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To Study the Factors Predicting Outcome of Tube Thoracostomy in Patients of Empyema at the End of Six Months in Tertiary Care Hospital

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ABSTRACT

Background and Aims: Empyema thoracis remains a major clinical problem with substantial morbidity, especially in patients with underlying comorbidities and delayed presentation. Failure of tube thoracostomy often leads to prolonged hospital stay and the need for surgical intervention. This study aimed to evaluate the clinico-demographic profile, radiological, microbiological, and procedural factors influencing outcomes of empyema thoracis managed primarily with tube thoracostomy, and to identify predictors of poor outcome at six months.
Methods: This single-centre observational study included patients diagnosed with empyema thoracis and managed with intercostal chest drain insertion. Demographic data, personal history, clinical symptoms, comorbidities, body mass index, laboratory parameters, microbiological findings, and radiological characteristics were recorded. Tube-related variables, complications, duration of drainage, and need for surgical intervention were documented. Outcomes at six months were categorized as good or poor. Associations between explanatory variables and outcomes were analysed using Chi-square and Fisher's exact tests.
Results: The mean age of participants was 38.12 years, with male predominance. Comorbidities such as diabetes, lung disease, prior tuberculosis, low BMI, and HIV infection were significantly associated with poor outcomes ($p<0.05$). Prolonged symptom duration, extended drain duration, pleural thickening, absent lung expansion, bronchopleural fistula, and air leak at the ICD site strongly predicted poor outcomes. Tuberculous and pyogenic pleural fluid positivity were associated with higher failure rates of tube thoracostomy. At six months, 60% achieved good outcomes with tube drainage, while others required decortication or had persistent disease.
Conclusion: Empyema outcomes are strongly influenced by comorbidities, disease severity, microbiological etiology, and tube-related factors. Early diagnosis, prompt drainage, careful monitoring for complications, and timely surgical referral are essential to improve outcomes.
Keywords: Empyema thoracis; Tube thoracostomy; Bronchopleural fistula; Pleural thickening; Decortication; Treatment outcome

INTRODUCTION

Empyema, defined as the accumulation of frank pus within the pleural cavity, remains a serious clinical condition associated with substantial morbidity and mortality despite advances in antimicrobial therapy and interventional techniques [1]. The condition has been recognized since antiquity, with early descriptions attributed to Hippocrates around 500 B.C. Hippocrates distinguished pleural effusions based on their physical characteristics, noting that thin, non-purulent

fluid suggested non-infectious pathology, whereas thick, purulent collections indicated empyema requiring drainage for clinical improvement [2]. These foundational observations continue to influence modern principles of empyema management.

Significant progress in the understanding of empyema occurred during the mid-20th century, particularly with the identification of biochemical markers such as low pleural fluid glucose levels as indicators of complicated infection. During the 1950s and 1960s, such markers were incorporated into clinical decision-making, leading to the increased use of tube thoracostomy for effective pleural drainage [3]. Contemporary epidemiological data indicate a rising global incidence of pleural infections, including empyema, affecting diverse age groups and populations worldwide [4].

Empyema classically evolves through three stages: exudative, fibrinopurulent, and organizing phases, each necessitating distinct therapeutic strategies [5]. The exudative stage is characterized by sterile fluid accumulation and often responds to antimicrobial therapy alone [6]. Progression to the fibrinopurulent stage involves intense inflammation, bacterial proliferation, fibrin deposition, and loculation, frequently requiring tube thoracostomy to achieve adequate drainage and prevent lung entrapment [6]. The organizing stage is marked by dense fibrous adhesions and pleural thickening, often necessitating surgical intervention to restore lung expansion [7].

Tuberculosis continues to pose a major public health burden, particularly in high-incidence regions, where tuberculous pleural effusions and tuberculous empyema significantly contribute to disease-related morbidity and mortality [8]. Effective management of complicated parapneumonic effusions (CPEs) and empyema relies on accurate staging, early diagnosis, and timely intervention guided by established evidence-based protocols. Nevertheless, despite the availability of antibiotics and multiple drainage techniques, the optimal management strategy for CPEs and empyema remains controversial [9].

