



Surgical Infections of the Thoracic and Abdominal Cavities: Etiology, Diagnosis, and Modern Treatment Strategies

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Abstract

Surgical infections of the thoracic and abdominal cavities remain among the most challenging and life-threatening conditions in modern surgery. Despite significant advances in antimicrobial therapy, imaging technologies, and minimally invasive surgical techniques, these infections continue to contribute substantially to postoperative morbidity, prolonged hospitalization, and mortality worldwide. Thoracic infections include empyema, mediastinitis, and postoperative pleural infections, while abdominal infections encompass peritonitis, intra-abdominal abscesses, anastomotic leaks, and postoperative wound infections extending into deep tissues. The pathogenesis of these infections is multifactorial, involving microbial contamination, host immune response impairment, ischemia, and surgical trauma.

Early diagnosis is critical and relies on a combination of clinical evaluation, laboratory markers such as C-reactive protein and procalcitonin, and advanced imaging modalities including computed tomography (CT) and ultrasound. Treatment strategies are based on a multimodal approach combining broad-spectrum antimicrobial therapy, timely surgical intervention, and intensive care support. Minimally invasive techniques such as video-assisted thoracoscopic surgery (VATS) and percutaneous drainage have significantly improved outcomes in selected patients.

This review aims to provide a comprehensive analysis of the etiological factors, diagnostic challenges, and modern therapeutic approaches for surgical infections of the thoracic and abdominal cavities, emphasizing evidence-based management and recent advancements in clinical practice.

Keywords

Surgical infection, thoracic cavity, abdominal cavity, peritonitis, empyema, intra-abdominal abscess, mediastinitis, sepsis, antimicrobial therapy, surgical drainage

Introduction

Surgical infections involving the thoracic and abdominal cavities represent a significant global health burden and remain a leading cause of postoperative complications in general surgery, thoracic surgery, and emergency medicine. These infections can arise as primary disease processes or more commonly as postoperative complications following elective or emergency surgical procedures.



The thoracic cavity is particularly vulnerable to infections due to its proximity to the respiratory tract and mediastinal structures. Conditions such as empyema thoracis, postoperative mediastinitis, and pleural space infections are associated with high morbidity and mortality if not managed promptly. Similarly, the abdominal cavity is prone to severe infectious processes such as secondary peritonitis, intra-abdominal abscess formation, and anastomotic leakage following gastrointestinal surgery.

The increasing prevalence of antibiotic-resistant microorganisms, including methicillin-resistant *Staphylococcus aureus* (MRSA), extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae, and multidrug-resistant *Pseudomonas aeruginosa*, further complicates treatment strategies. In addition, patient-related factors such as diabetes mellitus, immunosuppression, malnutrition, and advanced age significantly increase susceptibility to infection.

Despite advancements in perioperative care, surgical infections continue to account for prolonged hospital stays, increased healthcare costs, and elevated mortality rates. Therefore, understanding their pathophysiology, early recognition, and optimal management strategies is essential for improving patient outcomes.

This article provides a comprehensive review of surgical infections affecting the thoracic and abdominal cavities, focusing on their etiology, diagnostic approaches, and modern treatment principles.

Materials and Methods

This study is based on a comprehensive narrative review of current literature published between 2005 and 2025. Scientific databases such as PubMed, Scopus, Web of Science, and Google Scholar were reviewed using keywords including “thoracic surgical infection,” “intra-abdominal infection,” “empyema management,” “peritonitis treatment,” and “postoperative mediastinitis.”

Peer-reviewed clinical studies, randomized controlled trials, meta-analyses, and clinical guidelines from surgical societies were included. Articles focusing on pediatric populations were excluded unless directly relevant to adult surgical infection management.

Data extraction focused on:

Etiology and microbiology of infections

Diagnostic modalities and biomarkers

Surgical and non-surgical treatment strategies

Clinical outcomes and mortality rates

Advances in minimally invasive techniques



A qualitative synthesis approach was used to summarize findings and identify current trends in management.

Results

1. Etiology and Pathogenesis

Surgical infections of the thoracic and abdominal cavities are predominantly polymicrobial. Common pathogens include Gram-negative bacilli (*Escherichia coli*, *Klebsiella spp.*), Gram-positive cocci (*Staphylococcus aureus*, *Streptococcus spp.*), and anaerobic bacteria (*Bacteroides fragilis* group).

Thoracic infections often arise from:

Postoperative contamination after thoracic surgery

Pneumonia progression into pleural space

Esophageal perforation

Trauma-induced chest injuries

Abdominal infections are commonly caused by:

Gastrointestinal perforation (appendix, colon, stomach)

Anastomotic leakage after surgery

Ischemic bowel disease

Traumatic abdominal injury

The pathogenesis involves bacterial invasion, inflammatory cascade activation, cytokine release, and subsequent tissue necrosis. If untreated, localized infection may progress to systemic sepsis and multi-organ failure.

