Chapter 87
Approach to Empyema in the ICU

87.1 Introduction

Empyema, defined as the accumulation of pus within the pleural cavity, is a severe complication of infections such as pneumonia or sepsis. It is associated with significant morbidity and requires prompt identification and management to prevent progression and complications like fibrothorax or respiratory failure. The management of empyema in the intensive care unit (ICU) necessitates a multidisciplinary approach involving early recognition, accurate staging, and appropriate therapeutic interventions tailored to patient-specific factors [1, 2] [Ref: Algorithm 87.1].

87.2 Etiology and Risk Factors

Understanding the etiology and risk factors is crucial for early detection and prevention of empyema.

- Poor Oral Hygiene and Aspiration Disorders: Aspiration of oropharyngeal secretions containing anaerobic bacteria can lead to empyema, especially in patients with poor oral hygiene or swallowing disorders.
- Chronic Diseases: Conditions such as diabetes mellitus and cardiovascular disease compromise immune function, increasing susceptibility to infections that can progress to empyema.
- Immunosuppression: Patients with HIV, malignancies, or those on immunosuppressive therapy are at higher risk due to decreased immune defenses. In immunocompromised patients, fungi like *Candida* and *Aspergillus* species can cause empyema.

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- Hospital-Acquired Causes: Post-thoracic surgery complications and infections with methicillin-resistant *Staphylococcus aureus* (MRSA) significantly contribute to empyema in hospitalized patients.

87.3 Bacteriology

A thorough understanding of the microbiological agents involved is essential for effective treatment.

- Anaerobic Organisms: These are frequently implicated in empyema, particularly in cases associated with aspiration and poor dental hygiene. Anaerobes have a higher incidence in empyema compared to other pleural infections.
- Fungal Empyema: In immunocompromised patients, fungi like *Candida* and *Aspergillus* species can cause empyema, requiring antifungal therapy.
- Advanced Diagnostic Techniques: DNA amplification methods, such as polymerase chain reaction (PCR), enhance pathogen identification, especially for fastidious organisms not easily detected by conventional cultures [3].

87.4 Staging/Classification

Empyema due to pneumonia can be classified into three stages based on the progression of the disease:

- Exudative stage/Stage 1: Free-flowing exudate and does not contain bacteria per se. White cell count is usually low, and lactate dehydrogenase (LDH) level is less than half of the serum levels. pH and the glucose levels are mostly normal.
- Fibrinopurulent Stage/Stage 2: Bacterial invasion into the pleural space leading to triggering of the immune cascade resulting in fibrin deposition and loculation. In this stage there is usually a drop in pH to <7.2 and glucose levels below 40 mg/dL. The LDH levels are unusually high (>1000 IU/L). Presence of pus in this stage is called empyema.
- Chronic Organizing Stage/Stage 3: Fibrosis sets in leading to pleural fibrotic cortex formation leading to impaired lung function and prevention of re-expansion.

87.5 Laboratory

Send for complete blood count, liver function tests, renal function tests, coagulation studies, pleural fluid analysis (cytology, pH, protein levels, LDH, adenosine deaminase levels, Gram's stain, cultures). Blood cultures (depending if patient is in sepsis). Tracheal/sputum cultures should also be sent.

87.6 Imaging and Diagnostics

Accurate imaging is critical for diagnosis, staging, and guiding interventions.

- Thoracic Ultrasound (TUS): TUS is instrumental in assessing pleural effusions, detecting loculations, and guiding pleural procedures with real-time imaging.
- Computed Tomography (CT) Scan: Provides detailed images of the pleural space, identifying loculations, pleural thickening, and underlying lung pathology.
- Positron Emission Tomography (PET) and Magnetic Resonance Imaging (MRI): Recommended for complex cases, PET scans help differentiate empyema from malignancy, while MRI offers superior soft tissue contrast without radiation exposure.

87.7 Treatment Strategies

Advancements in medical and surgical therapies have improved empyema management.

