Initial Evaluation and Management

13

Nilesh Vyas and Haralamos Gatos

Introduction

Multi-system trauma constitutes a major global problem affecting millions of people annually inflicting a substantial financial impact on healthcare systems. Traumatic injury remains the major cause of preventable deaths in patients under 40 years. In addition to significant mortality and morbidity rates, there is a considerable socio-economic burden on society to care for these patients with long-term disabilities. Quality of life with a goal of return to pre-trauma levels of functional status is of course the long and short-term goals of care.

Rapid simultaneous assessment and resuscitation permitting a complete physical examination are the principles of initial management of major trauma. Time is a critical challenge to the resuscitation team because 60 % of the polytrauma patients that die do so within the first hour of hospitalization due to loss of airway, excessive blood loss, or from major injury to the central nervous system.

The most significant milestone in the management of major trauma management is the first Advanced Trauma Life Support (ATLS) course in 1978. Since then, enormous efforts have been conducted to save as many patients as possible, especially during the "golden" or first hour after trauma. Nevertheless, most preventable trauma deaths occur early in hospitalization. Prior to surgical intervention one needs to establish direct control of obvious external bleeding, appropriate immobilization, and assurance of adequate airway and breathing. Internal bleeding within the skull, chest, abdomen, or pelvis requires rapid transport to a definitive care facility. Most potentially preventable deaths occur due to airway obstruction, hemopneumothorax, intracranial hemorrhage, intracavitary bleeding, and resultant coagulopathy [1].

Basic tenets of trauma management include assurance of an adequate airway, adequate breathing and primary survey while simultaneously resuscitating and determining key supportive interventions to stabilize the patient.

Overall Approach to the Unstable Patient

In order to achieve the prevention of potential deaths due to major trauma a multifactor and multidisciplinary approach is required. The primary goals of care are to stabilize the patient and prevent secondary injury. The trauma team

N. Vyas (✉)
Dept. of Neurosciences, Inova Fairfax Hospital, Virginia Commonwealth University School of Medicine—Inova Campus, 3300 Gallows Road North Patient Tower, 2nd Floor, Falls Church, VA, USA
e-mail: nilesh.vyas@inova.org

H. Gatos
University Hospital of Larissa, Larissa, Greece
e-mail: gagatos@gmail.com

J.M. Ecklund and L.E. Moores (eds.), *Neurotrauma Management for the Severely Injured Polytrauma Patient*, DOI 10.1007/978-3-319-40208-6_13

achieves this by optimizing oxygenation, ventilation, and circulatory support. Identifying deranged vital signs and patients that are nearing physiological exhaustion is crucial during the initial assessment to act promptly for the safety of the patient.

The objective of triage is to prioritize patients with a high likelihood of early clinical deterioration. Triage of trauma patients considers vital signs and pre-hospital clinical course mechanism of injury, patient age, and known or suspected comorbid conditions. Findings that lead to an accelerated workup include multiple injuries, extremes of age, evidence of severe neurological injury, unstable vital signs, and preexisting cardiac or pulmonary disease.

Primary Survey

The primary trauma survey and following the "ABCs" of trauma serve to identify and immediately treat life-threatening injuries in a logical and systematic, sequential fashion. The primary survey is summarized in ATLS by ABCDE. ABCDE refers to airway, breathing, circulation, disability, and exposure. Frequent reassessment of "ABCs" during care is of great importance. Deforming and destructive injuries can be obvious but may distract the trauma provider. However, a systematic workup must be promptly conducted so that occult, potentially more critical injuries can be treated optimally. Any information obtained may prove crucial including preexisting medical conditions and medications, which may influence the decisions made during resuscitation.

Airway

Definitive airway control with endotracheal intubation is the goal standard, but obviously not indicated for all patients. The first priority is the airway because absence of a secure airway can kill the patient in minutes and therefore is frequently addressed by emergency medical services (EMS) personnel before arrival in the trauma bay of the hospital. The rapid assessment of signs of airway compromise consists of asking the patient a simple question. The absence of a response, or the presence of stridor or coughing can indicate inadequate airway management. The team must exclude airway obstruction by checking for foreign bodies, secretions, blood, vomitus, or fractures. Relief of obstruction with suction or jaw thrust maneuver frequently permits spontaneous ventilation.

