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Original Research Article

A CLINICAL AND BACTERIOLOGICAL STUDY OF EMPYEMA

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ABSTRACT

Background: Empyema thoracis remains a significant cause of morbidity, with varied clinical manifestations and low microbiological yield due to prior antibiotic exposure. This study aims to evaluate the clinical and bacteriological profile of patients with empyema admitted to a tertiary care centre.

Materials and Methods: A hospital-based observational study was conducted in the Department of Pulmonary Medicine, Gauhati Medical College & Hospital, Assam, from May 2019 to April 2020. Seventy-five patients above 15 years of age, diagnosed with empyema based on clinical, radiological, and pleural fluid criteria, were included. Detailed clinical evaluation, blood investigations, and pleural fluid analysis—including biochemistry, Gram stain, and culture were performed. Data were analysed using descriptive statistics.

Results: Of the 75 patients, 76% were males with a mean age of 44±16.7 years. The most common symptoms were cough (88%), dyspnoea (74.7%), fever (64%), and chest pain (49.3%). Comorbidities were present in 41.3%, predominantly diabetes mellitus (21.4%) and COPD (10.7%). Pleural fluid analysis showed frank pus in 80%, glucose ≤40 mg/dl in 86.7%, LDH >1000 IU/L in 78.7%, and ADA ≥40 U/L in 85.3%. Culture positivity was observed in 58.7% of cases. Gram-negative organisms predominated (65.7%), with Klebsiella pneumoniae (25%) being the most common isolate, followed by Pseudomonas aeruginosa (18.2%) and Staphylococcus aureus (15.9%). Mycobacterium tuberculosis was identified in 13.6% of patients. Prior antibiotic use did not significantly affect culture positivity.

Conclusion: Empyema thoracis continues to be a significant clinical challenge, particularly in resource-limited settings. Empyema thoracis in this study occurred predominantly in males and commonly, and pleural fluid findings showed typical presented with cough and dyspnoea. Diabetes was the leading comorbidity markers of complicated infection. Gram-negative bacteria—especially Klebsiella pneumoniae—were the most frequent isolates. These findings highlight the need for early diagnosis, pathogen-directed antimicrobial therapy, and prompt drainage to reduce morbidity and improve outcomes in empyema thoracis.

Keywords: Empyema thoracis, thoracocentesis, bacteriological profile, antibiotic use.

INTRODUCTION

Empyema is a localized or free collection of purulent material in the pleural cavity. It affects any group, sex and ethnicity and over 65,000 patients suffer from a pleural infection each year in the UK and USA.[1] Majority of patients present with fever, cough and chest pain. The patients do not remember whether they had any respiratory infection or any septic focus previously, since the infection was having been

controlled only to such an extent as to mark the seriousness of the disease.[2]

Predisposing conditions includes bacterial pneumonia, surgery, trauma, alcohol misuse, iatrogenic pleural infection and septicaemia.[3] The yield of bacterial culture of empyema fluid is low (60%).[4,5] It may represent effective antibiotic treatment prior to sample collection.[6]

In most cases aerobic bacterial infection is predominant. These include streptococcus pneumonia and staphylococcus aureus, gram negative bacteria like Escherichia coli, Hemophilus influenza, Klebsiella pneumonia. The commonest anaerobes are Bacteroides fragilis. Mixed aerobic and anaerobic bacteria are commonly isolated from empyema.[7,8]

This study was conducted to look for clinical and bacteriological profile of empyema in patients admitted to a tertiary care centre.

MATERIALS AND METHODS

Study Design and Setting: This hospital-based observational study was conducted in the Department of Pulmonary Medicine and allied specialties at Gauhati Medical College and Hospital, Assam, India. The study was carried out over a period of one year, from 1 May 2019 to 30 April 2020. The study was designed to assess the demographic characteristics, clinical presentation, laboratory profile, pleural fluid findings, and bacteriological spectrum of empyema among patients admitted to a tertiary care centre.

Ethical Considerations: Prior approval was obtained from the Institutional Ethics Committee before the initiation of the study. Written informed consent was obtained from all eligible participants before enrolment. Patient confidentiality was maintained throughout the study, and all collected data were used only for academic and research purposes.

Study Population and Sample Size: A total of 75 patients diagnosed with empyema and fulfilling the predefined eligibility criteria were included in the final analysis. Patients were recruited from the inpatient services of the Department of Pulmonary Medicine and allied specialties during the study period. Consecutive eligible patients were enrolled after clinical, radiological, and pleural fluid confirmation of empyema.

