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The Advanced Trauma Life Support (ATLS) course for doctors was introduced in Nebraska in 1978 and given nationally for the first time in 1980 by the American College of Surgeons. The goal of ATLS is to serve as a safe and reliable method for managing patients with traumatic injury and provide a "common baseline for the continued innovation and challenge of existing paradigms in trauma care."[1] Currently, it is taught in 50 countries, with nearly 1 million participants having completed the course. The most recent version (8th edition) was published in 2008.

— The Editor

ATLS Update

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Introduction

Early versions of the ATLS course were largely based upon a consensus of experts.[1] Likewise, previous editions of the course have been updated based upon expert opinion and a select review of the literature.[1] Given increasing international involvement and recognition of the importance of an evidence-based practice, the revision process was enhanced for the 8th edition.

For this edition, the ATLS subcommittee solicited recommendations for updates and additions from the International ATLS subcommittee, a dedicated trauma interest website, and various organizations and stakeholders.[1] A compilation of suggested changes was reviewed by the ATLS subcommittee and the evidence behind any revision was assigned a level of evidence (LOE) rating by an expert panel. *(See Table 1.)* In this manner, the subcommittee attempted to utilize an international, multidisciplinary, and evidence-based approach to improve the current edition.

The specific changes made to the ATLS educational course are reviewed here using the course's respective chapter headings. *(See Table 2.)*

Statement of Financial Disclosure

Dr. Dietrich (editor in chief), Drs. Fix and Germann (authors), and Falcone (peer reviewer), and Ms. Behrens (nurse reviewer) report no relationships with companies related to this field of study.

Initial Assessment

The first content revision is found in the Initial Assessment chapter and involves the performance of a rectal examination prior to placing a urinary catheter following traumatic injury.

As part of the routine resuscitation of trauma patients, urinary and gastric catheters are recommended. Urinary catheters assist in the monitoring of urinary output as a means of tracking volume status and renal perfusion. Transurethral bladder catheterization is contraindicated in patients in whom urethral transaction is suspected, as a partial urethral tear may be converted into a complete transection. A potential urethral injury may be suggested by a high-riding or nonpalpable prostate or a pelvic fracture. Thus, the 7th edition states that "the urinary catheter should not be inserted before an examination of the rectum and genitalia," and "a rectal examination should be performed prior to catheter placement."[2] The 8th edition has revised this recommendation to read, "A rectal examination may be performed before placing a urinary catheter."[3] This recommendation is supported by Esposito and colleagues, who performed a prospective study of clinical indicators other (OCI) than digital rectal examination (DRE) denoting gastrointestinal bleeding, urethral disruption, or spinal cord injury, and correlated DRE findings suggesting the same.[4] DRE findings agreed positively or negatively with one or more OCI of index injuries in 93% of all cases. Overall, negative predictive value of DRE was the same as that of OCI (99%). DRE was equivalent to OCI for confirming or excluding the presence of index injuries. The authors conclude that DRE rarely provides additional accurate or useful information that changes management. This study was assigned the 4th category of level of evidence (LOE 4).

Airway

Numerous revisions have been made to the Airway chapter, including updated material and recommendations regarding the use of carbon dioxide detectors, laryngeal mask airways (LMA), laryngeal tube airways (LTA), gum elastic bougies (GEB), and the evaluation of a difficult airway.

The 7th edition states that "a carbon dioxide [CO_2] detector [colorimetric CO_2 monitoring device] is indicted to help confirm proper intubation."[2] The 8th edition expands this recommendation for CO_2 detection from endotracheal tube confirmation to specifying that capnography (continuous CO_2 detection with a waveform) is preferred to capnometry (single measurement of CO_2).[3] Two references (LOE 3) are included in the 8th edition in support of capnography and capnometry. Grmec and Mally describe a prospective study performed in the prehospital setting that compared three different methods for immediate confirmation of endotracheal tube placement in patients with severe head injury: auscultation, capnometry, and capnography.[5] The confirmation of final tube placement was performed by a second direct visualization with laryngoscope. In the 81 patients evaluated, capnometry and capnography (after sixth breaths) were significantly better indicators for tracheal tube placement (sensitivity 100%, specificity 100%) than auscultation (sensitivity 94%, specificity 66%). Silvestri and Ralls performed a prospective, observational study of the out-of-hospital use of continuous end-tidal carbon dioxide monitoring and the rate of unrecognized misplaced intubation.[6] The overall incidence of unrecognized misplaced intubations was 9%. The rate of unrecognized misplaced intubations in the group for whom continuous $ETCO_2$ monitoring was used was zero, whereas the rate in the group for whom continuous $ETCO_2$ monitoring was not used was 23.3% (95% CI 13.4%–36.0%).

The role of the LMA as an alternative airway device was previously undefined in the ATLS course. The LMA is considered a useful airway device in a patient who has had failed attempts at intubation or bag-valve-mask ventilation (BVM).[3] However, the LMA is not considered a definitive airway. For this reason, ATLS recommends that physicians plan for a definitive airway when patients have an LMA in place on arrival to the emergency department (ED). Nine references regarding LMA have been added to the newest edition, including three studies meeting a category 2 LOE. [7-15] These three studies maintain the usability (including patients immobilized in a rigid cervical collar), safety, and efficacy of the LMA. Similarly, other studies referenced in support of the LMA (LOE 3 and 4) support its effectiveness as a rescue airway during resuscitation if both BVM and endotracheal tube intubation have been unsuccessful.

The LTA is an "extraglottic airway device with similar capability to provide successful ventilation to the patient as that of the LMA." As with the LMA, the LTA is not considered a definitive airway device. Level 2 and 4 evidence is presented in support of this new recommendation.[16-18] Level 2 evidence in support of the use of LTA was provided by Russi and Miller.[18] The aim of this

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Table 1. ATLS Level of Evidence Rating System

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	Systematic review of level 1 studies	Systematic review of level 1 studies	Systematic review of level 1 studies
	Prospective cohort, poor quality RCT	Retrospective study, untreated controls from a previous RCT	Development of diagnostic criteria on basis of consecutive patients against a gold standard	Clinically sensible costs and alternatives, values obtained from limited studies, multiway sensitivity analyses
3	Systematic reviews of level 2 studies	Systematic reviews of level 2 studies	Systematic reviews of level 2 studies	Systematic reviews of level 2 studies
	Case-control study		Study of nonconsecutive patients (no consistently applied gold standard)	Limited alternatives and costs; poor estimates
4	Case series	Case series	Case-control study	No sensitivity analyses
			Poor reference standard	
5	Expert opinion	Expert opinion	Expert opinion	Expert opinion

Used with permission from: Wright JG, Swiontkowski MF, Heckman JD. Introducing levels of evidence to the journal. *J Bone Joint Surg Am* 2003;85A:1-3.

study was to determine if LTA offers improved placement success and times over the Combitube (ETC) and endotracheal tube (ETT) in a simulated difficult airway. Sixty-nine prehospital providers — emergency medical technicians (EMT-Bs) and paramedics (EMT-Ps) — were assessed in a series of trauma scenarios involving the placement of an ETT, ETC, and LTA in a difficult airway simulator. Primary outcome measures were placement time and success for each device. Successful placement in the manikin was defined by adequate placement depth, inflation of device cuffs, the presence of breath sounds, and the absence of epigastric sounds. EMT-Ps successfully placed an ETT in 68.9% (31/45) of attempts. EMT-P success for ETC and LTA scenarios were 82.2% (37/45) and 100% (45/45). EMT-B success in the ETC was 87.5% (21/24) and 100% (24/24) with the LTA. Differences in successful placement between all devices were significant for paramedics only. Like the LMA, the LTA is placed without direct visualization of the glottis and does not require significant manipulation of the head and neck.

