

Presumptive antibiotic use in tube thoracostomy for traumatic hemopneumothorax: An Eastern Association for the Surgery of Trauma practice management guideline

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BACKGROUND:	Antibiotic use in injured patients requiring tube thoracostomy (TT) to reduce the incidence of empyema and pneumonia remains a controversial practice. In 1998, the Eastern Association for the Surgery of Trauma (EAST) developed and published practice management guidelines for the use of presumptive antibiotics in TT for patients who sustained a traumatic hemopneumothorax. The Practice Management Guidelines Committee of EAST has updated the 1998 guidelines to reflect current literature and practice.
METHODS:	A systematic literature review was performed to include prospective and retrospective studies from 1997 to 2011, excluding those studies published in the previous guideline. Case reports, letters to the editor, and review articles were excluded. Ten acute care surgeons and one statistician/epidemiologist reviewed the articles under consideration, and the EAST primer was used to grade the evidence.
RESULTS:	Of the 98 articles identified, seven were selected as meeting criteria for review. Two questions regarding presumptive antibiotic use in TT for traumatic hemopneumothorax were addressed: (1) Do presumptive antibiotics reduce the incidence of empyema or pneumonia? And if true, (2) What is the optimal duration of antibiotic prophylaxis?
CONCLUSION:	Routine presumptive antibiotic use to reduce the incidence of empyema and pneumonia in TT for traumatic hemopneumothorax is controversial; however, there is insufficient published evidence to support any recommendation either for or against this practice. (<i>J Trauma Acute Care Surg.</i> 2012;73: S341–S344. Copyright © 2012 by Lippincott Williams & Wilkins)
KEY WORDS:	Tube thoracostomy; antibiotics; empyema; hemothorax; pneumothorax.

STATEMENT OF THE PROBLEM

Pneumothoraces and hemothoraces account for most injuries sustained in thoracic trauma.¹ Eighty-five percent of all patients with chest injuries requiring intervention can be managed with tube thoracostomy (TT) alone; the remainder require thoracotomy.¹ Posttraumatic empyema and pneumonia

are potential complications of TT, and prophylactic antibiotics have been advocated to decrease the incidence of these infections. Prophylactic antibiotics reduce the incidence of surgical wound infections; however, they are administered before incision to obtain adequate antibiotic tissue levels. With open (and possibly closed) traumatic hemopneumothorax, the pleural cavity has already been violated, and antibiotic levels cannot be achieved before injury, therefore, they are not truly “prophylactic.” The term “presumptive” has been suggested such that antibiotics are given soon after injury to reduce the incidence of empyema and pneumonia after TT.¹ Because the practice of administering presumptive antibiotics to decrease the incidence of infectious complications in TT is controversial, the Eastern Association for the Surgery of Trauma (EAST) Practice Management Guidelines Work Group published guidelines in 1998.¹ The work group concluded that there was sufficient Class I and II data to recommend presumptive use of antibiotics in patients undergoing TT for traumatic hemopneumothorax.¹ The work group also concluded that a first-generation cephalosporin should be limited to 24 hours if given before placement of TT.¹ These recommendations were based on 11 prospective and retrospective studies from 1977 through 1997 (Table, Supplemental Digital Content 1, at <http://links.lww.com/TA/A192>).^{2–12} A Level 3 recommendation was generated from this data that suggested a possible reduction in pneumonia, but not in empyema. The EAST Practice Management Guidelines Committee has updated these 1998 recommendations to reflect the current literature.

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Two questions specifically addressed regarding the management of presumptive antibiotics in TT for traumatic hemopneumothorax were:

1. Do presumptive antibiotics reduce the incidence of empyema or pneumonia?
2. If presumptive antibiotics reduce the incidence of empyema or pneumonia, what is the optimal duration of antibiotic prophylaxis?

