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Yearbook *of* Anesthesiology-10



Yearbook

Indian College of Anaesthesiologists

Editors
Raminder Sehgal
Anjan Trikha

Foreword
Muralidhar K

JAYPEE

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CHAPTER 2

Recent Trends in Trauma Care

Chhavi Sawhney, Yudhyavir Singh

INTRODUCTION

Historically, trauma care dates back to 800–700 bc, when during the Trojan War many warriors possessed the knowledge of wound care and Machaon acted as the chief trauma surgeon. His techniques and skills can be considered as the origin of trauma management.[1] Most of the experience in trauma management was derived from the combat and then adapted to civilian trauma. The experience during the two world wars laid the foundations of current trauma care system and continues to improve with new innovations and techniques.

PREHOSPITAL PHASE

Most of the preventable deaths occur within minutes to few hours after trauma. There are two approaches regarding the extent of care provided to the trauma victims in the prehospital setting. The "scoop and run" approach mainly focuses on minimizing the prehospital time. The prehospital care is limited to cervical spine stabilization and splinting of long bone fractures which can be managed by the personnel trained in providing basic life support.[2]

Aeromedical Transport

Integration of aeromedical transport with the emergency medical services (EMS) is an asset to the prehospital care of trauma victims.[3] As a result of air evacuation, the 1-hour radii of hospitals has increased from 45 miles by ground to 150 miles. It is seen that airlifting a critical trauma patient decreases mortality, if ground transport is not possible or the distance is more than 45 miles.[4] However, the advantages of air transport in urban areas have been diluted by the cost and overtriage of patients with minor trauma. Bledsoe reported that 60% of the patients air transported had minor trauma and 25% required less than 24 hours of hospital stay. The operational cost of aeromedical services per hour is huge, hence overutilization of the service should be avoided. It is risky for the aeromedical personnel and there are instances of several deaths or injuries every year. Development of protocols to identify the candidates who would benefit from air transport would be helpful in conservation of resources.

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Hemostatic Dressings

The other model for trauma care is the "stay and play" approach where, prehospital management is done by the physicians on the basis of clinical presentation, anatomical and physiological scoring system. Initial airway management and bleeding control is provided and depending upon the response, the patient is shifted to the designated facility.

Prehospital torso and junctional areas bleeding control is challenging but has the potential to improve survival. Previously, the strategies included minimal handling, direct pressure on wounds and fracture splinting. Now, devices such as junctional tourniquets, pelvic circumferential binders and ITClamp® have been developed to improve prehospital resuscitation.[5] There are reports which support the use of hemostatic dressings in situations where pressure dressings are unable to control the bleeding. Topical hemostatic compounds like zeolite and kaolin have been used for junctional zones such as neck, axilla, and groin which are problematic areas for hemorrhage control.[6] A variety of chitosan-based dressings (ChitoFlex, ChitoGauze, and CeloxGauze) which create a physical barrier and aid gauze adherence to the wound are also available.[7] As the systemic absorption is limited, there is no risk of inappropriate coagulation distant from the site of application. These dressings decrease prehospital blood loss and hence, reduce mortality. Large varieties of products are available but more robust data is required to compare these options.

Telemedicine

The advances in telecommunication technology have been associated with the simultaneous emergence of telemedicine. The electronic medical records and focused assessment with sonography for trauma (FAST) images are transmitted from rural or primary centers to tertiary care facilities using a satellite network.[8-10] These are a few examples of transferring real-time data from remote locations to expedite management. The "concept" of telemedicine is currently being employed in trauma emergency department (ED). Using bidirectional audiovisual equipment, level 1 trauma centers extend their expertise to guide resuscitation at community hospitals. Latifi et al. described their experience with five rural hospitals attached to a level 1 trauma hospital. The authors observed that the teleconsultation with a trauma surgeon helped in improving outcome by aiding in initial assessment and was cost-effective.[11] But, unreliable communication system and lack of prospective evidence are some of the limitations to the widespread use of telecommunication.[12]

In the present coronavirus disease (COVID-19) pandemic and even in the post COVID era, telemedicine will have an immense role such as scheduling postoperative follow up, managing recovery issues and even, wound care management. It works as "virtual personal protective equipment (PPE)" and helps in saving travel time, cost and conserving resources. Teleconsultation is also being used for new outpatient appointments, reviewing history and imaging.[13]

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Telerehabilitation which includes home-based rehabilitation programs and video-based rather than direct physical training will also decrease in-hospital stay and expedite safe home discharge especially for trauma victims.[14]

TRAUMA DAMAGE CONTROL

Hemorrhage and neurologic injuries are the two most frequent causes of trauma-related mortality. Standard parameters for assessing shock severity included monitoring vital signs, urine output, and organ perfusion parameters such as base deficit and lactate levels. Recent techniques such as noninvasive cardiac output monitoring, near infrared spectrometry, and sublingual videomicroscopy have been recommended for continuous monitoring. All these techniques have their benefits and drawbacks and further studies are required.

