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Original Article

# Bedside pleuroscopy in the Intensive Care Unit

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## Abstract

**Objectives:** It is not always possible to move critically ill patients to the operating or endoscopy room for a pleuroscopy. Bedside pleuroscopy is indicated for these patients. The aim of this study was to investigate the safety and complications of bedside pleuroscopy in an Intensive Care Unit (ICU). **Materials and Methods:** The patients who had undergone routine examinations for pleural effusion, with no established diagnosis at the previous admission were included in this analysis. Patients received local analgesia with bedside pleuroscopy performed by a chest physician in the ICU with continuous monitoring. **Results:** Twenty-five patients (17 males and 8 females) with a mean age of 74 ± 3 years were enrolled. Their mean APACHE II score was 23 ± 1. The duration of drainage from the pigtail catheter was a mean 3.9 ± 0.2 days, and mean ventilator usage was 6 ± 0.7 days. The length of stay in the ICU was 11 ± 1 days. Most pleural effusions occurred on the right side (17/25, 68%). Fifteen patients (60%) had malignant effusions, four (16%) had parapneumonic effusions, three (12%) had empyema, and two (8%) had tuberculosis. Complications occurred in 11 (44%) patients. There were no major complications such as bleeding or procedure-related death. The most common complication was transient chest pain ($n$ = 6, 24%). **Conclusions:** Pleuroscopy performed at the bedside in the ICU is a simple and safe procedure. It has the potential for use in critical patients as serious complications are rare.

**Keywords:** *Bedside, Complication, Intensive care, Pleural effusion, Pleuroscopy*

## Introduction

Crude mortality rates are higher for Intensive Care Unit (ICU) patients with pleural effusion than for those without pleural effusion [1]. Pleural effusion of unknown etiology in the ICU is a challenge, especially in recurrent, unresolved cases [2]. Pleuroscopy is indicated for these critical patients [3], but it might not be possible to move them to the operating room or endoscopy room.

In our institution, respiratory physicians have been performing bedside pleuroscopy for over 5 years in the ICU. We proved that using flexible bronchoscopy for pleuroscopy in undiagnosed pleural effusion with acute respiratory failure is good clinical practice [4]. This study was designed to examine complications and outcomes following bedside pleuroscopy in these critical patients.

## Materials and methods

### Patient recruitment and inclusion criteria

We performed a retrospective analysis of patients undergoing bedside pleuroscopy for recurrent, undiagnosed exudative pleural effusion in our ICU over a 5-year period. Patient characteristics and procedure data were retrieved from the procedures record book and the Patient Examination System databank in our dedicated bronchoscopy room. Admission and discharge dates and if applicable, date of death, were obtained from the hospital's Patient Administration System database.

The date of removal of the pigtail catheter and any reports of complications were retrieved from the procedure notes and progress notes. Radiographs were examined through a Centricity® PACS (Picture Archiving and Communications System Workstation, GE Healthcare Technologies, Barrington, IL, USA), and histology and microbiology reports were obtained from the laboratory computerized system. All patients with an exudative pleural effusion according to Light's criteria were included. Patients were included if they had undergone routine examinations for pleural effusion including medical history, clinical examination, chest radiography, sputum smears for acid-fast bacilli and cytology, thoracentesis for

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biochemistry, cytology and microbiology, with no established diagnosis at the previous admission.

Totally, 60 patients were admitted to our ICU due to undiagnosed pleural effusions from September 2007 to January 2011. Of these 60 patients, 15 refused pleuroscopy and thoracentesis drainage (4 patients with lung cancer and "do-not-resuscitate" orders and terminal care; 3 with anti-platelet use with recent coronary artery disease, 5 patients with complex septated with thick pleural effusion, and 3 patients with hepatobiliary disease with coagulopathy). Twenty patients received continuous pigtail catheter drainage only without pleuroscopy (the majority were critical patients who received routine drainage in emergency situations or at night or on holidays when pleuroscopy was not promptly available). Only 25 patients received bedside pleuroscopy with the insertion of a pigtail catheter. The study was conducted in accordance with the Declaration of Helsinki and was approved by the Local Ethics Committee of the institution. Informed written consent was waived because the study was a retrospective data analysis.