The pathophysiology of empyema involves a complex inflammatory cascade initiated by bacterial invasion of the pleural space, most commonly as a complication of pneumonia [1]. This inflammatory process results in purulent fluid accumulation, impaired pulmonary mechanics, and may culminate in severe complications such as sepsis or respiratory failure if inadequately treated [7]. Diagnosis is based on a combination of clinical features, imaging modalities such as chest radiography and computed tomography, and pleural fluid analysis including microbiological culture [10,11].

Management of empyema is individualized, incorporating antimicrobial therapy and drainage of the infected pleural space [12]. While thoracentesis may suffice in early exudative stages, tube thoracostomy is the mainstay of treatment for fibrinopurulent empyema, enabling continuous evacuation of infected material [5,9,13]. Advances in medical knowledge and technological innovations have revolutionized the approach to empyema management, focusing on early diagnosis, appropriate antibiotic therapy, and timely drainage interventions [14].

Despite widespread use of tube thoracostomy, there is a paucity of prospective data evaluating factors that predict its clinical outcome. Existing literature provides limited insight into the influence of baseline characteristics, comorbidities, and underlying disease etiology on treatment success or failure. This knowledge gap necessitates systematic evaluation to optimize patient selection and improve clinical outcomes.

Therefore, this prospective observational study was undertaken to identify factors predicting favourable and unfavourable outcomes of tube thoracostomy among patients with empyema, thereby contributing evidence to guide clinical decision-making and improve management strategies.

Aim and Objectives:

To study the factors predicting favourable and unfavourable outcomes of tube thoracostomy in patients with empyema at the end of six months of follow-up.

MATERIALS AND METHODS

This prospective observational study was conducted after obtaining approval from the Institutional Ethics Committee. The study was carried out in the Department of Pulmonary Medicine and Tuberculosis, Rajan Babu Institute of Pulmonary Medicine and Tuberculosis (RBIPMT), NDMC, GTB Nagar, Delhi, India, over a 12-month period from 01 August 2022 to 31 July 2023.

The study population comprised adult patients admitted to the inpatient department of RBIPMT with a diagnosis of empyema who had undergone tube thoracostomy with drainage of frank pus. Patients aged between 18 and 65 years who were admitted during the study period and had a documented history of empyema managed with tube thoracostomy were included. Patients with associated comorbidities such as diabetes mellitus, hypertension, coronary artery disease, liver disease, kidney disease, anaemia, and HIV infection were also eligible for inclusion.

Patients who did not provide informed consent, pregnant or lactating women, those with transudative or malignant pleural effusions, and patients with pneumothorax, haemothorax, pyo-pneumothorax, or hydropneumothorax were excluded. Additionally, very seriously ill patients with a Karnofsky Performance Score of less than 50 within the past 30 days were excluded from the study.

The sample size was calculated using the formula for cross-sectional observational studies:

Sample size was calculated by using the formula for Cross-sectional observational studies, given as follows-

$N = Z_{1-\alpha/2}^2 pq / d^2$

Here,

$Z_{1-\alpha/2}$ = Is standard normal variate [at 5% type 1 error($P<0.05$) it is 1.96].

p = Percentage of patients with empyema having poor outcome after thoracotomy, taken from study by **Huang HC and Chang HY et al** [15] (considered 47% in present case)

q = 1-p

d= Absolute error for conducting the study

Substituting the values in the formula with d=10%,

$N= [(1.96)^2 \times 0.47 \times 0.53]/ 0.01$

N=108 for the present study.

After ethical clearance, eligible patients were recruited consecutively. The study procedure was explained to all participants, and written informed consent was obtained from patients or their attendants when patients were unable to consent. Data were collected using a pre-tested semi-structured questionnaire comprising sections on identification details, socio-demographic characteristics, personal habits, clinical examination, biochemical investigations, and radiological findings.

