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Surgical approach and outcomes of empyema patients in Prof. Ngoerah Hospital: a single-center retrospective observational study

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ABSTRACT

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Background: The number of patients with empyema thoracis is increasing with time despite rigorous prevention methods such as vaccination and antibiotic use. Surgical interventions are often required for advanced cases, though outcomes may differ due to other factors and staging. This study retrospectively evaluates the surgical management and outcomes of patients with empyema.

Methods: We performed a retrospective observational study at Cardiothoracic and Vascular Surgery Divison in Prof Ngoerah Hospital from January 2019 to December 2021. Patients were diagnosed with imaging and pleural fluid analysis and referred to the cardiothoracic and vascuar surgery department. 22 patients were included in this study and had their demographic data, comorbidities, surgical interventions, and outcomes analyzed. An range of interventions was performed such as open thoracotomy, video-assisted thoracoscopic surgery (VATS), or as a combination. Outcomes assessed included the need for repeat surgery, length of hospital stay (LOS), and ICU stay. All data were analyzed using IBM® SPSS 26.0 using univariate descriptive analysis.

Results: Out of the 22 patients (mean age 42.55 years), there were more males than females (68.2%), and half of them came into the hospital with complex empyema (Light's Category 7). Open thoracotomy was the most common intervention (54.5%), followed by VATS (31.8%). Most patients (81.8%) did not require repeat surgeries. LOS ranged from 2 to 48 days (mean: 17.18), and ICU stays averaged 5.24 days. Comorbidities such as pneumonia (31.8%), tuberculosis (18.2%), and diabetes mellitus (13.6%) were seen.

Conclusion: This study highlights possible barriers in providing optimal care to patients with empyema and its comorbidities and includes late diagnosis for favorable surgical outcomes. This issue is particularly significant, as a substantial proportion of patients continue to present with advanced stages of empyema.

Keywords: empyema, surgical outcomes, pleural infection, retrospective study.
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INTRODUCTION

Empyema thoracis, often chronologically found as a complication of pneumonia, is defined as the accumulation of pus inside the pleural cavity. Even though the diagnosis of empyema has declined significantly after the introduction of antibiotic use, the incidence of pleural infections is increasing annually, hence contributing to the increasing cases of empyema worldwide. On 1996, the incidence of empyema was 3.96 cases in every 10000 individuals in the US, and this number has increased to 8.10 cases in every 10000 individuals on 2008, rising around 70%. Additionally, a similar demography is seen between patients with pneumonia and empyema, further asserting the interaction between the two respective diseases. In the United Kingdom, the peak incidence for pneumonia is among children aged 5 and under, whereas the highest increase in empyema incidence is among the 1-4 years old age group as well. Interestingly, a US study has found that the pneumococcal conjugate vaccine (PCV) did not decrease the number of patients with empyema.[1–3] In Canada, aside from the growing burden of disease, a change in disease pattern is also seen. The pediatric and geriatric population are particularly epidemiologically seen vulnerable to empyema, seen from an increase in incidence of up to 4 times the number on 1995 among the pediatric population and a 50% percentage change of incidence

among the elderly.[4] In Indonesia, basic health reseacrh 2018 has mentioned that the incidence of pneumonia increases with age, similar to what is seen in other countries.[5] Aside from pneumonia, empyema may also truncate from vascular abnormalities, immunodeficiency-related problems, or infection in adjacent locations including the diaphragm, esophagus, and oropharynx.[1]

