

Advanced Trauma Life Support, 8th Edition, The Evidence for Change

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The American College of Surgeons Committee on Trauma's Advanced Trauma Life Support Course is currently taught in 50 countries. The 8th edition has been revised following broad input by the International ATLS sub-

committee. Graded levels of evidence were used to evaluate and approve changes to the course content. New materials related to principles of disaster management have been added. ATLS is a common language teaching one safe

way of initial trauma assessment and management.

Key Words: Wounds and Injuries, Traumatology [education], Life Support Care, Emergency Treatment [standards], Resuscitation [education].

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The Advanced Trauma Life Support (ATLS) course for doctors was introduced in Nebraska in 1978. It was adopted by the American College of Surgeons and was rapidly introduced across North America in the early 1980s. The course in its initial iterations represented a consensus view by experts of a safe initial approach to trauma management. Its standardized approach coincided with the development of organized trauma centers and systems. It has been credited with improving the knowledge of physicians in organization and procedural skills in the care of the injured, particularly those early in training or lacking experience.^{1–4} There is evidence that

standardizing the process of care leads to reduced mortality and morbidity in trauma systems.⁵ ATLS introduced a simple yet effective approach to initial assessment and management of trauma that has continued to have widespread appeal. International promulgation soon followed the North American Introduction and the ATLS course is now taught in over 50 countries. Nearly 1 million participants have completed the course.

Sequential editions have been edited by the ATLS subcommittee with input from the International ATLS subcommittee and subsequent approval by the Committee on Trauma (COT) Executive Committee. This system was very effective in supporting the course based on expert opinion and select review of current literature for the first 25 years.² However, the increasing international audience for the course and the recognition of the importance of evidence-based medicine fostered a need to update the revision process.⁶ Many nations and organizations have developed models for organizing and teaching trauma care. Representatives from the international community have demonstrated broad support and interest in

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maintaining a common language among trauma care providers. The COT Executive Committee in 2006 and 2007 supported a vision of continued development of ATLS as a common language of trauma care. Its mandate is to teach one safe way of providing initial assessment and care for the injured. To support this vision, future edits will be driven by evidence and will seek greater international involvement in the revision process.⁷

OBJECTIVES

- To present the content changes in the 8th edition of the ATLS course.
- To present the supporting evidence evaluated by the ATLS subcommittee.

METHODS

In 2007, the COT increased international participation by creating three new international regions. These regions were also invited to appoint representatives to the ATLS subcommittee. The revision process for the 8th edition was broadcasted through the International ATLS subcommittee membership, through Trauma.Org, a dedicated trauma interest web site with broad international subscription as well as being disseminated through major North American stakeholders including the AAST.

Contributors were asked to submit proposed changes by chapter along with supporting evidence to the ATLS office through <http://www.trauma.org/> or directly through <http://web.facs.org/atls/atlscourse.revisionsdefault.htm>.

Many systems to classify medical evidence have been published and promoted over the past 15 years. The system by Wright et al.^{8–12} was chosen as it has been adopted by several prominent journals, is easily interpreted and appears to have a high rate of interobserver agreement (Table 1).

The compilation of suggested changes was then reviewed by the ATLS subcommittee in serial meetings in 2006/2007 leading to the final revisions. An expert panel assigned a level of evidence rating to each reference cited in the compendium of changes^{13–205} (Table 2). The ATLS subcommittee did not perform systematic reviews on all suggested changes and in many cases evidence for formal systematic review was lacking. The committee did incorporate these reviews when available. The emphasis on one safe way was used to guide approval of these changes particularly where the level of supporting evidence was poor. The ATLS course will not be at the sharp edge of changes in trauma assessment, resuscitation, and adoption of new technology. It will serve as a common baseline for continued innovation and challenge of existing paradigms in trauma care. The revision process was also cognizant of significant regional variation in practice. Once again it is hoped that wherever these deviate significantly from course content that they will foster well designed trials to evaluate and support alternate and new approaches to trauma care.