PROCESS

A computerized search of the National Library of Medicine MEDLINE database was undertaken using the PubMed Entrez (www.pubmed.gov) interface. English language citations for the period of 1997 through 2011 were included, focusing on presumptive or prophylactic antibiotic use in TT for traumatic hemopneumothorax. Review articles, letters to the editor, and case reports were excluded from the search. The dates selected allowed for minimal overlap since the last published guidelines. In addition, the bibliographies of each article were reviewed for references not originally identified by the MEDLINE search. Of the 98 articles identified by both methods, seven were prospective or retrospective and selected as meeting criteria for review.

Articles were classified and recommendations were generated according to the EAST primer "Utilizing Evidence-Based Outcome Measures to Develop Practice Management Guidelines."¹³ Articles were classified as Class I, II, or III according to the following definitions:

Class I: Prospective randomized controlled trials.

Class II: Clinical studies in which data were collected prospectively or retrospective analyses based on clearly reliable data, such as cohort, observational, prevalence, or case-control studies.

Class III: Studies based on retrospectively collected data, including database or registry review, case series, or expert opinion.

The Practice Management Guidelines Committee Work Group for Presumptive Antibiotics in Tube Thoracostomy for Traumatic Hemopneumothorax consisted of 10 acute care surgeons and one statistician/epidemiologist who reviewed the articles and collaborated to produce this practice management guideline. Recommendations were then classified as Level 1, 2, or 3 according to the following definitions:

Level 1: The recommendation is convincingly justifiable based on the available scientific information alone. This recommendation is usually based on class I data, however, strong class II evidence may form the basis for a Level 1 recommendation, especially if the issue does not lend itself to testing in a randomized format. Conversely, low-quality or contradictory Class I data may not be able to support a Level 1 recommendation.

Level 2: The recommendation is reasonably justifiable by available scientific evidence and strongly supported by expert opinion. This recommendation is usually supported by Class II data or a preponderance of Class III evidence.

Level 3: The recommendation is supported by available data, but adequate scientific evidence is lacking. This recommendation is generally supported by Class III data. This type of recommendation is useful for educational purposes and in guiding future clinical research.

The evidentiary table was created using the five references (Table, Supplemental Digital Content 2, at <http://links.lww.com/TA/A193>).

RECOMMENDATIONS

Do presumptive antibiotics reduce the incidence of empyema or pneumonia in TT for traumatic hemopneumothorax?

1. There is insufficient published evidence to support any recommendation either for or against the use of presumptive antibiotics to reduce the incidence of empyema or pneumonia in TT for traumatic hemopneumothorax.

Scientific Foundation: Presumptive Antibiotics

Posttraumatic empyema and pneumonia are potential infectious complications in patients who sustain both penetrating and blunt chest trauma, resulting in an increased length of stay, cost, and morbidity to the patient. As demonstrated in Table/SDC 1 and published in the 1998 guidelines,¹ prophylactic antibiotics have been advocated by some authors^{2,3,6,7,10,11} to reduce these infectious complications in patients who undergo TT for traumatic hemopneumothorax. Conversely, several studies did not show that antibiotics reduced either pneumonia or empyema.^{4,5} Two meta-analyses of these same studies concluded that prophylactic antibiotics may reduce the incidence of empyema;^{9,12} however, both analyses assumed that the study populations were similar, when in fact, this was not supported by objective data.¹ In addition, varied antibiotic use and, thus, different treatment regimens raise enough concerns to preclude the drawing of any valid conclusions.

After reviewing the literature from 1977 through 1997, the EAST Practice Management Guidelines Work Group published guidelines in 1998,¹ giving a Level 3 recommendation for prophylactic antibiotic use to potentially reduce the incidence of pneumonia in patients receiving TT after chest trauma. This recommendation was based on Class I and II data; however, there was insufficient data to suggest that prophylactic antibiotics reduce the incidence of empyema. Because of conflicting data, supported by some studies with methodological flaws, this practice currently remains debatable.