### Definitions

A refractory undiagnosed pleural effusion was defined as a pleural effusion requiring repeat thoracentesis or pigtail catheter drainage despite medical treatment. Pleural effusions with neoplastic cells or neoplastic infiltration in a pleural tissue biopsy sample were considered cancerous. Empyema was defined as grossly purulent fluid in the pleural space. A complicated parapneumonic effusion was defined as that meeting one or more of the following criteria: (1) pH <7.00; (2) lactate dehydrogenase level >1000 U/L; (3) glucose level <40 mg/dL; or (4) positive effusion culture or Gram stain without gross pus in the fluid. The diagnosis of tuberculous pleurisy was based on the presence of caseating granulomas or epithelioid cell granulomas with no evidence of other pulmonary granulomatous diseases such as sarcoidosis. Hospital-acquired infection following the procedure was defined as pneumonia or empyema diagnosed on clinical and radiological grounds (new infiltrates on chest radiography or computed tomography), supported by microbiology where available. The pain was assessed by the nursing staff using a simple, locally developed, unvalidated, and visual analog scale [5,6].

Major and minor complications were routinely recorded. Major complications were retrospectively defined as events requiring active medical or surgical management during the hospital stay. Minor complications were defined as events requiring medical supervision only. The length of hospital stay was defined as the total number of days during the stay in which pleuroscopy was performed. The duration of drainage was measured from the day pleuroscopy was performed to the day on which the pigtail catheter was removed [4-6].

### Pleuroscopic procedures

Before pleuroscopy, the patients were placed in the lateral decubitus position with the side of the pleural effusion on top [4]. Bedside chest sonography was used to ensure the location of the pleural effusion and avoid areas with pleural nodule, and mass septation, to allow for safe entry of the trocar. The skin was then sterilized with povidone-iodine, and local analgesia with 2% lidocaine was given.

Incisions were made using a knife with a width of 5.3 mm. Using the Seldinger technique, a trocar 5.5 mm in diameter was inserted into the pleural space. The bronchoscope was then inserted through the trocar, and the pleural cavity was inspected after all fluid had been drained. Biopsies were performed under direct visual control in all suspected areas, and systematically in several parts of the parietal pleura for cytological and pathological examination. In addition, a biopsy of the parietal pleura was performed over a rib to avoid neurovascular bundles. Adhesions between two pleural leaves were removed when necessary. A 16F pigtail catheter was inserted for drainage after the pleuroscopy [Figure 1]. Chest radiographs were routinely obtained after the procedure and subsequently until removal of the drainage catheter.

The flexible-rigid pleuroscope (model LTF 160 or 240; Olympus, Tokyo, Japan) was used, with a flexible tip and an upward angulation of 160° and a downward angulation of 130°. The total length of the instrument was 27 cm, with an external diameter of 7 mm and an inner working channel of 2.0 mm. The pleuroscope accommodated biopsy forceps and other instruments for further treatment.

Before the procedures, the instruments were submersed in a protein-dissolving, hydrochloride-containing solution. The operating channels were filled with this solution with a syringe, and cleaning was performed for 15 min. The instruments were then rinsed with water and cleaned with soft brushes, and disinfection was performed with the aldehyde-containing solution Cidex (Johnson and Johnson Medical GmbH, Geschäftsbereich ASP, Hummelsbütteler Steindamm 7122851 Norderstedt) The disinfection took about 15 min. The instruments were then rinsed with demineralized water. The washed and dried instruments were then sterilized by placing them into gas-tight cabinet containing a formalin tablet for 24 h. The optics were also sterilized in the same manner [7,8].

All patients received local analgesia with 2% lidocaine administered by a chest physician in the ICU with continuous monitoring [Figure 2].

