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## Case Report

## Aerosolized antibiotics therapy for infected traumatic pulmonary pseudocysts: A case report

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## ABSTRACT

**Background:** Traumatic pulmonary pseudocysts are caused after thoracic trauma. They do not usually require specific therapy when no complications arise, such as infection and bleeding. Complicated pulmonary pseudocysts, however, can be life threatening and require specific treatment. Although treatments of systemic antibiotics and surgery for infected cysts have been reported, to the best of our knowledge, there are no reports on aerosolized antibiotics therapy for infected traumatic pulmonary pseudocysts.

**Case presentation:** We present the case of a 31-year-old woman who was severely injured and suffered a blunt thoracic trauma in a vehicular accident, and required ventilator management in a previous hospitalization. Seven days later, she developed acute respiratory distress syndrome and was transferred to our department. We were unable to maintain proper oxygenation with ventilator management alone and established venous–venous extracorporeal membrane oxygenation. She then developed persistent bacteremia of *Pseudomonas aeruginosa* owing to infected traumatic pulmonary pseudocysts. On the 21st day of her hospitalization, the drainage for the enlarged cyst led to minor improvements in her respiratory condition. On the 32nd day of hospitalization, in addition to systemic antibiotics therapy, the aerosolized antibiotics therapy (inhalation of tobramycin (135 mg) every 12 h) was administered for the treatment of resistant infected pseudocysts. Her respiratory condition gradually improved, and the infected pseudocysts shrank. On the 43rd day of hospitalization, she was successfully removed from extracorporeal membrane oxygenation.

**Conclusions:** Aerosolized antibiotics therapy may be a potential option for patients with infected traumatic pulmonary pseudocysts when conventional therapies are not successful.

## Background

Lung parenchymal injury caused by blunt chest trauma is frequently accompanied by pulmonary contusion and intrapulmonary hemorrhage. Traumatic pulmonary pseudocysts are uncommon and do not usually require specific therapy in cases in which no

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complications arise, such as infection and bleeding [1–5]. Infected traumatic pulmonary pseudocysts, however, are often life threatening, are associated with high mortality, and require specific treatments, including antibiotic administration, drainage, and surgery [1,6].

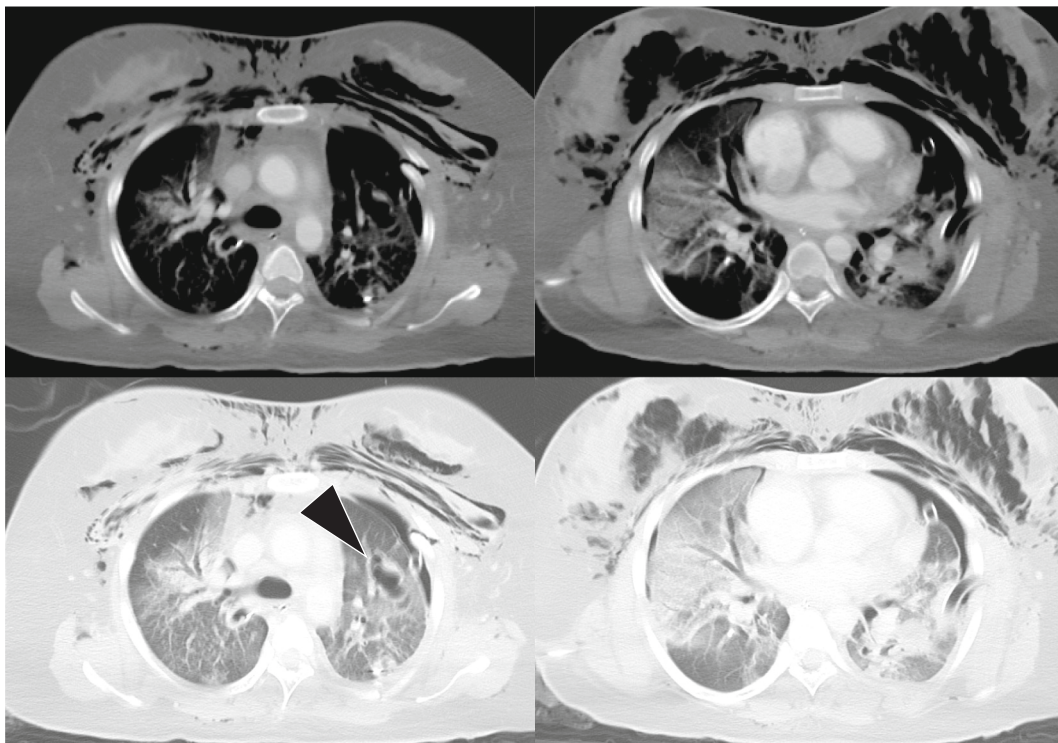
The aerosolized antibiotics have been shown to be beneficial to patients with respiratory tract infections that respond poorly to intravenous antibiotic therapies [7–11]. The benefit of the aerosolized antibiotics is that high concentrations of antibiotics can be exposed to tracheobronchial and pulmonary tissues and can directly act against biofilms [10–13]. There have been reports on aerosolized antibiotics for patients with ventilator-associated pneumonia with *Pseudomonas aeruginosa* or *Acinetobacter baumannii*, however, we could not find any reports on aerosolized antibiotics for infected traumatic pulmonary pseudocysts.

