

Rapid Score as a Prognostic Factor for Patients with Empyema in a Tertiary Care Center - A Prospective Observational Study

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Abstract Background: Empyema is a serious pleural infection with significant morbidity and mortality. The RAPID score is a validated tool for early risk stratification. This study aimed to evaluate the prognostic value of the RAPID score in adult empyema patients in a tertiary care setting. **Methods:** A prospective observational study was conducted on 61 adult patients with confirmed empyema. RAPID scores were assigned at admission to stratify patients into low (0–2), medium (3–4), and high (5–7) risk groups. Clinical features, microbiological profile, radiological findings, need for surgery, hospital stay, and 3-month mortality were recorded and analysed. **Results:** Most patients were male (82%) and aged <50 years (52.5%). Diabetes (42.6%) and tuberculosis (26.2%) were prevalent; *Pseudomonas aeruginosa* (19.7%) was the most common isolate. RAPID scores classified 65.6% as low risk, 29.5% as medium, and 4.9% as high. Unadjusted analysis showed higher mortality in medium-risk vs. low-risk groups (27.8% vs. 5%; $p = 0.026$), with no deaths in the high-risk group. On multivariable logistic regression, medium risk had higher but non-significant odds of mortality (aOR 8.03; 95% CI 0.61–105.13; $p = 0.112$); subgroup analysis suggested a stronger association in non-TB empyema (aOR 13.67; $p = 0.061$). Only age was independently associated with mortality ($p = 0.014$). RAPID score was not associated with hospital stay or surgical intervention. **Conclusion:** The RAPID score is a useful bedside tool for predicting short-term mortality in empyema, particularly in medium-risk patients, though it does not predict hospital stay or surgical need. Age was the strongest individual predictor of mortality.

Keywords: Empyema, RAPID score, Pleural infection, Mortality prediction, Surgical intervention

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1. Introduction

Empyema refers to the accumulation of pus within the pleural cavity, typically caused by infection spreading into this space. It develops when organisms such as pyogenic bacteria, fungi, parasites, or mycobacteria enter the pleural area, either by direct spread from pneumonia or by direct introduction during procedures. When empyema results from pneumonia, it is classified as a complicated parapneumonic effusion [1].

There has been a steady global rise in the incidence of empyema, which continues to contribute significantly to morbidity and mortality across all age groups, including adults and children. This trend has been reported in both developed and developing countries [2].

Given the high rates of illness and death associated with pleural infections, efforts have focused on identifying risk

factors that can predict poor outcomes. This has led to the development of scoring systems designed to help clinicians identify high-risk patients early, allowing for more timely and targeted treatment in selected groups [3].

Currently, the only outcome prediction tool for pleural infection that has undergone both prospective evaluation and external validation is the RAPID score [4]. This system was derived from data collected in two of the largest multicenter pleural infection studies MIST-1 and MIST-2 [5]. The RAPID acronym includes five baseline parameters: renal function (urea), age, purulence of pleural fluid, infection source, and nutritional status (serum albumin level). These variables help estimate three-month mortality risk and anticipated hospital stay [6].

Despite its clinical relevance, there are only a limited number of studies that have applied the RAPID score specifically to cases of empyema. Even with its limitations, the RAPID score appears to be a useful tool for assessing illness severity at the time of hospital

admission. This study aims to contribute further evidence by identifying individuals at higher risk of mortality and by supporting early, targeted interventions for better clinical outcomes. This study aimed to evaluate the prognostic value of the RAPID score in adult empyema patients in a tertiary care setting.

2. Materials and Methods

This prospective observational study was carried out in the Department of Pulmonary Medicine, Jawaharlal Institute of Postgraduate Medical and Research (JIPMER), Puducherry, from July 2020 to December 2021. The ethical committee approved the study before its initiation.

2.1. Inclusion Criteria

Adult patients (>18 years of age) with empyema admitted to the Pulmonary Medicine ward at JIPMER were included.

2.2. Exclusion Criteria

The study excluded follow-up cases of empyema undergoing treatment at other hospitals, patients with recurrent ipsilateral empyema, and those with bleeding disorders.