Normally, the parietal pleura produces just enough fluid (0.01mL/kg/hour) to maintain the balance between the resorptive capacity and production of the pleural fluid. Pleural fluid is drained mainly through the gradient pressure in the visceral pleura, lymphatic drainage, and cellular-based mechanisms. Parapneumonic effusion, a pleural effusion that is secondary to pneumonia, precedes empyema and occurs through three main stages, being exudative, fibrinopurulent, and organization stage. The exudative stage emphasizes on the role of proinflammatory cytokines including interleukin 8 (IL-8) and tumor necrosis factor alpha (TNF-α) in disturbing the production-resorption balance in the pleural cavity by increasing the permeability of capillaries in the pleural cavity. This allows the pleural mesothelial cells to ease the entry of lactate dehydrogenase (LDH) and white blood cells-deprived fluids to the pleural cavity. The provision of antibiotics will adequately clear the effusions if they are found within this stage. Otherwise, if the disease is left untreated, it will progress to the fibrinopurulent stage, where bacteria translocate through brittle endothelial barriers and replicates in the pleural cavity, inducing immune responses including coagulation cascades and migration of neutrophils. This will promote neutrophil migration, fibrin deposition, and septate formation. This stage is indicated by an increase LDH levels inside the fluid. The organization stage is characterized by fibroblast proliferation and pleural thickening. The pleural cavity soon becomes less flexible and separated with the deposition of fibrotic materials, producing loculated effusions, a reduced lung function, and increased infection risk. An increased complexity, typically determined by the formation of more locules, decreases the effectivity of medical management and increases the need of a surgical intervention.[1,3,6]

A large comorbidity range is seen among patients with empyema worldwide, and they may affect the individual's vulnerability to parapneumonic effusions. A study in India has shown that patients with diabetes, hypoalbuminemia, loculation, and tuberculosis has a less ideal prognosis in comparison to those without.[7] These diseases are often associated with a higher risk of infections or immunodeficiency states; hence the outcome may be plausible. An example would be the fact that S. milleri empyema is more common in those with malignancy and diabetes mellitus, which is uncommon in those without as it is a commensal, benign flora of the human oropharynx.[8] Additionally, immunocompromised patients are more prone to fungal infections, and the mortality rate of patients with fungal-related empyema is 73%, making them more liable to fatality.[1] Additionally, alcoholism is a baseline characteristic that is independently associated with the development of empyema.[9]

The diagnosis of pleural infections and empyema are more often than not tardy as symptoms are typically vague and may mimic other diseases. Patients may initially experience dry coughs and low-grade fever, which develops into pleuritic pain and shortness of breath 7 days after the initial disease presentation. Pleuritic pain is an indication of the accumulation of fluid in the pleural cavity, particularly the parietal pleura, which is rich in nerve endings. During this period, patients often present with a productive cough and high fever accompanied with chills. When this happens, a pleural fluid sample is usually drawn to determine the source of fluid in the pleural cavity. A pus is typically seen in the pleural fluid of patients with empyema, and a cloudy pleural fluid rich in neutrophils are commonly seen in individuals with complex parapneumonic effusions. Radiological findings may also aid in the diagnosis of empyema, including x-ray, ultrasonography, and CT scans.[10]

The management of early-stage empyema typically focuses on optimizing antibiotics use. Additionally, early chest tube insertion and drainage alongside intrapleural fibrinolytics are also associated with less surgical outcomes.[11] However, once empyema reaches a more advanced stage, surgical procedures are often needed. The aim of surgical intervention is to remove the empyema through various methods, including through completely obliterating the pleural cavity. Aside from that, another aim would be to correct the primary issue in the lung. Surgical intervention varies from a case to another, including debridement, decortication, and open drainage.[12] Choosing an appropriate management is important as studies have found that the development of empyema is an independent risk factor of further complications in individuals with parapneumonic effusions.[9]

This study is a lndonesian single-center retrospective study on surgical approaches taken on empyema cases in our hospital and the outcome of the approach. Through this study, we aim to update clinicians and researchers an applicative insight of available guidelines or strategies in catering to empyema.

METHODS

This study is a single-center retrospective observational study performed at Cardiothoracic and Vascular Surgery Division in Prof Ngoerah Hospital from January 2019 to December 2021 on patients with Empyema. Patients were diagnosed with imaging and pleural fluid analysis and referred to the cardiothoracic and vascular surgery division for further treatments

We used convenience sampling for data collection. Patients were stratified into three categories based on Light's classification[13], as seen on **Table 1**. Three variables were utilized: (1) Anatomy of pleural cavity, (2) bacteriological characteristics of the pleural fluid, and (3) pH of the pleural fluid. Demographic data was also taken including sex, age, surgical procedures taken, repeated surgeries taken, length of stay in the ward, as well as the length of stay in the ICU.