Therefore, this report aimed to present a case of traumatic pulmonary pseudocysts, infected with bacteria, that was successfully treated with a combination of systemic and aerosolized therapies.

## Case presentation

A 31-year-old woman was injured in a vehicular accident, and was transported to a hospital. She suffered bilateral extensive lung contusions, hemothorax, and multiple rib fractures, and required ventilator management and thoracic drainage. Seven days later, her respiratory condition worsened, and she developed acute respiratory distress syndrome (ARDS). Moreover, her pneumothorax did not improve, and she had persistent air leaks. She was transferred from the previous hospital to our department in view of the necessity for respiratory management using venous–venous extracorporeal membrane oxygenation (VV-ECMO). Upon arrival at our institution, her partial pressure of arterial oxygen/fraction of inspired oxygen ratio ( $\text{PaO}_2/\text{FiO}_2$ ) was 81.4 with a manual flow-inflating bag. Computed tomography (CT) showed lung contusions and traumatic pulmonary pseudocysts (Fig. 1). We induced VV-ECMO to maintain her oxygenation status and for ARDS treatment.

The patient received prophylactic systemic antibiotics therapy (tazobactam/piperacillin 4.5 g every 6 h). However, *Pseudomonas aeruginosa* was identified in blood and sputum cultures on the 7th day following admission at our hospital. On the 13th day, multidrug-resistant *Pseudomonas aeruginosa* was detected in blood and sputum cultures. Systemic antibiotics (meropenem) were administered based on the results of drug susceptibility test on the 19th day. However, the traumatic pulmonary pseudocyst in the left upper lung lobe was complicated owing to the presence of an abscess. The abscess was drained on the 21st day (Fig. 2). The culture in the drain of abscess was also multidrug-resistant *Pseudomonas aeruginosa*. Her respiratory condition was dependent on ECMO. On the 24th day, the administration of meropenem was changed from intermittent to continuous (3 g per day).



**Fig. 1.** Computed tomography findings on admission.

Enhanced computed tomography (upper, lung window setting; lower, mediastinum window setting) showing a traumatic pulmonary pseudocyst (arrowheads), bilateral consolidation, subcutaneous emphysema, and bilateral pneumothorax. Thoracostomy tubes were placed in the left thoracic space.

Regardless of these treatments, including continuous systemic antimicrobial administration and abscess drainage in the presence of ECMO, the patient's respiratory and inflammatory status did not improve. Therefore, we added the aerosolized antibiotics therapy for the treatment resistant infected traumatic pulmonary pseudocysts on the 32nd day. Aerosolized tobramycin (135 mg) was administered every 12 h with the use of an ultrasonic nebulizer (Aeroneb®, Aerogen, Ireland). This aerosolized therapy of tobramycin was off-label use.