2.3. Methods

All 61 adult patients aged over 18 years who presented with symptoms suggestive of empyema underwent detailed clinical evaluation using a structured oral and written proforma. Initial screening was performed through history-taking, physical examination, and chest radiography. If pleural effusion was suspected on X-ray, an ultrasound of the thorax was conducted to confirm the presence of fluid. Further investigations, such as CT thorax and fiber-optic bronchoscopy, were performed when clinically indicated. Pleural fluid was aspirated under ultrasound guidance and analyzed for pH, glucose, LDH, Gram stain, aerobic and anaerobic bacterial cultures using BacT/ALERT FA and FN plus bottles, as well as fungal and mycobacterial cultures.

Based on these results, patients were managed with appropriate treatment. The RAPID score was applied to all confirmed empyema cases to categorize risk as low (score 0–2), medium (score 3–4), or high (score 5–7). Standard treatment protocols included intravenous antibiotics, pleural fluid drainage through thoracentesis or intercostal chest tube insertion, and fibrinolytics in cases with loculated effusions on ultrasound.

Patients were considered for surgical intervention if they met criteria such as a large cavity (>50 ml), persistent multiloculations despite fibrinolysis, fibrin coating on the visceral pleura, or prolonged drainage (>50 ml/day beyond 7 days despite appropriate antibiotics and chest tube placement). Such cases were referred to the Cardiothoracic and Vascular Surgery (CTVS) department for surgical management. All patients were followed up for three months, during which the length of hospital stay, requirement for surgery, and in-hospital mortality within

the study period were recorded.

2.4. Statistical Analysis

Data were summarised as mean $\pm$ SD or percentages. Continuous variables were compared using one-way ANOVA and categorical variables with Pearson's chi-square test. Multivariable logistic regression, adjusting for age, sex, BUN, albumin, infection source, and TB aetiology, was used to assess independent predictors of in-hospital mortality; results are reported as adjusted odds ratios (aOR) with 95% confidence intervals (CI). Subgroup analyses were performed for TB and non-TB empyema. A p-value <0.05 was considered significant. Analyses were conducted using IBM SPSS Statistics, Version 21.0.

3. Results

Most study patients were under 50 years of age (52.5%), with 41% aged 51–70 years and only 6.6% above 70 years. Males constituted the majority (82%), while females made up 18%. All patients presented with breathlessness (100%), and commonly associated symptoms included chest pain (88.5%), fever (83.6%), cough (80.3%), sputum production (62.3%), and weight loss (50.8%). Smoking history was reported in 52.5% of patients. Socioeconomically, the upper lower class formed the largest group (52.5%), followed by the lower class (24.6%), lower middle class (21.3%), and upper middle class (1.6%) (Table 1).

Table 1. Demographic and Clinical Profile

Parameter		N (%)
Age	<50	32 (52.5%)
	51–70	25 (41%)
	>70	4 (6.6%)
Gender	Male	50 (82%)
	Female	11 (18%)
Symptoms	Breathlessness	61 (100%)
	Chest pain	54 (88.5%)
	Fever	51 (83.6%)
	Cough	49 (80.3%)
	Sputum	38 (62.3%)
	Weight loss	31 (50.8%)
Smokers	Smokers	32 (52.5%)
	Non-smokers	29 (47.5%)
Socioeconomic status	Upper middle class	1 (1.6%)
	Lower middle class	13 (21.3%)
	Upper lower class	32 (52.5%)
	Lower class	15 (24.6%)

Among the comorbidities observed, diabetes mellitus was the most prevalent, affecting 42.6% (n=26) of patients. Systemic hypertension was reported in 24.6% (n=15), while chronic kidney disease and a history of tuberculosis were each noted in 18% (n=11) of cases.

Chronic obstructive pulmonary disease (COPD) was present in 9.8% (n=6), and both coronary artery disease and malignancy were identified in 6.6% (n=4) of patients each. Less common comorbidities included chronic liver

disease in 3.3% (n=2) and hypothyroidism in 1.6% (n=1) (Table 2).