Table 1 A Brief Summary of Wright et al. Levels of Evidence. JBJS(A)

| Level of evidence | Treatment | Prognosis | Diagnosis | Economic and Decision analysis |
|-------------------|---|---|---|---|
| 1 | RCT with significant difference or narrow confidence intervals | Prospective study with single inception cohort and >80% follow-up | Testing of previously applied diagnostic criteria in a consecutive series against a gold standard | Clinically sensible costs and alternatives; values obtained from many studies; multiway sensitivity analyses |
| 2 | Systematic reviews of level 1 studies Prospective cohort, poor quality RCT | Systematic review of level 1 studies Retrospective study, untreated controls from a previous RCT | Systematic review of level 1 studies Development of diagnostic criteria on basis of consecutive patients against a gold standard | Systematic review of level 1 studies Clinically sensible costs and alternatives, values obtained from limited studies, multiway sensitivity analyses |
| 3 | Systematic reviews of level 2 studies Case-control study | Systematic review of level 2 studies | Systematic review of level 2 studies Study of nonconsecutive patients (no consistently applied gold standard) | Systematic review of level 2 studies Limited alternatives and costs; poor estimates |
| 4 | Retrospective cohort study Systematic review of level 3 studies | | Systematic review of level 3 studies Case-control study Poor reference standard | Systematic review of level 3 studies No sensitivity analyses |
| 5 | Case series | Case series | Expert opinion | Expert opinion |
| | Expert opinion | Expert opinion | Expert opinion | Expert opinion |

From Ref. 12.

Table 2 ATLS 8th Edition Compendium of Changes

| Chapter | Subject | 7th Edition | 8th Edition |
|--------------------|-----------------------------|---|---|
| Initial assessment | Rectal examination | A rectal examination should be performed before inserting a urinary catheter | A rectal examination should be performed selectively before placing a urinary catheter. If the rectal examination is required the doctor should assess for the presence of blood within the bowel lumen, a high-riding prostate, the presence of pelvic fractures, the integrity of the rectal wall, and the quality of the sphincter tone. (LOE 4) ¹³ |
| Airway | Carbon dioxide detectors | A CO ₂ detector (colorimetric CO ₂ monitoring device) is indicated to help confirm proper intubation The LMA's role in the resuscitation of the injured patient has not been defined | A carbon dioxide (CO ₂) detector (ideally capnography but if not available by a colorimetric CO ₂ monitoring device) is indicated to help confirm proper intubation of the airway (LOE 3) ^{14,15} There is an established role for the LMA in the management of a patient with a difficult airway, particularly if attempts at tracheal intubation or bag-valve-mask ventilation have failed. The LMA does not provide a definitive airway. Proper placement of this device is difficult without appropriate training. When a patient has an LMA in place on arrival in the emergency department, the doctor must plan for definitive airway. (LOE 3), ¹⁶⁻¹⁹ (LOE 2), ²⁰ (LOE 3), ²¹ (LOE 2), ^{22,23} (LOE 4) ²⁴ |
| | Laryngeal mask airway (LMA) | | The laryngeal tube airway (LTA) is an extraglottic airway device with similar capability to provide successful ventilation to the patient as that of the LMA. The LTA is not a definitive airway device and plans to provide a definitive airway must be implemented. (LOE 4) ^{25,26} (LOE 2) ²⁷ |
| | Laryngeal tube airway | New material* | An useful tool when faced with the difficult airway is the Eschmann tracheal tube introducer (ETTI) also known as the gum elastic bougie (GEB). (LOE 4). ²⁸ It is a 60 cm long, 15 French intubating stylette (LOE 5). ²⁹ The ETTI is employed when vocal cords cannot be visualized on direct laryngoscopy. (LOE 5). ³⁰ In multiple operating room studies, successful intubation is seen at rates greater than 95% with ETTI ³⁰ (LOE 4) ^{31,32} (LOE 2) ³³ (LOE 3) ³⁴ (LOE 5) ³⁵ (LOE 4) ³⁶ (LOE 5). ^{37,38} In cases where potential cervical spine injury is suspected, ETTI-aided intubation was successful in 100% of cases in less than 45s (LOE 5). ³⁹ This simple device allowed rapid intubation of nearly 80% of prehospital patients with difficult direct laryngoscopy. (LOE 4) ⁴⁰ |
| | Gum Elastic Bougie | New Material* | It is important to assess the patient's airway before attempting intubation to predict the likely difficulty. Factors which may predict difficulties with airway maneuvers include significant maxillofacial trauma, limited mouth opening and anatomical variation such as receding chin, overbite, or a short thick neck. The mnemonic LEMON (look, evaluate, mallampatti, obstruction, neck) is helpful as a prompt when assessing the potential for difficulty. (LOE 4), ⁴¹ (LOE 1) ⁴² |
| | Difficult airway | New material* | Warmed isotonic electrolyte solutions (eg lactate ringers (RL) or normal saline), are used for initial resuscitation. This type of fluid provides transient intravascular expansion and further stabilizes the vascular volume by replacing accompanying fluid losses into the interstitial and intracellular spaces. An alternative initial fluid is hypertonic saline although current literature does not demonstrate any survival advantage. (LOE 3) ^{43,44} (LOE 2) ^{45,46} |
| Shock | Crystallloid | Warmed isotonic electrolyte solutions are used for initial resuscitation. RL is the initial fluid of choice. Normal saline is the second choice. | |

