

## ARTICLE

# Management of Acute Necrotizing Lung Infections: The Role of Surgery

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## Abstract

**Background:** There has been an increasing role of surgical intervention in managing patients with acute necrotizing lung infections and their complications, such as lung abscess and lung gangrene. **Patients and Methods:** In this retrospective study, conducted between 2003 and 2013, we presented patients of acute necrotizing pneumonia (ANP) and its complications, who required surgical interventions. **Results:** Twenty five patients required surgical management of their ANP. At the time of referral to cardiothoracic surgery all patients had evidence of ongoing sepsis despite the antibiotic therapy or have already developed complications. Patients presented with; persistent fever (n=18), cough with or without expectoration (n=25), hemoptysis (n=8), empyema (n=8), persistent air leak (n=3), severe hypoxia (n=3), septic shock (n=2), cachexia (n=6), leucocytosis (n=19), severe leucopenia (n=3) and severe anemia (n=6). All patients were initially managed by internists, pneumologists and infectious disease teams for periods

ranging from 1- 6 weeks prior to referral to cardiothoracic surgery. These patients required one or more of the following surgical procedures; anatomical lung resection (n=10), non-anatomical lung resection & debridement (n=15), and other procedures (n=10). No pneumonectomies were done in our series. There was no intra-operative mortality and only one post-operative mortality in our series. **Conclusion:** Surgical intervention including major or limited lung resection, for unilateral necrotizing lung infections is a safe procedure for patients with persistent sepsis who are not responding adequately to medical therapy or who have already developed complications.

**Keywords:** Acute necrotizing pneumonia, lung abscess, lung gangrene, lung resections, necrotizing granulomas.

## Introduction

Acute necrotizing pneumonitis (ANP) and massive necrosis of lung tissue is a serious, often fatal complication

of pneumonia. Although ANP, lung abscess and lung gangrene represent a spectrum of variable forms of parenchymal destruction, all three forms can coexist. ANP radiographically shows lung consolidation with peripheral necrosis and multiple small cavities, and it rapidly deteriorates and often leads to acute respiratory failure. Lung gangrene initially shows pulmonary consolidation soon followed by extensive necrosis with cavitations. The necrotic tissue can present as a mass within the cavity and can simulate mycetoma (1,2). They are all characterized by various degrees of vascular obstruction, which correlate with the risk failure of medical treatment. ANP and pulmonary gangrene are usually caused by bacteria such as *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, *H. Influezae*, *Pseudomonas aeruginosa* (2-5) and *Mycobacterium tuberculosis* (6,7). Although Methicillin-resistant *Staphylococcus aureus* (MRSA) has been responsible of many cases of ANP acquired in hospitals among patients on ventilators or with

In our practice we follow a more aggressive surgical approach for those cases who do not respond to proper medical treatment and rapidly progress into complications.

## Patients and Methods

### Settings

This is a retrospective study of patients presenting with ANP and its complications who required surgical intervention between 2003-2013. All procedures were performed in King Fahad Specialist Hospital (Buridah) and King Fahad University Hospital (Al Khober). Clinically all patients were severely ill at the time of referral to cardiothoracic surgical service. All of these patients were managed by internists, pneumologists and infectious disease teams for periods ranging from 1- 6 weeks (average 2 weeks) prior to referral to cardiothoracic surgery.

### Patient Characteristics

Eighteen patients were males and seven were females.