Table 2. Comorbidities and Risk Stratification

Comorbidity	N (%)
Diabetes mellitus	26 (42.6%)
Systemic hypertension	15 (24.6%)
Chronic kidney disease	11 (18%)
Tuberculosis	11 (18%)
COPD	6 (9.8%)
Coronary artery disease	4 (6.6%)
Malignancy	4 (6.6%)
Chronic liver disease	2 (3.3%)
Hypothyroidism	1 (1.6%)

Pleural fluid analysis showed aerobic bacterial growth in 50.8% of patients, anaerobic growth in 4.9%, and fungal growth in 1.6%. Tuberculosis diagnostics revealed CBNAAT positivity in 21.3%, LJ culture positivity in 4.9%, and ZN/AP staining positivity in 3.3%. *Pseudomonas aeruginosa* (19.7%) was the most common aerobic isolate, followed by *Escherichia coli* (9.8%), *Klebsiella pneumoniae* (8.2%), *Staphylococcus aureus* (4.9%), and both *Streptococcus pyogenes* and *Streptococcus constellatus* (1.6% each). Anaerobic isolates included *Parvimonas micra*, *Prevotella baroniae*, and a mixed growth of *Bacteroides fragilis* and *Bacteroides thetaiotaomicron* (1.6% each), while *Aspergillus terreus* was the only fungal pathogen isolated (1.6%) (Table 3).

Table 3. Comorbidities and Risk Stratification

Category	Details	Number of Patients (N=61)
Pleural Fluid Culture Results	Aerobic Culture – Growth Present	31 (50.8%)
	Aerobic Culture – No Growth	30 (49.2%)
	Anaerobic Culture – Growth Present	3 (4.9%)
	Anaerobic Culture – No Growth	58 (95.1%)
	Fungal Culture – Growth Present	1 (1.6%)
	Fungal Culture – No Growth	60 (98.4%)
Tuberculosis Diagnostic Results	CBNAAT Positive	13 (21.3%)
	LJ Culture Positive	3 (4.9%)
	Microscopy (ZN/AP Staining) Positive	2 (3.3%)
Aerobic Organisms Isolated	<i>Pseudomonas aeruginosa</i>	12 (19.7%)
	<i>Escherichia coli</i>	6 (9.8%)
	<i>Klebsiella pneumoniae</i>	5 (8.2%)
	<i>Staphylococcus aureus</i>	3 (4.9%)
	<i>Streptococcus pyogenes</i>	1 (1.6%)
	<i>Streptococcus constellatus</i>	1 (1.6%)
Anaerobic Organisms Isolated	<i>Parvimonas micra</i>	1 (1.6%)
	<i>Prevotella baroniae</i>	1 (1.6%)
	<i>Bacteroides fragilis</i> + <i>thetaitaomicron</i>	1 (1.6%)
Fungal Organism Isolated	<i>Aspergillus terreus</i>	1 (1.6%)

Among the study population, 65.6% were classified as low risk (RAPID score 0–2), 29.5% as medium risk (score

3–4), and 4.9% as high risk (score 5–7). The mean hospital stay was comparable across groups: 12 days for low risk, 10 days for medium risk, and 11 days for high risk ($p = 0.537$). Mortality within three months was significantly higher in the medium-risk group (27.8%) compared to the low-risk group (5%), with no deaths reported in the high-risk group ($p = 0.026$). Among individual RAPID score components, only age showed a significant association with mortality ($p = 0.014$), while blood urea nitrogen ($p = 0.599$), pleural fluid purulence ($p = 0.217$), infection source ($p = 0.101$), and albumin levels ($p = 0.328$) were not significant (Table 4).