The GEB is another new addition to ATLS in 2008. The GEB, also known as the Eschmann Tracheal Introducer (ETTI), is a 60 cm-long, 15 French stylette with a Coude tip angulated at 40°. When the vocal cords cannot be visualized on direct laryngoscopy, the GEB may be passed blindly beyond the epiglottis with the angulated tip positioned anteriorly. Tracheal position is confirmed by feeling for clicks as tracheal rings are struck or when the tube rotates as it enters the right or left bronchus. An endotracheal tube is passed over the stylette and the GEB is then removed. Level 2-5 evidence supports the use of GEB as an airway adjunct.[19-31] In multiple operating room studies, successful intubation occurred at rates greater than 95% with GEB.[19,20,23,24,26-29,31]

The final amendment in the Airway chapter is new material regarding the prediction of a difficult airway. This segment emphasizes the importance of assessing the patient's airway prior to an intubation attempt in order to predict the difficulty. The mnemonic LEMON ("Look externally, Evaluate 3-3-2 rule, Mallampati, Obstruction, Neck mobility") is helpful in judging the potential for intubation difficulty.[32,33] External characteristics that may predict difficulty with intubation include significant maxillofacial trauma, limited mouth opening, and anatomical variation such as a receding chin, overbite, or a short neck. The 3-3-2 rule evaluates the alignment of the pharyngeal, laryngeal, and oral axes, and may predict the ease of intubation. *(See Figure 1.)* Mallampati classification assesses the ability to visualize the hypopharynx. *(See Figure 2.)* Conditions that cause airway

Table 2. Major Updates to ATLS

Chapter	Major Updates
Initial Assessment	Rectal examination
Airway	Carbon dioxide devices LMA, LTA, gum elastic bougie Difficult airway assessment
Shock	Fluid resuscitation Angioembolization Cardiac tamponade Base deficit and lactate
Thoracic	Pneumothorax Blunt aortic injury ED thoracotomy
Abdomen	Explosive devices Hemodynamically unstable pelvic fractures
Head Trauma	Classification of minor head injury Canadian Head CT rules Penetrating brain injury
Spine and Spinal Cord Trauma	Blunt carotid and vertebral injuries No support for steroids in cord injury CT of cervical spine Atlantooccipital dislocation
Musculoskeletal Trauma	Tourniquets Compartment syndrome
Pediatric Trauma	Functional outcome Abdominal imaging (CT and FAST) Abdominal bruising
Geriatric Trauma	Transfusions Elder abuse
Trauma in Women	Restraints in pregnant patients Airbags in pregnant patients
Transfer to Definitive Care	Use of a checklist in transfer form

obstruction, such as epiglottitis, peritonsillar abscess, and trauma, will make laryngoscopy and ventilation difficult. Finally, neck mobility is assessed with the understanding that patients with limited neck movement, such as those in a hard cervical collar, are more difficult to intubate.

Shock

In the 8th edition update of the ATLS Shock chapter, the initial management of hemorrhagic shock and pericardial tamponade and the utility of a base deficit and lactate are revised.

Prior versions of ATLS declare that "warmed isotonic electrolyte solutions are used for initial resuscitation" with lactated ringer's (RL) being the initial fluid of choice and normal saline the second choice.[2] The current edition does not preference RL over normal saline, but now states "warmed isotonic electrolyte solutions, such as lactated ringer's and normal saline, are used for initial resuscitation."[3]

Hypertonic solutions are considered to have a greater ability to expand blood volume, and thus elevate blood pressure, and can be administered as a small-volume infusion over a short time period. However, the current literature does not support the routine use of hypertonic saline, as no survival advantage has been demonstrated.[34-37] Evidence for this statement is supported by LOE 2 and 3 research. A meta-analysis (LOE 2) of 14 randomized trials comparing hypertonic saline to isotonic and near-isotonic crystalloid failed to demonstrate any benefit of hypertonic crystalloid in the resuscitation of trauma patients.[37]

ATLS continues to teach the four classes of hemorrhage based upon clinical signs as a useful tool for estimating the percentage of acute blood loss. These clinical findings often represent a continuum of ongoing hemorrhage and a way to guide initial therapy. However, volume replacement is guided by the patient's response to initial therapy, not solely by the initial classification category. The current edition contains an enhanced description of the initial fluid therapy, including an introduction to the concept of permissive hypotension.

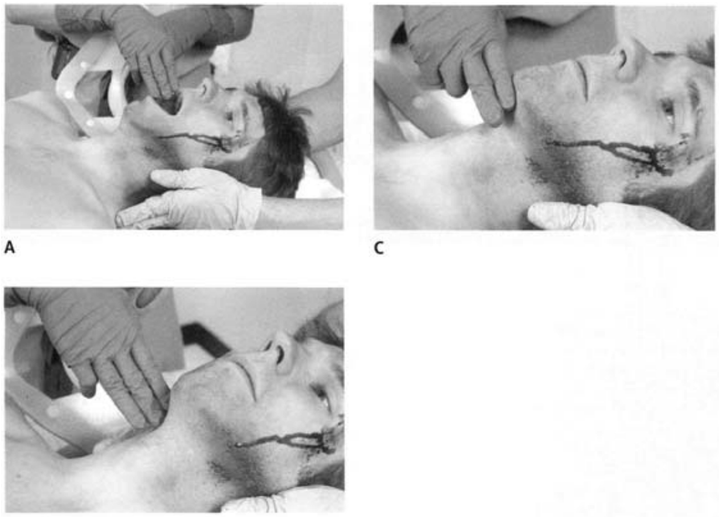
The 8th edition states:

> "Fluid resuscitation and avoidance of hypotension are important principles in the initial management of blunt trauma patients particularly those with traumatic brain injury [TBI]. In penetrating trauma with hemorrhage, delayed 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."[1]

Balancing the goal of organ perfusion with the risks of rebleeding by accepting a lower-than-normal blood pressure has been termed "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 not a substitute for, definitive surgical control of bleeding.