- Antimicrobial Therapy: Initiate broad-spectrum antibiotics covering aerobic and anaerobic bacteria, adjusting based on culture results. Consider MRSA coverage in hospital-acquired cases.
- Intrapleural Fibrinolytic Therapy: The combination of tissue plasminogen activator (tPA) and deoxyribonuclease (DNase) has shown efficacy in breaking down fibrinous septations, enhancing chest tube drainage in complex cases [4].
- Tube Thoracostomy: Pleural fluid LDH >1000 IU/L, glucose <40 mg/dL, or a loculated pleural effusion suggests that the pleural effusion is unlikely to resolve with antibiotics alone and thus one should aim for tube thoracostomy.
- Minimally Invasive Techniques:
- Video-Assisted Thoracoscopic Surgery (VATS): Allows for direct visualization, drainage, and debridement with less morbidity compared to open thoracotomy, especially beneficial in chronic empyema.
- Vacuum-Assisted Closure (VAC): Used in managing chronic empyema cavities, promoting granulation tissue formation and reducing infection risk.

87.8 Special Situations and Considerations

- Post-Pneumonectomy Empyema: Management includes individualized open surgical techniques such as open window thoracostomy or muscle flap transposition to obliterate the empyema cavity.
- Stage-Specific Management.

Empyema progresses through three stages, each requiring tailored interventions.

87.8.1 Exudative Stage

- Treatment:
- Initiate broad-spectrum antibiotics with anaerobic coverage. Antibiotic should be based on patient's history and clinical condition and local antimicrobial resistance pattern.

For community acquired, second- or third-generation cephalosporin (e.g., Ceftriaxone) plus Metronidazole or Aminopenicillin plus beta-lactamase inhibitor (Ampicillin sulbactam).

For hospital acquired/post-procedural—methicillin-resistant *Staphylococcus aureus* (MRSA) and *Pseudomonas* cover should be given (e.g., Cefepime plus vancomycin and metronidazole or vancomycin plus piperacillin tazobactam).

The antibiotic should be de-escalated according to culture sensitivity data as soon as it is available.

- Close monitoring: Invasive drainage may not be required if the effusion is small and the patient is stable.

87.8.2 Fibrinopurulent Stage

- Treatment:
- Continue targeted antimicrobial therapy.
- Drainage Options:
- Image-Guided Chest Tube Placement: First-line intervention for draining loculated fluid.
- Intrapleural Fibrinolytics: Administer tPA and DNase to enhance drainage in complex loculations.
- VATS: Considered if chest tube drainage fails or the patient deteriorates.
- Rationale: Effective drainage prevents progression to the chronic stage and facilitates lung re-expansion [5].

87.8.3 Chronic Organizational Stage

- Treatment:
- Decortication: Surgical removal of the thick pleural peel via VATS or open thoracotomy to restore lung expansion and prevent long-term respiratory dysfunction.
- Ensuring Lung Re-expansion: Throughout all stages, it is crucial to ensure the lung re-expands properly to prevent persistent spaces that can harbor infection.

87.9 Outcomes and Prognosis

Understanding prognostic factors guides treatment intensity and anticipates outcomes.

- Prognostic Factors:
- Severity of Illness: Higher morbidity in patients with significant comorbidities or immunosuppression.
- Promptness of Intervention: Early diagnosis and treatment improve prognosis.
- Pathogen Virulence: Infections with resistant or virulent organisms may worsen outcomes.
- Scoring Systems and Biomarkers:
- Utilize tools like the RAPID score to predict mortality risk and guide treatment decisions.
- Monitor biomarkers such as C-reactive protein (CRP) and procalcitonin to assess response to therapy.

A clinical risk score—RAPID score (Table 87.1)—has been designed taking age, albumin levels, urea levels, infection acquired (community/acquired), and