Table 2 ATLS 8th Edition Compendium of Changes (continued)

| Chapter | Subject | 7th Edition | 8th Edition |
|---|--|--|---|
| Fluid resuscitation | Initial fluid resuscitation based on the 4 ATLS classes of hemorrhage is presented. Assess the patient's response to fluid resuscitation and evidence of adequate end organ perfusion† | The goal of resuscitation is to restore organ perfusion. This is accomplished by the use of resuscitation fluids to replace lost intravascular volume, and has been guided by the goal of restoring a normal blood pressure. It has been emphasized that if blood pressure is raised rapidly before the hemorrhage has been definitely controlled, increased bleeding may occur. This may be seen in the small subset of patients in the transient or nonresponder categories. Persistent infusion of large volumes of fluids in an attempt to achieve a normal blood pressure is not a substitute for definitive control of bleeding. Fluid resuscitation and avoidance of hypotension are important principles in the initial management of blunt trauma patients particularly with TBI. In penetrating trauma with hemorrhage, delaying aggressive fluid resuscitation until definitive control may prevent additional bleeding. Although complications associated with resuscitation injury are undesirable, the alternative of exsanguination is even less so. A careful balanced approach with frequent reevaluation is required. Balancing the goal of organ perfusion with the risks of rebleeding by accepting a lower than normal blood pressure has been called "Controlled resuscitation," "Balanced Resuscitation," "Hypotensive Resuscitation" and "Permissive Hypotension." The goal is the balance, not the hypotension. Such a resuscitation strategy may be a bridge to but is also not a substitute for definitive surgical control of bleeding. (LOE 3) ⁴⁴ (LOE 5) ^{47–50} (LOE 2) ⁵¹ (LOE 4) ⁵² (LOE 2) ⁵³ | Failure to respond to crystalloid and blood administration in the emergency department dictates the need for immediate definitive intervention to control exsanguinating hemorrhage, (e.g. operation or angiembolization) (LOE 4), ^{54–57} (LOE 3), ⁵⁸ (LOE 4), ^{59–67} (LOE 3) ⁶⁸ (LOE 2) ⁶⁹ Acute cardiac tamponade due to trauma is best managed by thoracotomy. Pericardiocentesis may be used as a temporizing maneuver when thoracotomy is not an available option (LOE 4). ^{70–77} |
| Angio-embolization and definitive control of hemorrhage | Treatment of cardiac tamponade | Angio-embolization described for hemodynamically abnormal pelvic fractures with negative diagnostic peritoneal lavage | Base deficit and/or lactate |
| | | Pericardiocentesis is described as the initial management of traumatic tamponade in the shock and thoracic chapters | determining the severity of the acute perfusion deficit |
| | | Observation and/or aspiration of a pneumothorax are risky | Observation and/or aspiration of a pneumothorax |
| Emergency Department thoracotomy | Thoracic trauma | Penetrating thoracic trauma patients, who arrive pulseless with electrical activity may be candidates for resuscitative thoracotomy (RT). Patients sustaining blunt injuries who arrive pulseless with myocardial electrical activity (PEA) are not candidates for resuscitative thoracotomy (RT). (LOE 4) ^{85–91} Multiple reports confirm that emergency department (ED) thoracotomy for patients with blunt trauma and cardiac arrest is rarely effective.† | Penetrating thoracic trauma patients, who arrive pulseless with electrical activity may be candidates for resuscitative thoracotomy (RT). Patients sustaining blunt injuries who arrive pulseless with myocardial electrical activity (PEA) are not candidates for resuscitative thoracotomy (RT). (LOE 4) ^{85–91} Multiple reports confirm that emergency department (ED) thoracotomy for patients with blunt trauma and cardiac arrest is rarely effective.† |