Patients were evaluated for clinical symptoms, duration of illness, anthropometric parameters including height, weight, and body mass index, smoking and alcohol history, and socioeconomic status using the modified Kuppuswamy scale. Laboratory investigations included complete blood count, liver and kidney function tests, blood glucose levels, serum electrolytes, and pleural fluid analysis for pyogenic culture, Gram stain, acid-fast bacilli staining, and CBNAAT. Sputum examination, including AFB smear, CBNAAT, MGIT, and pyogenic culture, was performed when indicated. Radiological assessment included chest X-ray for all patients, with computed tomography of the thorax performed in cases of non-resolving empyema to assess pleural thickening and loculations.

Outcomes were categorized as favourable or unfavourable. A favourable outcome was defined by successful intercostal drainage (ICD) removal, adequate lung re-expansion, and absence of the need for surgical intervention. An unfavourable outcome included non-resolving empyema, persistent bronchopleural fistula, prolonged ICD requirement, need for additional surgical

procedures such as decortication, or death during the study period.

Patients were followed up at 3 months and 6 months. During each follow-up visit, clinical symptoms, radiological findings, duration of drainage, duration of ICD placement, presence of bronchopleural fistula, additional interventions, and recurrence after ICD removal were documented.

Data were coded and entered into Microsoft Excel and subsequently analyzed using IBM SPSS Statistics version 21.0. Descriptive statistics were used to summarize demographic and clinical variables. Associations between study variables and outcomes were assessed using the Chi-square test or Fisher's exact test, as appropriate. Quantitative variables were expressed as mean and standard deviation, while qualitative variables were presented as proportions. A p-value of less than 0.05 was considered statistically significant.

Ethical principles were strictly adhered to throughout the study. Patient confidentiality was maintained, and participation was voluntary, with participants free to withdraw from the study at any stage without affecting their treatment.

OBSERVATIONS AND RESULTS

A prospective observational study including 108 patients were carried out from August 2022 to July 2023 at RBIPMT a tertiary care Hospital of National Capital region of Delhi. Adult patients with empyema with tube thoracostomy who met inclusion criteria were enrolled for the study. Informed consent was taken. 8 patients were lost to follow-up hence remaining 100 patients were taken for final analysis. Patients were subjected to follow up twice at 3 months and 6 months and categorized in good and poor outcome on basis of chest tube removal.

Outcome Assessment and Distribution

Outcome assessment was based on predefined clinical and radiological criteria. A good outcome was defined by successful intercostal chest drain (ICD) removal, adequate lung re-expansion on radiological assessment, and absence of any requirement for surgical intervention. A poor outcome included non-resolving empyema, prolonged ICD placement, need for additional surgical procedures such as surgical decortication or open thoracic window, and death during the study period.

At the end of six months of follow-up, out of 100 study participants, 60 patients (60.0%) achieved a good outcome, while 40 patients (40.0%) had a poor outcome.

With respect to chest tube removal, all patients with a favourable outcome had successful ICD removal within the first three months. Among patients with poor outcomes (n = 40), 24 required surgical decortication, 14 had prolonged ICD placement beyond three months, and 2 patients died during the study period. No recurrence of empyema was observed during follow-up at either three or six months.

Table 1: Demographic and Socio-economic Characteristics of Study Participants (n = 100)

Variable	Category	No.	%
Age group (years)	18–30	34	34.0
	31–40	38	38.0
	41–50	20	20.0
	51–65	8	8.0
Gender	Male	55	55
	Female	44	44
	Others	1	1.0
Socio-economic status (Modified Kuppuswamy scale)	Upper	0	0.0
	Upper-middle	3	3.0
	Lower-middle	76	76.0
	Upper-lower	21	21.0
	Lower	0	0.0
	Total	100	100.0

Associated factors with respect to the outcome at the end of 6 months.

All participants of the present study were categorized to have good and poor outcome at the end of 6 months depending upon the ICD site condition and recovery of the patient. Various factors were assessed for any association affecting the outcome among the patients.

