Western Trauma Association Critical Decisions in Trauma: Diagnosis and management of esophageal injuries

Walter L. Biffl, MD, Ernest E. Moore, MD, David V. Feliciano, MD, Roxie A. Albrecht, MD, Martin Croce, MD, Riyad Karmy-Jones, MD, Nicholas Namias, MD, Susan Rowell, MD, Martin Schreiber, MD, David V. Shatz, MD, and Karen Brasel, MD, Denver, Colorado

AAST Continuing Medical Education Article

Accreditation Statement
This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education through the joint providership of the American College of Surgeons and the American Association for the Surgery of Trauma. The American College of Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

AMA PRA Category 1 Credits™
The American College of Surgeons designates this journal-based CME activity for a maximum of 1 AMA PRA Category 1 Credit™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Of the AMA PRA Category 1 Credit™ listed above, a maximum of 1 credit meets the requirements for self-assessment.

Credits can only be claimed online

AMERICAN COLLEGE OF SURGEONS
Inspiring Quality:
Highest Standards, Better Outcomes

100+ years

Objectives
After reading the featured articles published in the Journal of Trauma and Acute Care Surgery, participants should be able to demonstrate increased understanding of the material specific to the article. Objectives for each article are featured at the beginning of each article and online. Test questions are at the end of the article, with a critique and specific location in the article referencing the question topic.

Claiming Credit
To claim credit, please visit the AAST website at http://www.aast.org/ and click on the “e-Learning/MOC” tab. You must read the article, successfully complete the post-test and evaluation. Your CME certificate will be available immediately upon receiving a passing score of 75% or higher on the post-test. Post-tests receiving a score of below 75% will require a retake of the test to receive credit.

System Requirements
The system requirements are as follows: Adobe® Reader 7.0 or above installed; Internet Explorer® 7 and above; Firefox® 3.0 and above, Chrome® 8.0 and above, or Safari™ 4.0 and above.

Questions
If you have any questions, please contact AAST at 800-789-4006. Paper test and evaluations will not be accepted.

Disclosure Information
In accordance with the ACCME Accreditation Criteria, the American College of Surgeons, as the accredited provider of this journal activity, must ensure that anyone in a position to control the content of J Trauma Acute Care Surg articles selected for CME credit has disclosed all relevant financial relationships with any commercial interest. Disclosure forms are completed by the editorial staff, associate editors, reviewers, and all authors. The ACCME defines a ‘commercial interest’ as “any entity producing, marketing, re-selling, or distributing health care goods or services consumed by, or used on, patients.” “Relevant” financial relationships are those (in any amount) that may create a conflict of interest and occur within the 12 months preceding and during the time that the individual is engaged in writing the article. All reported conflicts are thoroughly managed in order to ensure any potential bias within the content is eliminated. However, if you perceive a bias within the article, please report the circumstances on the evaluation form.

Please note we have advised the authors that it is their responsibility to disclose within the article if they are describing the use of a device, product, or drug that is not FDA approved or the off-label use of an approved device, product, or drug or unapproved usage.

Disclosures of Significant Relationships with Relevant Commercial Companies/Organizations by the Editorial Staff
Ernest E. Moore, Editor: PI, research support and shared U.S. patents Haemonetics; PI, research support, TEM Systems, Inc. Ronald V. Maier, Associate editor: consultant, consulting fee, LFB Biotechnologies. Associate editors: David Hoyt and Steven Shackford have nothing to disclose. Editorial staff: Jennifer Crebs, Jo Fields, and Angela Suaia have nothing to disclose.

Author Disclosures
David V. Feliciano: consultant, Berkeley Research Group; payment for lectures, multiple academic institutions; royalties, McGraw-Hill; stock, IBM. The remaining authors have nothing to disclose.

Reviewer Disclosures
The reviewers have nothing to disclose.

Cost
For AAST members and Journal of Trauma and Acute Care Surgery subscribers there is no charge to participate in this activity. For those who are not a member or subscriber, the cost for each credit is $25.
ABSTRACT: This is a recommended management algorithm from the Western Trauma Association addressing the diagnostic evaluation and management of esophageal injuries in adult patients. Because there is a paucity of published prospective randomized clinical trials that have generated Class I data, the recommendations herein are based primarily on published observational studies and expert opinion of Western Trauma Association members. The algorithms and accompanying comments represent a safe and sensible approach that can be followed at most trauma centers. We recognize that there will be patient, personnel, institutional, and situational factors that may warrant or require deviation from the recommended algorithm. We encourage institutions to use this guideline to formulate their own local protocols. The algorithm contains letters at decision points; the corresponding paragraphs in the text elaborate on the thought process and cite pertinent literature. The annotated algorithm is intended to (a) serve as a quick bedside reference for clinicians; (b) foster more detailed patient care protocols that will allow for prospective data collection and analysis to identify best practices; and (c) generate research projects to answer specific questions concerning decision making in the management of adults with esophageal injuries. (J Trauma Acute Care Surg. 2015;79: 1089–1095. Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.)

