Massive hemoptysis managed by rescue extracorporeal membrane oxygenation

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ABSTRACT

Massive hemoptysis can have a rapid and potentially fatal clinical course. A 68-year-old woman presented with recurrent hemoptysis complicated by refractory hypoxemia and shock despite aggressive intervention. The use of veno-venous extracorporeal membrane oxygenation was a nontraditional intervention that ultimately proved to be lifesaving, but is by no means recommended for routine use in this setting.

KEYWORDS Bronchial artery embolization; extracorporeal membrane oxygenation; massive hemoptysis

Massive hemoptysis accounts for 10% of hemoptysis but should always be considered a medical emergency.¹ It can have a rapid and potentially fatal clinical course. Hypoxemia and hemodynamic instability may hinder stabilization and prevent definitive intervention even after usual resuscitative measures have been implemented. This case highlights the condition's etiology, incidence, and mortality as well as the use of extracorporeal membrane oxygenation (ECMO) in this setting.

CASE DESCRIPTION

A 68-year-old woman presented in transfer with respiratory failure from hemoptysis. She was cyanotic with severe hypoxemia (oxygen saturations of 30% to 40%), and chest radiograph showed severe loss of aeration (*Figure 1*). She was in shock with a mean arterial blood pressure in the low 50s mm Hg despite 3 L of normal saline, blood product administration, and infusions of norepinephrine and vasopressin. Copious amounts of bright red blood were spewing from her oral endotracheal tube. She had been successfully paralyzed and changed to pressure control ventilation due to increased pressures on assist control ventilation, with a rate of 24 bpm, P_i of 20, positive end-expiratory pressure of 20 cm H₂O, and fraction of inspired oxygen of 100% generating tidal volumes of 200 to 350 mL. Her arterial blood gas was pH 7.22, partial pressure of carbon dioxide 73 mm Hg, and partial

pressure of oxygen 32 mm Hg; oxygen saturations remained 30% to 40%. It was not possible to clear blood via bronchoscopy through the 7.0 cm endotracheal tube placed at the transferring hospital.

The cardiothoracic team was called to initiate veno-venous ECMO in the emergency department, and the patient's oxygenation and shock improved, allowing for transfer to the intensive care unit. The endotracheal tube was exchanged to a larger size and a bronchoscopy was performed. She had a large, completely occlusive right main stem bronchus clot (*Figure 2a*). She was suspected to still be bleeding, so the clot was cleared to identify the bleeding source—active brisk bleeding from the right upper lobe in the B1 airway (*Figure 2b*). Interventional radiology was consulted. She was found to have an arterial-arterial and arterial-venous fistula in the right upper lobe (*Figure 2c*). A coil was placed in the feeding artery and beads were injected in the right bronchial artery (*Figure 2d*). She had hemodynamic recovery and ECMO was stopped after 50 hours, without systemic heparin being given. The vent was removed after 96 hours, and the patient was discharged home completely neurologically intact after 13 days. She was fortunate to not sustain any additional complications and had no bleeding issues postembolization.

DISCUSSION

Massive hemoptysis can be caused by a variety of conditions, such as infections (mycobacterial, fungal, or bacterial),

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Figure 1. Presenting chest radiograph with right hemithorax whiteout and congestion of the left hemithorax.

medications, cocaine, bronchitis, bronchiectasis, tumors eroding into the pulmonary vasculature, endobronchial tumors, vascular abnormalities, endometrial tissue (catamenial hemorrhage), foreign bodies, and fistulas between major arteries and the bronchial tree.^{1–7} Its incidence is difficult to assess, as there is no unifying definition of the condition. Bronchiectasis is a common cause, accounting for 31% to 66% of cases.¹ However, reports from regions with endemic tuberculosis state that tuberculosis is the most common cause.¹ Overall, bronchiectasis, tuberculosis, lung cancer, granulomatous disease, and pneumonia account for most known causes.¹ Mortality approaches 71% in those with bleeding rates >600 mL within 4 hours.⁸ Bronchial artery embolization (BAE) as first-line treatment has profoundly impacted mortality. A retrospective analysis found that mortality rates were 15% from 1995 to 1999, but decreased to 0% in 2000–2005.²

Figure 2. (a) Completely occlusive right main stem bronchus clot. (b) Active brisk bleeding from the right upper lobe in B1 airway. (c) Arterial-arterial fistula in the right upper lobe. (d) Coil placed in the feeding artery.

Management should focus on immediate stabilization, interventions to mitigate or stop the bleeding, and correction of the etiology. Initial management includes securing the airway by endotracheal intubation. Patients bleeding from a specific lung should be positioned with the bleeding lung down to minimize contamination of the nonbleeding lung. Rigid bronchoscopy may identify the source and evacuate clots.¹ Flexible bronchoscopy can sometimes identify the source, and various modalities can be used to temporize the bleeding: cold saline lavage, adrenaline flush, and balloon tamponade.^{1,9,10} Definitive treatments include BAE and surgical resection. BAE is now the gold standard; it can be repeated if unsuccessful on the first attempt.¹ Surgical resection is becoming less common due to the high mortality associated with major surgery and is usually reserved for those in whom BAE failed.

This patient needed BAE and, though unconventional, ECMO afforded time to identify the location of the bleed. ECMO provides extended respiratory and cardiac support by creating an external heart-lung bypass. Because of the need for heparin and the loss of Von Willebrand factor multimers crucial for hemostasis in prolonged use, clinicians must be mindful of an increased bleeding tendency. Veno-venous ECMO drains blood into a circuit to oxygenate and remove carbon dioxide and then returns the blood to the venous system. It requires adequate cardiac function.¹¹ Veno-arterial ECMO utilizes a peripheral cannulation of an artery (femoral or axillary) to bypass the heart and lungs and provide both circulatory and respiratory support. Veno-venous ECMO can provide both oxygenation and ventilation without the added complications seen with veno-arterial ECMO.^{12–14} Although it is costly, due to successful results, more resources have been applied to its development.¹⁵ Further investment into ECMO may lead to increased accessibility for a wider range of patients, although certain implementation criteria remain: severe respiratory failure despite maximal standard of care treatment, low chance of survival if continued on current treatment, a reversible pathologic process, and a potential for a good outcome.¹⁶ ECMO has emerging promise for a wider spectrum of other uses. The use of ECMO to prevent warm ischemic injury during donation after circulatory determination of death was first shown in dogs by Marchioro et al in 1963. Since then, several studies have shown positive effects, as it allows selective perfusion to organs and has increased organ supply by increasing the number of donors by 33%.^{17–20} Others have shown the viability of short-term veno-venous ECMO and veno-arterial ECMO in patients with severe upper or central airway obstruction.

Massive hemoptysis may cause severe instability, which can challenge clinicians' ability to achieve definitive treatment. ECMO, when applied judiciously, may assist in the management as its application continues to evolve with increased usage and availability.

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