2. Clinical Manifestations

Clinical presentation varies depending on severity and anatomical location.

Thoracic cavity infections:

Fever and chills

Chest pain

Dyspnea and tachypnea



Purulent pleural drainage (in empyema)

Signs of sepsis in advanced cases

Abdominal cavity infections:

Abdominal pain and tenderness

Guarding and rigidity

Fever

Nausea and vomiting

Ileus and bowel dysfunction

Septic shock in severe cases

Early symptoms may be nonspecific, especially in immunocompromised patients, making diagnosis challenging.

3. Diagnostic Approach

Early and accurate diagnosis is critical for successful management.

Laboratory Tests

Elevated white blood cell count (WBC)

Increased C-reactive protein (CRP)

Procalcitonin as a marker of bacterial sepsis

Blood cultures for pathogen identification

Imaging Techniques

Ultrasound: useful for detecting abdominal abscesses and fluid collections

Computed Tomography (CT): gold standard for both thoracic and abdominal infections

Chest X-ray: initial evaluation of pleural effusion or empyema

MRI: useful in complex soft tissue or mediastinal infections

Microbiological Analysis

Aspiration of infected fluid is essential for culture and antibiotic sensitivity testing.



4. Treatment Strategies

Management requires a multidisciplinary approach combining medical and surgical interventions.

4.1 Antimicrobial Therapy

Empirical broad-spectrum antibiotics should be initiated immediately after diagnosis. Therapy is later adjusted based on culture results.

Common regimens include:

Carbapenems for severe infections

Beta-lactam/beta-lactamase inhibitors

Vancomycin for MRSA coverage

Metronidazole for anaerobic infections

4.2 Surgical Management

Surgical intervention is often required for source control.

Thoracic infections:

Video-assisted thoracoscopic surgery (VATS)

Open decortication in chronic empyema

Mediastinal drainage

Abdominal infections:

Laparoscopic or open drainage of abscesses

Resection of necrotic bowel

Repair of perforated organs

Peritoneal lavage

4.3 Minimally Invasive Techniques

Minimally invasive approaches have significantly reduced morbidity:

Percutaneous drainage under CT or ultrasound guidance

Laparoscopic lavage in peritonitis



VATS for empyema

4.4 Intensive Care Support

Hemodynamic stabilization

Fluid resuscitation

Vasopressor therapy in septic shock

Nutritional support (enteral preferred)

5. Outcomes and Prognosis

Prognosis depends on:

Time to intervention

Patient comorbidities

Microbial resistance patterns

Extent of infection

Mortality rates:

Empyema: 10–20% in advanced stages

Severe peritonitis: up to 30–40% in septic patients

Mediastinitis: 15–50% depending on timing of treatment

Early diagnosis and prompt surgical source control significantly improve survival.

Discussion

Surgical infections of the thoracic and abdominal cavities remain a major clinical challenge despite advancements in diagnostic and therapeutic techniques. The key determinant of patient survival is early recognition and timely source control. Delays in intervention are strongly associated with increased mortality and complication rates.

The rise of antimicrobial resistance complicates empirical therapy and necessitates continuous surveillance of local microbiological patterns. In particular, multidrug-resistant Gram-negative organisms have become increasingly prevalent in hospital-acquired infections.

Minimally invasive surgical techniques have revolutionized the management of these infections. VATS has largely replaced open thoracotomy in many cases of empyema, offering reduced



postoperative pain, shorter hospital stays, and faster recovery. Similarly, laparoscopic approaches in abdominal infections have demonstrated favorable outcomes compared to traditional open surgery.

However, limitations remain in patients with advanced sepsis, extensive adhesions, or hemodynamic instability, where open surgical intervention is still required.

Future directions in management include the development of targeted antimicrobial therapies, improved sepsis biomarkers, and enhanced imaging technologies for earlier detection. Additionally, artificial intelligence-based predictive models may assist in identifying high-risk patients preoperatively.

A multidisciplinary approach involving surgeons, intensivists, radiologists, and infectious disease specialists is essential for optimal outcomes.

Conclusion

Surgical infections of the thoracic and abdominal cavities are complex, life-threatening conditions requiring prompt diagnosis and aggressive management. Advances in imaging, antimicrobial therapy, and minimally invasive surgery have significantly improved outcomes; however, mortality remains high in severe cases.

Early source control, appropriate antibiotic therapy, and intensive care support are the cornerstones of successful treatment. Continued research into antimicrobial resistance, diagnostic biomarkers, and surgical innovations is essential to further reduce morbidity and mortality associated with these infections.

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