

Extracorporeal membrane oxygenation and toilet bronchoscopy as a bridge to pneumonectomy in severe community-acquired methicillin-resistant *Staphylococcus aureus* pneumonia

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Abstract:

Community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) pneumonia is associated with very high mortality. Though surgical evacuation of necrotic tissue is desirable in patients unresponsive to antimicrobial therapy, most patients are acutely ill precluding surgical intervention. We utilized a combination of extracorporeal membrane oxygenation (ECMO) with frequent toilet bronchoscopies to salvage an unaffected right lung from spillage of necrotic pus from left lung cavitary CA-MRSA pneumonia in a 22-year-old patient. Our patient while on ECMO and after decannulation was positioned with the right lung up at all times with 1-2 toilet bronchoscopies every day for almost 30 days. This time was utilized for ventilator weaning and optimizing the nutritional status prior to extrapleural left pneumonectomy. Prevention of soilage of the unaffected right lung and mitigating volutrauma with ECMO support combined with the subsequent surgical evacuation of necrotic left lung tissue led to a favorable outcome in this case. This strategy could be of value in similar presentations of unilateral suppurative pneumonia, where the progressive disease occurs despite optimal medical therapy.

Key words:

Cavitary pneumonia, necrotizing pneumonia, lung gangrene, Panton-Valentine leukocidin, salvage therapy

Severe necrotizing pneumonia caused by community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA), especially the strain producing Panton-Valentine leukocidin (PVL) has a very high fatality rate.^[1,2] Use of extracorporeal membrane oxygenation (ECMO) as rescue therapy in pediatric patients affected by CA-MRSA has been previously reported.^[3] Unlike pediatric population, pneumonia with PVL producing CA-MRSA in adults is associated with up to 100% mortality.^[4] We report a unique strategy of frequent toilet bronchoscopy and venovenous (VV) ECMO to salvage the lesser affected lung in case of severe left CA-MRSA pneumonia as a bridge to pneumonectomy with a successful outcome.

Case Report

A 22-year-old female with no prior medical history developed fever and productive cough for 5 days which was treated with azithromycin. Her symptoms progressed to high-grade fever, hemoptysis, and left sided pleuritic chest pain. Her white blood cell count was 24,000/ μ L with

90% neutrophils and a computed tomography (CT) scan of chest revealed opacification of the left lung with air bronchograms, multiple varying sized cavities with abscess formation with a left pleural effusion [Figure 1a]. PVL producing CA-MRSA was isolated from sputum and blood. Broad spectrum antimicrobial treatment for cavitary pneumonia which included vancomycin

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was initiated. Blood and sputum cultures grew MRSA positive for PVL. Left pleural ultrasound identified a complicated pleural effusion with septations. Pleural fluid from a diagnostic left sided thoracentesis grew MRSA as well and left sided tube thoracostomy was performed.

Intensive Care Unit transfer was necessitated by massive hemoptysis requiring endotracheal intubation and mechanical ventilation. Her right main stem bronchus was selectively intubated followed by embolization of the left upper and lower bronchial arteries. Heavy sedation was maintained to decrease cough with continued selective right lung ventilation. Additional antibiotics including linezolid, clindamycin, and rifampin were begun to optimize antimicrobial coverage for MRSA. Thoracic surgery consultation was obtained and left pneumonectomy was recommended given a degree of lung necrosis. A repeat CT chest on day 6 showed the progression of the pneumonic process with complete opacification of the left lung with multiple air bronchograms. Also noted was the involvement of the right lower lobe with a cavitary lesion with surrounding centrilobular nodules [Figure 1b]. Bilateral and progressive lung involvement impeded planned surgical resection.

The patient subsequently developed severe hypoxemia with $\text{PaO}_2/\text{FiO}_2$ ratio <100 on FiO_2 0.8 and positive end-expiratory pressure (PEEP) of 12 cm H_2O on volume-control ventilation on day 7 of hospital course. Deep sedation and neuromuscular blockade were begun. In an attempt to salvage the right lung from spillage and contamination from the necrotic left lung, vigorous pulmonary toilet, and frequent bronchoscopies to remove copious purulent material [Figure 2] were performed twice daily. The procedure was frequently limited by

worsening hypoxemia. On hospital days 8-9, patient had PaO_2 64 on volume-cycled ventilation, FiO_2 1, PEEP 14 cm H_2O despite sedation, and neuromuscular blockade. Serial $\text{PaO}_2/\text{FiO}_2$ ratios <100 along with oxygenation index >40 (highest oxygenation index = 46) prompted consideration for ECMO to provide oxygenation support and to prevent acute lung injury in the lesser involved lung, while the fulminant CA-MRSA infection was being treated. On day 9, VV ECMO was initiated via left subclavian and left femoral veins for severe hypoxemia, and the patient was positioned with her right lung up at all times [Figure 1c]. An aggressive toilet bronchoscopy strategy was utilized twice daily to remove as much necrotic and infected endobronchial material as possible to prevent spoilage of the right lung. An adult bronchoscope was used for toilet bronchoscopy. Examination of the right lung was carried out before removing purulent discharge from the left to avoid cross-contamination.

Thrombocytopenia due to linezolid necessitated substitution with ceftaroline therapy while continuing clindamycin and rifampin. On day 18, she was decannulated from VV ECMO. There was a concern for seeding of the right lung with a single cavity as seen on imaging on day 22 [Figure 1c]. Nevertheless, clinical parameters remained stable without fever, worsening leukocytosis or hypoxemia. Aggressive weaning was continued while optimizing the patient for tracheostomy and percutaneous gastrostomy tube on day 25. As her nutritional status improved, and there was no further evidence to support infection of the right lung and she underwent a left extrapleural pneumonectomy with intercostal muscle flap buttressing of bronchial (day 31). The surgical pathology revealed extensive necrosis predominantly around the airways, widespread pulmonary intra-arterial thrombosis with extensive organizing acute lung injury [Figure 3a and b]. Rapid clinical improvement ensued thereafter with decannulation from tracheotomy on day 43 and discharge to a skilled nursing facility (SNF) on day 47. She has survived her stay at the SNF and has been discharged home without the need for supplemental oxygen.