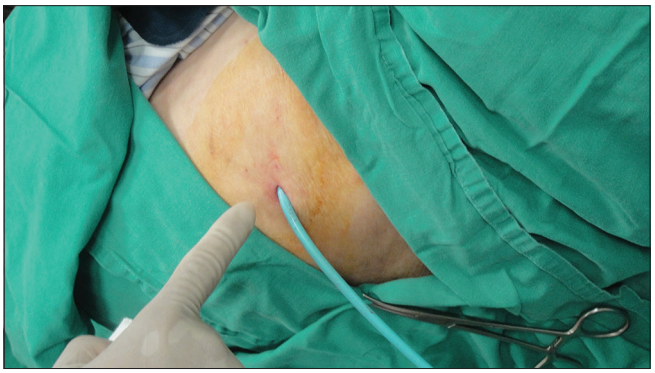

**Figure 1:** A 16F pig-tail catheter is inserted for drainage after the pleuroscopy

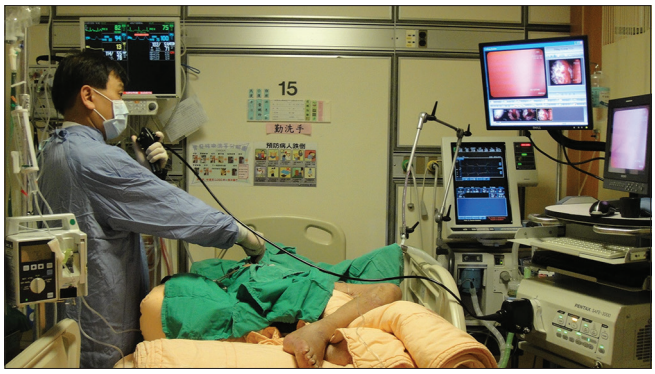

**Figure 2:** All patients receive local analgesia with 2% lidocaine administered by a chest physician in the Intensive Care Unit with continuous monitoring

## Results

### Characteristics of the patients

During the 5-year study period, 60 patients were identified as having refractory undiagnosed pleural effusions in the ICU. In total, 25 patients (17 males and 8 females) underwent pleuroscopic procedures at the bedside. The characteristics of these 25 patients are summarized in Table 1. The mean age of the study population was 74 ± 3 years. APACHE II scores ranged from 18 to 32, with a mean of 23 ± 1.

Drainage from the pigtail catheter was continued for a mean duration of 3.9 ± 0.2 days (range, 2–6 days), and mean ventilator usage was 6 ± 0.7 days (range, 3–11 days). The length of stay in the ICU ranged from 5 to 30 days, with a mean of 11 ± 1 days. The pleural effusions occurred mostly on the right side (17/25, 68%).

### Causes of pleural effusion

The results of the pleural effusions are summarized in Table 2. Fifteen patients (60%) had malignancies, of whom 11 had lung cancer, and one each had breast cancer, esophageal cancer, a hepatoma and a malignant mediastinal tumor. Of the benign lesions, infection (36%) was an important source, with four patients having parapneumonic effusions, three empyema and two tuberculous pleurisy.

### Complications

Complications from the pleuroscopy procedures are summarized in Table 3. A total of 11 (44%) patients had complications. There were no major complications such as bleeding or procedure-related death. The most common complication was transient chest pain ($n$ = 6, 24%) due to the pigtail catheter, which was easily controlled with conventional analgesics and disappeared after removal of the catheter. Subcutaneous emphysema without symptoms in 3 patients (12%) was self-limiting in <3 days. Other minor complications were hypotension ($n$ = 1, 4%) and wound infection ($n$ = 1, 4%), however, these conditions were modifiable through improvements in daily medical treatment.

**Table 1: Clinical characteristics of patients**

| Characteristic | Value, mean±SD or percentage |
|---|---|
| Age (years) | 74±3 (range 47-97) |
| Gender | |
| Male/female | 68/32 |
| Side of pleural effusion | |
| Right | 68 |
| Left | 32 |
| APACHE II score | 23±1 |
| Duration of ventilator use (days) | 6±1 |
| Duration of pig-tail catheter drainage (days) | 3.9±0.2 |
| Length of ICU stay (days) | 11±1 |

Data are expressed as mean (SD). APACHE II: Acute physiology and chronic health evaluation II, ICU: Intensive Care Unit, SD: Standard deviation

**Table 2: Causes of undiagnosed pleural effusions**

| Etiology | *n* (%) |
|---|---|
| Malignancy (%) | 15 (60) |
| Pleural metastatic tumor | 14 (56) |
| Lung cancer | 11 (44) |
| Breast cancer | 1 (4) |
| Hepatoma | 1 (4) |
| Esophageal cancer | 1 (4) |
| Mediastinal tumor | 1 (4) |
| Benign (%) | 10 (40) |
| Infection | 9 (36) |
| Parapneumonic effusion | 4 (16) |
| Empyema | 3 (12) |
| TB pleurisy | 2 (8) |
| Others: traumatic hemothorax | 1 (4) |