High-volume fluid resuscitation after hemorrhagic shock may aggravate injury-related bleeding, acute traumatic coagulopathy (ATC), organ failure and even, mortality. Damage control resuscitation involves rapid hemorrhage control, permissive hypotension, early use of blood products and minimal crystalloids use.[15] Targeting the systolic blood pressure (SBP) at 80–85 mm Hg helps to maintain coronary perfusion and avoid exsanguination and clot disruption. But the patients with traumatic brain injury (TBI) require a higher SBP to maintain cerebral perfusion pressure.

There has been a significant change over the last 30 years in the resuscitation fluid for trauma patients. A balanced transfusion regimen with minimum crystalloids and resembling whole blood is recommended.[16] The transfusion of red blood cell (RBC), fresh frozen plasma (FFP) and platelets in ratio of 1:1:1 prevents early death from exsanguination by achieving hemostasis.[17,18] However, the timing and ratio of platelets to FFP and RBCs is still debatable. Although, component therapy is still in place, the use of whole blood has also made a resurgence. With the recent use of platelet sparing leukoreduction filters, platelet containing whole blood is readily available.[19] Based on the encouraging results and easy availability, whole blood transfusion has been suggested for prehospital transfusion protocol as well. However, severe hemorrhage and resuscitation can lead to a lethal triad of coagulopathy, metabolic acidosis and hypothermia. To prevent ATC, tranexamic acid administration within 3 hours of injury is recommended for patients who are in shock or likely to develop shock. The parameters used for coagulation monitoring like platelet count, prothrombin time and activated partial thromboplastin time are of limited value in trauma. The viscoelastic hemostatic assays (VHA) such as thromboelastography (TEG) and rotational thromboelastography (ROTEG) provide rapid and specific information about clot formation and lysis and hence, allow for a more targeted therapy.[20]

Recent guidelines suggest that dynamic parameters such as focused ultrasound and arterial pressure waveform analysis could be used for predicting volume responsiveness and adequacy of resuscitation.[21]

Damage control surgery is based on the principle of minimal manipulation in a short duration to control hemorrhage in high-risk or severely injured

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patients. Temporary closure techniques, vacuum assisted closure and negative pressure wound therapy have brought a paradigm shift in trauma resuscitation and critical care.[22]

REBOA AND RESUSCITATIVE THORACOTOMY

The use of resuscitative endovascular balloon occlusion of the aorta (REBOA) has gained momentum as endovascular approach to control noncompressible torso hemorrhage. Although the technique was originally described in 1950s, the increased availability and familiarity with the endovascular technique has led to a resurgence of REBOA. Intra-aortic balloon occlusion helps to augment mean arterial pressure to the proximal organs maintaining myocardial and cerebral perfusion. The circulating blood volume can be preserved till definitive surgical management is undertaken. Depending upon the suspected origin of bleeding, the intra-aortic occlusion is performed at different levels. Zone 1 is akin to thoracic aorta clamping that is performed during resuscitative thoracotomy (RT). In acute trauma patient with massive hemopericardium, RT is performed as a last resort. The technique is highly invasive with low survival rates.[23,24] As RT allows for direct access to thoracic vasculature for direct clamping or release of cardiac tamponade, it is indicated in suspected or confirmed major intrathoracic injury and cardiovascular collapse. The use of REBOA should be restricted to patients with exsanguinating hemorrhage arising from below the diaphragm. Moore et al. compared REBOA and RT for noncompressible truncal hemorrhage. The authors concluded that early deaths were fewer in patients undergoing REBOA and survival was equivalent when compared with RT.[25] Future multicenter studies are needed to expand on this approach.

TRAUMA CRITICAL CARE

Trauma resuscitation initiated in the ED may continue in the ICU. Hence, trauma ICU frequently works as an extension of ED for ongoing resuscitation. ATC is seen in 10–25% patients with severe trauma and is associated with increased mortality. The transfusion of packed red blood cells (PRBCs), FFP and platelets in a fixed ratio (1:1:1) focuses on balancing RBCs, platelets and FFP but it does not improve the fibrinogen level.[23] There is an increase in 28-day mortality with fibrinogen level less than 229 mg/dL and less than 100 mg/dL is another risk factor for mortality. So, frequent monitoring of fibrinogen level in ICU using viscoelastic coagulation tests aids in prompt diagnosis and rapid management with cryoprecipitates or fibrinogen concentrate to improve survival rate.

