

# Inequity in Access to ECMO During COVID-19

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## Abstract

Extracorporeal membrane oxygenation (ECMO) emerged during the COVID-19 pandemic as a therapy for advanced cases that had progressed to severe acute respiratory distress syndrome (ARDS). However, demand for the treatment exceeded capacity in many regions, and the resource-intensive nature of ECMO meant that it was mostly feasible only at specialized centers or other tertiary-care facilities. This shortage served to exacerbate preexisting inequities implicit in the healthcare landscape of the United States. Regionalization, a philosophy of organizing medical services through collaboration between separate facilities and providers in a given area, was utilized by various regions to maximize available resources, and may be able to be targeted to address and reduce inequities in access.

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At the peak of the COVID-19 pandemic, extracorporeal membrane oxygenation (ECMO) emerged as a treatment for cases that had advanced to severe acute respiratory distress syndrome (ARDS). However, the number of patients referred for ECMO exceeded the capacity of specialized centers to provide the treatment, leading to increased mortality: 90% of a cohort of patients in Tennessee who were eligible for ECMO but did not receive it because of limited capacity died before discharge, despite young age and few comorbidities. In comparison, mortality in a similar group was 43% when capacity was available (Gannon et al., 2022). Delayed initiation of ECMO (after 2-5 days compared to 0-1 days) was also associated with poorer prognosis (Li et al., 2021). As described in “The Rationing of a Last-Resort Covid Treatment,” an article on

ECMO shortages that ran in *The New York Times* in July 2021, in cases where patients at hospitals without ECMO capacity had to be transferred out, “getting patients moved to a hospital with ECMO often depend[ed] on relationships between doctors and having a case manager ‘who really knows how to push’” (Fink, 2021).

## Inequity in Access

This shortage in ECMO has implications in health inequity in the U.S. The pandemic had the greatest impact on disadvantaged communities: Neighborhoods with high proportions of Black, Hispanic, low-income, and uninsured residents experienced a significantly higher burden of COVID-19 compared to wealthier and white-predominant areas (Gaffney, 2022). However, these same communities also have less Intensive Care Unit (ICU) infrastructure: A

2020 study found that 49% of the lowest-income communities in the U.S. had no ICU beds, compared to only 3% of the highest-income communities (Kanter et al., 2020). A 2020 study evaluating assets of hospitals in the U.S. found that Black- and Hispanic-serving hospitals, defined as hospitals in the top decile of Black and Hispanic inpatients, have on average \$5,197 and \$5,763, respectively, in physical resources for patient care per bed per day, compared to \$8,325 at white-serving hospitals (Himmelstein and Himmelstein, 2020). These hospitals also have lower nurse-to-census ratios (Arora et al., 2021). ECMO is a costly treatment: Its complexity requires trained specialists and higher nursing-to-patient ratios, and median duration of treatment for COVID-19 was 20 days, with ICU stays of 36 days. Thus, capacity is typically not available at smaller community hospitals, leading to ECMO mostly being supported at expert, high-volume centers (White and Lo, 2021)—which, given the lack of infrastructure and resources mentioned above, excludes many hospitals that primarily serve disadvantaged communities.

Patients at hospitals without ECMO can be transferred to tertiary-care ECMO centers, but even this process can exacerbate inequity. During the pandemic, one selection process to determine which eligible patients would receive ECMO favored a “first-come-first-served” basis, as ECMO outcomes are shown to be linked to timing of initiation. However, such a system can disadvantage patients who present late to hospitals due to poor access to healthcare. In itself, triage for

admission to ICU can exacerbate inequity: Protocols that operate on a “save-the-most-lives” philosophy give lower priority to minority groups with more medical comorbidities that worsen their survival probabilities; however, a “random allocation” approach means a disadvantaged patient with a poor prognosis receives equal priority for treatment to a disadvantaged patient with an excellent prognosis, leading to more treatment of patients likely to die regardless and less frequent treatment of patients likely to survive if treated (White and Lo, 2021).