Table 4. RAPID Score Stratification and patient outcomes

Category	Details	Numbers	P value
RAPID Score Risk Stratification	Low Risk (Score 0–2)	40 (65.6%)	–
	Medium Risk (Score 3–4)	18 (29.5%)	
	High Risk (Score 5–7)	3 (4.9%)	
Mean Length of In-Hospital Stay	Low Risk	12 days	0.537
	Medium Risk	10 days	
	High Risk	11 days	
Mortality Within 3 Months	Low Risk	2 (5%)	0.026
	Medium Risk	5 (27.8%)	
	High Risk	0	
RAPID Score Variable-wise Mortality	Blood Urea Nitrogen (<5, 5–8, >8 mmol/L)		0.599
	Age (years)		0.014
	Purulence of Pleural Fluid		0.217
	Infection Source (CA vs HA)		0.101
	Albumin (<2.7 vs ≥2.7 g/dL)		0.328

Radiological assessment revealed that 55.7% of patients had empyema with ipsilateral consolidation, 29.5% had empyema with bilateral consolidation, and 14.7% had isolated empyema. These patterns showed no significant association with mortality ($p = 0.999$). Surgical intervention was indicated in 44.3% of patients, primarily due to large pleural cavities with loculations (26.6%) or persistent drainage with fibrinous peel (18%). Despite meeting criteria, only 4.9% (n=3) underwent surgery, all of whom belonged to the low-risk RAPID score group, with no significant correlation between RAPID score and surgical intervention ($p = 1.000$) (Table 5).

Multivariable logistic regression adjusting for age, sex, BUN, albumin, infection source, and TB aetiology showed that medium RAPID risk was associated with higher odds of in-hospital mortality compared with low risk (aOR 8.03; 95% CI 0.61–105.13; $p = 0.112$), although this was not significant. No deaths occurred in the high-risk group (aOR 0; $p = 1.000$). Among covariates, none showed significant independent association with mortality (Table 6).

Subgroup analysis revealed a stronger but non-significant association in non-TB empyema (medium vs. low: aOR 13.67; 95% CI 0.88–213.27; $p = 0.061$) compared with TB empyema (medium vs. low: aOR 3.13; 95% CI 0.08–122.12; $p = 0.518$) (Table 7).

Table 5. Radiological Pattern and Surgical Interventions

Category	Details	Number / Result	P value
Radiological Pattern of Lung Involvement	Empyema only	9 (14.7%)	0.289
	Empyema + Ipsilateral Consolidation	34 (55.7%)	
	Empyema + Bilateral Consolidation	18 (29.5%)	
Statistical Significance with Mortality			0.999
Indications for Surgical Intervention	Large pleural cavity with >50 ml + loculations	16 (26.6%)	
	Persistent drainage >50 ml/day + fibrinous peel	11 (18.0%)	
	Patients meeting surgical indication criteria	27 (44.3%)	
Surgical Interventions Performed	Total patients who underwent surgery	3 (4.9%)	
	RAPID risk category of operated patients	All 3 in the Low-Risk Group	
	Correlation with RAPID Score		1.000

Table 6. Multivariable Logistic Regression of In-Hospital Mortality Within 3 Months

	aOR	95% CI	p-value
Low risk	Ref	—	—
Medium risk	8.03	0.61 – 105.13	0.112
High risk	0.00	0.00 – ∞	1
Age (per year)	1	0.93 – 1.09	0.934
Male sex (vs female)	1.1	0.11 – 10.73	0.931
BUN category 1 vs 0	0	0.00 – ∞	0.999
BUN category 2 vs 0	0	0.00 – ∞	1
Albumin <2.7 g/dl (vs ≥2.7)	0.59	0.04 – 7.80	0.687
Infection source: hospital	1.36	0.13 – 14.75	0.801
TB aetiology present	3.66	0.28 – 48.28	0.324

Table 7. Subgroup Multivariable Analysis by TB Aetiology

		aOR	95% CI	p-value
Non-TB empyema	Medium vs Low	13.67	0.88 – 213.27	0.061
	High vs Low	0	0.00 – ∞	0.999
TB empyema	Medium vs Low	3.13	0.08 – 122.12	0.518
	High vs Low	0	0.00 – ∞	0.999

4. Discussion

In our prospective observational study, empyema was more commonly seen in patients aged under 50 years (52.5%), consistent with Indian studies by Gupta et al., Tandon et al., and Jain et al., who associated this with the higher prevalence of tuberculosis common in the age group of < 50 years in developing countries [7,8,9]. In contrast, Chen et al., reported a higher incidence (38%) in individuals above 65 years in developed settings where TB prevalence is lower. Male predominance (82%) in our study aligns with the known higher prevalence of risk factors such as smoking and alcohol use among men [10,11].

