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FELLOWS-IN-TRAINING & EARLY CAREER PAGE

The Perfect ECMO Candidate

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One quiet Saturday morning, as I sat down in front of the computer and began to review my patient charts, an uncomfortably familiar alarm sounded overhead:

"Attention please. Cardiothoracic surgery STAT to the medical intensive care unit."

This announcement is used at my hospital, invariably suggesting 1 of 2 scenarios: a patient has developed a tension pneumothorax, requiring an urgent chest tube placement; or a patient requires emergent evaluation for the initiation of extracorporeal membrane oxygenation (ECMO).

Initially jarred from the alarm, I rose from my desk and intently made my way up to the medical intensive care unit, where I was immediately engulfed by the vortex of frontline providers and bystanders crowded around a seemingly lifeless patient.

"Can you tell me what's going on with the patient?" I inquired, as I was the first person to arrive from the cardiac surgery team.

The fellow in charge of the code spoke rapidly: "We don't know much about him. All we know is that he is in his mid-40s. He arrived an hour ago and suddenly lost his pulse. We were able to get return of spontaneous circulation after 30 min of CPR, but his hemodynamic status remains tenuous despite being on maximal pressors. Labs show severe hyperkalemia and his transaminases are above 10,000. We are not sure why. Do you think he would be a good candidate for ECMO?"

The gentleman lay motionless before me, his bedsheets disheveled from deep chest compressions. His lips had already turned bluish and his fingertips were becoming dusky right before me like ripening fruit. A somber realization began to sink in. My gut sensed that this listless patient, persisting only by the intermittent boluses of inotropes being administered, would not likely survive this event.

"Does he have end-stage kidney disease or liver failure? What's his body mass index?" I asked.

Searching around the room for his colleagues' confirmation with little success, the resident reported: "We aren't sure. We have not been able to gather much history or find any records."

I then asked, "How about cancer? Other comorbidities? Any pre-existing conditions?"

"Umm…Not as far as we know," added a provider from behind.

The apparent uncertainty was not reassuring, and the patient's current clinical picture did not inspire much in the way of confidence with regard to his survivability; yet, one of the assisting medical residents insisted assertively, "This person is young and may have a good chance of recovery. This is the perfect ECMO candidate!"

ECMO is an invasive platform adapted from the heart-lung bypass machine that offers extended support to persons whose heart and/or lungs are unable to sustain life in the acute setting (1). Emergent initiation of ECMO involves the insertion of venous and/or arterial cannulae into the arrested patient and connecting him or her to the "heart/lung" circuit, which serves as a stop-gap measure for maintaining the patient's cardiorespiratory functions (2).

However, the use of ECMO is not without stipulations. Because its risks are commensurate with its life-saving potential, this technology must be used selectively to avoid doing more harm. For instance, as ECMO is not a viable destination platform on its own, it must be incorporated into a larger clinical strategy such as bridge to recovery, or other more long-term platforms such as ventricular assist devices or transplantation (3). Here, objective, upfront assessment of the patient's candidacy is paramount to his prognosis (4,5). When used appropriately, ECMO can mitigate the immediate threat to life and lead to a meaningful recovery. Conversely, when patients are placed on ECMO without a plan to bridge, they are relegated to a

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TABLE 1 Conditions Where ECMO Should Be Considered and Is Commonly Associated With Favorable Outcomes

Respiratory failure (age <65 yrs)
ARDS with primary lung injury from infection, aspiration, or trauma
Primary graft dysfunction following lung transplantation (within 7 days)
Pulmonary vasculitis
Cardiac failure (age <65 yrs)
Acute fulminant myocarditis
Cardiomyopathy (first presentation)
Primary graft failure: post heart/heart-lung transplant
AMI-cardiogenic shock without multiple organ failure
Drug overdose with profound cardiac depression or arrhythmia
Pulmonary embolism with cardiogenic shock
In-hospital cardiac arrest (with ECMO commenced within 60 min)
Post-cardiac surgery (failure to wean from CPB)

Adapted from the Extracorporeal Life Support Organization (ELSO) guidelines (6).
AMI = acute myocardial infarction; ARDS = acute respiratory distress syndrome; CPB = cardiopulmonary bypass; ECMO = extracorporeal membrane oxygenation.