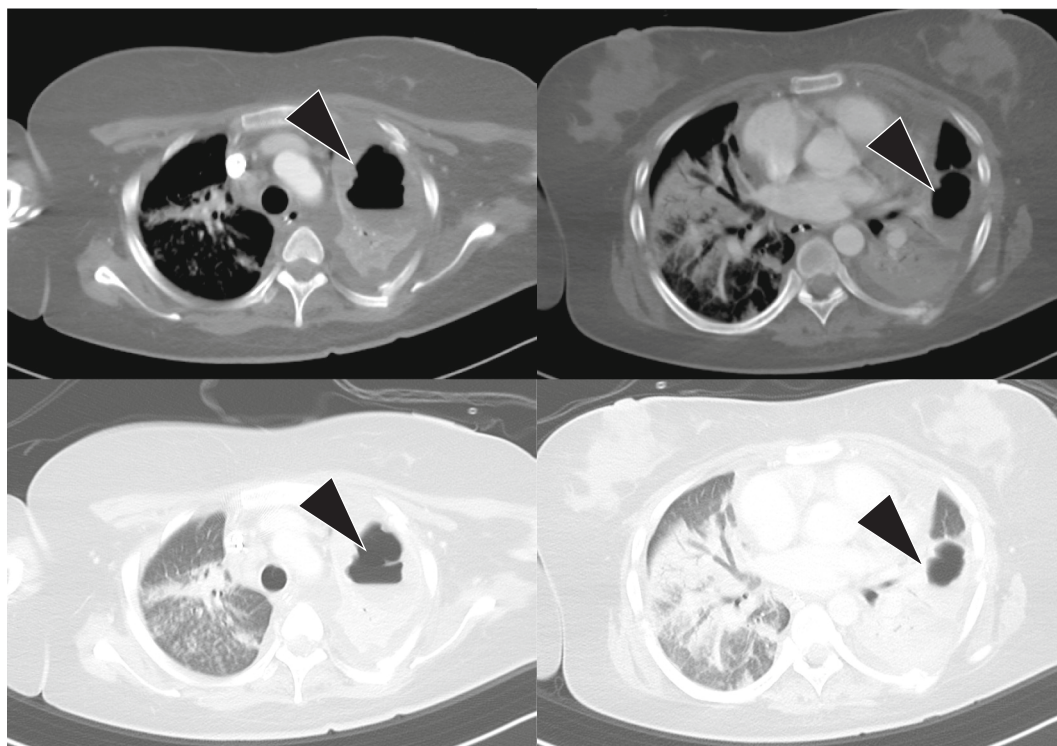
Her respiratory status improved after the onset of administration of the aerosolized tobramycin. Nine days later, the infected traumatic pulmonary pseudocysts began to shrink (Fig. 3). On the 43rd day of hospitalization and the 12th day from the beginning of the aerosolized therapy, she was successfully withdrawn from ECMO. On the 58th day of hospitalization aerosolized antibiotics therapy was completed (i.e., on the 27th day following the aerosolized therapy). On the 65th day, she was transferred to the hospital where she was originally admitted, to rehabilitate. She was placed on mechanical ventilation following tracheostomy. Finally, she was discharged without ventilator support and sequelae at approximately 6 months after the accident.

## Discussion

We demonstrated the findings associated with a patient with infected traumatic pulmonary pseudocysts refractory to systemic antimicrobial administration who was successfully managed with aerosolized antibiotic therapy.

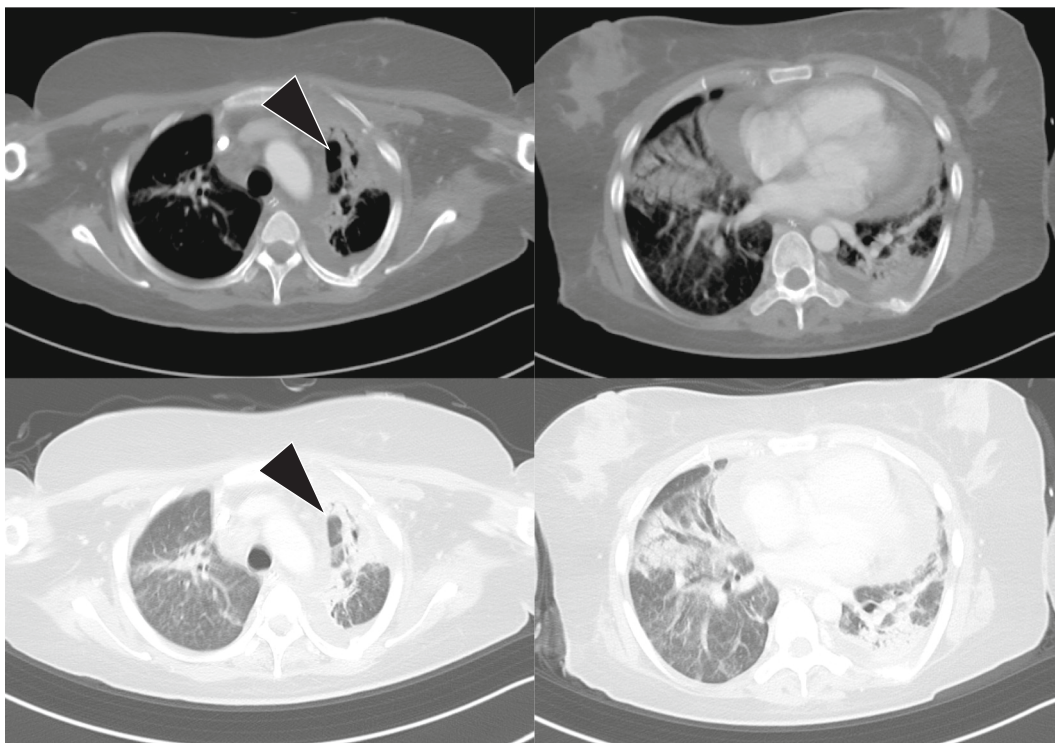
Traumatic pulmonary pseudocysts are relatively rare complications of blunt chest trauma, and occur in approximately 5–10 % of chest trauma cases [2–5]. Most traumatic pulmonary pseudocysts do not require specific therapy and spontaneously improve with conservative therapy. However, when traumatic pulmonary pseudocysts are secondarily infected and grow, specific treatment is required [2–4]. Our patient with infected traumatic pulmonary pseudocysts had uncontrolled infection of multidrug-resistant *Pseudomonas aeruginosa*. We treated her not only with systemic antibiotic therapy but also with continuous systemic antibiotics therapy and drainage for infected traumatic pulmonary pseudocysts. However, these treatments did not elicit adequate responses. However, when the aerosolized antibiotic tobramycin was added to the conventional treatments for uncontrolled infected traumatic pulmonary pseudocysts, the infection was controlled and her respiratory status improved, and ECMO was withdrawn. The aerosolized antibiotics therapy was successful, and she avoided thoracic surgery for infected pseudocysts.