Inclusion Criteria

Patients aged more than 15 years were included if they were diagnosed with empyema based on any of the following criteria:

1. Presence of frank pus on thoracocentesis.
2. Non-purulent pleural fluid with one or more of the following findings:
   - Positive Gram stain or positive bacterial culture.
   - Pleural fluid glucose less than 40 mg/dL.
   - Pleural fluid lactate dehydrogenase level more than three times the upper limit of normal serum LDH.

Exclusion Criteria

Patients were excluded from the study if they met any of the following criteria:

1. Patients who did not provide consent.
2. Patients aged 15 years or below.
3. Patients with empyema secondary to penetrating or blunt chest trauma.
4. Patients with empyema following surgical procedures such as esophagectomy, pneumonectomy, or other thoracic surgical interventions.

Clinical Data Collection: A detailed clinical history was obtained from each patient using a structured data collection format. Demographic details such as age, sex, and socioeconomic status were recorded. Age was categorized into 15–30 years, 31–50 years, 51–70 years, and more than 70 years. Duration of illness was grouped as ≤15 days, 16–30 days, 31–60 days, and 61–90 days.

Clinical symptoms including fever, cough, sputum production, hemoptysis, shortness of breath, weight loss, and chest pain were documented. History of previous antibiotic intake before hospital admission was specifically recorded. Associated comorbidities such as diabetes mellitus, chronic obstructive pulmonary disease, asthma, HIV infection, and pancreatitis were also noted. A thorough general physical examination and respiratory system examination were performed in all patients.

Radiological Evaluation and Pleural Fluid Aspiration: All patients underwent chest radiography for initial assessment of pleural involvement. Ultrasonography of the thorax was performed to confirm the presence, side, and extent of pleural collection. The side of empyema was recorded as right-sided or left-sided disease. Ultrasound-guided thoracocentesis was performed under aseptic precautions for diagnostic evaluation of pleural fluid.

Blood Investigations: Routine hematological and biochemical investigations were performed in all patients. These included hemoglobin concentration, total leukocyte count, erythrocyte sedimentation rate, random blood sugar, renal function tests, liver function tests, serum lactate dehydrogenase, C-reactive protein, and relevant serological tests. Hemoglobin was categorized as <7 g/dL, 7–10 g/dL, and >10 g/dL. Total leukocyte count was categorized as <4000/cumm, 4000–11000/cumm, and >11000/cumm. ESR was categorized as <40 mm/hour and >40 mm/hour.

Pleural Fluid Analysis: Pleural fluid aspirate was examined for gross appearance and classified as frank pus or seropurulent fluid. Biochemical, cytological, and microbiological analyses were performed. Pleural fluid investigations included total leukocyte count, differential leukocyte count, protein, glucose, adenosine deaminase, lactate dehydrogenase, acid-fast bacilli staining, Gram staining, aerobic bacterial culture, and antibiotic sensitivity testing.

Pleural fluid glucose was categorized as ≤40 mg/dL and >40 mg/dL. Pleural fluid LDH was categorized

as <1000 IU/L and >1000 IU/L. Pleural fluid protein was categorized as ≤3 g/dL and >3 g/dL. Pleural fluid ADA was categorized as <40 U/L and ≥40 U/L.

Microbiological Evaluation: Pleural fluid samples were subjected to Gram staining and aerobic culture for identification of bacterial organisms. Culture results were classified as growth or no growth. Culture-positive isolates were further identified according to standard microbiological procedures. Organisms identified in the study included Klebsiella pneumoniae, Pseudomonas aeruginosa, Staphylococcus aureus, Streptococcus pneumoniae, Acinetobacter baumannii, Escherichia coli, Burkholderia cepacia, Cronobacter sakazakii, and Streptococcus constellatus. Tubercular empyema was diagnosed based on microbiological and supporting pleural fluid findings. Anaerobic culture was not performed because of practical difficulties related to sample collection, transport, and maintenance of anaerobic conditions.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences version 23.0. Continuous variables were expressed as mean ± standard deviation. Categorical variables were presented as frequency and percentage. Ninety-five percent confidence intervals were calculated for selected categorical variables. The association between previous antibiotic intake and pleural fluid culture positivity was assessed using the chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Data

