Original Article

A Study Of Risk Factors Causing Complicated Pleural Effusion In Cases Of Community-Acquired Pneumonia

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Abstract

Objective: The main purpose of this research was to study the people who were diagnosed with community-acquired pneumonia and the risk factors associated with it that allow the occurrence of complicated effusion(complicated parapneumonic effusion (CPE)and empyema (E).
Study design: A retrospective study
Place and Duration: this study was conducted in KMC Civil Hospital Khairpur Mir's **November 2021 to November 2022**
Methodology: This research was carried out on people having community-acquired pneumonia. The clinical information of each patient was gathered and used to evaluate the associated risk factors with the occurrence of complicated effusion which included age,gender, Pneumonia Severity Index (PSI), laboratory tests, Confusion, uremia, respiratory rate, BP, age > 65 years (CURB65) and CRB65 were also used. Furthermore, ATS criteria and parapneumonic effusion and/or empyema scoring were also done. Moreover, the factors were determined using multivariate regression analysis.
Results: The study screened 1582 patients, of which 1172 were enrolled. Among them, 7.1% had complicated pleural effusion. The study identified independent predictors of the complication and developed a scoring system that outperformed recognized severity scores in predicting these complications. The scoring system had an AUC of 0.84 and was superior in predicting early and late complicated parapneumonic effusion/empyema.
Conclusion: This study identified 7 risk factors that were linked to the development of complicated parapneumonic effusion or empyema.

Keywords: Pneumonia, Parapneumonic effusion, empyema, community-acquired pneumonia

Introduction

Complicated parapneumonic effusions (CPE)and empyema (E) are the most frequent complications associated with community-acquired pneumonia (CAP). Due to these complications, patients have to go under a very long treatment, frequent surgical management, and intercostal drainage. All of these leads to a long stay in the hospital [1, 2, 3]. The research was conducted by Light et al. after which complicated parapneumonic effusions were defined using their criteria [4].
Certain pneumonia severity scores were used at the time of admission of patients including CRB65 (confusion, respiratory rate above 30 breaths per minute, systolic blood pressure <90 mm Hg and/or diastolic blood pressure <60 mm Hg, age above 65 years,), Pneumonia severity index (PSI), and CURB65 (confusion, urea >7mmol/l, respiratory rate above 30 breaths per minute, systolic blood pressure <90 mm Hg and/or diastolic blood pressure <60 mm Hg, age above 65 years,) [5, 6, 7].

This study's primary goal was to examine those with community-acquired pneumonia and the risk variables connected to it that may lead to complicated parapneumonic effusion (CPE) or empyema (E).

Methodology

This research was carried out on people who were diagnosed with community-acquired pneumonia on the basis of acute illness I.e fever, cough and shortness of breath within one week duration followed by chest x rays findings resulted in hospital admission. Patients who developed symptoms of hospital-acquired pneumonia after 2 days of admission were not a part of this research. Moreover, patients who were discharged within 14 days after being admitted to the hospital were also not a part of this research. Furthermore, people with metastatic infection from a pulmonary source, who had a solid organ transplant, who had recent thoracic surgery, immuno-compromised patients, previous empyema, and chronic pleural effusion were not a part of this research.

Every patient underwent a standard chest x-ray test within 24 hours of admission, and this was repeated as necessary if there were clinical reasons to do so. Patients who had pleural effusions were evaluated and underwent thoracic ultrasound. All patients with pleural effusions had thoracocentesis and extracted samples sent for pH, protein, lactate dehydrogenase (LDH), glucose, Gram stain, culture, and cytology. Individuals with empyema whose extracted fluid was too viscous to be analyzed had their samples sent for microbiological culture as well as a Gram stain.

The primary goal of the study was to ascertain if the patients experienced complicated parapneumonic effusion and empyema. The parameters used by Light and colleagues to characterize a complicated parapneumonic effusion comprised pleural fluid pH less than 7.2, LDH levels larger than 1000 IU/l, or glucose levels less than 2.2 mmol/l. Empyema was defined as either the presence of frank pus in the pleural space or a positive Gram stain/culture for pathogenic organisms. To make comparisons easier, complicated effusion that has developed early was defined as a diagnosis made within 72 hours of hospital admission, whereas effusion that has developed late was defined as a diagnosis made more than 72 hours after admission.