Aerosolized antibiotics have several advantages. The aerosolized antibiotics can be delivered at high concentrations to tracheo-bronchial and pulmonary tissues, and can prevent antibiotic resistance [10–13]. Moreover, the aerosolized antibiotics therapy can act



**Fig. 2.** Computed tomography findings on the 17th day of hospitalization (on venous–venous extracorporeal membrane oxygenation due to persistent bacteremia with infected traumatic pulmonary pseudocysts). Enhanced computed tomography (upper, lung window setting; lower, mediastinum window setting) showing enlargement of traumatic pulmonary pseudocysts. Traumatic pulmonary pseudocysts were 40 mm (upper lobe) and 23 mm (lower lobe) in maximum diameter with fluid collection presented as air–fluid levels (arrowheads).





**Fig. 3.** Computed tomography findings on the 41st day. Enhanced computed tomography (upper, lung window setting; lower, mediastinum window setting) showing reduced size of infected pseudocysts without fluid collection (arrowheads).

on the tracheal and pulmonary biofilm which is otherwise unreachable. Furthermore, the aerosolized antibiotics can reduce the exposure to systemic antibiotics. In systematic reviews and retrospective studies, the aerosolized antibiotics have been reported to be effective for patients with ventilator-associated pneumonia with multidrug-resistant *Pseudomonas aeruginosa* or *Acinetobacter baumannii* [7–11]. Tobramycin inhalation therapy for patients with cystic fibrosis has been shown to be effective to improve pulmonary function and decrease the density of *Pseudomonas aeruginosa* in prior retrospective and randomized controlled studies [14,15]. Therefore, we added aerosolized antibiotics to conventional systemic antibiotics for infected traumatic pulmonary pseudocysts with multidrug-resistant bacteria. The patient's bacteremia and oxygenation statuses improved after the administration of additional aerosolized antibiotics. To our knowledge, there are no reports and studies on aerosolized antibiotics therapy for infected traumatic pulmonary pseudocysts. Reviews and collections of cases who received aerosolized antibiotics for infected traumatic pulmonary pseudocysts may prove important for future relevant medical studies.

## Conclusion

Aerosolized antibiotics therapy may have the potential to be an additional treatment for patients with infected traumatic pulmonary pseudocysts when conventional therapies are not successful.

## Abbreviations

ARDS	Acute respiratory diseases syndromes
VV-ECMO	Venous-venous extracorporeal membrane oxygenation
PaO <sub>2</sub> /FiO <sub>2</sub>	Partial pressure of arterial oxygen/fraction of inspired oxygen ratio
CT	Computed tomography
PEEP	Positive end expiratory pressure
PS	Pressure support

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collection, analysis, and interpretation of data, in the writing of the report, and in the decision to submit the article for publication.

### Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images.

### Competing interest

The authors declare that they have no competing interests.

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