Gender	Frequency	Percent
Male	57	76.0 %
Female	18	24.0 %
Age group in years		
15-30 Years	23	30.7 %
31-50 Years	25	33.3 %
51-70 Years	23	30.7 %
>70 Years	4	5.3 %
Duration of illness		
≤15 days	23	30.7 %
16-30 days	36	48.0 %
31-60 days	12	16.0 %
61-90 days	4	5.3 %
Socio economic status		
Lower	45	60.0 %
Upper Lower	13	17.3 %
Lower Middle	11	14.7 %
Upper Middle	6	8.0 %
Upper	0	0
Side of empyema		
Right Side	41	54.6 %
Left Side	34	45.3 %

Majority of the patients, 76%, in the present study were males, while 24% were females. Male to female ratio is 3.1:1. 33.3% were in age group of 31-50 years, while equal proportion of patients, 30.7% were in the age groups of 15- 30 years and the 51-70 years whereas 5.3 % were above 70 years of age. The mean (SD) age was 44±16.7 years. The mean (SD) duration of symptoms was 30.1±20.6 days.

Table 2: Clinical presentation

Symptoms	Frequency	Percentage
Fever	48	64%
Cough	66	88 %
Sputum	31	41.3 %
Hemoptysis	5	6.7 %
Shortness of breath	56	74.7 %
Weight loss	21	28 %
Chest pain	37	49.3 %

88% of study population had cough followed by shortness of breath in 74.7%, fever in 64%, chest pain in 49.3% and sputum production in 41.3%. Weight loss was present in 28% of patients and 6.7% of them were suffering from hemoptysis.

Table 3: Previous antibiotic intake

Antibiotic intake	Frequency	Percent
Yes	27	36 %
No	48	64 %

Table 4: Comorbidities

Comorbidity	Frequency	Percent
Asthma	3	4.0 %
COPD	8	10.7 %
Diabetes Mellitus	16	21.4 %
HIV	3	4.0 %
Pancreatitis	1	1.3 %

Thirty-one patients out of 75 had co morbidities. Among the patients included in the study, majority 21.4% of them had diabetes mellitus as comorbidity, followed by COPD in 10.7%. Equal proportion of patients 4% had asthma and HIV, while 1.3% reported pancreatitis.

Table 5: Blood Parameters

Variable	Criteria	Frequency	Percentage	95% C.I	Mean	Standard Deviation
Hemoglobin(mg/dl)	<7	6	8%	2.7-14.7		
	7-10	19	25.3%	16-36	10.7	2.1
	>10	50	66.7%	56-77.3		
TLC (per cumm)	<4000	1	1.3%	0-4		
	4000-11000	16	21.3%	12-30.7	17019.0	7507.8
	>11000	58	77.3%	68-86.7		
ESR	<40	13	17.3%	9.3-25.3	62.0	24.6
	>40	62	82.7%	74.7-90.7		
RBS Mean (SD)	62.0 (24.6)	-		121.5-177.3		
CRP Mean (SD)	109.1 (75.4)	-		92.9-126.2		

Pleural Fluid Analysis

Table 6: Gross appearance

Pleural fluid Gross appearance	Frequency	Percentage
Frank Pus	60	80 %
Seropurulent	15	20 %

Table 7: Pleural fluid biochemical parameters

Variable	Criteria	Frequency	Percentage	95% C.I	Mean	Standard Deviation
Glucose (mg/dl)	<=40	65	86.7%	78.7-93.3	45.5	59.0
	>40	10	13.3%	6.7-21.3		
LDH (IU/L)	<1000	16	21.3%	12-30.7	7808.8	18209.8
	>1000	59	78.7%	69.3-88		
Protein (g/dl)	<=3	5	6.7%	1.3-13.3	4.5	0.9
	>3	70	93.3%	86.7-98.7		
ADA (U/L)	<40	11	14.6%	8-22.7	90.6	47.6
	=>40	64	85.3%	77.3-92		

86.7% had glucose levels of less than or equal to 40 mg/dl, while 13.3% of patients who were diabetic had pleural fluid glucose above 40 mg/dl. The mean pleural fluid sugar was 45.5 mg/dl.

Majority 78.7% of the patients had high LDH values of above 1000 IU/L, while 21.3% had level below 1000 IU/L. The mean LDH value was 7808.8 IU/L. 70 (93.3%) patients have a protein level of greater than 3 g/dl in their pleural fluid. 64 (85.3%) patients have high ADA value of more than or equal to 40U/L.