The practice of antibiotic prophylaxis in TT after chest trauma remains controversial for numerous reasons. The timing of administration of antibiotics may explain why antibiotics given after injury and before TT in traumatic hemopneumothorax may not be as effective as those given truly prophylactically.¹⁴ In surgical cases, adequate antibiotic tissue levels are reached when administered before incision, thereby reducing the incidence of surgical site infection. The term "prophylactic" may not be accurate after open (and possibly closed) traumatic injury of the chest because contamination of the pleural space has already occurred at the time of injury before antibiotic administration. Drug concentrations in the tissues are not achieved before contamination and, therefore, should be considered presumptive therapy when antibiotics

are given after injury. In addition, several studies did not control for mechanism of injury (penetrating vs. blunt) or did not specify the mechanism of injury.^{3,4,6,7,11} Two of these studies also reported presumptive antibiotics in TT for spontaneous pneumothoraces, a nontraumatic patient population.^{3,4} This heterogeneity confounds which patient population may actually benefit from presumptive antibiotics. Furthermore, although the Centers for Disease Control and Prevention have definitions for the diagnosis of empyema and pneumonia, few studies adhered to these definitions. Several studies used nonstandard or no standard definition for both empyema and pneumonia.

The EAST Practice Management Guidelines Committee determined to update the 1998 guidelines based on more recently published literature. Of the 98 articles identified by the methods previously described, seven articles met criteria for further review.

Two randomized prospective studies were reviewed by the current Practice Management Guidelines Work Group. In 1998, Gonzalez and Holevar¹⁵ published the results of their randomized prospective study of the role of prophylactic antibiotics for TT in patients with isolated chest trauma. They concluded that patients who received antibiotics had significant reductions in infectious complications and suggested that patients who undergo TT for chest trauma would benefit from prophylactic antibiotics. The complications of empyema and pneumonia were not evaluated separately in their article. Likewise, several studies have made similar conclusions based on this same method of analyzing complications together.^{3,6,7}

Maxwell et al.¹⁴ published the results of their randomized prospective study in 2004 and concluded that presumptive antibiotics did not appear to reduce the incidence of either empyema or pneumonia. And while this, the largest study to date (224 patients received 229 TTs), showed no benefit, the 3-year study was terminated because of poor patient accrual that resulted in less than 20% of the predicted number of patients needed, therefore reflecting a possible Type II statistical error in their conclusion.

Three additional retrospective studies were reviewed by the current work group.¹⁶⁻¹⁸ These studies evaluated the risk factors in patients who developed posttraumatic empyema. Aguilar et al.¹⁶ and Mandal et al.¹⁷ concluded that antibiotics were not associated with a reduced risk of empyema, and because of the low incidence of posttraumatic empyema, routine antibiotic prophylaxis was not warranted. Eren et al.¹⁸ published their results in 2008 and found that patients received presumptive antibiotics for TT if they underwent emergent thoracotomy, had soft tissue destruction of the chest wall, or had an associated long bone fracture. They concluded that prophylactic antibiotics may be recommended in patients with risk factors for posttraumatic empyema, including longer duration of chest tube or intensive care unit length of stay, pulmonary contusion, retained hemothorax, or exploratory laparotomy. These three retrospective studies are included in SDC/Table 2 for reference only and were not used when making the updated recommendations because no patient received presumptive antibiotics for TT alone.

In addition, two additional meta-analyses have been published since the 1998 guidelines. In 2006, the third meta-analysis

on presumptive antibiotic use in TT for traumatic hemopneumothorax was published by Sanabria et al.¹⁹ After reviewing and analyzing five randomized controlled Class I studies, they concluded that prophylactic antibiotics in patients with chest trauma decreases the incidence of both posttraumatic empyema and pneumonia. However, this meta-analysis did not include the randomized controlled study by Gonzalez and Holevar¹⁵ from 1998 nor did it differentiate blunt from penetrating chest injuries. In addition, one trial was excluded from subgroup analysis because of the antibiotics used (clindamycin).² These limitations raise concerns regarding the validity of their results.