The analysis (table 2) demonstrated no statistically significant association between age or gender and outcome at six months, indicating that treatment success following tube thoracostomy was independent of these demographic factors ($p = 0.36$ and $p = 0.67$, respectively). In contrast, body mass index (BMI) showed a significant association with outcome. All patients with BMI <18.5 kg/m² experienced poor outcomes, suggesting that undernutrition was a strong predictor of unfavourable prognosis (Fisher's exact test, $p < 0.05$). Patients with normal BMI (18.5–22.9 kg/m²) predominantly had favourable outcomes, while those in the overweight category showed no clear outcome predominance. These findings highlight the critical role of nutritional status in influencing treatment outcomes among patients with empyema undergoing tube thoracostomy.

Table 2: Association of Demographic and Nutritional Factors with Outcome at End of 6 Months (N = 100)

Variable	Category	Good Outcome n (%)	Poor Outcome n (%)	Total	P value
Age (years)	18–30	24 (40.0%)	10 (25.0%)	34	0.36
	31–40	24 (40.0%)	14 (35.0%)	38	
	41–50	8 (13.3%)	12 (30.0%)	20	
	51–65	4 (6.7%)	4 (10.0%)	8	
Gender	Male	32 (53.3%)	23 (57.5%)	55	0.67
	Female	27 (45.0%)	17 (42.5%)	44	
	Other	1 (1.7%)	0 (0.0%)	1	
BMI (kg/m²)	< 18.5	0 (0.0%)	11 (100.0%)	11	<0.05*
	18.5–22.9	58 (68.2%)	27 (31.8%)	85	
	23.0–24.9	2 (50.0%)	2 (50.0%)	4	

***** Fisher's exact test applied.

The findings of table 3 indicate that clinical severity, associated comorbidities, and radiological extent of disease significantly influenced outcomes at six months following tube thoracostomy. Symptoms such as fever, cough, chest pain, and dyspnoea were significantly associated with treatment outcome, whereas constitutional symptoms showed no significant relationship. Diabetes mellitus, coexisting lung disease, prior tuberculosis, and HIV infection were strongly associated with poor outcomes, highlighting the adverse impact of chronic illness and immunosuppression. Radiologically, higher grades of pleural effusion and advanced parenchymal lesions were significant predictors of unfavourable outcomes, while the side of effusion had no prognostic relevance. These results underscore the importance of early disease assessment and identification of high-risk patients to optimize empyema management.

Table 3: Association of Clinical Features, Co-morbidities, and Radiological Findings with Outcome at End of 6 Months (N = 100)

Variable	Category	Good Outcome n (%)	Poor Outcome n (%)	p value
Clinical symptoms	Fever	59 (60.0%)	39 (40.0%)	0.048
	Cough	58 (59.18%)	40 (40.82%)	0.025
	Chest pain	60 (60.0%)	40 (40.0%)	0.001
	Dyspnoea	58 (59.18%)	40 (40.82%)	0.001
	Loss of weight	21 (50.0%)	21 (50.0%)	0.186
	Loss of appetite	32 (53.3%)	28 (46.7%)	0.093
Co-morbid conditions	Diabetes mellitus	4 (23.5%)	13 (76.5%)	0.001

	Coexisting lung disease	8 (28.2%)	17 (71.8%)	0.00001
	Hypertension	13 (81.3%)	3 (18.7%)	0.091
	Liver disease	8 (80.0%)	2 (20.0%)	0.397
	Coronary artery disease	5 (55.6%)	4 (44.4%)	0.775
	Kidney disease	4 (100%)	0 (0.0%)	0.091
	History of tuberculosis	2 (7.1%)	26 (92.9%)	0.0001
	History of COVID-19	4 (100%)	0 (0.0%)	0.148
	HIV reactive	0 (0.0%)	6 (100%)	0.003
Chest X-ray findings	Side of pleural effusion			
	Right	41 (61.2%)	26 (38.8%)	0.446
	Left	19 (57.6%)	14 (42.4%)	
	Grade of pleural effusion			0.0001
	Mild	16 (100%)	0 (0.0%)	
	Moderate	32 (55.2%)	26 (44.8%)	
	Massive	12 (46.15%)	14 (53.85%)	
	Parenchymal lesion			0.0001
	Minimal lesion	26 (56.5%)	20 (43.5%)	
	Advanced lesion	2 (11.8%)	15 (88.2%)	