Among the culture positive patients, 11 (25%) were having positive Klebsiella pneumoniae growth, while 8 (18.2%) were positive for pseudomonas aueroginosa, 7 (15.9%) were positive for Staphylococcus aureus, 6 (13.6%) were positive for tuberculosis, 5 (11.4%) tested positive for Streptococcus pneumonie. 2 (4.5%) each, tested positive for Acinetobacter baumanii and E.coli, while 1 (2.3%), each, were found to be positive for Burkholderia capacia and Cronobacter sakazakii.

Table 8: Bacteriological profile in empyema

	Frequency	Percent	95% C.I
No growth	31	41.3%	30.7-53.3
Growth	44	58.7%	46.7-69.3
Acinetobacter Baumanii	2	4.5%	0-6.7
Burkholderia Capacia	1	2.3%	0-4.0
Cronobacter Sakazakii	1	2.3%	0-4.0

E.Coli	2	4.5%	0-6.7
Tuberculosis	6	13.6%	2.7-14.7
Klebsiella Peumoniae	11	25%	6.7-22.7
Pseudomonas Aueroginosa	8	18.2%	4-18.6
Staphylococcus Aureus	7	15.9%	2.7-17.3
Streptococcus Constellatus	1	2.3%	0-4.0
Streptococcus Pneumoniae	5	11.4%	1.3-12

Table 9: Association between PF culture and previous antibiotic intake

Previous Antibiotic intake	PF Culture for organism		p value
	Positive	Negative	
Yes	15 (55.6)	12 (44.4)	0.682
No	29 (60.4)	19 (39.6)	

Higher proportion of the patients who had no previous antibiotic intake was found to be culture positive for organisms than the ones with previous antibiotic intake. However, this is not statistically significant (p>0.05).

Hence there is no association between previous antibiotic intake and culture positivity.

DISCUSSION

In this study it is observed that out of 75 patients, majority of them were males 74% and females were 26% and the male to female ratio was found to be 3.1:1. Similarly Acharya reported that 77.5% were males and 22.5% were females and the male to female ratio was 3.4:19. Hemanta kumar Sethy also showed that males were outnumbering females (87% vs 13%).[10] In our study 60% of patients belong to lower class followed by upper lower (17.3%) and lower middle (14.7%) and there were no patients in the upper class. According to the study conducted in Pakistan by Salma Ghaffar results showed 83% of the patients belong to the poor socioeconomic status.[11]

The clinical manifestations of an empyema can vary widely, depending on both the nature of the infecting organism and the competence of the patient's immune system.

The most common presenting complaint was cough (88%), followed by breathlessness 74.7%, fever 64% and least 6.7% had hemoptysis which is similar to reports of various studies. Acharya revealed that cough was seen in 92.5%; shortness of breath 92.5% of patients; followed by fever in 87.5% and chest pain 80%.[9] According to Kamat cough (94%) was the most common symptom followed by fever (76%), chest pain (75%) and dyspnea (53%)12. Another study by K Wanjari showed that fever was the most common symptom in 90% of patients followed by cough in 80% and followed by chest pain, dyspnea with 60% each.[13]

41.3% of our study population had comorbidity, amongst which 21% had diabetes mellitus followed by COPD in 10.7%,4% having asthma and HIV each. In contrast to this ke - cheng chan found that most common comorbidity was hypertension in 30.6% followed by diabetes mellitus (26.7%), CAD (15.6%), malignancy (15%), chronic lung disease (11.5%), CKD (10.8%), liver cirrhosis (10.5%).[14] Daniel J.B. Marks, conducted a 12-year study in UK which shows that malignancy was seen in 8.6%, diabetes mellitus in 8.1%, COPD in 6.2% and HIV in3.4% of patients.[15] A.D. Ferugson stated that out of 119 patients, 57(47.8%) had one or more co morbidity and lung diseases were found in 49 (41%) patients. Among the lung disease, most common was COPD, followed by bronchial carcinoma.[16]

In the present study, 33.3% had anaemia, 77.3% had leukocytosis and mean TLC is found to be 17018.96/cumm. ESR was elevated in 82%. CRP was elevated in all cases and mean value was found to be 109.