### **Regionalization of ECMO**

One solution to addressing the ECMO shortage is regionalization, a strategy utilized by areas such as North Carolina, Minnesota, southern California, and Greater Paris. Regionalization involves the “integrated organization of a healthcare system, wherein regional structures are responsible for providing and administering health services in a specific region...to improve the quality of provided care and to properly utilize available resources” (Ramos et al., 2020).

In 2013, Duke formalized a program that partnered the Duke ECMO Center with local facilities across the southeastern U.S. to accept ECMO referrals. The program sought to increase ECMO access across the region and build mobile ECMO infrastructure. Referring centers called into an established hotline at Duke; patients accepted for transfer were transported by the ECMO transport team, which consisted of the coordinator, an ICU intensivist or ECMO surgeon, an ICU charge nurse, and the Duke Life Flight charge

nurse. Approximately half of accepted patients had cannulation initiated on-site at the referring center with support by a Duke cannulation and transport team, based on factors such as patient stability, geographic location of referring center, distance of transport, weather, etc. (Bonadonna et al., 2019).

The Southern California ECMO Consortium was formed specifically in response to the pandemic. The consortium's objective was to ensure equitable use of ECMO throughout the region and unify ECMO criteria for COVID-19 patients. The consortium tracked ECMO capacity across its centers, facilitated distribution of patients according to available resources, and formed critical care transport teams. It used ECMO exclusion criteria based on the Extracorporeal Life Support Organization (ELSO) Guidelines for Adult Respiratory Failure and developed its own guidelines for inclusion criteria that weighed factors such as capacity, projected duration of treatment, and predicted survival differently based on the current stage of the pandemic. These guidelines were reviewed by a biomedical ethicist to ensure maximal community benefit. In collaboration with public health agencies, the consortium shared ECMO capacity and use data with the county Health Services Capacity Task Force and COVID-19 Incident Management Team of San Diego to discuss management of regional healthcare capacity, identify potential emerging shortages, and assist the centers in building capacity (Odish et al., 2021).

In the Picardy province of France, as well as the Greater Paris area, the pandemic

also gave rise to regionalization of critical care. In Picardy, regional mobile ECMO teams operated as part of a broader initiative that coordinated the admission of COVID-19 patients with ICU availability (Terrasi et al., 2020). In Greater Paris, an ECMO-specific network was formed which: 1) prepared an inventory listing all available ECMO supplies in the region; 2) homogenized ECMO indication and management; 3) facilitated a WhatsApp group wherein participants discussed ECMO indications and real-time availability of equipment and coordinated the dispatch of mobile ECMO teams, and 4) summarized ECMO activity and updated all network participants on issues including thrombotic risk, strategy for anticoagulation, and other medical topics. ECMO candidacy was based on fulfilling the eligibility criteria used in the ECMO arm of the ECMO to Rescue Lung Injury in Severe ARDS (EOLIA) trial; indications were also evaluated by a medical team that consisted of at least 2 intensivists (Lebreton et al., 2021).

In addition to maximizing available resources, regionalization of a specialized resource such as ECMO can also be targeted to address inequities in access. In Picardy, France, only one facility, the ICU of the Amiens University Hospital, had the capacity to initiate ECMO at the outbreak of the pandemic. To address this, a regional mobile ECMO team created by the Amiens University center, consisting of an intensivist, a thoracic surgeon, and a ECMO specialized nurse, became available 24/7 for all emergency departments and ICUs of the region. The mobile team traveled to

community hospitals to initiate ECMO on-site; patients were then transported by helicopter or road to the Amiens University ICU (Terrasi et al., 2020).

