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Selected Topics: Critical Care

USE OF EXTRACORPOREAL MEMBRANE OXYGENATION AND SURGICAL EMBOLECTOMY FOR MASSIVE PULMONARY EMBOLISM IN THE EMERGENCY DEPARTMENT

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☐ **Abstract—Background: Massive pulmonary embolism (PE) carries significant morbidity and mortality with current standard of care modalities. Case Report: We present the case of a 63-year-old male status post abdominal surgery 2 weeks before presenting to the emergency department with a massive pulmonary embolism and subsequent acute cardiopulmonary failure. Why Should an Emergency Physician Be Aware of This?: Here we describe a case of extracorporeal membrane oxygenation (ECMO) deployed in the emergency department as a bridge to embolectomy to successfully treat massive pulmonary embolism. This provided the opportunity to establish a "Code ECMO" protocol and algorithm for PE with cardiopulmonary instability so that patients can be rapidly triaged to the appropriate treatment modality.**

☐ **Keywords—pulmonary embolism; PE; extracorporeal membrane oxygenation; ECMO; embolectomy**

INTRODUCTION

Pulmonary embolism (PE) accounts for up to 5% of all hospital mortality and has been estimated to cause 200,000 deaths per year in the United States (1,2). Massive PE carries an extremely high mortality rate, exceeding 50%, and carries significant morbidity with the current standard of care modalities (3). Venoarterial extracorporeal membrane oxygenation (VA ECMO) provides temporary cardiopulmonary support in patients with acute cardiopulmonary failure and may be employed as a bridge to clot extraction (4). The use of VA ECMO consists of blood being drawn from the venous system, pumped through an oxygenator, and re-infused to the arterial system (5). Simplification of the VA ECMO circuit and percutaneous cannulation techniques have made it more accessible and rapidly deployable. It has been well-described that it can be effectively used in various environments to provide support to critically ill patients with acute cardiac or respiratory disease (6). In a large case series, ECMO was an important adjuvant tool in the treatment of acute cardiogenic shock of various etiologies, with survival rates of 40% to discharge when used in the setting of cardiopulmonary resuscitation (7). However, despite promising improved outcomes, there are currently no published clinical guidelines for the rapid deployment of VA ECMO in the setting of massive PE (8). In this case, VA ECMO was used successfully in the emergency department (ED) to resuscitate a patient suffering from cardiac failure and massive PE.

CASE REPORT

A 63-year-old male patient, 2 weeks status post abdominal surgery, presented to the ED complaining of acute-onset shortness of breath, weakness, and near syncope. He had

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been convalescing at home without complication. He was brought to the hospital by emergency medical services and upon arrival was found to have altered cognition, heart rate 110 beats/min, respiratory rate 24 breaths/min, blood pressure 111/68 mm Hg, a mottled appearance, profound jugular venous distention, and was markedly dyspneic. The patient's condition rapidly deteriorated and he suffered cardiopulmonary arrest. Advanced cardiac life support was initiated; the patient was intubated, and received 5 min of cardiopulmonary resuscitation (CPR). Return of spontaneous circulation was achieved for a few moments and the patient then arrested a second time. Electrocardiogram revealed sinus tachycardia, with a left bundle branch block and nonspecific ST changes. Bedside ultrasound demonstrated right heart strain post arrest. Formal cardiac echocardiogram confirmed right heart strain and clot in transit. It was determined that the patient was experiencing a massive PE and the ECMO team was promptly notified. The patient was successfully placed on femoro−femoral venoarterial ECMO within 12 min of notification while concurrently receiving CPR. Blood pressure and oxygenation improved immediately and dramatically after initiating bypass. The patient was taken to the operating room for emergent surgical embolectomy (Figures 1 and 2). The patient was found to be neurologically intact after postoperative recovery; cerebral performance category score was 1. He was discharged in his baseline functional state and subsequently returned to full-time employment.