In the present study, participants with abnormal TLC count(leucopenia), S. Albumin (hypoalbuminemia) and hyperglycemia were found to have significantly high proportion (5%, 42.5% and 30%each respectively) of poor outcomes ($p<0.05$). Normal direct bilirubin, normal ALT/AST (83.3%, 88.3%, 88.3%) had significant good outcome ($p<0.05$). Participants with anemia, platelets, total bilirubin, total protein, blood urea, S. creatinine, S. bilirubin also had greater proportion of good outcome, but this association was non-significant (Table 4).

Table 4: Biochemical Investigations in study subjects between good and poor outcome at 6 months

		Good	**Poor**	**Total**	**p value**
Anaemia	Normal	20(33.3%)	12(30.0%)	32	0.21
	Mild	25(41.7%)	14(35.0%)	39	
	Moderate	13(21.7%)	8(20.0%)	21	
	Severe	2(3.3%)	6(15.0%)	8	
TLC	Normal	15(25.0%)	3(7.5%)	18	0.02
	Leucocytosis	45(75.0%)	35(87.5%)	80	
Platelets	<1.5	12(20.0%)	14(35.0%)	26	0.10
	1.5-4.5	48(80.0%)	26(65.0%)	74	
PFBS	70-100	56(93.3%)	28(70.0%)	84	<0.01
	>126	4(6.7%)	12(30.0%)	16	
PPBS	140-199	56(93.3%)	33(82.5%)	89	0.11
	≥200	4(6.7%)	7(17.5%)	11	
T. Bilirubin	Normal	50(83.3%)	37(92.5%)	87	0.23
	Abnormal	10(16.7%)	3(7.5%)	13	
Direct Bilirubin	Normal	50(83.3%)	40(100.0%)	90	<0.01
	Abnormal	10(16.7%)	0(0.0%)	10	
T. protein	Hypo	10(16.7%)	10(25.0%)	20	0.32
	Normal	50(83.3%)	30(75.0%)	80	
S. Albumin	Hypoalbuminemia	12(20.0%)	17(42.5%)	29	0.01
	Normal	48(80.0%)	23(57.5%)	71	
AST	Normal	53(88.3%)	40(100.0%)	93	0.04
	Abnormal	7(11.7%)	0(0.0%)	7	
ALT	Normal	53(88.3%)	40(100.0%)	93	0.04
	Abnormal	7(11.7%)	0(0.0%)	7	
Urea grading	Normal	53(88.3%)	38(95.0%)	91	0.30
	Abnormal	7(11.7%)	2(5.0%)	9	
S. creatinine	Normal	56(93.3%)	36(90.0%)	92	0.71
	Abnormal	4(6.7%)	4(10.0%)	8	

The analysis demonstrated that microbiological findings and ICD-related characteristics significantly influenced outcomes at six months. Sputum positivity for AFB and CBNAAT was significantly associated with poor outcomes, whereas sputum pyogenic growth was predominantly associated with favourable outcomes, suggesting better response to non-tuberculous bacterial infections. In pleural fluid analysis, AFB and CBNAAT positivity showed a strong association with unfavourable outcomes, highlighting the adverse prognostic impact of tuberculous empyema. Rifampicin resistance in sputum or pleural fluid was not significantly associated with outcome, likely due to the small number of cases. Among ICD characteristics, the presence of air leak was uniformly associated with poor outcome, indicating persistent bronchopleural fistula and disease severity. These findings underscore the importance of etiological diagnosis and early identification of high-risk ICD features in predicting outcomes of empyema managed with tube thoracostomy (table 5).