Discussion

To our knowledge, this is the first report of a case of severe necrotizing CA-MRSA pneumonia that failed medical treatment, successfully treated with a combined strategy of VV ECMO, frequent toilet bronchoscopy, and surgical resection.

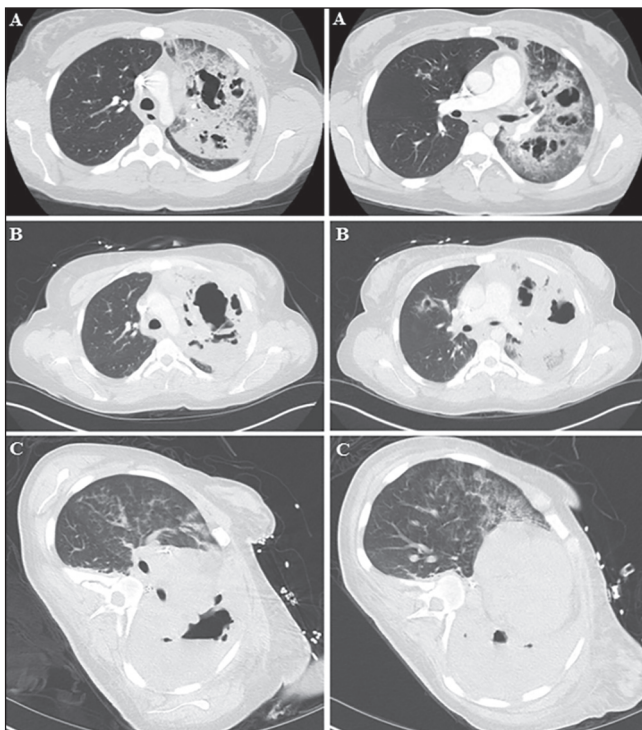


Figure 1: Computed tomography chest showing necrotic cavitary pneumonia on day 1 (a) with progression to frank necrosis and cavitation on day 6 (b) and day 22 (c)

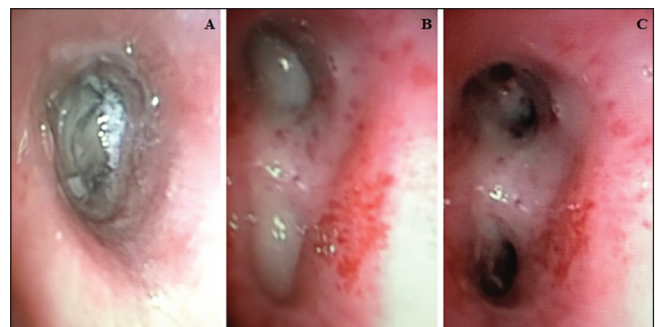


Figure 2: Bronchoscopic images (day 22) showing necrotic material in the left main stem bronchus (a) and left upper and lower lobe bronchi (b) with transient clearing post toilet bronchoscopy (c)

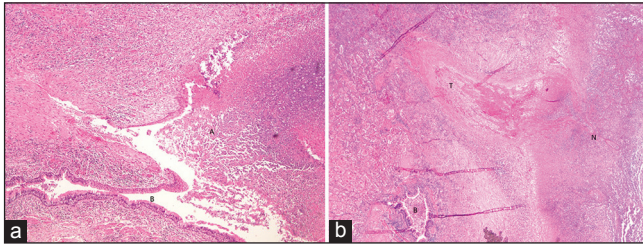


Figure 3: (a) Acute bronchopneumonia seen in the pneumonectomy specimen showing abscess (A) and bronchus (B) (H and E, $\times 10$). (b) Pneumonectomy specimen showing thrombosis (T) with a bronchus (B) and necrotizing pneumonia (N) (H and E, $\times 10$)

CA-MRSA pneumonia has universally been reported to have very high mortality.^[5,6] Presence of the specific virulent factor PVL add to the risk of mortality and morbidity regardless of methicillin-resistance.^[7] Use of ECMO in severe CA-MRSA pneumonia with respiratory failure has been associated with successful outcomes in the pediatric population.^[3] In adults, however, the utility of this strategy is not known. The use of ECMO in the management of severe hypoxemia coupled with twice daily toilet bronchoscopy prevented further spoilage and the injurious effects of volutrauma in the lung that was affected to a lesser extent. Surgical resection has been shown to be a reasonable option for necrotizing lung infections in the setting of failed medical therapy with high survival rates.^[8,9] In a retrospective series from Harborview Medical Center, the mortality rate was 8.5% in 35 patients who underwent resection for necrotizing infections.^[8] More recently, Schweigert *et al.* reported their experience with 20 patients who presented with necrotizing lung infections and underwent surgical intervention.^[9] The overall surgical mortality was 15%. Among the 4 patients who had to undergo emergent pneumonectomy, 2 died in the postoperative period. Most patients with necrotizing lung infections are severely ill and surgical interventions carry significant risk. In our patient, ECMO and frequent toilet bronchoscopy allowed clinical stabilization, prevention of the progression of infection in the lesser affected lung, and optimization of nutritional status prior to pneumonectomy. The present strategy could be of value in similar presentations of severe

necrotizing CA-MRSA pneumonia with predominantly unilateral involvement.

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Conflicts of interest

There are no conflicts of interest.

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