Supportive research regarding fluid resuscitation is provided and categorized as level 2–5 evidence.[35,38-44] Dutton and colleagues (LOE 2) randomized 110 patients presenting in hemorrhagic shock to one of two fluid resuscitation protocols: target SBP > 100 mmHg (conventional) or target SBP of 70 mmHg (low).[39] Fluid therapy was titrated to this endpoint until definitive hemostasis was achieved. In-hospital mortality, injury severity, and survival were determined for each patient. The study cohort had a mean age of 31 years, with 51% suffering penetrating trauma. While a significant difference in SBP was observed between the two groups, the overall survival was 92.7%, with four deaths in each group. The authors concluded that lack of effect on mortality between groups was likely impacted by improvements in diagnostic and therapeutic technology, the heterogeneous nature of

Figure 1. 3-3-2 Rule



To allow for alignment of the pharyngeal, laryngeal, and oral axes, and therefore simple intubation, the following relationships should be observed: The distance between the patient's incisor teeth should be at least 3 finger breadths (A); the distance between the hyoid bone and the chin should be at least 3 finger breadths (B); and the distance between the thyroid notch and floor of the mouth should be at least 2 finger breadths (C).

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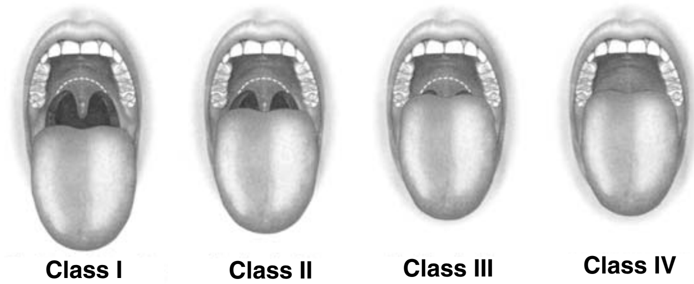
Figure 2. Mallampati Classification



Mallampati classifications: Used to visualize the hypopharynx. **Class I:** soft palate, uvula, fauces pillars visible. **Class II:** soft palate, uvula, fauces visible. **Class III:** soft palate, base of uvula visible. **Class IV:** hard palate only visible.

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human traumatic injuries, and the imprecision of SBP as a marker for tissue oxygen delivery. Bickell and colleagues (LOE 2) performed a prospective trial comparing immediate and delayed resuscitation in patients with penetrating torso trauma and a prehospital BP < 90mmHg.[38] Five-hundred and ninety-eight patients were assigned to either immediate fluid resuscitation before they reached the hospital and in the trauma center, or no fluid resuscitation until they reached the operating room. Among the 289 patients who received delayed fluid resuscitation, 203 (70%) survived and were discharged from the hospital, as compared with 193 of the 309 patients (62%) who received immediate fluid resuscitation (P = 0.04). The mean estimated intraoperative blood loss was similar in the two groups. Among the 238 patients in the delayed-resuscitation group who survived to the postoperative period, 55 (23%) had one or more complications (adult respiratory distress syndrome, sepsis syndrome, acute renal failure, coagulopathy, wound infection, or pneumonia), as compared with 69 of the 227 patients (30%) in the immediate resuscitation group (P = 0.08). The duration of hospitalization was also shorter in the delayed resuscitation group. Authors conclude that in hypotensive patients with penetrating torso injuries, delay of aggressive fluid resuscitation until operative intervention improves the outcome.

As the goal of a "balanced" resuscitation is end-organ perfusion, a failed hemodynamic response to crystalloid and blood administration dictates the need for immediate intervention (operation or angioembolization) to control exsanguinating hemorrhage.[3] Although no more details or recommendations regarding embolization are provided in this section of the 8th edition, 16 new references are listed regarding the use of angioembolization for pelvic fracture and solid organ injury, namely splenic and hepatic hemorrhage.[45-60] The use of angioembolization in an unstable patient with a pelvic fracture is also discussed in the Abdominal and Pelvic Trauma chapter.

Further amendments made to the Shock chapter of the ATLS manual include the use of pericardiocentesis in cardiac tamponade. In prior ATLS manuals, pericardiocentesis is described as the initial treatment of traumatic tamponade. The prior edition states that "appropriate placement of a needle…into the pericardial sac for tamponade" temporarily relieves this life-threatening condition.[2] The updated position states that "cardiac tamponade is best managed by thoracotomy."[3] Pericardiocentesis is now considered a temporizing maneuver to be used when thoracotomy is not an available option. Eight LOE 4 articles support this new recommendation.[61-68]

The final revision to the Shock chapter involves the use of base deficit and lactate. The 7th edition teaches that a base deficit may be useful in estimating the severity of the acute perfusion deficit,[2] whereas the 8th edition declares that a base deficit and/or lactate can be useful in determining the presence and severity of shock. This slightly stronger wording and the addition of lactate have been added with the support of four LOE 2 and 3 studies.[69-72] Kaplan and colleagues found these markers of inadequate local tissue perfusion especially relevant in the patient with a "normal" blood pressure.[71] In this observational, retrospective review of trauma patients requiring vascular repair of torso or extremity injury, the initial ED base deficit and lactate (in addition to pH, anion gap, strong ion difference, and strong ion gap) discriminated survivors from non-survivors. Serial measurements of these values can also be used to monitor the response to therapy.

Thoracic Trauma

Revisions to the Thoracic trauma chapter of the updated ATLS manual involve the treatment of pneumothorax, ED thoracotomy, and surgical management of blunt aortic injury.[3]

A pneumothorax is best treated with a chest tube placed at the fourth or fifth intercostal space, just anterior to the midaxillary line.[2,3] Previously, observation and/or aspiration of any pneumothorax was considered "risky," as a simple pneumothorax can quickly convert to a life-threatening tension pneumothorax, particularly if it is unrecognized or positive-pressure ventilation is applied.[2] Current ATLS recommendations state that observation and aspiration of an asymptomatic pneumothorax "may be appropriate," but the choice should be made by a "qualified doctor"; otherwise, placement of a chest tube should be performed.[3] The recommendation to support this change from "risky" to "may be appropriate" was based on level 2 and 4 evidence.[73-75] Brasel and colleagues (LOE 2) performed a prospective trial that randomized blunt trauma patients with occult pneumothoraces to computed tomography (CT) scan or observation.[74] An occult pneumothorax (OPTX) was defined as a pneumothorax seen on abdominal CT scan but not on an anteroposterior chest x-ray (CXR) as read by the trauma chief resident or attending staff member. Primary outcome measures were respiratory compromise and progression of pneumothoraces. Thirty-nine patients with 44 pneumothoraces were enrolled. Eighteen patients received CT scan, and 21 patients were observed. There was no difference in overall complication rate. No patient had respiratory distress related to the OPTX or required emergent CT scan. The authors conclude that occult pneumothoraces can be safely observed in patients with blunt traumatic injury.