All patients with polytrauma are assumed to have cervical spine injury (CSI) until proven otherwise, because there is a 4–20 % cervical spine injury prevalence. Therefore, all assessments and procedures must take care of the cervical spine by immobilization (rigid cervical collar) until subsequent investigations definitively exclude cervical spine injury. This should always be in a provider's mind while assessing and managing a patient's airway.

Definitive airway management with endotracheal intubation is required if there is (1) inadequate ventilation or oxygenation, (2) impending airway obstruction secondary to injury, (3) decreased level of consciousness (GCS <8). Early intubation must be considered in severe multisystem injury and hemodynamic instability, facial burns, inhalation injuries, and when the patient is dangerously aggressive.

Correct endotracheal tube position must be confirmed with end-tidal carbon dioxide and oxygenation measurements in addition to chest radiography. Special precautions may be needed if the resuscitation team suspects difficult airway management.

Breathing

Once the airway is checked or secured the assessment of breathing and ventilation is of next greatest priority. Life-threatening injuries that must be ruled out are tension pneumothorax, open pneumothorax, massive hemothorax, flail chest, and cardiac tamponade. Thoracic injuries are responsible for 25 % of all trauma deaths. In unstable patients, the diagnosis of tension pneumothorax is made clinically and may not require radiographic verification. In these circumstances,

the patient should be treated with needle decompression followed by chest tube insertion. One must be aware of the occult pneumothorax that is evolving rapidly after endotracheal intubation and rarely can even be fatal. Thoracic trauma in addition to causing respiratory collapse can also cause hemodynamic instability due to a massive hemothorax often from lacerated intercostal arteries but also from injury to the heart, lungs, or great vessels.

Circulation

Shock is a state of oxygen delivery insufficient to sustain normal tissue and cellular function. Hemorrhagic shock is the most common cause of traumatic shock. Other types of shock include cardiogenic (myocardial infarction, dysrhythmias), obstructive (tension pneumothorax, cardiac tamponade, pulmonary embolus), and distributive (septic shock, anaphylaxis, neurogenic shock). The lethal triad of the multi-injured patient is hypothermia, coagulopathy, and acidosis. All of these can result from prolonged and irreversible shock.

A decrease in core body temperature increases mortality of patients in hemorrhagic shock. Coagulation factors involved in hemostatic pathways and platelet activity are adversely affected during hypothermia [2]. Hypoperfused tissue that receives rapid restoration of normal blood flow can be secondarily injured by reperfusion injury. This should not prevent the rapid and full restoration of normal perfusion however. The adequate correction of traumatic coagulopathy is essential to increase the survival rate of trauma patients.

Restoration of intravascular volume and normalization of blood pressure ensures adequate organ perfusion. Systemic arterial hypotension has become the most widely used identification for potential shock, but it may not indicate the actual state of tissue oxygen perfusion. Multi-injured patient with a normal SBP may not always have adequate perfusion systemically.

Significant volume of blood loss can occur from several sites. Obvious external sites of bleeding must be controlled immediately. Scalp or other severe lacerations can cause excessive blood loss and should be treated with external pressure during resuscitation and, if this is not sufficient to control the bleeding, sutures should be considered. If available, a simple Weitlaner retractor applied to the laceration often provides quick attenuation of blood loss. Fractured long bones are dealt with by reduction and traction in order to decrease ongoing blood loss, as well as relieve pain, prevent further injury, and restore blood flow to potentially compressed vessels.

Bleeding wounds with obvious vessel injuries should be treated with pressure dressings, until a surgeon can definitively control them in the operating room. Specialized agents added to advanced, hemostatic dressings such as kaolin or chitosan can aid in controlling bleeding in addition to direct pressure. The use of tourniquets is appropriate but should be used judiciously because they can worsen ischemia and damage adjacent or distal structures.