KEY WORDS: Esophagus; trauma; algorithm; injury; thoracotomy.

Injuries to the esophagus are uncommon but can be catastrophic, particularly when present in the thoracic esophagus and when diagnosis and treatment are delayed. Penetrating injuries are more common than blunt injuries. In a single urban Level I trauma center with 15% admissions due to penetrating trauma, the incidence of esophageal injury from 2009 to 2014 was 0.14% (Denver Health Medical Center, unpublished data). The incidence among blunt trauma admissions was 0.06%, compared with 0.6% among penetrating trauma admissions. Of the total, 43% were in the cervical esophagus and 57% in the thoracic esophagus. Iatrogenic and spontaneous (emeticogenic) perforations are more common than traumatic esophageal injuries, as reported by Richardson.1 In his 20-year experience, he operated on 9 traumatic, 18 spontaneous, and 34 iatrogenic perforations. Because of the similarities in diagnosis and management and the fact that acute care surgeons may be called upon to manage all types of perforations, the algorithms herein (Fig. 1) will pertain to all traumatic as well as nontraumatic perforations.

A. A recommended diagnostic approach to the patient with penetrating neck trauma has been published recently by the Western Trauma Association (WTA).2 As outlined in that algorithm, clinical findings consistent with vascular or aerodigestive injury warrant operative exploration, particularly if the injury is in Zone II of the neck (Table 1). Clinical findings of esophageal injury are unreliable, identifying just 80% of injuries in the cervical esophagus.3 Thus, nonspecific signs or symptoms or Zone I injuries should prompt computed tomographic angiography (CTA) of the neck.

B. In general, unstable patients with penetrating thoracic injuries should be taken immediately to the operating room (OR).4–8 Such patients should be positioned supine to allow access to multiple body cavities (i.e., bilateral pleural cavities and abdomen).9 If an esophageal injury is identified, appropriate incisions or extensions must be made. A bilateral anterolateral thoracotomy allows access to both pleural cavities. If median sternotomy is initially performed for other indications, a lateral extension may allow access to the proximal (right thoracotomy) or distal (left thoracotomy) esophagus.

C. Penetrating injuries to the chest with potential transmural injury have been investigated with multiple studies including chest radiography, arteriography, bronchoscopy, esophagography, esophagoscopy, and cardiac ultrasonography.4,6,9,10 Many of these studies may be obviated by performing CTA, which has proven to be a safe, efficient, and cost-effective means of determining missile trajectory and targeting specific diagnostic evaluation of organs at risk.5,7,8,10

D. The finding of periesophageal air and/or fluid on CT scan are concerning for esophageal injury and generally mandate further action—especially if in the trajectory of a missile or penetrating object. The exception is the finding of a tiny amount of pneumomediastinum in the absence of fluid or concerning mechanism, clinical, or other imaging findings. This is a not infrequent, clinically insignificant finding following blunt trauma and is usually related to pulmonary injuries or simply an anomaly.11,12 In such cases, it is reasonable to manage patients expectantly, with a brief observation and further evaluation in the case of a clinical change.11–13

E. Injuries to the hypopharynx may be safely managed nonoperatively in many cases, as low intraluminal pressure and the overlapping middle and inferior pharyngeal constrictor muscles facilitate a rapid, spontaneous seal of stab and small gunshot wounds.14,15 Intravenous broad-spectrum antibiotics and restricted oral intake are recommended during healing. In the lower hypopharynx—that is, below the tips of the arytenoid cartilages—or in the

Submitted: April 17, 2015; Revised: April 21, 2015; Accepted: May 29, 2015; Published online: October 1, 2015.

From the Departments of Surgery (W.L.B., E.E.M.), Denver Health Medical Center, Denver, Colorado; Indiana University School of Medicine (D.V.F.), Indianapolis, Indiana; University of Oklahoma School of Medicine (R.A.A.), Oklahoma City, Oklahoma; University of Tennessee-Memphis Health Sciences Center (M.C.), Memphis, Tennessee; Legacy Emanuel Medical Center (R.K.-J.), Portland, Oregon; University of Miami School of Medicine (N.N.), Miami, Florida; Oregon Health Sciences University (S.R., M.S., K.B.), Portland, Oregon; University of California-Davis (D.V.S.), Sacramento, California.