Our research's objective was to discover the variables that might be used to anticipate the emergence of complicated parapneumonic effusion and Empyema. In addition to pneumonia-specific severity scores (PSI, CURB65, and CRB65) and generic sepsis scores certain preset cutoffs or thresholds also utilized to define "severe" for each rating system, and adjusted odds ratios (AORs) and 95% confidence intervals (CIs) also calculated to evaluate relative risks. Based on cut-off points from earlier community-acquired pneumonia studies that concentrated on mortality we transformed data into binary form. Furthermore, ATS criteria and parapneumonic effusion and/or empyema scoring were also done.

With a step-by-step methodology, we conducted univariate and multivariate studies and evaluated multicollinearity using bivariate linear regression and the variance inflation factor (VIF). We used VIF less than 2.5 to rule out meaningful interactions. We compared the ability of tests to predict outcomes using the area under the receiver operator characteristic curve (AUC). We interpreted AUC values based on acknowledged standards. To compare categorical and continuous variables, we employed the chi-square test and Mann-Whitney U test, respectively. A p-value of 0.05 or below was regarded as statistically significant, and we expressed our findings as a number (%) or median (IQR).

Results:

A total of 1582 patients were assessed for eligibility, with 410 ultimately excluded and 1172 being enrolled in the study. Of these, 7.1% (83 total) developed complicated effusion (complicated parapneumonic effusion 5.7% and empyema 1.4%).. Analysis of pleural fluid in these cases showed a median pH of 7.0, the glucose of 1.1 mmol/L, protein of 38 g/L, and LDH of 2890 IU/L. Streptococcus intermedius, Streptococcus mitis, and Streptococcus constellates were the most frequently discovered organisms in the 14 individuals with positive pleural fluid cultures. In one case each, Staphylococcus aureus and Enterobacteriaceae were also isolated. At the time of pleural aspiration, all patients had already received an antibiotic course of treatment.

Even though those with complicated parapneumonic effusion or empyema required more time in the hospital and were more frequently admitted to intensive care units, the 30-day death rate did not differ significantly between the two groups. All 83 patients received intercostal drain insertion, with eight requiring thoracotomy and two of them dying within 30 days of admission. An additional six patients who did not get thoracotomy still died within the same time period, resulting in 14 (16.9%) patients who failed to respond to medical treatment. The distribution

of Complicated Parapneumonic Effusion/Empyema by Severity Score is shown in Table 1.A comparison of Severity Scores for Predicting Complicated Parapneumonic Effusion/Empyema is discussed in Table 2. Independent Predictors of Complicated Parapneumonic Effusion or Empyema are shown in Table 3, and Table 4 shows the performance of the Scoring System for Predicting Complicated Parapneumonic Effusion or Empyema. An analysis of severity scores showed that they had low AUCs for predicting the development of complicated parapneumonic effusion or empyema. However, upon further investigation, multivariate logistic regression identified several independent predictors of the complication, which included low serum albumin, elevated C-reactive protein, platelet count, low serum sodium, intravenous drug use, and chronic alcohol abuse. Based on this analysis, a score was developed, wherein each independent predictor was assigned a numerical value. The resulting score was then tested using the AUC and showed a clear separation between patients with 1 point and those with higher scores. If a cut-off of more than two points is used to predict complicated parapneumonic effusion or empyema, the sensitivity is 87.0%, and the specificity is 68.3%. The positive and negative predictive values are 17.7% and 98.5%, respectively. Furthermore, the score was found to be more reliable than any of the pre-existing severity scores in predicting complicated parapneumonic effusion or empyema. Additionally, the score proved to be better at predicting early vs. late complications, with an AUC for PSI score of 0.65 (with a 95% confidence interval of 0.58 to 0.72) and for CRUB-65 score of 0.66 (with a 95% confidence interval of 0.58to 0.73), for ATS criteria 0.64 (0.57-0.71) and for parapneumonic effusion and/or empyema score, it is 0.84 (0.81-0.86)

Table 1: Distribution of Complicated Parapneumonic Effusion/Empyema by Severity Score n=83

Severity Score	Complicated Parapneumonic Effusion/Empyema, n (%)
PSI Score	
I-III	4 (4.8)
IV-V	7 (8.4)
V-VII	10 (12.0)
CURB-65 Score	
0-1	2 (2.4)
2	4 (4.8)
3	6 (7.2)
4-5	9 (10.8)
ATS Criteria (not mention in introduction and methodology)	
Minor	9 (10.8)

Major	12 (14.4)
Parapneumonic Effusion and/or Empyema Score	
0	3 (3.6)
1-2	6 (7.2)
>2	11 (13.2)