All descriptive analyses are performed using IBM® SPSS 26.0. Normality of the data is observed through Shapiro-Wilk. Data is presented in Mean and Standard Deviation (SD) while categorical data is presented in frequencies (n) and percentages.

RESULTS

A total of 22 patients were included in this retrospective study. The summary of patient's characteristics is seen on Table 2. A notable gender disparity was seen from the data with 68.2% patients (n=15) being males and 31.8% (n=7) being females. A wide age range may also be seen with patients' age ranging from 2 years old to 73 years old with a mean age of 42.55 years old and standard deviation of 20.62 years. Additionally, we stratified patients based into the 3 light's criteria (category 5, 6, 7) based on the anatomical findings of the pleural cavity, bacteriological characteristics of pleural fluid, and chemical characteristics (pH) of the pleural fluid. The majority of were included in category 7 (50%, n= 11), while 31.8% (n=7) patients were categorized into empyema risk category 5 and 18.2% of patients (n=4) were categorized into risk category 6. In terms of comorbidities, the most common comorbidity seen among patients was pneumonia (31.8%, n=7) followed by pleural effusion in 22.7% of patients (n=5), tuberculosis in 18.2% of patients (n=4), malignancy and diabetes mellitus in 13.6% of patients (n=3), followed by nephrotic syndrome/kidney failure, SLE, COPD, Rib fracture, anemia, and hypoalbuminemia.

The treatment modalities used for empyema varied among patients. The most common procedure used was open thoracotomy, performed on 54.5% of patients (n=12). Video-assisted thoracoscopic surgery (VATS) was the second most common option implemented in patients, performed on 31.8% of patients (n=7). A combination of open thoracotomy and VATS was used in 9.1% of patients (n=2) and 4.5% of patients (n=1) underwent a combination of thoracotomy and thoracoplasty. This is visually described in the pie chart seen on Figure 1.

The frequency of recurrent surgery was an output we drew in this study. Most patients (81.8%, n=18) did not require another round of surgery to manage their conditions. However, 18.2% of patients (n=4) did underwent recurrent surgery. The length of hospital stay (LOS) is an outcome measure observed in this study as well. Hospital stays ranged significantly

Table 1. Categories based on Light's Criteria.[13]

Anatomy of Pleural Cavity	Bacteriological Characteristics of Pleural Fluid	pH of Pleural Fluid	Light's Criteria
Ao: Minimal pleural effusion and thickening	Gram stain/culture positive, not loculated, not frank pus	pH <7.00 and/ or glucose <40 mg/dL	4 (Simple complicated parapneumonic effusion)
A1: Mild-Moderate pleural effusion with thickness of >1cm and under ½ of the hemithorax	Gram stain/ culture positive, multiloculated	Co: pH ≥ 7.20	5 (Complex complicated Parapneumonic Effusion)
A2: Broad pleural effusion (equal to or ½ of hemithorax)	Frank pus, single locule/free flowing	Co: pH <7.20	6 (Simple Empyema)
Loculated pleural effusion with thickening of parietal pleura	Frank pus, multiple locules		7 (Complex Empyema)

Table 2. Patients' Characteristics and Outcome of Empyema Treatment

Characteristic Variables	N (%)	Minimum	Maximum	Mean	Standard Deviation
Sex					
Male	**15 (68.2)**				
Female	**7 (31.8)**				
Age (yrs)		**2**	**73**	**42.55**	**20.62**
Empyema Risk Category					
5	7 (31.8)				
6	4 (18.2)				
7	11 (50)				
Comorbidities					
Malignancy	3 (13.6)				
Tuberculosis	4 (18.2)				
Pneumonia	7 (31.8)				
Pleural effusion	5 (22.7)				
Diabetes Mellitus	3 (13.6)				
Anemia	1 (4.5)				
Hypoalbuminemia	1 (4.5)				
Nephrotic syndrome or kidney failure	2 (9.1)				
SLE	2 (9.1)				
COPD	1 (4.5)				
Rib fracture	1 (4.5)				
Treatment on Empyema					
Open Thoracotomy	12 (54.5)				
VATS	7 (31.8)				
Open Thoracotomy + VATS	2 (9.1)				
Open Thoracotomy + Thoracoplasty	1 (4.5)				
Use of Recurrent Surgery					
Recurrent	4 (18.2)				
Non-Recurrent	18 (81.8)				
Length of Stay (Days)		2	48	17.18	12.08
Length of Stay in Intensive Care Unit (Days)		1	24	5.41	5.42