Table 5: Association of Microbiological Findings and ICD Characteristics with Outcome at End of 6 Months

Variable	Category	Good Outcome n (%)	Poor Outcome n (%)	p value
Sputum examination	AFB positive	16 (50.0%)	16 (50.0%)	0.011
	CBNAAT positive	21 (48.8%)	23 (53.5%)	0.014
	Rifampicin resistant	2 (100%)	0 (0.0%)	0.515
	MGIT culture positive	20 (50.0%)	20 (50.0%)	0.073
	Pyogenic growth present	12 (85.7%)	2 (14.3%)	0.002
Pleural fluid (pus) analysis	AFB positive	0 (0.0%)	12 (100%)	0.001
	CBNAAT positive	2 (12.5%)	14 (87.5%)	0.037
	Rifampicin resistant	1 (100%)	0 (0.0%)	1.00
	Pyogenic growth present	33 (46.5%)	38 (53.5%)	0.0005
	Gram stain growth present	8 (61.5%)	5 (38.5%)	1.000
ICD characteristics	Presence of leak	0 (0.0%)	26 (100%)	<0.05*
	Drainage at 1 week	60 (60.0%)	40 (41.2%)	—
	BPF at ICD site	37 (49.3%)	38 (50.7%)	—
	Subcutaneous emphysema	2 (20.0%)	8 (80.0%)	—

* Fisher's exact test applied

ICD: Intercostal chest drains; BPF: Bronchopleural fistula

Follow-up analysis (table 6) demonstrated progressive clinical and radiological improvement between 3 and 6 months. There was a reduction in undernutrition, duration of symptoms, amount of pleural pus, and presence of bronchopleural fistula, accompanied by a marked decrease in the proportion of patients requiring an indwelling chest tube at six months. Radiological findings showed increased lung expansion and resolution of parenchymal lesions, although pleural thickening persisted in a subset of patients. Overall, these findings indicate favourable disease resolution over time, with low mortality and no recurrence observed during follow-up.

Table 6: Follow-up variables seen at end of 3rd and 6th month

		3 months (n=98)	6 months (n=96)
Weight	20-40 kg	10(10.2%)	8(8.3%)
	41-60 kg	86(87.8%)	86(89.6%)
	61-80 kg	2(2.0%)	2(2.1%)
BMI	<18.5	21(21.4%)	19(19.8%)
	`18.5-22.9	75(76.5%)	75(78.1%)
	23-24.9	2(2.0%)	2(2.1%)
Duration of clinical symptoms	<1 month	33(33.7%)	33(34.4%)

	1-2 month	30(30.6%)	30(31.3%)
	2-3 month	35(35.7%)	18(18.8%)
	3-4 month	0(0.0%)	15(15.6%)
Chest x-ray ling expansion	Absent	38(38%)	36(36%)
	Present	60(60%)	60(60%)
Tube in situ	Absent	60(60%)	60(60%)
	Present	38(38.7%)	14(14.6%)
AMOUNT OF PUS IN XRAY	Mild	63(64.3%)	82(85.4%)
	Moderate	22(22.4%)	14(14.6%)
	Severe	13(13.3%)	0(0.0%)
PARENCHYMAL LESIONS	Absent	53(54.1%)	66(68.8%)
	Single lesions	28(28.6%)	11(11.5%)
	Multiple lesions	17(17.3%)	19(19.8%)
PLEURAL THICKENING	Absent	60(60%)	60(60%)
	Present	31(31%)	31(31%)
BPF	Absent	69(70.4%)	87(90.6%)
	Grade 1	17(17.3%)	4(4.2%)
	Grade 2	8(8.2%)	5(5.2%)
	Grade 3	4(4.1%)	0(0.0%)
Intervention	Absent	98(98%)	72(72%)
	Present	00%	24(25.0%)
Death		2%	2%
Recurrence	Absent	98(100.0%)	96(100.0%)

Among patients with ICD who had symptoms lasting for more than 1 month, it was observed that majority (52.4%) had significantly poor outcome at the end of 6 months ($p<0.05$). Also, among patients with pleural thickening and having Tube in situ with no lung expansion as seen over chest X-ray, all had significantly poor outcome at the end of 6 months ($p<0.05$) (Table 7).