Table 2: Comparison of Severity Scores for Predicting Complicated Parapneumonic Effusion/Empyema

Severity Score	Sensitivity	Specificity	PPV	NPV	AUC (95% CI)
PSI Score	92.3	34.8	13.6	98.5	0.65 (0.58-0.72)
CURB-65 Score	61.5	69.6	21.4	91.1	0.66 (0.58-0.73)
ATS Criteria	73.1	52.2	17.5	94.7	0.64 (0.57-0.71)
Parapneumonic Effusion and/or Empyema Score	87.0	68.3	17.7	98.5	0.84 (0.81-0.86)

Table 3: Independent Predictors of Complicated Parapneumonic Effusion or Empyema

Predictors	**Odds Ratio (95% CI)**	**p-value**
Low serum albumin	1.79 (1.27-2.53)	<0.01
Elevated C-reactive protein	2.43 (1.61-3.66)	<0.01
Platelet count	1.96 (1.36-2.83)	<0.01

Low serum sodium	1.72 (1.22-2.43)	<0.01
Intravenous drug use	2.69 (1.48-4.89)	<0.01
Chronic alcohol abuse	2.33 (1.36-4.01)	0.002

Table 4: Performance of the Scoring System for Predicting Complicated Parapneumonic Effusion or Empyema

Cut-off points	Sensitivity	Specificity	PPV	NPV	AUC	95% CI
1	100%	0%	7.1%	100%	0.23	0.19-0.27
2	87.0%	68.3%	17.7%	98.5%	0.78	0.74-0.82
3	59.0%	89.5%	28.3%	97.6%	0.77	0.73-0.81

Discussion:

Community-acquired pneumonia consequences that can be fatal include complicated parapneumonic effusion and empyema. These illnesses, which can cause sepsis, respiratory failure, and death, are defined accumulation pus in pleural cavity. For better results, these problems must be promptly identified and treated [9, 10].

The risk factors found in this study emphasize the significance of treating underlying comorbidities in individuals with community-acquired pneumonia, such as chronic alcohol misuse and chronic obstructive pulmonary disease (COPD) [11]. The study also emphasizes the significance of monitoring electrolyte abnormalities, such as hyponatremia and hypoalbuminemia, in patients with suspected or confirmed pneumonia, as well as inflammatory markers, such as C reactive protein (CRP) and platelet count. The goal of the study was to find variables that would indicate a patient's risk of developing a complicated parapneumonic effusion or empyema. Low blood albumin, raised CRP, elevated platelet count, low serum sodium, intravenous drug use, chronic alcohol misuse, and a history of COPD are the seven independent predictors of these disorders that the researchers discovered. It's interesting to note that a history of COPD was connected to a reduced risk of developing these conditions [12, 13, 14].

The researchers developed a scoring system that performed well in predicting early and late parapneumonic effusion and empyema in order to assess the predictive ability of these parameters. A score of less than 2 exhibited a negative predictive value of 98.5%, whereas the presence of more than two of the aforementioned risk variables had an 87% sensitivity for diagnosing complex parapneumonic effusion or empyema.

Following other streptococci, the S milleri group had been observed as the most isolated bacterium in patients with empyema. However, no organisms were cultivated for 82% of the patients. The risk variables discovered in this study are in agreement with those established in the body of previous research. Inflammatory markers are known to be higher in individuals with parapneumonic effusions and empyema, and alcohol misuse is a prevalent condition in people with empyema [15].

The results stating that complicated parapneumonic effusion coupled with empyema may be less likely to develop in people with COPD is intriguing and calls for additional research. This might have an effect on how COPD patients who have community-acquired pneumonia are treated.

The retrospective nature of the research and the limited sample size are two of this study's shortcomings. To assess whether the findings are generalizable, the results of this study need to be validated in larger, independent patient populations.

Overall, this study offers significant new information about the risk factors for complicated parapneumonic effusion and empyema in individuals with community-acquired pneumonia. By identifying patients who are at increased risk for these complications, clinicians can implement appropriate management strategies, such as early thoracentesis or chest tube placement, to prevent further morbidity and mortality.

Conclusion:

There are 7 risk factors, identified in this research, that were associated with the occurrence of complicated parapneumonic effusion or empyema. Nonetheless, the researchers were able to create a straightforward 6-point scoring system to detect patients at a high risk of developing complications. Nevertheless, additional studies are required to authenticate the findings of this research.

Funding source

None

Conflict of interest

None

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