Patients with penetrating thoracic injuries who arrive pulseless but with myocardial electrical activity may be candidates for immediate resuscitative thoracotomy.[2,3] However, patients who sustain blunt injuries with the same presentation are not candidates for thoracotomy, as multiple reports (LOE 4) confirm this maneuver rarely to be effective.[3,76-80] Likewise, in patients with penetrating thoracic injuries and no signs of life and no cardiac electrical activity, no further resuscitative effort should be made.[2,3] To note, ATLS states that a "qualified surgeon" must be present at the time of the patient's arrival to determine the need and potential for success of a resuscitative thoracotomy in the ED.[2,3] Rhee and colleagues performed a review of 24 studies, (n = 4620) that reported ED thoracotomy for both blunt and penetrating trauma during the previous 25 years.[81] The primary outcomes analyzed were in-hospital survival rates. Survival rates were 8.8% for penetrating injuries and 1.4% for blunt injuries. Absence of signs of life in the field yielded a survival rate of 1.2%. The best survival results are seen in patients who undergo thoracotomy for thoracic stab injuries and who arrive to the ED with signs of life.

The 8th edition includes substantiated support for endovascular repair for blunt traumatic aortic injury. The treatment of traumatic aortic rupture involves either primary repair or resection of the torn segment and replacement with an interposition graft. The techniques of endovascular repair are rapidly evolving as an alternative approach for repair of blunt traumatic injury.[3,82-84] A recent study (not referenced in the ATLS manual) assessed the early efficacy and safety of endovascular stent grafts in traumatic thoracic aortic injuries and compared outcomes with the standard operative repair.[83] The outcome data of this prospective, nonrandomized, multicenter study included mortality, complications, and intensive care unit and hospital days. Overall, 125 patients (64.9%) were selected for endovascular stent graft and 68 (35.2%) for operative repair. Stent grafting was selected in 71.6% of the 74 patients with major extrathoracic injuries and in 60.0% of the 115 patients with no major extrathoracic injuries. Overall, 25 patients in the stented group (20.0%) developed 32 device-related complications, 18 of which were endoleaks (14.4%). Procedure-related paraplegia developed in 2.9% in the operative repair group and 0.8% in the stent graft group. Multivariable analysis adjusting for severe extrathoracic injuries, hypotension, GCS, and age showed that the endovascular stent graft group had a significantly lower mortality (adjusted odds ratio: 8.42; 95% CI 2.76–25.69; adjusted p = <0.001), and fewer blood transfusions (adjusted mean difference: 4.98; 95% CI 0.14–9.82; adjusted p = 0.046) than the operative repair group. Among the 115 patients without major extrathoracic injuries, higher mortality and higher transfusion requirements were also found in the operative group. The authors conclude that endovascular stent graft is associated with significantly lower mortality; however, there is a considerable risk of serious device-related complications.

Abdominal and Pelvic Trauma

New educational material on explosive devices and recommendations in the Abdominal and Pelvic Trauma chapter involve the management of hemodynamically unstable patients with pelvic fractures.

Explosive devices cause injuries through several mechanisms. These include penetrating fragment wounds and blunt injuries from the patient being thrown or struck. Therefore, when evaluating these patients, both penetrating and blunt mechanisms of injury need to be considered. Patients close to the source of the explosion may have additional pulmonary and hollow viscera injuries related to blast pressure. However, "the potential for high-pressure injury should not distract the doctor from a systematic, ABC approach to identification and the treatment of the more common blunt and penetrating injuries." Twelve LOE 3–5 articles are referenced by the ATLS manual regarding explosive devices.[85-96]

Pelvic fractures have a significant association with injuries to intraperitoneal and retroperitoneal visceral and vascular structures. However, hypotension may or may not be related to the pelvic fracture itself. Patients with hemorrhagic shock and unstable pelvic fractures have four potential sources of blood loss: fractured bone surfaces, pelvic venous plexus injury, pelvic arterial injury, or extrapelvic sources. The updated recommendations

Figure 3. Algorithm for Unstable Patient with Pelvic Fracture

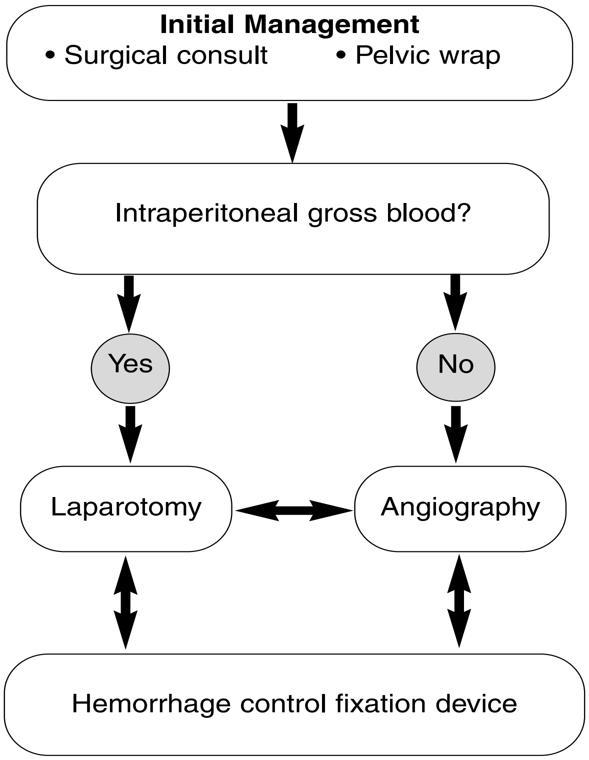

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Table 3. Canadian Head CT Rules

Head CT is required for patients with minor head injuries (i.e., witnessed loss of consciousness, definite amnesia, or witnessed disorientation in a patient with a GCS score of 13 to 15) and any one of the following:

High risk for neurosurgical intervention:

- GCS score less than 15 at two hours after injury
- Suspected open or depressed skull fracture
- Any sign of basal skull fracture (e.g., hemotympanum, raccoon eyes, CSF otorrhea or rhinorrhea, Battle sign)
- Vomiting (more than two episodes)
- Age greater than 65 years

Moderate risk for brain injury on CT:

- Amnesia before impact (more than 30 minutes)
- Dangerous mechanism (e.g., pedestrian struck by motor vehicle, occupant ejected from motor vehicle, fall from height more than three feet or five stairs)

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highlight the importance of excluding other intraabdominal sources of hemorrhage in this population.[3]

In patients with hemorrhagic shock and unstable pelvic fractures, the pelvis should be temporarily stabilized or "closed" with a commercial compression device or sheet. Further decisions to control ongoing pelvic bleeding include angiographic embolization, surgical stabilization, and direct surgical control.[3] Angioembolization has been a recommended therapy to control hemorrhage in the hemodynamically unstable patient with pelvic fractures who is found to have a grossly negative diagnostic peritoneal lavage (DPL).[2] Both the 7th and 8th editions recommend a decision for angiographic embolization or operative repair to be made based upon the identification of intraperitoneal blood via DPL or Focused Assessment Sonography in Trauma (FAST) examination. This algorithmic approach recommends laparotomy in the presence of gross blood and angiography/embolization when either of these studies is negative in a hemodynamically unstable patient with a pelvic fracture.[2,3] *(See Figure 3.)* Twenty-two new references were reviewed (LOE 2–4) and cited regarding the management of hemodynamically unstable pelvic fractures.[45,48,53,55-57,59,97-110]