Blood loss of 10–20 % of total blood volume can be treated with intravenous fluid administration and should be reversed rapidly. Blood loss of 20–40 % must be treated with blood transfusion. Blood loss of greater than 40 % is frequently due to ongoing bleeding and in addition to transfusion should be treated surgically as soon as possible to control the source of the blood loss.

Intra venous access is of paramount importance to maintaining adequate circulation and should be obtained simultaneously with the primary survey. Ideal intravenous access includes two large bore cannulas placed in the upper extremities. Subclavian or internal jugular venous access should be considered as the next alternative.

Systolic blood pressure (SBP) must be restored to normal levels by rapid intravenous infusions of an isotonic crystalloid solution (normal saline, lactated ringers). Colloid solution (albumin) is not recommended in the trauma

setting. Elevation of SBP prior to achieving adequate hemostasis may be harmful.

Disability

A rapid neurological assessment using GCS and examination of pupils is of critical importance. Traumatic brain injury (TBI) is common in polytrauma patients and is a common cause of long-term disability and even death. Early identification of TBI and appropriate interventions can minimize these negative outcomes. Cervical spine injury (CSI) is also common and assessment of extremity motor and sensory function is important. Particularly in patients who need early treatment for an unstable airway, a very quick assessment of the patient's neurological exam prior to sedation can help prioritize the need for intracranial injury management. Decreased level of consciousness may have numerous etiologies including but not limited to poor oxygenation, metabolic disturbances, intoxication, and brain injury. Focal neurological injuries are more likely to indicate brain, spine, or nerve injury.

Exposure—Environment

Clothes are removed taking care to avoid hypothermia by use of external warming and warm intravenous fluids. The trauma provider must exclude dorsal injuries by "logrolling" the patient to ensure stability of possible thoracolumbar spine or total spine precautions. Exposure of the patient facilitates the transition to the secondary survey and assessment of other injuries to the patient.

Monitoring

Continuous monitoring of pulse, blood pressure, and respiratory rate is necessary and indispensible even in hospitals that are not trauma centers. Monitoring if possible should include temperature, pulse oximetry, end-tidal carbon dioxide, and occasionally an arterial line for blood pressure.

If there is no suspicion of urethral injury, urinary catheter placement demonstrating sufficient urine output indicates adequate end-organ tissue perfusion. In all intubated patients, when skull base and facial fractures are ruled out, an orogastric tube should be inserted in order to avoid aspiration.

Assessment and Secondary Survey

Secondary survey and continuing resuscitation requires complete physical examination and focuses on directing further diagnostic studies.

Reassessment is essential, and can identify previously missed injuries. In polytrauma patients a definitively secured airway, SBP > 100, and Pulse rate < 100 per minute are crucial in order to leave the trauma bay for further investigations and treatments.

Samples of blood for cross matching for transfusion should be obtained. CBC, BMP, and tox screen. Arterial blood gas can help determinate acid–base deficits imbalances.

Any hemodynamic instability or hypoxemia must be immediately recognized, requiring rapid re-assessment. The differential diagnosis must suspect associated thoracic, abdominal, spinal, and long bone injuries.

Traumatic Brain Injury

Current TBI management focuses on prevention of primary injury and avoidance of secondary injury. The cornerstones of modern TBI treatment start with optimizing the "ABCs" of trauma care in both the acute and subacute time frames. A single episode of hypotension dramatically increases the risk for unfavorable outcome [3]. Brain Trauma Foundation guidelines recommend to strictly avoid hypotension, systolic less BP than 90 mm Hg.

Surgical evacuation of mass lesions causing neurological deficit in emergent fashion is also

required for focal lesions such as depressed skull fractures, epidural hematomas, subdural hematomas, or large intraparenchymal hematomas. For this reason, non-contrast head computed tomography (HCT) remains the optimal imaging modality for suspected TBI and should be performed in all appropriate patients as soon as the patient is stable to travel from the trauma bay to the radiology department. Treatments for TBI beyond surgery typically involve management of elevated intracranial pressure (ICP) and maintaining a cerebral perfusion pressure (CPP) of 60 mm Hg. Prior recommendations for CPP goals of up to 80 mm Hg may exacerbate both cerebral and pulmonary edema.