Table 87.1 RAPID score

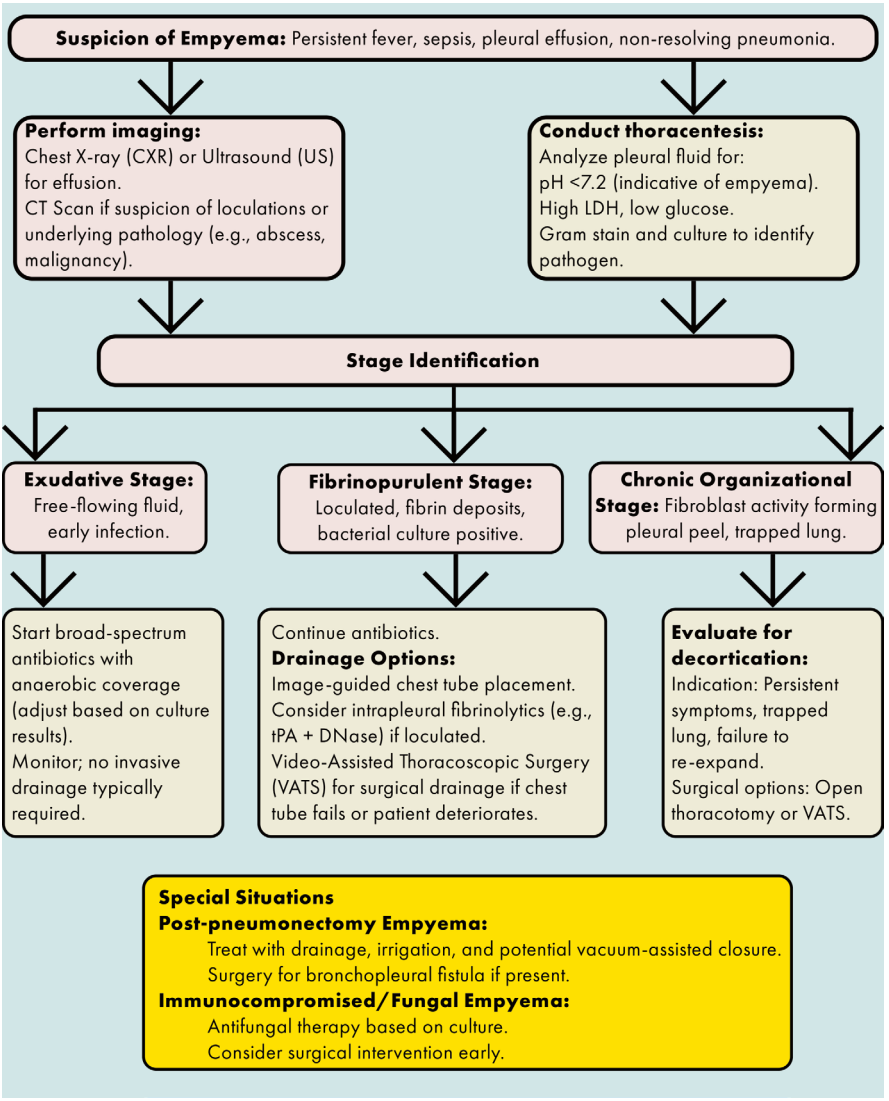
Variable	Value	Score
Age (years)	<50	0
	50–70	1
	≥70	2
Albumin (g/dL)	≥2.7	0
	≤2.7	1
Urea (mg/dL)	<30	0
	30–48	1
	≥48	2
Infection	Community acquired	0
	Hospital acquired	1
Purulence	Non-purulent	0
	Purulence	1

purulence of pleural fluid as variables. All variables have a minimum score of 0, whereas age and urea have a maximum score of 2, and the rest have 1. As per the score, high risk (score 5–7) has a 3-month mortality rate of 43.8%, medium risk (score 3–4) has 10.8%, and low risk (score 0–2) has 1.4%.

87.10 Conclusion

Managing empyema in the ICU requires a systematic, stage-based approach tailored to individual patient needs. Early recognition, accurate staging, and timely interventions—including antimicrobial therapy, drainage procedures, and surgical options—are essential. Imaging advancements like TUS, CT, PET, and MRI enhance diagnosis and guide management. Intrapleural fibrinolytics and minimally invasive techniques like VATS and VAC therapy have improved outcomes, particularly in complex or chronic cases. Special considerations for post-pneumonectomy emphasize the need for individualized care strategies. Ensuring lung re-expansion and preventing long-term complications are critical for improving patient outcomes.

Algorithm 87.1: Approach to empyema in the ICU



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