The WTA develops algorithms to provide guidance and recommendations for particular practice areas but does not establish the standard of care. The WTA algorithms are based on the evidence available in the literature and the expert opinion of the task force in the recent time frame of the publication. The WTA considers use of the algorithm to be voluntary. The ultimate determination regarding its application is to be made by the treating physician and health care professionals with full consideration of the individual patient’s clinical status as well as available institutional resources; it is not intended to take the place of health care providers’ judgment in diagnosing and treating particular patients.

Address for reprints: Walter L. Biffl, MD, 777 Bannock St, MC 0206 Denver, CO 80204; email: walter.biffl@dhha.org.

DOI: 10.1097/TA.0000000000000772

© 2015 Wolters Kluwer Health, Inc. All rights reserved.
setting of extensive tissue damage, operative intervention is often necessary.\textsuperscript{15}

F. CT evidence of cervical esophageal injury should prompt cervical exploration, particularly in the presence of signs or symptoms consistent with injury.\textsuperscript{2} This area is easily accessed surgically, with low morbidity, and open exploration allows direct evaluation and repair of the esophagus. This avoids the expense of multiple diagnostic studies and the potential for delay in intervention because of false-negative diagnostic workup. In contrast, if clinical suspicion is low, abnormal CT findings may be further investigated by esophagoscopy and/or esophagography (see G).

G. Evaluation for esophageal injuries involves esophagoscopy and esophagography. In 1987, Weigelt et al.\textsuperscript{3} reported that in the cervical esophagus, the sensitivity of esophagography was 89%, and thus, it was recommended that it be routinely combined with esophagoscopy. Furthermore, in their experience in the early 1980s, flexible esophagoscopy was not sufficiently accurate and missed five (63%) of eight injuries, so they recommended rigid esophagoscopy. More contemporary literature, however, demonstrates that flexible videoendoscopy is very accurate in experienced hands (Table 2).\textsuperscript{16–19} If endoscopic findings are equivocal, esophagography should follow. The standard technique for contrast esophagography is to first administer water-soluble contrast. It is absorbed rapidly from the mediastinum and thus will not cause mediastinal fibrosis. Because this property also compromises the study’s sensitivity, a “negative” water-soluble contrast study result should be followed by a confirmatory study using thin barium.\textsuperscript{20} This is true even when using digital fluoroscopy. Buecker et al.\textsuperscript{21} reported that 22% of injuries were missed with aqueous contrast medium but subsequently diagnosed with barium. As an alternative to fluoroscopic esophagography, helical CT esophagography has been proposed and seems to be very accurate, with the advantages of avoiding the need for additional transportation to the fluoroscopy suite and the active participation of a radiologist as well as the potential for misinterpretation of the live images. Furthermore, it allows a contrast study in patients who are unable to actively participate (e.g., those who are intubated or mentally altered), as the contrast may be administered via a tube.\textsuperscript{22} Given the difficulty in imaging the upper cervical esophagus and the potential for pulmonary edema if contrast is aspirated, the clinician must weigh the risks versus the benefits of immediate operative cervical exploration. Conversely, compared with the cervical esophagus, open surgical exploration of the thoracic esophagus is significantly more morbid and thus should not be undertaken indiscriminately. In the past, it was suggested that delays to operative repair—even to confirm the diagnosis—resulted in excessive morbidity.\textsuperscript{23} However, as reviewed recently by Ivatury et al.,\textsuperscript{24} the literature suggests that, while the rates of primary repair are lower, delayed diagnosis and treatment of a thoracic esophageal injury do not necessarily lead to adverse outcomes. Thus, an efficient diagnostic evaluation is recommended in the stable patient to rapidly confirm an injury. Potential injury to the thoracic esophagus is similarly pursued by either esophagoscopy or esophagography. In the authors’ experience, esophagography is more accurate in the thoracic compared with cervical esophagus, especially if contrast is being administered by tube in the intubated or mentally altered patient.

H. Blunt trauma to the neck may result in significant vascular or aerodigestive injuries, but they are much less common than those following penetrating trauma. As noted earlier, the incidence of blunt esophageal injuries was one tenth that of penetrating injuries at an urban Level I trauma center during a recent 5-year period (Denver Health Medical Center, unpublished data). When a blunt trauma patient with cervical trauma requires immediate surgery, it is usually for airway injury. Signs or symptoms of vascular or esophageal injury are generally investigated via radiographic or endoscopic studies. The pursuit of nonspecific radiographic findings is outlined in G earlier.