**Table 1.** The clinical presentations of these patients at the time of referral expressed as numbers and percentages.

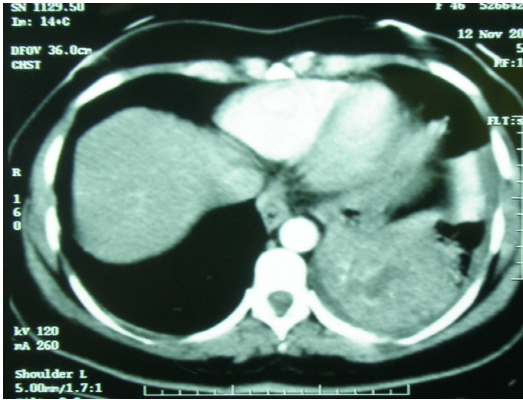
Presenting feature	Number	Percentage
Persistent fever	18	72
Cough $\pm$ expectoration	25	100
Hemoptysis	8	32
Severe hypoxia	3	12
Septic shock	2	8
Empyema	8	32
Cachexia	6	24
Persistent air leak	3	12
Severe anemia	6	24
Leukocytosis	19	76
Leukopenia	3	12

other risk factors, it has been an increasing cause of ANP acquired in community. ANP cases are usually managed medically with antibiotics and other supportive measures. Indications for resection for acute pulmonary necrotizing infections are not well established and should be individualized for each patient. The commonest indications include; persistent or major hemoptysis, abscess formation, empyema, progression to lung gangrene (3).

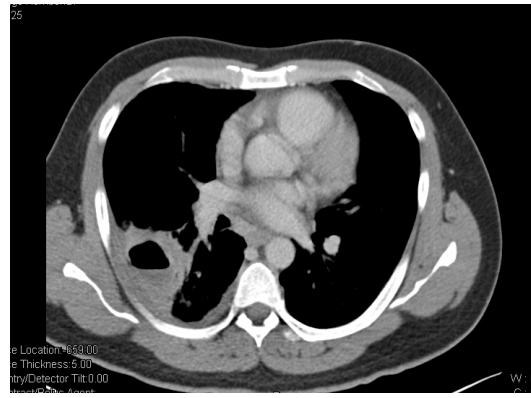
The average age was 37 years (2months -76 years). Eight patients (32%) were diabetic, 2 patients (8%) were intubated and ventilated for about 1 week, 3 patients (12%) had swine flu and 4 patients (16%) had underlying pulmonary TB. No other co morbidities were seen. Table (1) shows the clinical presentation of these patients at the time of referral.

### Imaging Studies

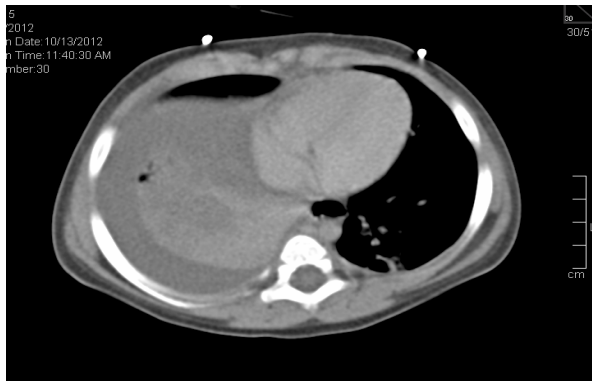
Radiological studies were done for all patients. Patients



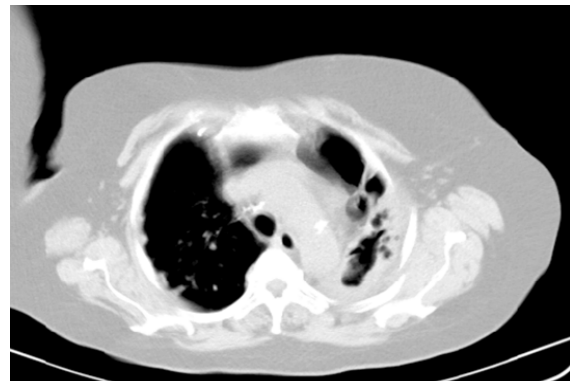
**Figure 1.** Chest CT showing acute necrotizing pneumonia in the left lower lung lobe. The lobe shows patchy areas without contrast uptake.



**Figure 2.** Chest CT of a patient with lung abscess, showing a single cavity arising from the right lower lobe. Patient developed severe respiratory distress and hypoxia.