Table 2 ATLS 8th Edition Compendium of Changes (continued)

| Chapter | Subject | 7th Edition | 8th Edition |
|-------------|--|--|---|
| Abdomen | Blunt traumatic aortic injury | New material* | Techniques of endovascular repair are rapidly evolving as an alternate approach for surgical repair of blunt traumatic aortic injury. (LOE 4) ⁹² (LOE 3) ⁹³ |
| | Explosive devices | New Material | Explosive devices cause injuries through several mechanisms. These include penetrating fragment wounds and blunt injuries from the patient being thrown or struck. Patients close to the source of the explosion may have additional pulmonary or hollow viscus injuries related to blast pressure which may have delayed presentation. The potential for pressure injury should not distract the doctor from a systematic A, B, C approach to identification and treatment of the more common blunt and penetrating injuries. (LOE 4) ^{94,95} (LOE 5) ⁹⁶⁻⁹⁹ (LOE 3) ¹⁰⁰ (LOE 4) ¹⁰¹⁻¹⁰⁴ (LOE 5) ¹⁰⁵ The pelvis should be temporarily stabilized or "closed" using an available commercial compression device or sheet to decrease bleeding. Intraabdominal sources of hemorrhage must be excluded or treated operatively. Further decisions to control ongoing pelvic bleeding include angiographic embolization, surgical stabilization, or direct surgical control. (LOE 4) ^{55,57,62,64,65,66} (LOE 3) ⁶⁸ (LOE 4) ¹⁰⁶⁻¹¹¹ (LOE 3) ¹¹² (LOE 4) ¹¹³⁻¹¹⁷ (LOE 2) ¹¹⁸ (LOE 4) ¹¹⁹ (LOE 3) ¹²⁰ |
| Head trauma | Hemo-dynamically abnormal pelvic fractures | Describes management based on DPL + (celiotomy) and DPL – Angiography-embolization§ | The categorization of traumatic brain injury reflects a continuum. The definition of minor traumatic brain injury has reverted to GCS 13-15, with moderate changed to 9-12. Neurotrauma literature varies on these ranges, but multiple major organizations including Eastern Association for the Surgery of Trauma and the Center for Disease Control use 13-15, which is also consistent with the Canadian CT Head Rule introduced in this revision. The Canadian CT Head Rule has been adopted as a guide to clarifying when CT scans of the head should be used. (LOE 4), ¹²¹ (LOE 1), ^{122,123} (LOE 2), ¹²⁴ (LOE 1), ¹²⁵ (LOE 2), ^{126,127} (LOE 4) ¹²⁸ Objects that penetrate the intracranial compartment or infratemporal fossa must be left in place until possible vascular injury has been evaluated and definitive neurosurgical management is established. Disturbing or removing penetrating objects prematurely may lead to fatal vascular injury or intracranial hemorrhage. More extensive wounds with nonviable scalp, bone, or dura are treated with careful debridement before primary closure or grafting to secure a watertight wound. In patients with significant fragmentation of the skull, debridement of the cranial wound with opening or removing a portion of the skull is necessary. Significant mass effect is addressed by evacuating intracranial hematomas, and debridement of necrotic brain tissue and safely accessible bone fragments. In the absence of significant mass effect, surgical debridement of the missile track in the brain, routine surgical removal of fragments distant from the entry site and reoperation solely to remove retained bone or missile fragments does not measurably improve outcome and is not recommended. Repair of open-air sinus injuries and CSF leaks that do not close spontaneously (or with temporary CSF diversion) is recommended, using careful watertight closure of the dura. (LOE 4) ¹²⁹⁻¹³⁴ |
| | Classification and head CT | Mild brain injury defined as GCS 14-15. CT is ideal in all patients except completely asymptomatic and neurologically normal | |
| | Penetrating brain injury | New material* | |