TABLE 3 Conditions Where ECMO Should NOT Be Applied, as Survival Is Very Low

Respiratory failure
Interstitial lung disease/pulmonary fibrosis
Lung transplant chronic rejection
Cystic fibrosis
Severe acute restrictive lung disease with relative clear CXR (early) is suggestive of cryptogenic organizing pneumonia (bronchiolitis obliterans with organizing pneumonia), and biopsy should be performed prior to instituting ECMO if this condition is suspected
Long-term immunosuppressed (heart, renal, bone marrow transplant recipients, HIV, graft vs. host lung disease)
Cardiac failure
Unrepaired moderate-severe aortic or mitral valve regurgitation

Adapted from the ELSO Guidelines (6).
CXR = chest x-ray; HIV = human immunodeficiency virus; other abbreviations as in Table 1.

state between life and death; a tragic, unconscious, steady downward spiral into multisystem organ failure. This consequence also has tremendous implications from a resource stewardship standpoint, as initiation and daily management of ECMO, especially in prolonged instances, can drain substantial intensive care unit-level resources. Therefore, it is essential to carefully select individuals who might yield the greatest likelihood of survival (1,2).

In this vein, the Extracorporeal Life Support Organization has devised guidelines that describe the indications and practice of ECMO, which are clear and now well-adopted by most centers that utilize this platform (6,7). Contraindications for establishing ECMO have also been solidified, recognizing the profound ramifications of poor patient selection, although they tend to be more relative in practice (**Tables 1 to 4**) (6). Additional policies have been implemented based on the imperative to bridge ECMO patients to more durable therapy. Most notably, and controversially, under the current United Network for Organ Sharing allocation guidelines, ECMO placement elevates the patient's status on the transplant waiting list (8).

TABLE 2 Conditions Where ECMO Is Often Considered, but Outcome Is Variable

Respiratory failure
ARDS from secondary lung injury (i.e., intra-abdominal sepsis or burns)
Lung transplant recipients 7 to 30 days post-transplant
Lung transplant recipient >30 days and suitable for retransplantation from ECMO
Age >65 yrs (any cause)
Cardiac failure
Chronic cardiomyopathy (suitable for VAD and heart transplant) with acute severe heart failure or sepsis
Ischemic cardiogenic shock with multiple organ failure or sepsis
Heart transplant recipient with chronic rejection and end-stage heart failure and suitable for VAD and retransplantation
Age >65 yrs (any cause)

Adapted from the ELSO Guidelines (6).
VAD = ventricular assist device; other abbreviations as in Table 1.

However, although honing guidelines is important, it is only half of the battle. In the opening case scenario, for example, when I arrived to the code that morning, I realized that the other half of the battle was emotional, psychological, and social. It reminded me of a story by George Orwell where he, as a British officer once dispatched in Burma, was called upon by the townsfolk to shoot an elephant that had broken out of captivity. Although when he came across the elephant, he knew that he did not want to do so, the crowd around him now had expectations, and he "…could feel their two thousand wills pressing him

TABLE 4 Contraindications for All Forms of ECMO

Presence of additional severe chronic organ failures (cirrhosis, end-stage renal disease, hepatic failure)
Severe brain injury
Malignancy
Age >75 yrs

Adapted from the ELSO Guidelines (6).
Abbreviations as in Table 1.

forward, irresistibly" (9). As a frontline responder to a code, I, too, had been engulfed by a crowd, and I could feel their collective fervent desire to revive the patient. It was difficult to remain clear-headed in that highly stressful setting. I did not want to let down my colleagues, my patient, and the patient's family. I could also sense a physical urgency from the crowd for me to proceed with an action for which I inherently could not fathom a meaningful outcome.

As physicians, we assume that our actions are guided only by objectivity, that the applications of medical sciences are always exact and clear-cut. However, in reflecting on this experience, I realized that the true reality of how these scenarios typically evolve is often born out of a confluence of duties—some of them conflicting and others blurred by the condition of the human experience. Our duties toward absolute contraindications may be complicated by the sense of duty we feel toward saving the dying patient when called upon in an emergent setting.