**Figure 3.** Chest CT of a 2 month old patient with severe ANP caused by pseudomonas and complicated into lung abscess and loculated empyema, the right lower lobe shows patchy areas without contrast uptake.



**Figure 4.** Chest CT of a patient with lung gangrene, showing multiple cavities occupying the left upper lobe & surrounded with areas of consolidation

with ANP showed patchy consolidation, with formation of microabscesses (Figure 1). An abscess was defined as a cavitory lesion occupying less than 50% of the affected lobe, with thick walls (Figures 2&3). Gangrene was defined as a lack of perfusion with extensive necrosis and cavitations usually affecting more than 50% of the involved lobe (Figure 4). The necrotic tissue may present as a mass within the cavity simulating mycetoma radiologically.

#### ***Radiological and surgical interventions***

Initial trials of draining the intrathoracic empyema was done in 10 patients; by tube thoracostomy (ICT) insertion in 7 cases and CT guided drainage in 3 cases with unsatisfactory response. Indications for lung resection were persistence of pulmonary sepsis (N=12) (evidenced by persistent fever, leukocytosis, severe leukopenia in addition to the radiological picture, in spite of the aggressive antibiotic therapy), draining of intrathoracic loculated empyema

(N = 8). Other indications included control of massive hemoptysis (N = 2), control persistent air leak after tube thoracostomy (N = 3). The aim of lung resection was not only to remove the primary source of the ongoing lung infection but also to remove all the necrotic lung tissue and debris and to preserve the surrounding lung parenchyma as much as possible.

#### **Results**

##### ***Clinical Management***

A total of 25 patients underwent surgical intervention for necrotizing pneumonia and lung gangrene between 2003 and 2013. At the time of referral to cardiothoracic surgery there were evidence of persistent sepsis and failure of medical treatment. The time from admission to the initial surgical consultation was 1 to 6 weeks (average 2 weeks).

### ***Surgical Techniques***

General anesthesia was conducted through a double lumen tube in the majority of the patients, although in 2 cases of hypoxia it was not tolerated and conventional anesthesia was done. The surgical approach was through posterolateral thoracotomy in 14 cases, anterolateral thoracotomy in 4 cases, a limited thoracotomy in 2 cases and VATS was used in 5 cases. The surgical procedures included 10 anatomical lung resections (7 lobectomies and 3 segmentectomies) and 15 non-anatomical resection (including wedge resections & debridement procedures). No pneumonectomies were performed in our series. Additional procedures that were required intra-operatively included drainage of the subphrenic space in 2 cases, debridement and drainage of liver abscess in 1 case and decortication in 7 cases. All divided stumps were reinforced by either a pleural flap or pericardial flap with application of bioglue on top. All stapled lines of parenchymal resection were reinforced with bioglue application to minimize air leak. In two patients, the diaphragm was found perforated with subphrenic collection and a liver abscess was found in one of these cases. The subphrenic space was properly drained and the liver abscess was drained and debrided. Although the areas of diffuse inflammation surrounding the damaged lobes or segments were not removed surgically, significant improvement was evidenced postoperatively. The blood loss was 500 – 1000 cc, and all were compensated in the operative room or in the intensive care post operatively guided by the frequent laboratory results.

### ***Pathological Studies***

All removed tissues were sent for pathological examination, and various cultures. Examination confirmed ANP in 18 cases, lung abscess in 2 cases and lung gangrene in 5 cases. In 4 cases there was evidence of necrotizing tuberculous granuloma. In one case of ANP with mixed infection there was evidence of Hodgkin's lymphoma in the underlying resected lobe.

### ***Culture Results***

All collected samples (pleural fluid, pleural tissue and lung tissue) were sent to laboratory investigation. Fifteen of the cultures were negative and 10 cultures showed either MRSA, *Streptococcus pneumoniae*, *Pseudomonas aeruginosa* or mixed infection. Three patients proved to have swine flu predisposing to the acute necrotizing pneumonia. Tuberculosis was confirmed with identification of acid fast bacilli in one lung tissue culture.