from 2 to 48 days, with a mean of 17.18 days and standard deviation of 12.08 days. Furthermore, the length of stay in the intensive care unit ranged from 1-24 days with a mean of 5.24 days and standard deviation of 5.24 days.

DISCUSSION

The study's patient demographics indicate a gender difference, with males (68.2%) much more impacted than females (31.8%). This gender disparity aligns with several global research indicating that males, especially in middle age, face an elevated risk of developing empyema. For instance, Finley et al. in Canada noted a comparable pattern, emphasizing that males are more often diagnosed with pleural infections.[4]

This study encompasses a wide age span, with patients from 2 to 73 years old, with a mean age of 42.55 years. This variable age range reflects studies from other regions, such as Tian et al. in China, which indicated a varied age group impacted by empyema, but with a greater prevalence among older persons.[14] Pneumonia (31.8%) was the predominant comorbidity in our sample, consistent with global findings that empyema frequently arises as a consequence of pneumonia. The study by Hasan and Ambarwati et al. showed analogous findings, identifying pneumonia as a predominant source of pleural infections.[1] Four individuals also presented with tuberculosis in our study. Wen et al. has found that being male, high pleural adenosine deaminase, and having a high WBC count are significant risk factors for empyema in patients with TB.[15] Further studies may aid in confirming this, especially as Indonesia is a tuberculosis endemic country.

The research categorized patients according to Light's criteria (category 5, 6, and 7) based on the morphological, bacteriological, and chemical properties of the pleural fluid. The majority of patients were classified into category 7 (50%), signifying more severe occurrences of empyema. Periasamy et al. noted a comparable pattern in India, where advanced instances of empyema, frequently identified at a later stage, required intricate surgical procedures.[7] This underscores the worldwide difficulty of early diagnosis of empyema, which is essential for enhancing outcomes.

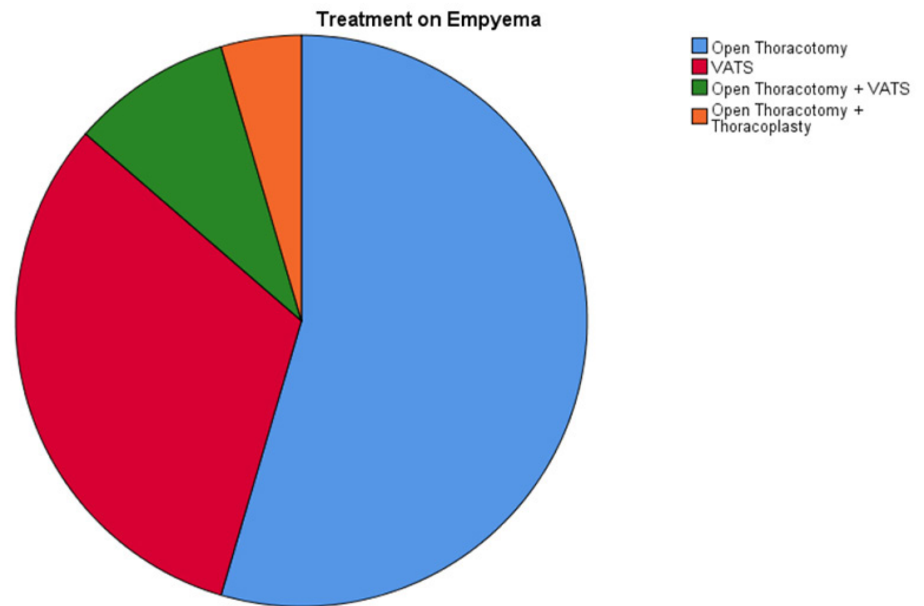

Figure 1. Empyema Treatment Method Distribution

This study indicates a preference for open thoracotomy (54.5%) as the primary treatment strategy for empyema, with video-assisted thoracoscopic surgery (VATS) utilized in 31.8% of cases. A lesser number of patients (9.1%) underwent a combination of thoracotomy and VATS. These treatment modalities correspond with international practices while also emphasizing the disparities in available technologies across various areas.

