

Use of prophylactic antibiotics in placement of chest tubes in the setting of patients with chest trauma

Clinical Bottom Line:

We recommend the use of antibiotic prophylaxis in trauma patients that require chest tube placement in the emergency department, as it has been shown to reduce the development of empyema (a rare, yet high morbidity and mortality complication). The benefit for other outcomes, such as pneumonia, prevention or mortality is less clear.

PICO Question:

In adult trauma patients (>18 y/o), what effect does antibiotic prophylaxis for chest tube placement have on the development of empyema, pneumonia, and mortality?

Background:

Of the trauma patients that are seen in emergency departments, one third of them will be diagnosed with a chest injury that results in pneumothorax/hemothorax/hemopneumothorax. Although not all will require a chest tube, those that do, are at risk of developing not only superficial skin infections overlying the insertion site, but as well as chest cavity infections. One of the worst complications includes development of empyema, which has been reported as 32,000 cases a year, and of those, approximately 20-30% will either die or require further surgery (NIH, 2022). Although this is a rare complication, it has a high mortality rate. The use of antibiotic prophylaxis is common in the OR, however has remained controversial for trauma patients in the emergency department. Therefore, the interest in minimizing such complications has led to this systematic review to determine the efficacy of prophylactic antibiotics with traumatic chest tube placement.

Article 1:

Freeman, J. J., Asfaw, S. H., Vatsaas, C. J., Yorkgitis, B. K., Haines, K. L., Burns, J. B., ... & Kasotakis, G. (2022). Antibiotic prophylaxis for tube thoracostomy placement in trauma: a practice management guideline from the Eastern Association for the Surgery of Trauma. *Trauma Surgery & Acute Care Open*, 7(1), e000886.

Pubmed link:

<http://dx.doi.org/10.1136/tsaco-2022-000886>

Risk of Bias:

There is minimal risk of bias as this was a systematic review and meta-analysis that used 2 blind independent researchers who used GRADE methodology to determine quality of studies included.

The Basics:

This was a systematic review that included 14 studies (all of one were prospective) that ranged from type of antibiotics and length of antibiotic coverage in adult patients that sustained chest trauma and required chest tube for hemothorax or pneumothorax.

Methods:

Studies were obtained after a professional librarian performed search through MEDLINE (via PubMed), Embase (via Elsevier), Cochrane Central Register of Controlled Trials (via Wiley), Web of Science and ClinicalTrials.gov databases ranging from January 1900 to March 2020. There were initially a total of 596 studies that once duplicated, case reports, abstracts reviews, animal studies, editorials, and commentaries were taken out, ending with a total of 14 studies. Data was then extracted from each individual study, and publication bias was evaluated with the GRADE framework and using the Egger test by committee members individually, and majority consensus was performed if there was no clear decision.

Results:

Of the 14 studies, 12 studies looked at rates of empyema in all traumas, and blunt vs. penetrating trauma. In all traumas, odds ratio was 0.40 with confidence interval of 0.22-0.75, $P=0.004$ which is a significant reduction of empyema. However, when stratified into blunt (4 studies), and penetrating (8 studies), blunt trauma had odds ratio of 0.25 with CI of 0.06-1.12, $P=0.07$, which is not statistically significant, but may be due to smaller sample size. There was a total of 11 studies that looked at pneumonia, with odds ratio of 0.46 with CI of 0.20-1.04, $P=0.06$, which was not statistically significant. Analysis of mortality only included 3 studies, and was also not statistically significant, with an odds ratio of 0.82, CI of 0.47-1.47, $P=0.48$. This, however, may also be limited due to small sample/study size.

Limitations/Bias:

This study varied in what antibiotics were given ranging from ancef to clindamycin. It is also unclear what techniques were used in terms of sterility when chest tubes were placed. Other than that, the studies that were included had minimal heterogeneity, limiting as much bias as possible.

Article 2:

Elnahla A, Iuliucci KR, Toraih E, Duchesne JC, Nichols RL, Kandil E. The efficacy of the use of presumptive antibiotics in tube thoracostomy in thoracic trauma-results of a meta-analysis. *Am J Surg.* 2021 Nov;222(5):1017-1022. doi: 10.1016/j.amjsurg.2021.05.003. Epub 2021 May 13. PMID: 34272063.

Pubmed Link:

<https://pubmed.ncbi.nlm.nih.gov/34272063/https://pubmed.ncbi.nlm.nih.gov/34272063/>

Risk of Bias:

Moderate risk of bias as the meta-analysis went through their 13 studies and investigated their studies through the Cochrane Risk of Bias tool. While the authors did not comment on the risk of bias for this study in particular they did provide a table assessing the risk for each individual study. Additionally, they did not provide information related to heterogeneity of the studies.

The Basics:

This study is a meta-analysis which examined 13 studies together to look at the benefit of antibiotics during the placement of antibiotics for the purpose of infection prophylaxis. The study looked at two primary outcomes in particular: empyema and pneumonia.

Methods:

A systematic literature search was performed using PubMed, Cochrane, and Embase databases in May of 2020. Two reviews independently screened each article and the Studies were excluded if they were

review papers, conference papers, editorial letters, case reports/comments, had insufficient data, had overlapping patient populations or were non-human studies. The reviewers did not limit their selection by year or language. Initial search returned 1127 studies which were subsequently screened and limited to 13 including 12 RCTs and one retrospective cohort study ranging from 1977 to 2019. Publication bias was assessed using the Cochrane Risk of Bias Tool.