DISCUSSION

The Extracorporeal Life Support Organization reports the steady growth in the number of extracorporeal life support centers. In the United States, there are > 550,000 cardiopulmonary arrests each year, > 200,000 of which occur in hospitals. PE is an important, under-recognized and under-treated cause of death (9). Nationally, there

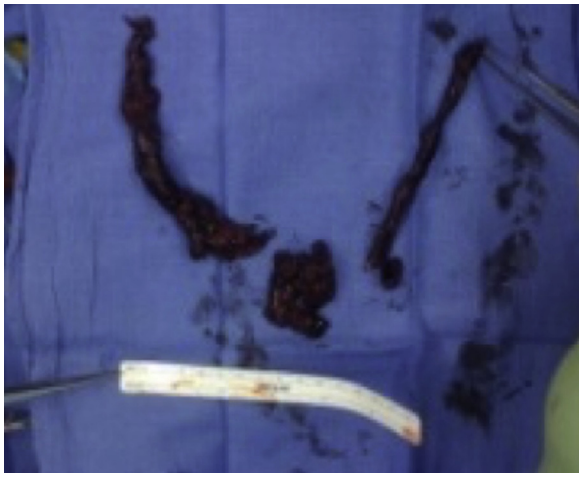

Figure 1. Retrieved pulmonary embolus.

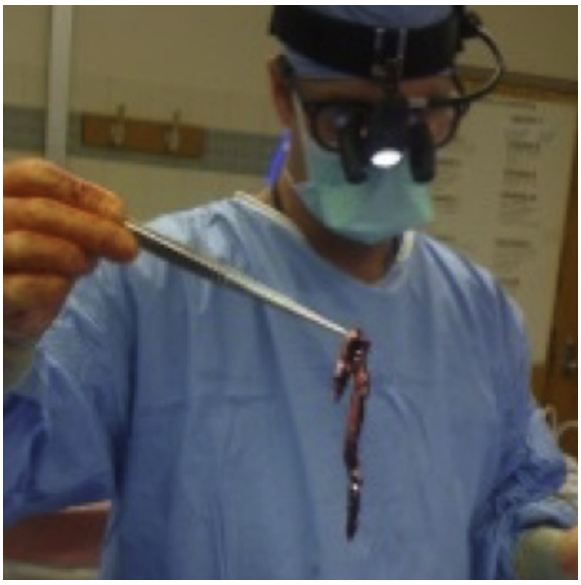

Figure 2. Retrieved pulmonary embolus.

is a recognized need to create treatment algorithms in a team-based approach. Over the past decade, ECMO has been used increasingly for patients with acute cardiopulmonary collapse as a bridge to definitive diagnosis and treatment, although many hospitals still do not have ECMO readily available. The purpose of ECMO is to maintain sufficient tissue perfusion and oxygenation to avoid end-organ damage (10). Commonly, first-line treatment of submassive PE is heparin or thrombolysis. Heparin provides anticoagulation, which is beneficial for small clots, as to avoid propagation. Tissue plasminogen activator (tPA) is an effective fibrinolytic and can be administered either locally with angiography or systemically. Obviously in situations such as a massive PE, the time to significant dissolution may not be adequate and high residual clot burdens may occur. This treatment modality was considered in this case, but was soon dismissed as we determined this was a massive PE given the profound right ventricle dysfunction and large clot in transit on echocardiogram with circulatory collapse.

While surgical embolectomy is generally considered a last treatment option, it is probably underutilized, and studies find it can be performed with low morbidity and mortality, as low as 6% (11). In one study, patients followed for 5 years after undergoing thrombolysis had a higher mortality and increased risk of recurrence PE than surgically treated patients (12). ECMO has become the standard of care for neonates with underdeveloped lungs or other causes of acute respiratory failure, such as severe asthma, and has a survival rate of nearly 90% in the neonatal population. However, ECMO has taken longer to gain acceptance in the adult population. It is not currently the standard of care and