The implications are profound, not only for medical decision-making, but also for patient outcomes. No matter how facile we become with ECMO, we will always be impervious to the complex social and emotional challenges that arise when we enter the room of an imminently dying patient and must make a life-altering decision. These dynamics are the most difficult to navigate, more than any algorithm. As bearers of powerful interventions with permanent consequences, we must ultimately learn to balance our own will and insights with the earnest expectations of others.

For trainees learning to wield such powerful technology, these lessons need to be reinforced. Under the current model, the decision-making process can often be nebulous, attending-driven, and seldom debriefed. So, although trainees become technically adept at utilizing ECMO and well-accustomed to the duress of cannulating patients in unstable, dynamic scenarios, we still have much to learn when it comes to the decision-making progress. We still have much to learn about ourselves.

Ultimately, as a resident in this scenario, the decision was not mine to make. This patient was eventually placed on ECMO after a long and difficult conversation. By the time he was transported to the cardiac surgery unit, his liver and kidneys had failed. Care was withdrawn once family was identified the following evening.

One day each of us will surely bear the responsibility of making a decision as seemingly leading actors. Perhaps, by then, more experience and evidence will have brought us closer to defining the "perfect" ECMO candidate. But no matter how much we know, this will always remain an inherently human process. Will we then take a moment to think about the invisible forces around us, hiding in plain sight, ceaselessly pulling us in many directions?

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RESPONSE: Challenges Associated With Complex, Rapid Decision-Making in Advanced Cardiac Failure

Choosing Wisely

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The development of increasingly sophisticated life-sustaining technology creates new opportunities for the management of patients with severe organ failure. However, these same technological advances create a host of clinical and ethical dilemmas around the initiation, and ultimately, termination of support (1). When faced with a patient in cardiogenic shock, in whom the etiology and prognosis are unclear, as in the case presented by Drs. Han and Swain, the decision of whether to initiate ECMO is indeed challenging. As outlined by the authors, existing guidelines specify indications and contraindications. However, as in the case presented, real-life decision-making may be harder to parse than is evident from a table of indications. Not to mention that definitive, evidence-based guidelines do not yet exist, so that current guidelines should be taken with a grain of salt and supplemented by data, when available, that more precisely define prognosis (2). Several prognostic scoring systems, based on clinical variables, have been proposed as a means of further triaging the appropriate use of ECMO in cardiac and respiratory failure (3–5). Additional studies are needed to clarify the role of ECMO in specific disease processes to maximize patient outcomes. Importantly, these are complex patients requiring urgent decisions. Because of this, we advocate for an experienced multidisciplinary team that can be assembled quickly to identify the most appropriate strategy (6,7).

Situations may arise when patients receiving ECMO become device-dependent, no longer able to be bridged to recovery, and without options for durable ventricular assist device or organ transplantation—what has been termed a "bridge to nowhere" (8). The emotional burden on patients, families, and—as highlighted by the authors—providers, and the decision-making regarding limitations to life-sustaining therapies in these scenarios are often difficult to manage. Adherence to indications and contraindications for ECMO initiation can often prevent the bridge to nowhere, but even with the most stringent criteria, these situations will be encountered. Discussion of potential outcomes, including bridge to nowhere, prior to ECMO initiation, and early involvement of palliative care and ethics consultations may help alleviate some of these challenges (9,10).

As device technology proliferates and situations such as this one occur more frequently, the need for education of trainees around this complex decision-making is paramount. This may occur through real-time participation in cases such as this one, case-based quality reviews, simulation training, and formal didactics. Ultimately, as technology becomes more advanced and readily available, organ failures that were previously incompatible with life will become increasingly more manageable. However, just because we can support someone does not mean that we should, and the decision to do so must take into consideration both the overall prognosis and the likelihood of an acceptable and sustainable quality of life. As with Drs. Han and Swain, it is important that clinicians at all levels of training be acutely aware of these issues.

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