I. Cervical esophageal trauma is generally managed operatively. A small series from South Africa\textsuperscript{25} suggested that nonoperative management could be safe and effective; however, there is a paucity of further data supporting this approach in trauma. The operative morbidity of cervical exploration is low enough that it is difficult to justify any complications related to nonoperative management. The available data pertaining to management of nontraumatic (i.e., iatrogenic or spontaneous) cervical perforations are fairly sparse and not controlled.\textsuperscript{26} In the setting of nontraumatic esophageal perforation, there are published series of nonoperative management of small, contained perforations.\textsuperscript{27,28} However, a small fraction of the reported cases are in the neck; the large majority are thoracic. In sum, while local expertise might be available to manage cervical esophageal injuries endoscopically or nonoperatively, it is not recommended as the preferred approach at this time unless performed under a controlled institutional protocol.

J. The cervical esophagus is approached via an incision along the medial border of the left sternocleidomastoid muscle; a cervical collar incision can be used if bilateral cervical exploration is planned. The esophagus should be exposed and circumferentially examined to identify all injuries. Endoscopy is recommended intraoperatively to aid in identifying a perforation that might be obscured by hematoma; to evaluate the opposite side to help identify a through-and-through injury; and to insufflate air following repair to assess for a leak. In addition, endoscopy can identify esophageal pathology that may have contributed to perforation or may be associated with a postoperative leak (e.g., malignancy or stricture).\textsuperscript{24,27,29} Methylene blue administration can also help identify multiple or small perforations such as in the setting of shotgun wounds.

K. The principles of esophageal repair include debridement of contaminated and necrotic material, closure of the defect, and control of esophageal drainage. The classical tenet of performing primary repair when less than 24 hours from perforation and avoiding primary repair when more than 24 hours has been disproven in clinical studies.\textsuperscript{1,24,30,31} Primary repair of cervical esophageal injuries...
can be performed when there is an ability to get a closure of healthy tissue without tension. The esophagus should be debrided to healthy tissue and repaired with a single- or double-layer closure using absorbable or nonabsorbable suture. (There are no studies comparing the techniques.)

If extensive tissue damage, consider operative management. If clinical suspicion is low and findings are subtle, proceed to esophagoscopy and/or esophagography. If exploring specifically for esophageal injury, left anterior cervical incision is preferred; otherwise, exploration is on the side of penetrating injury. Division of the injured cervical esophagus is avoided to prevent the need for a later complex reconstruction. The rare transection of the cervical esophagus, however, may require conversion to an end cervical esophagostomy. Drain placement and enteral feeding access are advised; gastric decompression may be indicated as well.

A patient with a very small, contained thoracic perforation and no signs of sepsis may be managed nonoperatively. As noted earlier (I), in the setting of iatrogenic or spontaneous esophageal perforation, published series report good outcomes following nonoperative management of small, contained thoracic esophageal perforations. However, these series have not included traumatic perforations, and it is important to consider that a major distinction between traumatic and nontraumatic perforations is that trauma may disrupt the tissue planes and thereby the potential containment of the esophageal leak. Thus, nonoperative management of traumatic esophageal perforations should be pursued with caution and ideally under a controlled institutional protocol.

A growing body of literature describes the deployment of esophageal stents or the application of clips to seal or close small esophageal perforations in stable patients. The vast majority of patients in these series have sustained iatrogenic or spontaneous perforations and not external trauma. Dasari et al. recently reviewed the existing literature, consisting of 27 case series. The authors conclude that stenting seems to be a safe, effective, and acceptable means of controlling esophageal leaks. However, they point out that many issues remain unresolved from this body of literature. There has been no direct comparison with surgical repair or nonoperative management; there is incomplete documentation of time to healing and complications including exacerbation of tears, esophageal perforation, bleeding, and stricture; and the reported mortality rates (13% overall) are of uncertain duration. Local expertise dictates whether esophageal stenting or clipping is an option. If these strategies are used, it is important to debride the perforation site and provide adequate drainage. This may be done thorascopically. In addition, provision of enteral nutrition must be achieved via either nasogastric tube or gastrostomy/jejunostomy tubes.