ICP monitoring is indicated for any patient with an acutely abnormal head CT and a GCS of 8 or less. This may also include patients requiring prolonged sedation for non-cranial surgical procedures or sedation for adequate ventilation. The gold standard for monitoring remains intraventricular catheter placement with the ability to monitor ICP and drain CSF as well, which can be a powerful method to decrease recalcitrant elevated ICP. Alternative ICP monitors use intraparenchymal fiberoptic or strain-gauge technology without the additional advantage of draining CSF. A target ICP of less than 20 mm Hg in combination with the CPP goal of 60 mm Hg is recommended. Sustained ICP greater than 25 mm Hg should prompt escalation of treatments to lower ICP either medical or surgical.

New multimodality monitoring techniques include brain tissue oxygen monitoring and parenchymal microdialysis. These new monitors can provide great volumes of data but are not at this point either the standard of care or proven to improve patient outcomes [4, 5].

First line treatments for elevated ICP include optimizing venous drainage with a loose fitting cervical collar and a straight cervical spine position with the head of the bed elevated 30° in the intensive care unit bed. Second line treatments for elevated ICP focus on hyperosmolar treatments with either hypertonic saline (more common) or mannitol (less common). Hyperventilation, although transiently effective, increases cerebral ischemia and therefore should be reserved exclusively for brief periods only during clinical evidence of herniation syndromes and as a bridge to surgical decompression. Third line treatments for refractory ICP management include barbiturate coma, therapeutic hypothermia, and even decompressive craniectomy. While barbiturate coma and hypothermia have long been used in improving outcomes and are the mainstay of complex ICP management in trauma patients, decompressive craniectomy remains controversial. The DECRA trial results have been used by some neurosurgeons as a reason to avoid decompressive craniectomy. This may be true for diffuse bilateral posttraumatic brain edema but does not apply to focal lesions or unilateral disease: circumstances which may be amenable to significant improvement with surgical decompression (Table 13.1).

The purpose of the initial survey in trauma concerning TBI is to diagnose and arrange evacuation of mass intracranial lesion and treat cerebral edema. Cerebral ischemia is the single

Table 13.1 Glasgow Coma Scale

Eye opening	Points	Verbal response	Points	Motor response	Points
Spontaneous	4	Oriented	5	Obeys commands	6
To voice	3	Confused	4	Purposeful movement	5
To pain	2	Inappropriate words	3	Withdraws	4
None	1	Incomprehensible	2	Flexion	3
		None	1	Extension	2
				None	1

most important factor that influences the outcome after TBI. Early monitoring aids the trauma provider in targeting therapy for cerebral edema and perfusion and minimizing secondary injury to the traumatized brain.

Summary

The initial care of the severely injured, polytrauma patient must focus the multidisciplinary trauma team on the methodical approach to evaluate and stabilize the patient. Following the ABCs outlined by the ATLS protocol provides this framework. This is the foundation for ensuring that any trauma patient achieves the optimal chance at improved outcomes, including patients with traumatic brain injury and other neurological compromise.

References

1. Kirkpatrick AW, Ball CG, D'Amours SK, Zygun D. Acute resuscitation of the unstable adult trauma patient: bedside diagnosis and therapy. Can J Surg. 2008;51(1):57.
2. Pohlman TH, Walsh M, Aversa J, Hutchison EM, Olsen KP, Reed RL. Damage control resuscitation. Blood reviews. 2015 Jul 31;29(4):251-62.
3. Bullock MR, Povlishock JT. Guidelines for the management of severe traumatic brain injury. Editor's Commentary. Journal of neurotrauma. 2007;24:2-p.
4. Chowdhury T, Kowalski S, Arabi Y, Dash HH. General intensive care for patients with traumatic brain injury: An update. Saudi J Anaesth. 2014;8(2):256.
5. Chowdhury T, Kowalski S, Arabi Y, Dash HH. Specific intensive care management of patients with traumatic brain injury: Present and future. Saudi J Anaesth. 2014;8(2):268.