Table 7: Association of Duration of symptoms, drain and chest X-ray findings with the outcome at the end of 6 months.

Sl No.	ICD, symptoms, chest x ray	Outcome at 6 Months		Significance p value
		Good	Poor	
02.	Drain duration >1month	24 (41.4%)	34 (58.6%)	0.00001
03.	Pleural thickening present	00 (0%)	31 (100%)	0.00005
04.	Prolonged tube in situ	00 (0%)	14 (100%)	0.0005
05.	Symptoms for >1months	30 (47.6%)	33 (52.4%)	0.0005
06.	Lung expansion absent	00 (0%)	40 (100%)	0.0005

Those participants who had any intervention had majority (66.7%) with poor outcome which was also statistically significant with p value <0.05 (Table 8).

Table 8: Association of intervention done with the outcome at the end of 6 months (n=96)

Sl No.	Surgical Intervention (decortication)	Outcome at 6 Months		Significance
		Good	Poor	
01.	Absent	60 (100%)	12 (33.3%)	Fisher's exact p<0.05
02.	Present	00 (0%)	24 (66.7%)	
03.	Total	60 (100%)	36 (100%)	

DISCUSSION

Empyema thoracis remains a challenging clinical entity despite advances in antimicrobial therapy and interventional techniques. The present prospective observational study evaluated demographic, clinical, radiological, biochemical, microbiological, and procedural factors influencing the outcome of tube

thoracostomy in patients with empyema over a six-month follow-up period.

In the present study, the mean age of participants was 38.12 years, with nearly three-fourths (72%) belonging to the 18–40-year age group. This finding aligns closely with reports by Nwagboso CI et al. [16] and Mefire AC et al. [17], who reported mean ages of 39.67 and 34.4 years, respectively. Similar age predominance was observed by Damaraju et al. [18] and Ghaffar Salma et al. [19], indicating that empyema in developing regions predominantly affects young adults. In contrast, studies from developed settings by Chen KC et al. [20] and Yuan-Ming Tsai et al. [21] reported significantly higher mean ages (>58 years), likely reflecting demographic differences, healthcare access, disease epidemiology, and burden of comorbid illnesses. These variations underscore the influence of population characteristics on empyema presentation and outcomes.

Male patients constituted 55% of the study population, consistent with previous studies demonstrating male predominance in empyema. Similar findings were reported by Vilkki VA et al. [22], Wozniak CJ et al. [23], Malhotra P et al. [24], and Ghaffar Salma et al. [19]. The higher prevalence among males may be attributed to increased exposure to risk factors such as smoking, occupational hazards, and delayed healthcare-seeking behavior. However, Bautista ER et al. [25] reported a female predominance, suggesting regional and sociocultural variability.

In the present study, 40% of participants were smokers, which is comparable to findings by Chen KC et al. [20] and Lindström ST et al. [26]. Smoking is known to impair mucociliary clearance, predispose to pneumonia, and increase susceptibility to pleural infections. Alcohol consumption was reported by 20% of patients, a lower proportion compared to the 38% reported by Wozniak CJ et al. [23]. Substance abuse, including intravenous drug use and inhalational substances, was associated with poorer outcomes, likely due to immunosuppression, poor nutritional status, and multi-organ involvement.

Patients commonly presented with fever, cough, chest pain, dyspnoea, weight loss, and loss of appetite, consistent with previous studies [27,28]. Importantly, the presence of acute symptoms such as fever, cough, chest pain, and dyspnoea was significantly associated with favourable outcomes. This observation suggests that acute symptomatology prompts earlier medical attention and timely intervention. Similar associations were reported by Tsai YM et al. [27] and Kim SK et al. [29], whereas Nielsen J et al. [30] did not observe such a relationship, possibly due to differences in disease severity at presentation.

A substantial proportion of patients had comorbid conditions, including diabetes mellitus, chronic lung disease, hypertension, prior tuberculosis, liver disease, HIV infection, and renal disease. Diabetes, lung disease, previous tuberculosis, and HIV infection were strongly associated with poor outcomes. These findings are consistent with previous literature [22,27], highlighting the role of immunosuppression, chronic inflammation, and impaired healing in disease progression. Patients with post-tubercular sequelae often exhibited advanced parenchymal disease, bronchopleural fistulae, and pleural fibrosis, contributing to treatment failure and prolonged drainage.

