming (insulating materials/ blankets to prevent further heat loss), active peripheral warming (externally warmed medium like hot air/ hot surface) and core warming (administration of warmed fluids) [7].

Ventilation: Ventilation strategy for trauma patients should be focussed to avoid hypoxaemia. Intubation becomes mandatory in situations like airway obstruction, altered consciousness with Glasgow Coma Score ≤ 8 , haemorrhagic shock, hypoventilation or hypoxaemia [8]. Rapid sequence induction is the best method. Hyper ventilation and hypocapnia causes problems due to increased vasoconstriction, decreased cerebral blood flow, impaired tissue perfusion and cerebral tissue lactic acidosis [9]. As hyperventilation increases mortality among trauma patients, target PaCO₂ should be maintained around 35–40 mmHg [10]. Hypocapnia (PaCO₂ <27 mmHg) leads to neuronal depolarisation, glutamate release and apoptosis [11]. However, if signs of imminent cerebral herniation like unilateral or bilateral pupillary dilation, decerebrate posturing are present hyperventilation can be done [12]. Ventilation with low tidal volume (6 ml/kg) is recommended in acute respiratory distress syndrome as high tidal volume (12 ml/kg) without positive end-expiratory pressure worsens pulmonary inflammation and alveolar coagulation [13].

Resuscitation fluids: Colloids (albumin, hydroxyethyl starches, dextrans, gelatins) and crystalloids (normal saline, ringer's lactate) are

both used in resuscitation. In contrast to crystalloids, colloid molecules cannot penetrate intact cell wall and therefore cause an oncotic gradient which attracts additional interstitial fluid into the vessels. Initially isotonic normal saline (NS) (0.9%) or Ringer's lactate (RL) is used as an initial bolus of 20 ml/kg body weight [14]. As lactate is metabolized to bicarbonate by liver which buffers acidosis lactated Ringer's solution is preferred over normal saline. Normal saline also has risk of metabolic acidosis and acute kidney injury. In case of poor response, after 20-30 minutes, second bolus of 20 ml/kg body weight of warm crystalloid solution should be given. Isotonic crystalloids are the best to be initiated in hypotensive bleeding trauma patient and excessive use of 0.9% NS should be avoided. Hypotonic solutions like Ringer's lactate should be avoided in patients with head trauma. As colloids causes hemostasis its use should be restricted. For > 40% of blood volume loss, blood transfusion is recommended to maintain tissue oxygenation. Packed red blood cells at a dose of 10 ml/ kg body weight or whole blood at a dose of 20 ml/kg body weight should be given in cases of hemorrhagic shock [15]. Studies have shown that albumin or artificial plasma expanders are not superior than crystalloid solutions for restoring perfusion [16]. Albumin use is associated with increased mortality among patients with traumatic brain injury. A urinary catheter should be placed to monitor urine output unless there is suspicion of pelvic fracture or urethral injury.

Damage Control Resuscitation is the strategy for hemorrhagic shock management in severely traumatized patient which requires large-volumes of blood product transfusion. This strategy decreases acidosis, hypothermia and coagulopathy which is common with large volumes of isotonic saline transfusion. Damage Control Resuscitation has three core concepts: Acute Coagulopathy of Trauma; Permissive Hypotension; Massive Transfusion and Hemostatic Resuscitation.

Acute Coagulopathy of Trauma: Nearly one-third of bleeding trauma patients have coagulopathy [17]. Death and multi-organ failure are more with coagulopathy. Early acute coagulopathy occurs due to bleeding-induced shock, acidosis, hemodilution, consumption of coagulation factors, hypothermia, tissue factor

release, Protein C activation or Hyperfibrinolysis, tissue injury-related thrombin-thrombomodulin-complex generation and activation of anticoagulant and fibrinolytic pathways [18]. Tourniquet, an efficient method to control haemorrhage should only be a method of acute haemorrhage control till surgical intervention as prolonged tourniquet leads to complications like nerve paralysis and limb ischaemia [19].

Permissive Hypotension: Shock worsens in patients with uncontrolled hemorrhage after IV fluids due to dislodgement of tenous clot and dilution of coagulation factors. Hence low normal Blood pressure is tolerated and IV fluids are limited to maintain enough end-organ perfusion pressure to vital organs. Children tolerate hypovolemia much better and can compensate for up to 45% of blood volume loss prior to becoming hypotensive.

Massive Transfusion&Hemostatic Resuscitation: In this strategy, Fresh Frozen Plasma (FFP), Platelets & Packed Red Blood Cells are used in ratio of 1:1:1 to approximate whole blood.