Breathlessness was reported (100%), followed by chest pain (88.5%), fever (83.6%), and cough (80.3%). These clinical presentations mirror findings from Acharya et al.,

who reported similar frequencies, reinforcing the common symptomatic spectrum in empyema. Diabetes mellitus was the most prevalent comorbidity (42.6%), followed by hypertension (24.6%) and chronic kidney disease (18%), with diabetes more frequently seen in the low-risk group, while hypertension and CKD were more common in medium-risk patients [12].

Microbiologically, *Mycobacterium tuberculosis* was the most frequently detected pathogen (26.2%), followed by *Pseudomonas aeruginosa* (19.7%). These findings align with previous Indian studies by Gupta et al., Jha et al., and Acharya et al., highlighting tuberculosis as a dominant cause in endemic regions. Anaerobic organisms, such as empyema cases, range from 29% to 85% of all empyema cases. *Bacteroides* species were isolated in 4.9%, while *Aspergillus terreus* was the sole fungal isolate. *Piperacillin/tazobactam* was the most commonly effective antibiotic across all RAPID risk categories [7,8,12].

Radiologically, right-sided empyema predominated (55.7%), consistent with Natanzon et al., Over half of the patient's showed empyema with ipsilateral consolidation, yet the extent and pattern of lung involvement did not significantly correlate with RAPID score categories ($p = 0.999$) [13].

When evaluating individual RAPID score variables, only age was found to be significantly associated with mortality ($p = 0.014$), in agreement with findings by Rahman et al. Corcoran et al., Although the overall 3-month mortality was 11.5%, it was disproportionately higher in the medium-risk group (27.8%, $p = 0.026$), with no deaths recorded in the high-risk group [4,6]. This diverges from studies by Rahman et al., and White et al., which reported higher mortality in both medium- and high-risk groups [4,14]. Our adjusted analysis further highlighted this discrepancy, as the high-risk category did not show increased mortality risk after controlling for confounders. This contrasts with prior Western cohorts, where both medium- and high-risk groups consistently demonstrated elevated mortality. The difference may reflect the high prevalence of TB-related empyema in our cohort and possible earlier intervention.

The mean in-hospital stay across RAPID categories showed no significant difference (12 days for low risk, 10 for medium, and 11 for high), differing from Rahman et al., who observed longer stays with increasing risk categories [4].

In the present study, surgical indications were identified in 27 patients (44.3%) based on criteria such as large pleural cavities with multiple loculations (26.2%) and persistent pleural fluid drainage exceeding 50 ml/day for >7 days with fibrinous pleural coating (18%). Despite meeting these criteria, only 3 patients (4.9%) underwent surgical intervention in the form of open lobectomy, all of whom were in the low-risk RAPID score group. These findings differ from those of Rahman et al., who reported a higher chance of surgical intervention in patients with increasing RAPID risk scores [4].

4.1. Limitations

This single-centre study has limited generalizability, with a small sample size especially in the high-risk group reducing statistical power. This limitation was particularly

evident in the multivariable logistic regression, where the small high-risk group precluded reliable effect estimation, resulting in wide confidence intervals and non-significant findings despite large effect sizes in some comparisons. The three-month follow-up precluded assessment of long-term outcomes. Resource constraints limited advanced imaging to clinically indicated cases, and variability in treatment decisions may have introduced bias.

5. Conclusion

The RAPID score proved to be a helpful tool for early risk classification in adults with empyema. In this study, it showed a significant association with short-term mortality, especially in the medium-risk category. However, it did not correlate with the need for surgery or the length of hospital stay. Of the five RAPID components, only age was significantly associated with mortality. Despite these limitations, the score may assist clinical decision-making by highlighting patients at greater risk and supporting early intervention. Larger studies with longer follow-up are needed to validate these findings and guide empyema management.

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