Head Trauma

Updates to the 8th edition of the Head Trauma chapter include new definitions of minor and moderate brain injury, use of the Canadian head CT rule, and new educational material on penetrating brain injury.[3]

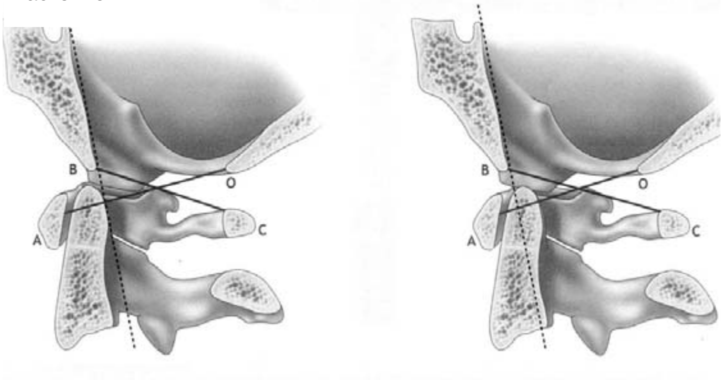
Previously, the definitions of mild, moderate, and severe brain injuries were as follows: mild = GCS 14–15, moderate = GCS 9–13; severe = GCS 3–8.[2] In the 8th edition, the authors have updated the definitions of brain injury to minor, moderate, and severe with the definitions as follows: mild brain injury = GCS 13–15, moderate = GCS 9–12, and severe = GCS 3–8. This reflects a greater consensus with organizations such as the Centers for Disease Control and Prevention and the Eastern Association for the Surgery of Trauma, which use GCS 13–15 for minor traumatic brain injury.[1] Furthermore, the Canadian Head CT Rule, introduced in this edition of ATLS, also uses this definition for minor head injury.

The 8th edition of ATLS teaches students to evaluate the need for brain imaging in trauma patients by using the Canadian Head CT rule.[111-113] In the 7th edition, the authors state that CT "should be considered in all brain-injury patients who have a loss of consciousness of greater than five minutes, amnesia, severe headaches, a GCS score of <15, or a focal neurologic deficit attributable to the brain."[2] The current edition recommends that students use the evidence-based criteria set forth in the Canadian Head CT rule. *(See Table 3.)* The initial paper was published by Stiell and colleagues in 2001 (LOE 2). The authors performed a prospective cohort study of 3,121 patients conducted in 10 EDs in Canada. All subjects had undergone minor head injury in the previous 24 hours and had a GCS score of 13–15. Indications for CT scanning in minor traumatic brain injury (MTBI) included high-risk criteria (GCS less than 15 at two hours, suspected open or depressed skull fracture, any sign of basilar skull fracture,

Figure 4. Atlanto-Occipital Joint Assessment

Normal | C0-C1 Instability

Wackenheim



BC/AO (Power's ratio) ≤ 1 | BC/AO (Power's ratio) > 1

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vomiting more than twice, age greater than 65 years) or moderate risk criteria (amnesia before impact of more than 30 minutes or dangerous mechanism, such as pedestrian struck, ejection from vehicle, or fall from greater than three feet or five stairs).[113] The high-risk factors were 100% sensitive (95% CI 92%–100%) for predicting need for neurosurgical intervention, and would require only 32% of patients to undergo CT. The medium-risk factors were 98% sensitive (95% CI 96%–99%) and 49% specific for predicting clinically important brain injury, and would require only 54% of patients to undergo CT.[113] Further validation and comparison of this rule to the New Orleans Criteria has been performed by the initial authors as well as external validation by another group and were both published in JAMA in 2005 (both LOE 1).[111,112] The authors of the 8th edition of ATLS have referenced these and other articles on this topic in support of the Canadian Head CT rule (LOE 1–4).[111-118]

The discussion of the management of minor, moderate, and severe brain injury is very similar in both the 7th and 8th editions. This version of ATLS uses the same algorithms for management of minor, moderate, and severe brain injuries. While these algorithms are based on a 1996 book by Narayan, *Neurotrauma,* a new table is included in the 8th edition of ATLS in which the authors give an overview of the management of TBI.[119] In the severe brain injury section, the authors discuss important crucial findings to look for on head CT. These findings are: intracranial hematoma, contusions, or midline shift, specifically a shift of 5 mm or greater, which is often indicative of need for surgical evacuation. New to the 8th edition is mention of CT angiography to evaluate for vascular injury. ATLS mentions that CTA may uncover unsuspected vascular injury to the skull base that could place the patient at risk for stroke. They state that these studies should be considered when a high-risk mechanism of injury is present.[3] Specific references to this, however, are not mentioned until Chapter 7, Spine and Spinal Cord Trauma.

New educational material is presented in the 8th edition in regard to penetrating brain injuries. First, the authors recommend CT scanning as opposed to plain radiographs in situations involving penetrating injuries to the brain.[120] The authors state that "when CT is available, plain radiographs are not essential."[3] Much of the evidence for this section is summarized in a supplemental section in the *Journal of Trauma* from 2001 entitled "Guidelines for the Management of Penetrating Brain Injuries."[120-122] Most of these recommendations are based on LOE-4 studies.[120,122-124] The authors make the point that many penetrating injuries are associated with vascular injuries, and therefore moving the penetrating object may cause harm. They state that "objects that penetrate the intracranial compartment or infratemporal fossa must be left in place until vascular injury has been evaluated and definitive neurosurgical management established."[3] Disturbing the object prematurely may lead to vascular injury or intracranial hemorrhage. CTA is recommended when vascular injury is suspected (trajectory passes through skull base or near venous sinus, substantial subarachnoid hemorrhage, or injury to the orbitofacial or pterional regions). MRI is not recommended if there is question of a missile injury. Broad spectrum antibiotics and one week of anti-convulsants are recommended in penetrating brain injury. Small bullet entrance wounds may be cleansed and closed in patients whose scalp is not devitalized and have no intracranial injury.[123] If there is dural injury or significant fragmentation of the skull, however, debridement and neurosurgical watertight closure is recommended. If there is significant mass effect, evacuating intracranial hematoma is recommended. In the absence of significant mass effect, surgical debridement of the missile track in the brain, removal of fragments, surgical removal of fragments, and reoperation to remove retained bone or missile fragments does not improve outcome and is not recommended.[123,124]

Spine and Spinal Cord Trauma

Revisions to the Spine and Spinal Cord Trauma chapter include sections on blunt carotid and vertebral vascular injuries (BCVI), CT evaluation of the cervical spine, steroid therapy in acute spinal cord injury, and radiographic diagnosis of atlanto-occipital dislocation.[3]