### ***Morbidity and Mortality***

23 patients (92%) were extubated at the end of the surgical procedure or required ventilation for less than 24 hours post operatively. Only 2 patients (8%) required ventilation for more than 24 hours. There were no intra-operative deaths but one patient with multiple co-morbidities (old age, diabetes, and prolonged ventilation) who developed adult respiratory distress syndrome (acute respiratory distress syndrome) died on the 14<sup>th</sup> postoperative day. All other patients improved and went home within 1-2 weeks of admission with no sequelae. On follow up for average period of 5 years, no recurrence of the same or other similar conditions were reported.

### ***Discussion***

ANP, lung abscess and lung gangrene represent a spectrum of variable forms of parenchymal destruction which is a serious and often fatal complication of pneumonia. The three forms of parenchymal destruction can coexist. ANP is characterized by a consolidated lung and peripheral necrosis, with multiple small cavities less than 1 cm in diameter. ANP can be progressive into abscess formation or frank gangrene.

Lung gangrene is characterized by the development of central vascular obstruction, bronchial obstruction and significant cavitations involving more than 50 % of a lobe with obvious necrotic debris floating in the cavity (3). ANP and its complications are characterized by various degrees of vascular obstruction, which correlate with the risk of medical therapy failure (1,8,9). These forms of parenchymal destruction are complications of pneumonia and at the time of presentation most of the cultures (sputum, blood, and pleural effusion) are negative. These patients show clinical findings of severe sepsis with uncontrolled fever, leukocytosis or severe leucopenia, weight loss despite the aggressive use of antibiotics. CT scans are clearly superior in evaluating the disease process. It detects areas devoid of perfusion, areas of local necrosis, cavitations or the characteristic air crescent sign (1,10).

Surgical management is required in the majority of cases, when signs of sepsis persist. The obstruction of the blood supply and the bronchial obstruction prevent both the delivery of antibiotics and the sputum expectoration (3). The commonest indications for lung resection in such cases include; persistent or major hemoptysis, abscess formation, empyema, bronchopleural fistula formation and progression to lung gangrene. Many cardiothoracic

surgeons follow a more aggressive surgical approach for those cases not responding to proper medical treatment and rapidly progressing into complications. After removal of the septic foci these patients shows significant clinical and laboratory improvement.

The commonest pathogens causing acute necrotizing pneumonia and pulmonary gangrene are usually bacteria such as *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, *H. Influezae* and *Pseudomonas aeruginosa*. In our series there were 3 cases of swine flu that developed severe necrotizing pneumonia and lung gangrene and required surgical resection of lung parenchyma. Although pulmonary gangrene usually occurs as a complication of pyogenic lung infection, it can occur as a complication of pulmonary tuberculosis (TB). Underlying pulmonary TB causes arteritis and vascular thrombosis of the affected lobe. In addition pyogenic infection can occur on top. In 4 cases there was evidence of necrotizing TB granuloma although these patients did not have any history or clinical findings suggestive of TB before. Hodgkin's lymphoma was diagnosed in the resected lobe of 13 years old patient presented with ANP and persistent sepsis unresponsive to medical treatment. She neither had lymphadenopathy nor organomegaly suggestive of lymphoma prior to diagnosis.

Technically, lung resection is not difficult in such cases with the average blood loss. No extra-ordinary blood products were required. The point is to prevent the development of complications such as air leakage from the bronchial stump or peripherally from the lung parenchyma. The use of staplers, re-inforcing the stump with viable tissue and the application of bio-glue all of these decreased the possible complications. We did not have any intra-operative mortalities or major complications. We performed resection only on cases of unilateral necrotizing pneumonia and lung gangrene. Bilateral severe disease was excluded from our study.

In conclusion, surgical resection is recommended in cases of ANP and lung gangrene whenever there is no response to the medical treatment and supportive measures. The failure of medical treatment is evidenced by persistence of sepsis and the development of complications. The aim of surgery is early removal of all septic foci to improve the prognosis of this lethal condition.

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