Table 2 ATLS 8th Edition Compendium of Changes (continued)

| Chapter | Subject | 7th Edition | 8th Edition |
|---|--|---------------|---|
| Spine | Blunt carotid and vertebral vascular injuries (BCVI) | New material* | Blunt trauma to the head and neck has been recognized as a risk factor for carotid and vertebral arterial injuries. Early recognition and treatment of these injuries may reduce the risk of stroke. Indications for screening are evolving. Suggested criteria for screening include: (a) C1–3 fracture (b) C spine fracture with subluxation (c) Fractures involving the foramen transversarium. Approximately 1/3 of these patients will have BCVI when imaged with CT angiography of the neck. (LOE 2) ¹³⁵ (LOE 2), ¹³⁶ (LOE 1) ¹³⁷ (LOE 3) ^{139, 140} |
| Steroids | In North America high dose methylprednisolone given to the patient with nonpenetrating spinal cord injury . . . is a currently accepted treatment* | New material* | There is insufficient evidence to support the routine use of steroids in spinal cord injury at present. (LOE 1) ¹⁴¹ (LOE 3) ¹⁴² (LOE 1), ¹⁴³ (LOE 1), ⁴⁴ (LOE 2), ¹⁴⁵ (LOE 1), ¹⁴⁶ (LOE 2), ¹⁴⁷ (LOE 1), ¹⁴⁸ (LOE 1), ¹⁴⁹ (LOE 2), ¹⁵⁰ (LOE 2) ¹⁵¹ |
| CT evaluation of the cervical spine | | | CT may be used in lieu of plain images to evaluate the C Spine. (LOE 3), ^{152–158} (LOE 1), ¹⁵⁹ (LOE 2), ¹⁶⁰ (LOE 1), ¹⁶¹ (LOE 2) ¹⁶² |
| Musculoskeletal trauma and extremity trauma | Atlantooccipital dislocation Tourniquet | New material* | Aids to identification of atlantooccipital dislocation on spine films including Power's ratio are included in the spinal skills station. (LOE 3) ^{163, 164} |
| | The judicious use of a pneumatic tourniquet may be helpful and lifesaving | | An acutely avascular extremity must be recognized promptly and treated emergently. The use of a tourniquet while controversial may occasionally be life and/or limb saving in the presence of ongoing hemorrhage uncontrolled by direct pressure. A properly applied tourniquet, while endangering the limb, can save a life. A tourniquet must occlude arterial inflow, as occluding only the venous system can increase hemorrhage. The risks of tourniquet use increase with time. If a tourniquet must remain in place for a prolonged period to save a life, the physician must be clear that the choice of life over limb has been made. (LOE 5), ^{96, 165} (LOE 4), ^{166, 167} (LOE 5), ^{168, 169} (LOE 4), ¹⁷⁰ (LOE 5) ¹⁷¹ |
| Compartment syndrome | | | A palpable distal pulse usually is present in compartment syndrome |
| Trauma in women | Restraints | New material* | Compared with restrained pregnant women involved in collisions, unrestrained pregnant women have a higher risk of premature delivery and fetal death. (LOE 4), ^{175, 176} (LOE 2) ¹⁷⁷ (LOE 4) ^{178–180} (LOE 2) ¹⁸¹ |
| Pediatric trauma | Airbags | New material* | There does not appear to be any increase in pregnancy-specific risks from deployment of airbags in motor vehicles. (LOE 4) ^{178, 180} |
| | Functional outcome | New material* | Long-term follow-up of functional outcome indicates that while victims of major trauma during childhood may retain functional disabilities, quality of life remains very high. (LOE 3) ¹⁸² |
| | Abdominal imaging CT | New material* | The presence of a splenic blush on computed tomography (CT) with intravenous contrast does not mandate exploration, and the decision to operate continues to be based on the amount of blood lost as well as abnormal physiologic parameters. (LOE 4) ¹⁸³ |