A new section to the 8th edition is "Blunt Carotid and Vertebral Vascular Injuries."[3] Blunt trauma to the head and neck has been found to be a risk factor for carotid and vertebral injuries and early recognition may reduce the risk of stroke. ATLS recommendations for screening CT Angiography (CTA) include: C1–C3 fracture, cervical spine fracture with subluxation, and fractures involving the foramen transversarium.[3] Five articles (LOE 1–3) are referenced in regard to this addition.[125-129] One study by Cothren in 2003 (LOE 1) used angiography to diagnose vertebral artery injuries on blunt trauma patients.[126] Of 605 patients who underwent diagnostic angiography as part of a blunt vertebral injury screening protocol, 92 patients were found to have vertebral artery injuries. Of these patients who had spine fractures, specific fracture patterns were found to have high associations with BVI (subluxations in 55%, extension of the fracture through the foramen transversarium in 26%, and upper cervical spine fractures in 18%). The authors conclude that routine screening for vascular injury should be performed on patients with these fracture patterns.[126] In another study, the same author (LOE 2) looked at more than 17,000 blunt trauma patients and found that 37% of patients with the fracture patterns above had blunt cerebrovascular injury (BCVI). Screening in this study was performed by CTA instead of angiography.[127] ATLS therefore recommends screening CTA in the above high-risk populations. Although the authors of ATLS do not make specific recommendations on treatment, the latter article mentions that some surgeons view anticoagulation as standard treatment for BCVI.[128]

ATLS continues to teach radiographic evaluation of the spine based on the NEXUS criteria (screening imaging of trauma patients with midline neck pain, tenderness on palpation, neurologic deficits, or altered level of consciousness or intoxication).[3] New to this edition, however, is emphasis on the use of CT scanning. The authors state, "CT scans may be used in lieu of plain images to evaluate the cervical spine."[3] This recommendation is based on LOE 1–3.[130-139] One study by Mower and colleagues examined more than 34,000 patients with blunt trauma and cervical spine injury. A total of 1,496 cervical spine injuries were identified, and of those, 35 injuries were missed on adequate plain-film imaging (2.81% of all injured patients).[136] A meta-analysis by Holmes and Akkinepalli looked at all studies that evaluated patients with both plain films and CT, and of seven studies that met criteria (plain films without three views, CT without entire spine, CT cuts >5 mm), there were no randomized controlled trials. The pooled sensitivity for plain films was 52%, and 98% for helical CT. Although CT was shown to have a higher sensitivity for diagnosing cervical spine injuries, all seven studies were performed at trauma centers where there was a high prevalence of injury.[135] The authors conclude that although CT was found to have a higher sensitivity, there is insignificant evidence at this time that CT should replace plain film radiography in all patients who require screening for cervical spine injury.[135] ATLS again reminds students that approximately 10% of patients with a cervical spine fracture have a second vertebral column fracture and should be radiographically screened. MRI is indicated in the presence of neurologic deficits.[3]

The management of spinal injury includes immobilization, intravenous fluids, medications, and appropriate transfer. In the 7th edition, high-dose methylprednisolone was recommended for patients with non-penetrating spinal cord injuries within the first eight hours.[2] In the 8th edition, the authors state, "at present, there is insufficient evidence to support the routine use of steroids in spinal cord injury."[3] This is based on multiple studies (LOE 1–3).[140-150] In the past, steroid recommendations were largely based on the NASCIS II trial, which did not find a difference in steroid therapy with the main patient population but did find a small difference in a post hoc subgroup analysis that showed a benefit in the steroid group.[151] Subsequent systematic reviews and high LOE studies have found no benefit to steroid therapy and trends toward increased morbidity and mortality.[142,146,147] Therefore, in this edition of ATLS, the authors conclude that there is insufficient evidence to support steroid use in spinal cord injury.

Both the 7th and 8th editions include a skill station that teaches participants to examine cervical, thoracic, and lumbar spine radiographs. New to the 8th edition, however, is a section that teaches participants how to identify atlanto-occipital dislocation. They describe a Power's ratio >1 and an abnormal Wackenheim's line (from the posterior clivus to the posterior dens) as useful markers of instability.[3] *(See Figure 4.)* These recommendations were based on both CT images and plain film images described in the radiographic literature.[152,153]

Musculoskeletal Trauma

Revisions in the current edition of ATLS for the Musculoskeletal Trauma chapter include updates on tourniquet use and compartment syndrome.[3]

Injuries to the musculoskeletal system occur in 85% of blunt trauma patients and only rarely cause threat to life or limb. Hemorrhage, crush syndrome, and compartment syndrome, however, can pose life and limb threats. New to the 8th edition is material on the use of tourniquets for vascular injuries, including traumatic amputation. The authors state:

> "Although controversial, the use of a tourniquet 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, may save a life. A tourniquet must occlude arterial inflow, as occluding only the venous system can increase hemorrhage."[3]

This recommendation is based on level 4 and 5 evidence.[154-160] One study (LOE 4) by Walters and colleagues compared seven commercially available tourniquets and found that only three of seven were effective in all tests of human volunteers.[155] A study by King evaluated five tourniquet systems for the Canadian Forces and found that the emergency medical tourniquet and latex surgical tubing performed the best.[157] A retrospective analysis of 550 Israeli soldiers in which 16% had tourniquets applied found that 78% of the tourniquets applied were effective in controlling hemorrhage.[158] There are no level three or above studies that assess tourniquet use.

Compartment syndrome is a limb threatening condition that develops when the pressure in the osteofascial compartment of the muscle causes ischemia. It is most commonly seen in the lower leg, forearm, foot, hand, gluteal region, and thigh. ATLS 8th edition includes a color diagram of lower leg compartment syndrome as well as a revised description of the signs and symptoms. In the 7th edition, the authors state "a palpable distal pulse usually is present in compartment syndrome."[2] The updated version states, "absence of a palpable distal pulse usually is an uncommon finding and should not be relied upon to diagnose compartment syndrome." Furthermore, the authors have emphasized and bulleted the early findings of compartment syndrome, which are: increasing pain greater than expected and out of proportion to the stimulus, palpable tenseness of the compartment, asymmetry of the muscle compartments, pain on passive stretch of the affected muscle, and altered sensation.[3] Evidence for this comes from three articles (LOE 3 and 5). Ulmer reviewed 1,932 titles on "compartment syndrome" and found only four prospective studies of compartment syndrome of the lower leg.[161,162] He found that the sensitivity of clinical findings to suggest compartment syndrome was low (13%–19%), and concludes that, "the clinical features of compartment syndrome of the lower leg are more useful by their absence in excluding the diagnosis than they are when present in confirming the diagnosis."[163] The clinical diagnosis is based on history of injury, physical signs, and having a high index of suspicion for the diagnosis. Management consists of acquiring compartment pressures and early surgical consultation.

Thermal Injuries

The chapter on Thermal Injuries in the 8th edition of ATLS is essentially the same as the prior version. No new references were included. Updated graphics representing approximate BSA are included as well as color photographs of second- and third-degree burns.

Again, educational material focuses on immediate lifesaving measures: airway control, stopping the burning process, and establishing intravenous access; assessment of the burn including body surface area calculation; primary and secondary survey; and special burn-related adjuncts and requirements. Similar sections are included on chemical burns, electrical burns, and cold injuries.