The meta-analysis by Bosman et al.,²⁰ which also included all the published studies from Sanabria et al.,¹⁹ also concluded that presumptive antibiotics decreased empyema. In addition, a subgroup analysis in patients with penetrating thoracic injuries who received presumptive antibiotics showed a reduced risk of infectious complications. Limitations of this study included direct comparisons of different antimicrobial drug classes (aminoglycosides vs. cephalosporins vs. tetracyclines) and published non-English literature. Furthermore, eight of the analyzed studies used nonstandard definitions (or no definition) for the diagnosis of pneumonia and empyema.

In the era of emerging resistant organisms, antibiotic prophylaxis is typically limited to 24 hours' duration and is usually a first-generation cephalosporin. First-generation cephalosporins provide adequate coverage for *Staphylococcus aureus*, the most common infectious organism in posttraumatic empyema. The randomized controlled study by Maxwell et al.¹⁴ compared two antibiotic regimens and one placebo regimen. Group A received cefazolin until TT was removed; group B received cefazolin for 24 hours, then placebo until TT was removed; and group C received placebo for the entire duration of TT. The average duration for TT was 4.6 days. Of concern was the increased incidence of resistant organisms in patients receiving antibiotics, including methicillin-resistant *S. aureus* and *Pseudomonas aeruginosa*. The study concluded that presumptive antibiotics were of minimal benefit considering the need to treat large numbers of patients to prevent a single empyema. This conclusion, combined with the emergence of resistant organisms, may make the decision to use presumptive antibiotics for TT in chest trauma unwise.

The EAST Practice Management Guidelines Work Group, led by Luchette, published its recommendations in the *Journal of Trauma* in 2000, supporting presumptive antibiotics in TT for traumatic hemopneumothorax to reduce the incidence of pneumonia (and not empyema). This was a Level 3 recommendation based on the best evidence and bedside practices at the time. The studies published that generated this recommendation, and the ones that have followed, continue to vary in quality and in outcome. In the past 10 to 15 years, the practice of medicine and surgery has continued to evolve based on evidence-based literature. This includes adhering to universal precautions and bundle compliance to decrease the incidence of hospital-acquired infections, including ventilator-associated pneumonia. We have become vigilant of the inappropriate use of antibiotics and the increased incidence of multidrug-resistant organisms and the associated cost and complications of such infections. The study by Maxwell et al.,¹⁴

although underpowered, is the largest study to date on this topic and is reflective of current practice of critical care surgeons because of the understanding of increasing organism resistance to antibiotics and the promotion of antibiotic stewardship. Moreover, the more recent support of prophylaxis with TT comes primarily from meta-analyses, which are not included in the classification system for evidence. This finding, along with the concerns about mixed patient populations and treatment algorithms being blended together in analyses, compromise the value of their conclusions and therefore their use in these recommendations.

In summary, after extensive review of the entire published English literature to date and using expert opinion, the current Practice Management Guidelines Work Group cannot make a recommendation for or against the routine use of presumptive antibiotics in TT for traumatic hemopneumothorax to reduce the incidence of empyema and pneumonia. In addition, this group is unable to recommend an optimal duration of antibiotic prophylaxis when antibiotics are administered for traumatic hemopneumothorax because there are insufficient published data to support the routine use of antibiotics.

CONCLUSION

No single published study has been powered to adequately address the practice of administering presumptive antibiotics in TT for traumatic hemopneumothorax to decrease the incidence of empyema or pneumonia. Until a large and likely multicenter, randomized, controlled trial can be performed, the routine practice of presumptive antibiotics in TT for chest trauma will remain controversial.

AUTHORSHIP

F.O.M., T.M.D., C.K.C.H., A.D.F., and N.M. participated in the literature search and data collection. All authors participated in data analysis, data interpretation, and manuscript writing.

DISCLOSURE

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