Somenath kundu et. al, study compared tuberculous and non-tuberculous empyema in 75 patients, where mean TLC and ESR in tuberculous empyema were 10027.6/cumm and 72 respectively. In non-tuberculous empyema mean TLC and ESR were 14877.1/cumm and 76 respectively.[17] Daniel J.B. Marks also revealed that mean CRP level was 100 in empyema survivors and 87 in those who died of empyema. In the same study Mean hemoglobin was 11.5 which is almost similar to 10.5g/dl in the present study.[15]

In our study 80% of patients had frank pus in 20% had seropurulent. In the study by Alfageme l, out of 82 patients, 53 cases had pus, 24 cases had Sero fibrinous pleural fluid18. Similar to current study, somenath kundu et al showed that frank pus was seen in 72.4% cases of tubercular empyema and 80.4% in non-tubercular empyema.[17]

The current study concludes that 86.7% of patients had pleural fluid sugar less than or equal to 40 and mean value is 45.5. LDH was more than 1000 IU/L in 78.7% of patients. mean value of LDH is 7808.8 IU/l.[18] Raised (>=40) ADA in pleural fluid was found in 85% of patients. The mean protein value is 4.5g/dl. The mean total count in pleural fluid is 2954.4. Majority (61.3%) of the cells in pleural fluid were lymphocytic. M.V. Varadhan also found 44% of cases with pleural fluid sugar less than 40mg%, 4% cases had LDH >1000u/l.[19] Contradicting to our study, Hemanta Kumar Sethy showed that low pleural fluid sugar of less than 40 was found in 52% and high LDH of more than 1000 IU/L in 44% of cases.[10]

58.6% of our study population had organisms grown in culture. Most common among them was gram negative organisms accounting to 65.7% followed by gram positive 34%. Amongst the organisms grown

most common was klebsiella pneumonia (25%), followed by pseudomonas auerginosa (18%), staphylococcus aureus (16%). Mycobacterium tuberculosis was found in 13.6% patients. Similarly study by Maskell, also shows that 58% of patients had positive culture grown. Aerobes (35%) was the most common, 9% and 12% were anaerobes and polymicrobes respectively.[20] In contrast to the present study most common organism was streptococcus species (streptococcus milleri>streptococcus pneumonia> streptococcus pyogenes) followed by anaerobes, staphylococcal species and gram-negative organisms. Among gram negative most common organism was E.coli.

Daniel J.B. Marks, also revealed the most common organism found were gram positive. Microbiological diagnosis obtained in 229 (56.4%) patients out of 406 and different organisms includes streptococci (16.3%), staphylococci (15.5%), Gram-negative organisms (8.9%), anaerobes (5.7%), pseudomonas (4.4%) and mycobacteria tuberculosis (9.1%); 8.4% were polymicrobial.[14]

Another study by Mohan Venkatesh Pulle, showed that tubercular etiology was found in 58.2% of cases, followed by gram negative organisms (63.8%). Gram positive organism was found in 29.8%. Both gram positive and gram negative was found in 6.4%. Among gram negative organisms, most common was pseudomonas (29.8%) followed by enterobacteriaceae (25.5%), acinetobacter (8.4%), klebsiella pneumonia (4.2%). Among gram positive organism, staphylococcus aureus was the most common.[21] Saurabh Karmakar comparatively had a high number of culture positive organism in empyema of 90.6%. Gram negative accounts for 73.3% of culture positives, among which pseudomonas was grown in 60%, followed by klebsiella in 14%, E. coli in 4%. Gram positives were found in 14.94% among which most common was staphylococcus aureus.[22]

Among our 44 culture positive patients, majority 60.4% of them did not take antibiotics, while in 55.6% of cases who took antibiotics were found to have positive culture. In the culture negative group 39.6% of patients did not receive any prior antibiotics. However, this correlation was not statistically significant. However, Sreeja Kothapally on pediatric empyema, found that all 100% of patients with pleural fluid culture positive had taken prior antibiotic, 9.6% patients in culture negative group did not take antibiotics.[23]

CONCLUSION

Pus anywhere in the body has to be drained more so when it is in the pleural cavity. Development of empyema should be rapidly recognised for successful treatment; the mortality of patients with empyema is 15-20% even with appropriate therapeutic attempts and in immunocompromised patients it is even higher. This may be due to inappropriate antibiotics, dosages and duration of antibiotic treatment. From the present study it can be concluded that empyema is more common in men. Cough was the most predominant presenting complaint among patients. Most common co morbidity found among empyema patients was diabetes mellitus. Gram negative organisms were the most common bacteria in empyema, amongst them klebsiella pneumoniae was found to be the most common organism grown in culture. The study also concluded that a greater number of culture positive result was found in patients who did not take prior antibiotics.

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