Results:

Overall, this study initially pooled its analysis showing that antibiotic administration was associated with a lower incidence of empyema and pneumonia with an OR; 0.6, 95%CI: 0.46 to 0.89, $p = 0.01$). This data was further broken down into various groups. The first subgroup was looking at empyema vs pneumonia to see which of these was protective for all types of trauma. This revealed an OR: 0.35, 95%CI: 0.19 to 0.66, $p = 0.001$ for empyema and (OR: 0.81, 95%CI: 0.55 to 1.18, $p = 0.271$), showing a protective effect for empyema but not for pneumonia. Further they broke down groups for empyemas in particular looking at blunt vs penetrating trauma showing OR: 0.25, 95%CI: 0.03 to 1.73, $p = 0.16$ and OR: 0.14, 95%CI: 0.04 to 0.47, $p = 0.001$ respectively. For pneumonia, they again broke the data down for blunt vs penetrating trauma showing OR: 1.22, 95%CI: 0.38 to 3.90, $p = 0.72$ and OR: 0.24, 95%CI: 0.12 to 0.53, $p = 0.001$, respectively.

Further, the authors broke the data down into duration of antibiotics as well looking at <24hrs and >24 hours of dosing with OR: 0.40, 95%CI: 0.21 to 0.79, $p = 0.008$ and (OR: 0.26, 95%CI: 0.14 to 0.46, $p = 0.001$, respectively. Overall, both of these time frames are protective against infection, however the >24hr dosing was more protective. Lastly, the authors examined the length of hospital stay for the placebo group vs the Antibiotic group with a SMD: 0.12, 95%CI: 0.24 to 0.002, $p = 0.046$ and suggest that this is significant in reducing length of stay.

Limitations:

This study has several limitations. First and foremost, this study does not supply us with information on the heterogeneity of the included studies results despite being a meta-analysis. This severely limits our ability to interpret and trust their data and understand if the conclusions they are drawing are accurate. The only real measurement we have for this is just visually looking at their forest plots. Lastly, they did not lay out their subgroup analysis in their methods but mention several subgroups in the results, seemingly finding this data after the analysis has been performed introducing a high possibility of bias to their interpretation. The results of this study in particular should be taken in context of the other studies.

Article 3:

Ayoub, Firas, Michael Quirke, and Daniel Frith. "Use of prophylactic antibiotic in preventing complications for blunt and penetrating chest trauma requiring chest drain insertion: a systematic review and meta-analysis." *Trauma surgery & acute care open* 4.1 (2019): e000246.

Pubmed link:

<https://tsaco.bmj.com/content/4/1/e000246.abstract>

Risk of Bias:

Risk of bias is minimal, this was a systematic review and meta-analysis. Articles were reviewed and compared using Cochrane Collaboration tool for assessing bias by two independent reviewers. The 12 included studies were categorized as "low risk".

The Basics:

The study was a systematic review and meta-analysis which included 12 randomized control trials looking at prophylactic antibiotic administration before chest tube insertion for adult trauma patients with both penetrating and blunt trauma. Primary outcome measures were rates of empyema and pneumonia. Secondary outcomes explored hospital length of stay and chest tube duration.

Methods:

A systematic literature search was performed searching four electronic databases Medline, Pubmed, Embase, and Cochrane Library using specified keywords. Articles of any date and language were included. Two reviewers independently reviewed each article, ultimately 939 records were examined and narrowed to 12 RCTs which were investigating use of prophylactic antibiotics for chest tube placement with primary outcome of rate of empyema and pneumonia. Two reviewers then independently reviewed article quality and bias using the Cochrane Collaboration Tool. Meta-analysis was performed using pooled random effect model study heterogeneity was assessed using X^2 and I^2 testing.

Results:

Of the 12 studies included, all were randomized control trials comparing prophylactic antibiotic before chest tube insertion to placebo. The 12 studies included 1263 patients. The incidence of empyema in prophylactic antibiotic group was 1% (7/679) compared with 7.2% (42/584) in the placebo group ($p=0.0001$). The incidence of post-traumatic pneumonia was 4.4% (27/616) in the prophylactic antibiotic group compared to 10.7% (56/521) in the placebo group ($p=0.0001$). Secondary outcomes investigating hospital length of stay and chest tube duration could not be performed due to high level of heterogeneity in the reported results, but overall most studies did report shorter length of hospital stay for patients receiving prophylactic antibiotics.

On meta-analysis, prophylactic antibiotics before chest tube insertion was associated with overall reduced risk of post traumatic empyema when compared with placebo (relative risk [RR] 0.25; 95% CI, 0.13 to 0.49; χ^2 test=4.42; $I^2=0.0\%$; $p=0.00$). Similar results were found when comparing prophylactic antibiotics to placebo for post-traumatic pneumonia after chest tube insertion (RR 0.41; 95% CI 0.24 to 0.71; χ^2 test=10.12; $I^2=11.1\%$; $p=0.002$)

Limitations:

This study has several limitations. Randomized control trials included were deemed to have been at low risk of Bias by Cochrane Collaboration review, but were not all double blinded RCTs. This study also did not separate blunt trauma from penetrating trauma injuries. Studies also did not include other patient risk factors for potential respiratory complication.

The largest weakness overall was that among the different studies, different antibiotics and dosing/duration of treatment were used so that the intervention was not uniform. Most of the studies used Cefazolin, however Clindamycin, Cefamandole, Cefadyl, Doxycycline, and Cefoxitin were also used in various studies.