Vasopressors: Vasopressors are useful to maintain target arterial pressure in presence of myocardial dysfunction. Sometimes aggressive fluid administration to restore blood volume increases hydrostatic pressure on wound, causes dislodgement of blood clots, dilutes coagulation factors and causes undesirable cooling. A study observed that the occurrence of coagulopathy was >40% with >2000 ml fluid administration, >50% with >3000 ml and >70% with >4000 ml fluid administration [20].

For patients with expected massive haemorrhage, Plasma or Fibrinogen concentrate and RBC may be used. For trauma patients with active bleeding tranexamic acid, a competitive inhibitor of plasminogen can be used [21].

Plasma (FFP or pathogen-inactivated plasma) should be administered to maintain PT and APTT <1.5 times the normal control. FFP contains nearly about 70% of normal level of all clotting factors [22]. However FFP transfusion is associated with risks like circulatory overload, allergic reactions and transfusion-related acute lung injury. When plasma fibrinogen level is < 1.5–2.0 g/l, fibrinogen concentrate or cryoprecipitate should be used.

Platelet count of $<100 \times 10^9/l$ is the threshold for diffuse bleeding [23]. Ionised calcium levels must be maintained within the normal range during massive transfusion as citrate in stored blood binds calcium and reduces ionised fraction [24]. Other antiplatelet reversal therapies include desmopressin and recombinant activated coagulation factor VII.

Desmopressin is used in those treated with platelet-inhibiting drugs or with von Willebrand disease & not routinely in bleeding trauma patient.

Prothrombin complex concentrate (PCC) is used for reversal of vitamin K-dependent oral anticoagulants [25]. As PCC is associated with risk of venous and arterial thrombosis during recovery, it should be used only during emergency reversal of vitamin K antagonists.

Head Trauma: Head trauma severity is related to mechanism of trauma, which is age specific. As children have larger head-to-body size ratio, thinner cranial bone and less myelinated neural tissue, they are more likely to develop an intracranial lesion following head trauma like diffuse axonal injury and secondary cerebral edema [26].

Signs associated with intracranial injury include prolonged loss of consciousness, disorientation, confusion, amnesia, worsening headache and persistent vomiting. Vital signs including end-tidal CO₂ should be monitored continuously.

Normal core temperature should be maintained. Sedation, analgesia and fluids should be started. Secondary injury from hypoxia, hypotension, hyperthermia or raised intracranial pressure should be avoided.

After structured approach of airway, breathing, circulation and disability, definitive treatment of primary intracranial injury should be done. Previously severe head injury was treated with high dose glucocorticosteroids, fluid restriction and hyperventilation to prevent cerebral edema.

However studies have shown that glucocorticosteroids exacerbates secondary brain injury and fluid restriction leads to hypovolemia, hypotension and decreased Cerebral perfusion pressure [27].

CT scan is done for moderate or severe head trauma or if signs of basal skull fracture (hemotympanum, raccoon eyes, otorrhea or rhinorrhea of cerebrospinal fluid, Battle's sign), boggy scalp hematoma are present.

CT may be required for minor head injury if any one of findings like Glasgow coma scale score <15 at 2 h after injury, open or depressed skull fracture, worsening headache, irritability are present [28].

Blunt Abdominal Trauma: Since abdominal organs are relatively larger and abdominal muscles are weak in children, they are prone to direct injury from blunt trauma.

Fluid resuscitation is most important for management of blunt trauma.

Termination of resuscitation: Guidelines for out-of-hospital withholding or termination of resuscitation for adult victims of traumatic cardiopulmonary arrest include absent pulse, unorganized electrocardiogram rhythm, fixed pupils and cardiopulmonary resuscitation more than 15 minutes [29].

The decision to withhold resuscitation in a child include penetrating or blunt trauma with injuries obviously incompatible with life, such as decapitation or hemicorporectomy; evidence of time lapse following pulselessness like dependent lividity, rigor mortis or decomposition.

Conclusion

Management of trauma patients with massive bleeding and coagulopathy is a challenge. A multidisciplinary approach and prompt intervention can be life saving.

Abbreviations

APTT: Activated Partial Thromboplastin Time, **CT:** Computed Tomography, **FFP:** Fresh Frozen Plasma, **i.v.:** Intravenous, **kg:** kilogram, **mg:** milligram, **mmHg:** millimetre Mercury, **NS:** Normal Saline, **PCC:** Prothrombin Complex Concentrate, **PT:** Prothrombin Time, **Paco2:** Partial Pressure of Carbon Dioxide, **RL:** Ringer Lactate

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