P. Patients with hemodynamic instability or sepsis or larger or older perforations should undergo surgical repair. The unstable patient should be positioned supine and undergo

---

**TABLE 1. Signs and Symptoms Suggestive of Vascular or Aerodigestive Injury**

<table>
<thead>
<tr>
<th>Sign/Symptom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airway compromise</td>
</tr>
<tr>
<td>Significant subcutaneous emphysema or air emanating from neck wound</td>
</tr>
<tr>
<td>Hemoptysis</td>
</tr>
<tr>
<td>Active bleeding from wound</td>
</tr>
<tr>
<td>Expanding or pulsatile hematoma</td>
</tr>
<tr>
<td>Hematemesis</td>
</tr>
<tr>
<td>Dyspnea</td>
</tr>
<tr>
<td>Odynophagia</td>
</tr>
</tbody>
</table>

---

**Figure 1.** Diagnostic evaluation and management of esophageal injury. *If extensive tissue damage, consider operative management. **If clinical suspicion is low and findings are subtle, proceed to esophagoscopy and/or esophagography.††If exploring specifically for esophageal injury, left anterior cervical incision is preferred; otherwise, exploration is on the side of penetrating injury. ‡Pursue with caution if traumatic perforation. §Anterolateral thoracotomy if patient unstable; posterolateral if injury is localized and patient is stable. Right thoracotomy for upper esophagus; left thoracotomy for lower esophagus.

© 2015 Wolters Kluwer Health, Inc. All rights reserved.
TABLE 2. Data From Trials on Flexible Endoscopy for Evaluation of Esophageal Injuries

<table>
<thead>
<tr>
<th>Authors</th>
<th>Patients, n</th>
<th>Injuries, n</th>
<th>Sensitivity, %</th>
<th>Specificity, %</th>
<th>PPV, %</th>
<th>NPV, %</th>
<th>Accuracy, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flowers et al.</td>
<td>16</td>
<td>31</td>
<td>100</td>
<td>96</td>
<td></td>
<td></td>
<td>97</td>
</tr>
<tr>
<td>Srinivasan et al.</td>
<td>17</td>
<td>55</td>
<td>100</td>
<td>92</td>
<td>33</td>
<td>100</td>
<td>99</td>
</tr>
<tr>
<td>Arantes et al.</td>
<td>18</td>
<td>163</td>
<td>23</td>
<td>96</td>
<td></td>
<td></td>
<td>99</td>
</tr>
<tr>
<td>Ahmed et al.</td>
<td>19</td>
<td>33</td>
<td>20</td>
<td>100</td>
<td></td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

NPV, negative predictive value; PPV, positive predictive value.

anteralateral thoracotomy, particularly if other injuries are present or suspected. The more stable patient or one in whom the diagnosis is definitive and other injuries have been ruled out may undergo posterolateral thoracotomy. The proximal esophagus is approached via right thoracotomy incision and the distal esophagus via a left thoracotomy. As discussed earlier (J), intraoperative endoscopy is recommended to aid in identifying the site(s) of perforation, to assess for a leak following repair, and to identify esophageal pathology that may have contributed to perforation or may be associated with a postoperative leak (e.g., malignancy or stricture).24,27 Methylen blue may be helpful as well. Debridement of contaminated and necrotic tissue is a cornerstone of management.

Q. Primary repair of esophageal injuries can be performed when there is an ability to get a closure of healthy tissue without tension.1,13,24,31 The esophagus should be debrided to healthy tissue and repaired as described in K.1,24 In the thoracic esophagus, it is recommended based on expert opinion that the repair should be buttressed with pleura, pericardium, intercostal muscle, diaphragm, or stomach (in the case of distal perforation). Drains have been commonly recommended; however, like many other practices, their use has not been scientifically studied. If there is significant contamination, a drain is advisable to potentially prevent abscess formation. Following repair, most recommend avoiding swallowing until there is documentation of healing—generally, by normal esophagography 5 days after repair. A feeding tube will allow provision of enteral nutrition during that period.

R. If primary repair is not possible because of contamination or unstable patient physiology but there is only a small amount of tissue loss, an effective strategy is to repair the esophagus around a surgeon-constructed large T-tube.37,38 This creates a controlled esophageal-cutaneous fistula, which may close spontaneously after edema resolves and the T-tube is removed.

S. More extensive tissue loss creates a significant challenge. In this case, it is appropriate to perform esophageal diversion. A side-cervical esophagostomy (as described in M) is created through a left cervical incision; the esophagus is debrided and drained; a gastrostomy is created; and a feeding jejunostomy is placed.1,13,24 Reconstruction is planned months later. It should be noted that in the setting of a perforated esophageal malignancy or in the presence of a severe structure, esophageal resection is an appropriate primary procedure.1 This would be rarely indicated in a trauma patient.

DISCLOSURE

The authors declare no conflicts of interest.

REFERENCES