During the past two decades, there has been an increase in the use of point-of-care ultrasound (POCUS) as a diagnostic tool and procedural adjunct in the ICU. Severe chest trauma involving airway, lungs and cardiac injuries are rapidly identified using ultrasound. In neurocritical care, patient with intracranial hemorrhage can be diagnosed and monitored using POCUS. Whereas, transcranial Doppler (TCD) and optic nerve sheath diameter aid in

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monitoring raised intracranial pressure.[26] Recently, the use of ultrasound for assessing the cardiac contractility and fluid status during cardiac arrest has also been recommended.

There is a growing evidence suggesting the early use of ECMO in resuscitation of severe trauma and management of secondary complications like cardiac arrest due to acute cardiac injuries and acute respiratory distress syndrome (ARDS). The potential advantages of ECMO in trauma setting include temporary circulatory arrest and neuroprotection after cardiac arrest till definitive management is done. The improvement within the ECMO device (centrifugal pump techniques, complete heparin coated circuits or the use of heparin-free ECMO) has been useful in trauma patients.[27] In a multicenter study by Zonies et al. higher survival rate was observed in traumatic ARDS with the use of ECMO when compared with nontrauma population (65 vs. 26%). The authors concluded that despite high bleeding risk, successful outcome in trauma patients can be attributed to younger age group and better baseline physiological status in the trauma subgroup.[28]

HYBRID OPERATING ROOMS

There is an increased role of interventional radiology in the management of bleeding trauma patient. The key areas include embolization of visceral vascular injuries which has obviated the need for surgical intervention. Endovascular stenting of major vessels such as descending thoracic aorta, subclavian and vertebral artery has replaced open repair of these vessels leading to a reduction in mortality and complications such as stroke and paraplegia. Temporary occlusion of major vessels such as aorta may provide stability pending surgical repair. Further, angiography and embolization is the procedure of choice for vessels which are difficult to access surgically like pelvic vessels.[29]

This has led to the development of hybrid ORs or RAPTORs (Resuscitation with Angiography, Percutaneous Techniques and Operative Repairs) allowing resuscitation, interventional radiology, intensive care and if required open surgery in the same OR using multidisciplinary approach.[5]

Richter et al. shared their orthopedic trauma experience after using a hybrid OR for 1 year. The authors reported that the OR was advantageous for placing implants, performing spine as well as pelvis cases using minimally invasive and conventional approach. Further, appropriate reduction and implant placement could be confirmed in the OR obviating the need for postoperative imaging. They did not find any increase in the perioperative infection rate. Although there is a paucity of literature but hybrid OR is a safe and effective option for trauma management in future.[30]

TRAUMA TRAINING

The trauma team needs to rapidly assess and manage patients to decrease the preventable deaths.[31] Simulation-based medical education (SBME) provides opportunities for training and evaluation of trauma care in prehospital

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phase, emergency room (ER) and mass casualty scenarios. It is also helpful in other aspects of trauma care like team work, communication and overall performance using trauma team performance observation tool.[32] Recently, a modified nontechnical skills (NOTECHS) scale for trauma (T-NOTECHS) is developed to teach and assess teamwork skills of trauma resuscitation teams. There are reports of improved resuscitation and task performance time using this tool.[31]

A variety of tasks and skills can be acquired and practiced using these modalities. There is a controversy as to which method (manikins or patients or computerized patient simulators) is the best particularly, to improve communication, cooperation and team work. Although, the impact of SBME regarding the improvement of performance is evident in literature but the long-term effects (retention of knowledge and skills) of simulation strategies in trauma needs to be evaluated.[33]

SPECIFIC INJURIES

Chest Trauma

Thoracic trauma is a significant cause of trauma mortality. Fortunately, operative management is required in less than 10% of blunt and 15–30% of penetrating chest injuries. Most chest injuries like tracheobronchial tree injuries, tension pneumothorax, massive hemothorax, open and simple pneumothorax can be managed with airway control, tube thoracostomy and fluid resuscitation. Potentially life-threatening injuries like flail chest and pulmonary contusions can cause respiratory failure for which newer ventilator modes like airway pressure release ventilation (APRV) and even, ECMO are being employed. There has been a dramatic change in the management of traumatic aortic disruption where endovascular repair has largely replaced open repair with good outcomes. Video-assisted thoracic surgery (VATS) is being used in hemodynamically stable patients after both blunt and penetrating trauma including diaphragmatic injury, persistent pneumothorax or retained hemothorax to reduce long-term mortality.[22]