Pediatric Trauma

Revisions to the 8th edition of the Pediatric Trauma chapter include new material on functional outcome of pediatric trauma patients, abdominal imaging (including CT and FAST), and abdominal bruising.

Injury is the most common cause of death and disability in childhood and motor vehicle-associated injuries are the most common cause of death in children of all ages. Deaths due to drowning, house fires, homicides, and falls follow in descending order.[3] As in the 7th edition, the differences between children and adults are addressed, including their size and shape, increased surface-area-to-weight ratio, skeleton, psychological status, and long-term effects (cognitive and personality changes) of trauma. New to this edition is emphasis that even though children may have disabilities after traumatic events, their long-term quality of life is robust and justifies aggressive resuscitation efforts. Evidence is based on a study in which van der Sluis and colleagues surveyed 59 pediatric polytrauma patients. After nine-year follow-up, authors found that the degree of physical disablement was low (12%), and that patients' quality of life using the RAND-36 scale did not differ between trauma patients and healthy controls (LOE 3).[164]

The airway, breathing, and circulation sections of this chapter are similar to the 7th edition, aside from updated graphics and a new mnemonic, "Don't be a DOPE" (Dislodgment of endotracheal tube, Obstruction, Pneumothorax, and Equipment failure). This is introduced as a reminder of potential pitfalls when intubated pediatric patients deteriorate. A new chart showing the physiologic impact of blood loss on pediatric hemodynamics emphasizes the rapid rate of deterioration after a certain compensatory point is exceeded in pediatric patients.[3]

New emphasis is placed in the 8th edition on the use of FAST for children. The 7th edition states, "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."[2] The 8th edition encourages use of FAST in children. In summary, the authors state that although comparatively few studies on the efficacy of ultrasound in children have been reported, its use as an extension of the abdominal examination in injured children is rapidly evolving, and it has the advantage that imaging may be easily repeated.[3] If large amounts of intraabdominal blood are found, significant injury is more likely to be present. However, even in these patients, operative management is indicated not by the amount of blood, but by hemodynamic abnormality and its response to treatment. ATLS authors also caution that "FAST is incapable of identifying isolated intraparenchymal injuries, which account for up to one-third of solid organ injuries in children."[135,165-172] This is based upon multiple studies (LOE 3) of the pediatric FAST. A study by Holmes and colleagues evaluated the FAST examination in 224 pediatric blunt trauma patients. Thirty-three of them had intraperitoneal fluid, while ultrasound identified fluid in 27. This gave ultrasound a sensitivity of 82% (95% CI 65%–93%) and specificity of 95% (95% CI 91%–97%).[167] A meta-analysis by the same author in 2007, which was not included in the 8th edition of ATLS cites overall sensitivity of pediatric ultrasound for hemoperitoneum as 80% (95% CI 76%–84%), with specificity of 96% (95% CI 95%–97%). The authors go on to state that the most rigorous studies of their meta-analysis yielded a sensitivity of 66% (95% CI 56%–75%) and specificity of 95% (95% CI 93%–97%)[173] In conclusion, the FAST examination does have utility in pediatric blunt trauma patients, but the decision to proceed to operative management should not be based on the FAST alone but in combination with the patients' hemodynamic stability and surgeons' assessment.

There is also new educational material regarding the use of abdominal CT for pediatric trauma. The authors state that the identification on CT scan of intraabdominal injuries in patients with no hemodynamic abnormalities can allow for non-operative management. Furthermore, they mention that "the presence of a splenic blush on CT with intravenous contrast does not mandate exploration. The decision to operate continues to be based on the amount of blood lost as well as abnormal physiologic parameters."[3] This statement is based on a study by Cloutier (LOE 4) in which a trauma registry identified 107 pediatric blunt trauma patients with splenic injury. Of the 63 patients with admission CT scan available, five (9.7%) had contrast blush. Four of these patients remained stable and one required splenectomy for hemodynamic instability. The authors conclude from this limited series that contrast blush alone does not predict failure of non-operative management in pediatric patients, as it does in adults.[174]

New material is presented in the 8th edition regarding abdominal bruising. The authors now state that the incidence of intraabdominal injury is significantly higher if abdominal wall bruising is observed during the primary or secondary survey.[3] This is based on evidence from a study by Lutz and colleagues (LOE 3) in which they used the crash surveillance database to identify 147,985 children who were restrained in motor vehicle collisions. Although abdominal bruising was rare (noted in 1.33%), children with a bruise were significantly more likely to have intraabdominal injury than those without a bruise (odds ratio 232; 95% CI, 75.9–710.3).[175]

One final addition to the 8th edition is a section on the importance of prevention of pediatric injury. The authors have included a box of the "ABCDEs of injury prevention." The prevention of pediatric injury involves analyzing injury data, building local coalitions, communicating the problem, developing prevention activities, and evaluating the interventions.[176]

Geriatric Trauma

Updates to the chapter Geriatric Trauma in the 8th edition include improved graphics, a diagram on the relationship between age and mortality, and expanded discussion regarding transfusions in trauma and elder abuse.

A diagram was added to the 8th edition to emphasize that older patients have a higher rate of preexisting disease as well as a three-fold higher rate of mortality than younger patients (9.2% vs 3.2%), as reported in a study by Milzman and colleagues.[177] The authors emphasize the fact that "seemingly minor mechanisms of injury can produce serious injury and complications because of the effect of multiple medications, especially anticoagulants."[3] Currently, trauma is the seventh leading cause of death in this population. As our population ages, elder trauma will become more frequent. It's estimated that in 2050, the elderly will represent 25% of the population.

The 8th edition emphasizes the judicious use of transfusions in the elder trauma patient. As in the 7th edition, authors state that blood should be transfused to achieve a hemoglobin over 10g/dL in those older than age 65, but that indiscriminate transfusions should be avoided because of risk of infection and immune response. New to this edition is an added clause that a high hematocrit can adversely affect myocardial function by increased blood viscosity. They also comment on early recognition and correction of coagulation defects, including reversal of drug-induced anticoagulation.[178]

The ATLS manual now contains an expanded section on elder abuse. Elder abuse can be categorized into six categories: physical abuse, sexual abuse, neglect, psychological abuse, financial and material exploitation, and violation of rights. The authors go on to describe many physical findings (i.e., contusions of inner arms, abrasions from restraints, oral injuries, burns) that suggest elder abuse and should prompt the provider to obtain a thorough history and take action. The 2004 report from the National Center on Elder Abuse states that 8.3 cases of abuse are reported for every 1,000 elder Americans and is vastly underreported.[179,180]

Trauma in Women

The section on Trauma in Women is updated in the 2008 edition to include new material and references on restraints and airbags in collisions involving pregnant patients as well as updated risk factors for poor fetal outcomes following trauma.

The authors include a chart that outlines the percentages of various types of blunt trauma in pregnancy as detailed in a 2003 study by Shah and Kilcline (LOE 4).[181] There is also new evidence presented that states, "There does not appear to be any increase in pregnancy specific risks from the deployment of airbags in motor vehicles."[182,183]

Again in this edition, the authors emphasize the importance of assessing and resuscitating the mother first, and then assessing the fetus before conducting a secondary survey of the mother.