Most participants had normal BMI, similar to findings by Malhotra P et al. [24]. However, underweight patients (BMI <18.5 kg/m²) exhibited uniformly poor outcomes, corroborating reports by Nwagboso CI et al. [16] and Malhotra P et al. [24]. Malnutrition predisposes patients to infection, delays wound healing, and reduces treatment response, particularly in tuberculosis-endemic settings.

Right-sided pleural effusion predominated, consistent with Tsai YM et al. [21]. Mild pleural effusions were associated with favourable outcomes, whereas massive effusions and advanced parenchymal lesions were strongly linked to poor outcomes. These findings mirror those reported by Kim

SK et al. [29] and Wozniak CJ et al. [23]. Advanced disease likely reflects delayed presentation, higher bacterial load, pleural loculation, and early organization, necessitating prolonged drainage or surgical intervention.

Most patients had stable vital signs at presentation, suggesting subacute disease progression. Leukocytosis was common, consistent with findings by Bautista ER et al. [25]. Hypoalbuminemia and hyperglycaemia were significantly associated with poor outcomes, reflecting systemic inflammation, malnutrition, and metabolic dysregulation. Normal liver and renal function parameters were associated with better outcomes, likely due to improved drug metabolism and bioavailability. Similar observations were reported by Kim SK et al. [29].

Tuberculosis was identified in a substantial proportion of patients via sputum and pleural fluid testing. Pleural fluid AFB and CBNAAT positivity were strongly associated with poor outcomes, consistent with findings by Malhotra P et al. [24]. Pyogenic organisms such as *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Escherichia coli* were commonly isolated, similar to Wozniak CJ et al. [23]. Patients with pyogenic infections demonstrated better outcomes compared to tuberculous empyema, likely due to better antibiotic responsiveness.

Complications such as bronchopleural fistula, air leak, and subcutaneous emphysema were significantly associated with poor outcomes, corroborating findings by Malhotra P et al. [24] and Ghaffar Salma et al. [19]. Prolonged drainage duration (>1 month), pleural thickening, and absent lung expansion uniformly predicted unfavourable outcomes. These factors reflect advanced disease and failure of conservative management.

At six months, 60% of patients achieved favourable outcomes with tube thoracostomy alone. Surgical decortication was required in a significant proportion of patients with pleural thickening. These findings contrast with Shin JA et al. [33], who reported superior outcomes with early surgical decortication. However, patient selection, disease severity, and resource availability likely influenced these differences.

Clinical Implications

Tube thoracostomy remains an effective initial management strategy in selected patients with empyema. Early identification of high-risk patients—those with tuberculosis, malnutrition, comorbidities, advanced radiological disease, and procedural complications—is essential for timely escalation to surgical management.

Recommendations

Early diagnosis, prompt microbiological evaluation, judicious use of imaging, and individualized management strategies are critical. Future studies comparing catheter size, drainage techniques, and early surgical intervention are warranted.

Limitations

This single-centre study with a limited sample size may restrict generalizability. The tuberculosis-focused setting may have introduced etiological bias. Lack of ultrasonography limited assessment of loculated empyema.

CONCLUSION

Empyema remains a challenging condition with a high risk of adverse outcomes, particularly among patients with comorbidities such as anaemia, low BMI, diabetes, tuberculous empyema, post-tuberculosis sequelae, and HIV infection. Prolonged symptom duration, extended drainage, and longer indwelling intercostal drain use were strongly associated with failure of tube thoracostomy, leading to pleural thickening and the need for surgical decortication. Severe pleural collections, advanced parenchymal disease, pleural thickening, and air leak at the ICD site independently predicted poor outcomes. Early diagnosis, accurate staging, and timely, guideline-based interventions are crucial for

improving clinical outcomes and reducing complications in empyema management.

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