Abdominal Trauma

Solid organ injuries (liver, spleen, and kidney) are the most common abdominal injuries with blunt abdominal trauma. Nonoperative management is the standard of care as long as these patients remain stable. These patients need to be intensely monitored for hemodynamic instability or physiological deterioration to detect missed injury or intraperitoneal bleed. Isolated solid organ injury due to penetrating abdominal trauma was traditionally managed with laparotomy but recently, nonoperative management is preferred in patients without peritonitis. For patients requiring emergency laparotomy, the principles of damage control surgery with minimal manipulation and short duration is recommended.[22]

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Head Trauma

The primary goal of treatment for patients with suspected TBI is prevention of secondary brain injury. In patients with TBI, SBP should be aimed at >90 mm Hg to maintain the cerebral perfusion pressure. In TBI patients who are on anticoagulants and antiplatelets, reversal of these agents to achieve INR < 1.6 and platelets >1,00,000 should be targeted to reduce mortality in patients on these medications.

Intracranial pressure (ICP) monitoring is recommended in patients with severe TBI to maintain an ICP < 20 and CPP between 50 and 70 mm Hg. Although, the evidence for use of hyperosmolar therapy is insufficient but still hypertonic saline and mannitol is the primary pharmacologic therapy available to decrease ICP. Decompressive craniectomy is being used to reduce ICP where it is refractory to other measures. The Brain Trauma Foundation (BTF) guidelines recommend the use of seizure prophylaxis to prevent early post-traumatic seizures along with the other deep vein thrombosis (DVT) and stress ulcer prophylaxis.[34]

Pediatric Trauma

Injury is the most common cause of death and disability in childhood. Recent trends in pediatric trauma resuscitation include crystalloid restriction and blood product-based resuscitation as recommended for the adults. Pediatric mass transfusion protocol includes initial 20 mL/kg bolus of isotonic crystalloid followed by weight-based blood product resuscitation with 10–20 mL/kg of PRBCs, FFP and platelets.[35] Most chest trauma can be managed with a combination of supportive care and tube thoracostomy. Severe chest trauma is usually a component of multisystem injury and the management is frequently similar as for the adults. In pediatric abdominal injuries, the presence of intraperitoneal blood on CT or FAST, grade of injury or presence of vascular blush does not mandate a laparotomy, if the patient is fluid responsive. Prompt exploration is indicated only if the patient is hemodynamically unstable or a diagnostic procedure is positive for blood. Angioembolization of solid organ injuries is an option but should be performed only in centers with experience in pediatric interventional procedures and ready access to OR. Management of TBI in children involves early endotracheal intubation, prevention of secondary brain injury and the use of hypertonic saline and mannitol to reduce brain edema.

CONCLUSION

There has been a paradigm shift in the resuscitation of trauma patients. Current practice involves DCR approach with permissive hypotension, balanced resuscitation with a high ratio of blood products, avoidance of crystalloids and early damage control surgery. Management of trauma patients continues to evolve though the basic principles of rapid identification and management remain the same. Operative management of chest and abdominal trauma has been replaced by conservative management and less invasive approach.

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This requires close and intense monitoring for the failure of nonoperative management, complications or missed injuries. Further research is required to investigate to role of targeted blood component therapy early in shock resuscitation. The role and effect of ECMO on the outcome in trauma patients also needs to be evaluated so that dedicated trauma ECMO units can be established.

KEY POINTS

- Goal of trauma care is zero preventable deaths after injury. This can be achieved by standardization of evidence-based care, application of new concepts and innovations of new devices.
- Prehospital emergency medical services (EMS) are fundamental to trauma care. The ideal system of trauma management is still controversial in terms of prehospital care and needs to be validated.
- Trauma resuscitation has evolved over time with an understanding of physiology of hemorrhagic shock. Trauma resuscitation is based upon the principles of DCR which aim to maintain and/or rapidly restore hemostasis so the clinical focus has shifted toward coagulopathy.
- Hybrid ORs with facilities for resuscitation, interventional radiology, intensive care and open surgery are cost-effective and beneficial. In future, there should be setting up of more hybrid ORs, especially in a level 1 trauma center.
- Trauma training using simulation-based training seems to be a promising educational technique to improve the skills and teamwork required for trauma care.

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