

EDITORIAL COMMENT

Cheating Death With ECMO

Coming Soon to a Theater Near You*



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The study by the Dusseldorf Extracorporeal Life Support (ECLS) Network in this issue of *JACC: Heart Failure* (1) adds to the inconvenient truth that extracorporeal membrane oxygenation (ECMO) is moving from an anecdotal therapy to a public health commodity. Much in the way that cardiopulmonary resuscitation began as an experimental technique in the basement of Baltimore City Hospital to part of elementary school education, ECMO is poised to evolve into a fundamental resuscitative therapy. It has 1 major problem: it is phenomenally expensive. Although ECMO creates exciting opportunities, it simultaneously creates troubling questions for clinicians, policymakers, and the public.

SEE PAGE 698

Cardiopulmonary bypass for open heart surgery demonstrated that extracorporeal circulation was feasible and ECMO arose as a modification of these circuits to allow prolonged circulatory and respiratory support. For nearly 30 years, the focus was in respiratory failure. Following the H1N1 pandemic in 2009 and publication of the CESAR (Conventional Ventilatory Support versus Extracorporeal Membrane Oxygenation for Severe Adult Respiratory Failure) trial (2), the use of ECMO has increased dramatically throughout the United States (3). With improvements in oxygenator technology and blood-contacting surfaces, teams expanded ECMO support to patients in cardiogenic shock. Recently, the oxygenator and pump have been integrated into smaller mobile

devices. Traditionally, patients are transported to specialized centers where ECMO therapy is initiated. This creates a selective pressure to survive transport and an awareness that time to ECMO deployment correlates to better patient outcome. Thus, it stands to reason that local deployment can potentially improve outcomes and importantly expand indications to patients with cardiac arrest and shock outside the tertiary care ECMO center.

The current study nicely demonstrates a systematic approach to out of “center” arrest or cardiovascular collapse over a 5-year period in a city with a population of 600,000 and total catchment of 800,000 (similar to Baltimore, Nashville, Charlotte, or Amsterdam). The program has a central hub that fields calls for ECMO at 17 other centers and decisions are made by the cardiac surgeon on call. When that person agrees, the mobile team is deployed and initiates basic ECMO at the scene. The patient is then transported back to the ECMO center and the support further escalated to stabilize the patient and bridge to the next appropriate steps.

Out of 115 patients (15 others were declined before initiation), 38 survived 1 year later. There was a large proportion of cardiovascular related causes and cardiac-directed interventions. The authors examine basic outcomes and costs. The study reinforces trends seen in other studies: high lactate and prolonged conventional resuscitation before ECMO initiation has a poor prognosis.

If we presume futility in this enterprise is a survival of <10%, and that number is where out of hospital arrest survivorship sits in best case regions (Japan, certain U.S. counties), then this paper suggests that reasonable outcomes can be achieved.

However, there are a number of questions that merit consideration. First the operational details are critically important. How was the program started and implemented? How were satellite programs educated

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and the processes to call started? Once the program went live, what resources were committed by the hub hospital to have teams available 24/7 and hospital capacity to absorb these patients? Who pays for it?

It is a surprisingly small number of referrals. Was there an understanding that drug overdoses, suicides, trauma, sepsis, and pulmonary embolism would be excluded? In this study, the majority of patients had a pure cardiac etiology, which likely influenced the outcomes. Why were 15 patients declined over the phone and then in person?

Second was there a time dependence on outcome? Did the inclusion or exclusion criteria change over time? Were outcomes better in the last year as compared with the first year? In other words, what did the team learn as the program progressed?

Third, what were the cost drivers? Was it hospital days, equipment, or dialysis? Cost effectiveness is more than cost of survival versus death, but rather quality-adjusted life years. In this way, the analysis allows comparisons to vaccinating children or operating on brain tumors. The current analysis fails to explore the matter in a meaningful way.

But the paper really should force all of us to consider ECMO as a public health issue. If there is a survivorship even among the elderly that is not zero, is there not an obligation to the public or an expectation by the public to deeply understand this technology. One can imagine that if a patient does not get ECMO within 30 min of cardiopulmonary resuscitation that a hospital or hospital system could “fail” to meet a basic quality metric, just as it does for not getting to catheterization laboratory in time after acute myocardial infarction.

In the United States, there are >200,000 out-of-hospital arrests. Several communities are currently exploring ECMO deployment in the street or in public buildings (4). A randomized clinical trial is underway in France to examine prehospital ECMO (NCT02527031). The estimated cost of U.S. ECMO is >\$300,000 per case (3). If even just 10% of these patients are treated with ECMO the cost to the system is over >\$6 billion. Real money.

There is also basic research that is necessary as ECMO grows. How do we resuscitate these patients (temperature, oxygen, flow)? How do we protect kidneys and importantly the brain during support? The most common cause of death on ECMO in the current study was related to brain injury.

Finally, there is an even more pressing area of public policy that must be addressed now. How should communities organize ECMO programs? Should there be networks that are held accountable to the clinical community and the public? Who should pay for this? And the most difficult question: When should we say no to ECMO?

This report from the Dusseldorf ECLS Network in this issue of *JACC: Heart Failure*, describes the next step in the evolution of ECMO, and highlights the urgent need for a systematic, multidisciplinary, and exhaustive examination of this technology that includes all stakeholders including the public.

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