Table 2 ATLS 8th Edition Compendium of Changes (continued)

| Chapter | Subject | 7th Edition | 8th Edition |
|----------|---------------------------|---|---|
| | Abdominal imaging FAST | Few studies on the efficacy of ultrasound in the child with abdominal injury have been reported. The role of abdominal ultrasound in children remains to be defined | The use of focused assessment by sonography in trauma (FAST) in the injured child is rapidly evolving. If large amounts of intraabdominal blood are found, significant injury is certain to be present. However, even in these patients, operative management is indicated not by the amount of intraperitoneal blood, but by hemodynamic abnormality and its response to treatment. FAST is incapable of identifying isolated intraperitoneal injuries, which account for up to one third of solid organ injuries in children. (LOE 3) ¹⁸⁴⁻¹⁹² The incidence of intraabdominal injury is significantly higher if abdominal wall bruising is observed during the primary or secondary survey. (LOE 3) ¹⁹³ |
| | Abdominal bruising | New material* | |
| Disaster | | New appendix and optional lecture New material* | There is little evidence at present, other than case reports and expert opinion, to support and guide current practice in disaster medicine. However, case reports of recent mass casualty events involving physical trauma, systematic review of previous reports and computer modeling of likely disaster scenarios have all been helpful in developing the rationale for current approaches to the medical and surgical response to injured patients in disasters. (LOE 3) ^{198,194-196} (LOE 5) ¹⁹⁷⁻²⁰⁵ |

* New material: This content was not included in the 7th edition.

† Fluid resuscitation. The 7th edition did state that fluid resuscitation should be guided by response and that requirements are difficult to predict. The 8th edition emphasizes the concept of balanced resuscitation and introduces the clinical scenario (e.g., TBI vs. penetrating injury) as a consideration in resuscitation.

‡ The recommendation on ED thoracotomy includes a review of signs of life for penetrating trauma (reactive pupils, spontaneous movement, organized EKG activity). The recommendation regarding blunt trauma emphasizes that ED thoracotomy is not indicated for blunt trauma in PEA.

§ The management algorithm for pelvic fractures has been updated to reflect the complementary roles of temporary stabilization, surgery, fixation, and angioembolization.

DISCUSSION

The ATLS course will continue to evolve in response to growth in knowledge, change in injury patterns, and evolution of trauma care and trauma systems around the world. The level of evidence supporting one safe way will undoubtedly improve with subsequent editions. The 8th edition has also made changes to syntax and points of emphasis reflecting feedback and correspondence received during the revision process. Finally the revised content and evolution in practice resulted in revisions to management algorithms for airway management and management of pelvic fractures. In the future, ATLS will incorporate new learning platforms to remain current and meet the expectations of the next generation of Trauma Care Providers.

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