In Canada, Finley et al indicated that open thoracotomy remained a prevalent treatment, whereas VATS gained preference due to its minimally invasive characteristics and expedited recovery periods. Conversely, Tsai et al. in Taiwan observed that VATS has established itself as the conventional treatment for empyema, markedly decreasing post-operative complications and length of hospitalizations.[16] The observation that merely 31.8% of patients in this study received VATS indicates potential obstacles to the broader implementation of this method in Indonesia, including cost, equipment availability, and training.

This study's preference for open thoracotomy may indicate the constraints of healthcare infrastructure, particularly in rural regions, where availability to specialized VATS instruments is limited. Although thoracotomy remains a requisite and efficacious technique, Shiraishi et al in Japan contend that with the increasing global accessibility of VATS technology, it ought to be prioritized owing to its reduced complication rates and abbreviated recuperation durations.[12]

This study indicates promising results for repeat surgery, with 81.8% of patients not necessitating a second procedure. This is a favorable result, indicating that, in the majority of instances, the initial surgical procedure was effective. Nevertheless, 18.2% of patients necessitated a second treatment, surpassing the figures published by Kwon, in which only a minor percentage of patients required supplementary surgeries owing to prompt intervention and superior initial therapy.[3]

The duration of hospital stay (LOS) in this study varied from 2 to 48 days, with an average of 17.18 days. This parallels studies in India by Periasamy et al. where prolonged hospitalizations were similarly noted due to the intricacy of empyema cases and the tardy presentation of patients. Conversely, nations with more sophisticated diagnostic and therapeutic methods, such as Taiwan, typically report reduced hospital durations. Tsai et al noted that early diagnosis and the application of VATS resulted in markedly shorter

hospitalizations, with the majority of patients discharged within 7 to 10 days.[7,16] Additionally, other studies have analyzed clinical factors that may contribute to length of stay, including hypoxemia and pleural effusions, as well as diastolic blood pressure, multilobuled empyemas, and hypoalbuminemia.[17]

The mean ICU duration of stay in our study was 5.24 days, aligning with findings reported by Tian et al in China, where more complex empyema cases necessitated intensive care. This study demonstrates that the necessity for ICU care reflects the severity of certain empyema patients, necessitating vigilant post-operative surveillance. This is a prevalent concern worldwide, as more severe cases, especially those with comorbidities, necessitate extended recovery durations and intensive care.[14]

CONCLUSION

This study offers significant insights into the surgical therapy of empyema within an Indonesian healthcare context. The study underscores issues associated with delayed diagnosis and the restricted access to modern surgical technologies, such as video-assisted thoracoscopic surgery (VATS), despite the utilization of both open thoracotomy and VATS, which are more prevalent in resource-rich environments. The results correspond with international trends, indicating that early diagnosis and prompt intervention, especially using minimally invasive techniques, might markedly enhance patient outcomes. In Indonesia, a significant proportion of patients continue to emerge with advanced empyema, resulting in prolonged hospitalizations and an increased likelihood of recurring surgeries. Enhancing early detection, broadening access to minimally invasive surgical alternatives, and improving healthcare infrastructure, particularly in remote regions, are essential for better outcomes.

CONFLICT OF INTEREST

Author declares there is no conflict of interest.

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None.

ETHICAL CONSIDERATION

Not mandatory in retrospective analysis descriptive based on outpatient clinics registry.

AUTHOR CONTRIBUTION

All author had contributed in manuscript writing and agreed for the final version of manuscript for publication.

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