

Retrospective Comparative Analysis of Thoracic Empyema in Patients Older/Younger than 65

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Abstract

Objectives: Thoracic empyema is characterized by the collection of infected fluid/pus in the pleural space. A multitude of etiologies and surgical approaches exist. The current study aims to assess outcomes in elderly and young patients undergoing surgery for thoracic empyema. **Methods:** A retrospective comparative analysis was undertaken comparing outcomes in elderly and young patients undergoing surgery with an established diagnosis of empyema. Two groups were generated for comparison 1) patients older than 65 and 2) patients younger than 65. Demographics, comorbidities, post-operative complications, surgical approach and mortalities were compared between groups. **Results:** 526 patients underwent surgery for empyema during the study period (1993-2016). Group A (<65) comprised 418 patients and group B (>65) comprised 108 patients. With respect to group A, the median age at surgery was 45.30 years. Median post-operative stay was 10.50 days (9.10 vs. 11.90 in VATS and open respectively). 30-day mortality in group A was 1.90% (3.30% vs. 0.47% in VATS and open respectively). Group B comprised 108 patients (median age 72.70 years). Median post-operative stay was 14.40 days (11.20 vs. 17.8, VATS vs. open, p = 0.001). Overall 30-day mortality was 8.30 % (7.5% vs. 9% in VATS and open respectively, p = 0.03). **Conclusions:** The associated mortality and in-patient stay was significantly greater in elderly cohorts when compared to younger. Minimal access approaches confer a number of advantages in elderly patients including shorter hospital stay and reduced mortality.

Keywords

Empyema, Video Assisted Thoracoscopy, Elderly, Surgery, Outcomes

1. Introduction

Empyema is characterized by collection of infected fluid in the pleural space [1] [2]. Most commonly, empyema results from infection of parapneumonic effusions [2]. Parapneumonic effusions complicate 40% of bacterial pneumonias and resolve spontaneously if adequately treated with antimicrobials. Failure of resolution however may lead to empyema. In 25% of cases no evidence of pneumonia exists [3]. Other causes include medical instrumentation, thoracic surgery, trauma, abdominal sepsis and rarely malignancy [4].

The pathological evolution of empyema is categorized into three stages (exudative, fibropurulent, organizing). Stage one (exudative) is characterized by the accumulation of fluid (with or without infection) in the pleural space [5] [6]. In the context of sterile fluid, prompt treatment of underlying pathology (pneumonia) frequently leads to complete resolution. Infected fluid mandates combined therapy (intercostal drainage/antimicrobials) [7].

Stages two and three arise as a consequence of medical failure in stage one. Stage two (fibropurulent) is characterized by the formation of fibrous septa and purulent exudate (pus). Septa precluded adequate pleural drainage and surgical evacuation may be indicated. Stage three (organizing) is characterized by pleural fibrous scarring (visceral and parietal) and subsequent lung entrapment. Stage three mandates surgical intervention to avoid lifelong sequelae of lung entrapment. Surgical principles of empyema management stem from Grahams practice and have remained unchanged for 100 years. Graham postulated three pillars of surgical management namely 1) evacuation of pus utilizing a closed drainage system, 2) re-expansion of the lung and 3) nutritional support.

Management of thoracic disease has progressed since the inception of VATS in the nineties [8] [9] [10] [11]. A multitude of studies exist demonstrating equivalent efficacy between open and minimal access approaches in thoracic surgery [12] [13]. VATS confers a number of advantages when compared to open procedures including reduced pain, reduced opioid requirement, enhanced recovery and potentially earlier mobilization/discharge with associated financial benefits [14] [15]. Elderly patients are particularly susceptible to complications associated with prolonged post-operative recovery [16]. As such it may transpire that elderly patients benefit significantly from minimal access procedures in the context of empyema [1]. Few studies have compared outcomes in empyema between elderly and young cohorts [1].

2. Objectives

The current study aimed to compare outcomes in elderly (greater than 65) and young (less than 65) patients undergoing surgery with an established diagnosis of empyema. Furthermore, the current authors aimed to determine the benefits, if any, associated with minimal access approaches in elderly patients with empyema.

3. Methods

A retrospective database comprising patients undergoing surgery for empyema was generated including all patients between the interval 1993-2016. Following institutional approval information was obtained from an NHS maintained electronic database, radiological investigations, serum biochemistry and patient notes. 187 data entry points were included relating to patient demographics and pre-operative variables (age, gender, presence of significant co-morbidities including asthma, chronic obstructive pulmonary disease, myocardial infarction, renal failure, cerebral ischemic events, smoking status and empyema stage). Intra-operative and post-operative variables were also recorded including surgical approach, in-patient hospital mortality, duration of post-operative hospitalisation and incidence of significant complications. Complications were further categorised as follows: arrhythmias, persistent air leaks, respiratory failure, re-operation and wound infection. A multi-modality diagnostic approach was adopted based on clinical, serological, radiological and pathological parameters. Computed tomography was the primary diagnostic tool. Exclusion criteria included those with post-operative histopathological confirmation of malignancy. Patients with missing data were excluded ($n = 93$) catering for a complete-cases analysis.