New material to the ATLS course includes evidence on the morbidity and mortality of the fetus. Authors state that the primary cause of fetal death is maternal shock and death, and that the second most common cause of fetal death is placental abruption. They emphasize that up to 30% of placental abruptions following trauma will not have vaginal bleeding.[3]

New material is also presented on the use of restraints for pregnant mothers involved in motor vehicle collisions. They state that compared with restrained pregnant women involved in collisions, unrestrained pregnant women have a higher risk of premature delivery and fetal death.[181,184-188] A retrospective cohort study by Wolf and colleagues (LOE 2) compared 1,243 restrained and 1,349 unrestrained pregnant women involved in motor vehicle crashes from 1980 through 1988. The authors found that unrestrained pregnant drivers were 1.9 times more likely to have a low birth weight baby (95% CI 1.2–2.9) and 2.3 times more likely to give birth within 48 hours after the motor vehicle crash (95% CI 1.1–4.8) than restrained pregnant drivers.[188]

Finally, the current ATLS manual contains a list of risk factors for fetal loss or placental abruption that should prompt continuous fetal monitoring. These risk factors are based on retrospective review of 271 pregnant blunt trauma patients by Curet and colleagues. Risk factors include: maternal heart rate >110, Injury Severity Score >9, evidence of placental abruption, fetal heart rate >160 or <120, ejection during motor vehicle accident, and motorcycle or pedestrian collisions.[184] Based on this evidence, the authors recommend that patients with no risk factors who have a viable fetus (20–24 weeks gestation) should be monitored for six hours, while patients with any of the above risk factors should be monitored for 24 hours.

Transfer to Definitive Care

The chapter on Transfer to Definitive Care is essentially the same as the 7th edition. However, there are updated graphics that show proper methods for transferring patients and an updated sample transfer form. This form is adapted from Schoettker and colleagues and emphasizes the importance of having a checklist with a transfer form to make sure that all procedures and items are accounted for (i.e., airway secured, oxygen, and documents obtained). The authors of this study implemented the above checklist system and found a significant decrease in interhospital transfer time post implementation.[189] ATLS encourages the use of some form of checklist when transferring patients.

Appendices

Although this paper will not go into depth regarding the appendices in the 8th edition of ATLS, it is worth noting that the appendices have been expanded and now include a section on Disaster Management and Emergency Preparedness. While there is little evidence at present to support and guide current practice in disaster medicine, the authors have included references to multiple studies and reviews that use computer modeling and recent events to guide practice.[3]

Conclusion

Significant improvements have been made in the 8th edition of the ATLS manual. The authors have made substantial efforts to improve syntax and graphics and include more evidence-based strategies and algorithms. Although many of the new recommendations are not supported by high levels of evidence, there have been efforts to include randomized controlled trials where available. This article has reviewed the major changes to the current edition of ATLS, and we anticipate future editions will continue to evolve and teach "one safe way" to care for trauma patients.

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CME/CNE Questions

1. Traumatic urethral injury may be suggested by all of the following physical findings *except:*
   A. High-riding or nonpalpable prostate
   B. Blood at the urethral meatus

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C. Pelvic fracture
D. Enlarged prostate

2. The "2" in the 3-3-2 Rule refers to:
   A. The distance between the patient's incisors teeth
   B. The distance between the thyroid notch and the floor of the mouth
   C. The distance between the thyroid notch and the chin
   D. The distance between the hyoid bone and the chin

3. Which of the following is an indication for immediate resuscitative thoracotomy?
   A. A patient who has sustained blunt chest trauma and had signs of life in the field who arrives to the ED with pulseless electrical activity (PEA)
   B. A patient who has sustained blunt chest trauma and had signs of life in the field who arrives to the ED with a pulse and subsequently becomes asystolic
   C. A patient who has sustained penetrating chest trauma and had signs of life in the field who arrives to the ED with pulseless electrical activity (PEA)
   D. A patient who has sustained penetrating chest trauma and arrives to the ED without a pulse or any electrical cardiac activity

4. According to ATLS, all of the following are true of laryngeal mask airway (LMA) *except:*
   A. The LMA is an alternative airway device.
   B. The LMA is a rescue airway device.
   C. Proper placement is difficult without training.
   D. The LMA is a definitive airway.

5. A patient presents to the ED with an unstable comminuted pelvic fracture. Vital signs are: blood pressure 90/45, pulse rate 130, and respiratory rate 24. Which of the following is the most appropriate next step?
   A. angiographic embolization
   B. skeletal traction
   C. commercial compression device
   D. operative repair

6. Minor traumatic brain injury is classified as a GCS (Glasgow Coma Scale) score of:
   A. 9–12
   B. 9–13
   C. 13–15
   D. 14–15

7. Which of the following are indications to obtain CT angiography to screen for blunt carotid and vertebral injuries (BCVI)?
   A. C1–C3 Fracture
   B. C spine fracture with subluxation
   C. Fractures involving the foramen transversarium
   D. All of the above

8. Which of the following is true regarding the use of a tourniquet in extremity trauma?
   A. Tourniquets have been found to be unsafe and should never be used.
   B. A properly applied tourniquet can be life-saving but limb-threatening.
   C. A properly applied tourniquet can be life-threatening but limb-saving.
   D. A tourniquet must be tight enough to occlude only the venous outflow.

9. In pediatric trauma to the abdomen, which of the following is true?
   A. The FAST exam has not been studied and should not be used.
   B. A splenic blush of contrast on CT scan mandates that the patient have exploratory laparotomy
   C. All patients with intraabdominal injury should be taken to the operating room
   D. The incidence of intraabdominal injury is significantly higher if there is evidence of abdominal wall bruising on exam.

10. Which of the following pregnant trauma patients have higher risk of premature delivery and fetal death?
   A. Unrestrained pregnant women
   B. Restrained pregnant women
   C. Pregnant women exposed to airbag deployment
   D. Pregnant women not exposed to airbag deployment

Answers: 1. D, 2. B, 3. C, 4. D, 5. C, 6. C, 7. D, 8. B, 9. D, 10. A

CNE/CME Instructions

Physicians and nurses participate in this continuing medical education/continuing education program by reading the article, using the provided references for further research, and studying the questions at the end of the article. Participants should select what they believe to be the correct answers, then refer to the list of correct answers to test their knowledge. To clarify confusion surrounding any questions answered incorrectly, please consult the source material. **After completing this activity, you must complete the evaluation form provided and return it in the reply envelope provided in order to receive a letter of credit.** When your evaluation is received, a letter of credit will be mailed to you.

CNE/CME Objectives

Upon completing this program, the participants will be able to:

a.) discuss conditions that should increase suspicion for traumatic injuries;
b.) describe the various modalities used to identify different traumatic conditions;
c.) cite methods of quickly stabilizing and managing patients; and
d.) identify possible complications that may occur with traumatic injuries.