Data are expressed as number of patients (%). TB: Tuberculosis

**Table 3: Complications of pleuroscopy**

| Complication | *n* (%) |
|---|---|
| Major (%) | 0 |
| Bleeding | 0 |
| Death (procedure-related) | 0 |
| Minor (%) | 11 (44) |
| Wound pain | 6 (24) |
| Subcutaneous emphysema | 3 (12) |
| Hypotension (periprocedure) | 1 (4) |
| Wound infection (drain site) | 1 (4) |
| Dislodged drain | 0 |
| Pneumonia/empyema | 0 |
| Procedure abandoned | 0 |

Data are expressed as number of patients (%)

## Discussion

We present data from a consecutive case series of bedside pleuroscopies performed in an ICU. We confirmed that serious complications are rare. Major complications in pleuroscopy have been reported in 0.0001%–0.24% of patients [9,10], the most serious being death or bleeding. No deaths were related to the procedure after we cautiously selected candidates for the procedure. According to the British Thoracic Society Pleural Disease Guidelines 2010 [11], all patients should be thoroughly assessed by a competent physician before the procedure, because most complications can be avoided by appropriate selection. Patients with the severe chronic obstructive pulmonary disease with hypoxemia ($PaO_2$ <60 mmHg) and

hypercapnia ($PaCo_2$ >45 mmHg) without intubation will not tolerate induction of a pneumothorax, and there may be further deterioration of gas exchange, so they are not suitable candidates for bedside pleuroscopy. When there is involvement of a contralateral lung or pleural lesion, pleuroscopy is not advisable unless tracheal intubation is used. Patients with an unstable cardiovascular status or who are hemodynamically unstable with high-dose vasopressor support should not undergo to a pleuroscopy. We consult a cardiologist before the procedure for any patient with a history of cardiovascular disease. Since pleuroscopy performed under sedation-assisted local anesthesia is associated with significant hypoventilation, which can compromise the condition of patients, we do not use intravenous sedation [12,13]. In our study, all procedures were done by a chest physician with the patient under 2% lidocaine local analgesia in an ICU equipped with monitoring devices. We believe local analgesia is suitable for critical patients rather than local or general anesthesia.

Bleeding diatheses must be considered and assessed appropriately on an individual basis. One of most serious complications, other than death, is severe bleeding due to blood vessel injury during the procedure [14,15]. However, this, and pulmonary perforations can be avoided with the use of chest sonography to locate safe points of entry, along with a cautious biopsy technique. In this study, due to the small trocar insertion wound, we used a small tube such as a pigtail 16 Fr catheter for drainage without any sutures. Standard chest tube insertion requires sutures and large tubes such as 32 Fr to create a large wound [16-18]. Minor bleeding from small wounds can be stopped easily with electrocoagulation or argon plasma coagulation at the ICU bedside.

Minor complications of this procedure include hypotension [16], wound pain, wound infection [17], pneumonia/empyema [18], subcutaneous emphysema [19], dislodged drains, venous thromboembolism, and abandoned procedures [20,21]. Wound pain is the most common minor complication and is potentially modifiable with pain medication [22,23]. All patients had 16 F pig-tail cathether drains after the procedure through the same entry port as the pleuroscopy to avoid the spread of subcutaneous emphysema. Intercostal drains were connected to an underwater seal and negative suction (−10 to − 20 cm/$H_2O$) was used if the lung failed to re-expand after 24 h [24,25]. Hypotension noted during the procedure was also correctable with adequate hydration. Minor complications are easily controlled and self-limited [26,27].

Pleuroscopy under local analgesia using a flexible bronchoscope is a simple procedure at the bedside and suitable for critical patients who cannot be moved to the operating room or endoscopy room. However, this study had some limitations. First, this is a retrospective practice review only, and as such has not been designed to demonstrate different outcomes from a statistical perspective. Second, only a small number of subjects were enrolled, so the results should be interpreted with caution. Third, this was a consecutive case series in a single center, and therefore our findings should not be over-generalized.

## Conclusions

Pleuroscopy performed at the bedside in an ICU with local analgesia appears to be an easy and well-tolerated procedure, and could be used for patients in critical condition. Given its potential, further, rigorous survey of this procedure should be undertaken.

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### Conflicts of interest

There are no conflicts of interest.

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