Two groups were generated for comparison A) patients younger than 65 and B) patients older than 65 based on the World Health Organization (WHO) classification of elderly. Summary statistics relating to patient demographics (age, gender, comorbidities), median age, 30-day mortality and length of stay were collated for each group. Results were collated in a contingency table. Group B (>65) was further categorized according to surgical approach adopted (VATS *vs.* open). 30-day mortality and length of stay were compared between VATS and open. Post-operative complications in groups A and B were assessed and subdivided according to organ system involved. Incidence of complications was compared between both groups and collated in a contingency table.

A Chi-square test was employed to determine differences in categorical variables between firstly groups A and B and secondly VATS *vs.* open. Continuous variables were compared using Students t test/Mann-Whitney U test depending on distribution of data. $p < 0.05$ was considered statistically significant. Data analysis was completed using GraphPad Prism 7.02 and IBM SPSS Statistics for Windows version 23 (IBM Corp., Armonk, N.Y., USA).

4. Results

526 patients underwent surgery with a diagnosis of empyema. Group A (<65) comprised 418 (79.47%) and group B (>65) comprised 108 patients (20.53%). There was no difference in distribution of gender between groups A (male 322/77%) and B (male 78/72%, $p = 0.99$) (**Table 1**). The frequency of empyema stage II (145/34.60% *vs.* 34/31.40%, $p = 0.99$, groups A and B respectively), empyema stage III (273/65.40% *vs.* 74/68.60%, $p = 0.99$, groups A and B), minimal

Table 1. A contingency table was generated to compare characteristics between groups A and B. A Chi-square test was utilized to determine statistical significance. The incidence of previous temporary ischemic attack was higher in elderly patients. Younger patients were more likely to smoke (current and past history). $p < 0.05$ was considered statistically significant.

| Characteristics (n = 526) | Group A (n = 418) | Percent | Group B (n = 108) | Percent | p value |
|------------------------------|----------------------|---------|----------------------|---------|---------|
| Mean age | 45.3 | | 72.7 | | |
| Male | 322 | 77% | 78 | 72% | 0.99 |
| Female | 96 | 23% | 30 | 28% | 0.99 |
| VATS | 207 | 49.5% | 53 | 49% | 0.99 |
| Open | 211 | 50.5% | 55 | 51% | 0.99 |
| Empyema stage II | 145 | 34.6% | 34 | 31.4% | 0.99 |
| Empyema stage III | 273 | 65.4% | 74 | 68.6% | 0.99 |
| Myocardial infarct | 9 | 2.1% | 5 | 4.6% | 0.25 |
| Asthma | 133 | 32% | 25 | 23% | 0.09 |
| COPD | 17 | 4% | 5 | 4.6% | 0.99 |
| Renal failure | 7 | 1.6% | 4 | 3.7% | 0.24 |
| History of TIA | 2 | 0.4% | 3 | 2.7% | 0.06 |
| Smoking history | 257 | 61% | 54 | 50% | 0.03 |

*VATS: video assisted thoracoscopy. *COPD: chronic obstructive pulmonary disease. *TIA: temporary ischemic attack.

access approach/VATS (207/49.50% vs. 53/49%, $p = 0.99$, groups A and B) and open approach (211/50.50% vs. 55/51%, $p = 0.99$, groups A and B) were similar between groups (**Table 1**).

The frequency of significant comorbidities was compared between groups. There was no difference in incidence of myocardial infarct (MI), asthma, chronic obstructive pulmonary disease (COPD), renal failure between groups. Elderly patients were more likely to have a diagnosis of previous temporary ischemic attack (TIA) (2/0.40% vs. 3/2.70%, groups A and B respectively). This approached but did not reach statistical significance ($p = 0.06$). Younger patients/group A (257/61%) were more likely to smoke (current and past history) than elderly patients/group B (54/50%, $p = 0.03$) (**Table 1**).

With respect to group A, the median age at time of surgery was 45.30 years. 207 (49.50%) underwent VATS and 211 (50.50%) underwent an open procedure (**Table 1**). Median post-operative stay was 10.50 days (9.10 vs. 11.90 in VATS and open respectively). Overall 30-day mortality in group A was 1.90%. Mortality was greater in the VATS group (3.30%) when compared to open (0.47%) (**Table 2**).

With respect to group B, the median age at time of surgery was 72.53. (49%) underwent VATS and 55 (51%) underwent an open procedure (**Table 1**). Median post-operative stay was 14.40 days (11.20 vs. 17.80 in VATS and open

Table 2. A contingency table was generated to compare incidence of complication between groups A and B. A chi square test and t-test/Mann Whitney-U test was utilized to determine statistical significance between groups. $p < 0.05$ was considered statistically significant. The incidence of respiratory failure, 30-day mortality and duration of post-operative stay was greater in group B.

| Post-op complications/mortality/stay | Patients \leq 65 (n = 418) | Patients $>$ 65 (n = 108) | p value |
|--------------------------------------|---------------------------------|------------------------------|-----------|
| Arrhythmias | 13 (3.1%) | 5 (5%) | 0.24 |
| Persistent air leak | 38 (9%) | 9 (8.3%) | 0.99 |
| Respiratory failure | 7 (1.6%) | 8 (7.4%) | <0.001 |
| Reoperation | 8 (1.9%) | 9 (1.8%) | 0.99 |
| Wound infection | 8 (1.9%) | 3 (2.7%) | 0.99 |
| In hospital/30-day mortality | 8 (1.9%) | 9 (8.3%) | 0.03 |
| Mean postoperative stay (days) | 10.5 | 14.4 | < 0.001 |

respectively, $p < 0.001$) (**Table 2**). Post-operative stay was longer in group B than group A ($p < 0.001$). 30-day mortality was greater in group B (1.90% vs. 8.30%, groups A and B respectively, $p = 0.03$) (**Table 2**). Group B was further analyzed to determine differences in mortality according to surgical approach adopted (VATS vs. open). There was no difference in mortality between VATS (7.50%) and open (9%) in group B ($p = 0.30$) (**Table 3**).

Complications were compared between groups A and B. There was no difference in incidence of arrhythmias ($p = 0.24$), persistent air leaks ($p = 0.99$), reoperation ($p = 0.99$) and wound infection ($p = 0.99$). The incidence of respiratory failure was significantly greater in group B (7.4% vs. 1.60%, $p < 0.001$) (**Table 2**).

5. Discussion

Therapies for empyema include medical (antibiotics), pleural space evacuation (intercostal drain) and surgery (open and thoracoscopic approaches) [7] [17] [18]. Surgical approaches induce significant physiological disturbances relating to 1) prolonged intraoperative lung isolation, 2) significant post-operative air leak and 3) exacerbation of sepsis during initial stages. Patient demographics have evolved with increasingly elderly patients referred for surgical evaluation [2]. In light of the associated morbidity and mortality, there is a pressing need to understand differences in outcomes between elderly and young patients undergoing surgery for empyema to cater for optimal surgical approach [2] [19].

The current study aimed to determine differences in outcomes between elderly and young patients undergoing surgery for empyema. In summary, the authors noted the following. The proportion of elderly patients undergoing surgery increased significantly throughout the study period. There was no difference in distribution of medical co-morbidities between groups. Surgical approaches were similar between groups with half of patients undergoing thoracoscopic procedures in both cohorts. Duration of inpatient stay and mortality were higher in elderly patients. There was no difference in mortality between thoracoscopic

Table 3. Group B was further categorized according to surgical approach adopted (VATS *vs.* open). A contingency table was generated and t-test/Mann Whitney-U test employed to determine statistical significance. Duration of post-operative stay was longer in patients undergoing an open procedure. Mortality was higher in the open group but this did not reach statistical significance.

| Median post-operative stay (days) | | | |
|-----------------------------------|-------|-------|---------|
| | VATS | OPEN | p value |
| Group B | 11.2% | 17.8% | < 0.001 |
| 30-day mortality (percent) | | | |
| | VATS | OPEN | p value |
| Group B | 7.5% | 9% | 0.30 |

and open approaches with respect to older patients. However, mortality was higher in younger patients undergoing thoracoscopic surgery when compared to open surgery.

A multitude of publications demonstrate the efficacy of VATS in the management of empyema [20] [21] [16]. However, few studies compare VATS and open approaches in elderly populations in a single institute [22] [23]. Scarci *et al.* reviewed fourteen studies evaluating outcomes in patients with empyema undergoing surgery. The authors concluded equivalent outcomes between VATS and open procedures and indicated VATS was associated with lower morbidity. Many of the studies included were limited by factors such as insufficient numbers, comparison of VATS and tube thoracostomy and failure to consider elderly and young patients as distinct cohorts [23].

The current study overcomes many of these limitations. 526 patients were evaluated generating one of the largest single institute cohorts in the published literature. Elderly patients were categorized independently and directly compared to younger cohorts. Moreover, surgical approach (VATS *vs.* open) was further evaluated in the context of elderly patients alone. Surprisingly, there was no difference in mortality between open and thoracoscopic approaches in the elderly group. This raises the question as to why a more invasive procedure generates similar mortality outcomes when compared to minimal access approaches. This may reflect better post-operative lung expansion in patients undergoing open procedures. Elderly patients have poorer physiological reserves when compared to younger patients. As such, failure of full lung expansion following surgery may contribute to increased mortality leading to similar mortality outcomes in minimal access and open procedures. Though thoracotomy is associated with increased pain and longer duration of inpatient stay, the advantage of full lung expansion and associated physiological improvement may confer a survival advantage during the initial post-operative period.

6. Conclusion

This study has some limitations (*i.e.* single institute, retrospective study). None-

theless, we have demonstrated that elderly patients should be considered independently from younger cohorts when assessing operative outcomes.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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