Regionalization can also improve access by load-balancing patient burden across areas with wide disparities: The collaboration between four ECMO centers in the Southern California ECMO Consortium united San Diego, the 2<sup>nd</sup>-most populated county in California with the 27<sup>th</sup>-highest incidence of cases per 100,000 residents, and Imperial County, the 30<sup>th</sup>-most populated county with the highest cumulative incidence of cases per 100,000 residents. San Diego contains 24 acute care hospitals, 6 of which have capacity for ECMO support and 3 of which are able to provide comprehensive management for adult patients on ECMO; in contrast, Imperial County has 2 hospitals with limited ICU beds and no ECMO capacity. The formation of the consortium allowed patients to be transferred out of Imperial County to hospitals in San Diego. Between June 19 and November 27, 2020, the consortium facilitated redistribution of potential ECMO patients from high census centers to lower census centers, aided by mobile ECMO and advanced critical care transport; the consortium was even able to accept patients from Riverside County, Arizona, and Nevada, areas outside its pre-established region, due to optimization of available capacity. Of note, no patients were declined ECMO based on insurance or funding status (Odish et al., 2021).

### **Disadvantages and Barriers**

Regionalization is not a perfect solution, as barriers stemming from the healthcare financing system of the U.S. remain. For the same reasons that facilities in underserved areas lack the ability to provide specialized, resource-intensive therapies such as ECMO, tertiary-care hospitals facing high patient burdens have little incentive to draw critical patients from underserved areas: These patients are often underinsured and the costs of their care frequently exceed reimbursement rates (Kanter et al., 2020). In addition, regionalization itself does not solve the inequities that exist in ICU triage; these inequities must be addressed directly in the guidelines that determine which patients should be eligible for ECMO.

Health policy can assist in filling these gaps by incentivizing hospitals to participate in regionalization of ECMO referrals, pooling of equipment, and regulation of beds, which has prevented equipment shortages in areas such as Greater France and Southern California (Lebreton et al., 2021; Odish et al., 2021). Fiscal support can be provided to concentrate ECMO at high-volume centers, which has been shown to be correlated with improved clinical outcomes (Arora et al., 2021; Lebreton et al., 2021) and reduced cost for the health system (Bonadonna et al., 2019). Policy can prevent the exclusion of underserved patients from ECMO networks by mandating that centers that partake in public funding must include low-resourced areas in their regionalization efforts, as seen in Picardy and Southern California (Terrasi et al., 2020; Odish et al., 2021). In addition,

guidance can be provided on how to define regions of operation: Instead of mere geographical boundaries, factors such as ICU resource availability should be taken into account to unite high-capacity and low-capacity areas and balance patient load, as exemplified by the Southern California ECMO Consortium's acceptance of patients from Arizona and Nevada (Odish et al., 2021). Lastly, support can be provided at a state or federal level to ensure interhospital transfer mechanisms are established with contingencies and can be supported by regional infrastructure, a strategy that proved critical in Arizona when patients from safety net hospitals, many of whom were from the Navajo nation, needed to be moved to better-resources centers (White and Lo, 2021).

ICU inequity, including inequity in access to ECMO, can also be targeted through guidelines for triage and treatment candidacy. Many current guidelines use life expectancy to guide maximum benefit of a resource, favoring patients with longer life expectancy to receive treatment; however, this disadvantages minority populations who have shorter life expectancies due to structural inequities. As proposed in White and Lo's (2021) review in the *American Journal of Respiratory and Critical Care Medicine*, equity can be balanced with population health outcomes by giving lower priority during triage to patients expected to die in the near term—for instance, within a year—from an established, objectively supported medical condition, but otherwise making no distinctions based on predicted life expectancy, similar to how duration of

benefit, rather than total life expectancy, is used to guide allocation of lung transplants. Policy can help determine the feasibility of this shift by 1) uniting key stakeholders, such as pulmonary and critical care physicians, insurance representatives, hospital administrators, community leaders, and patient advocates, to discuss the pros, cons, and barriers to such a change; 2) incentivizing or mandating adoption of this change in a trial hospital or region; and 3) providing funding for gathering data on how such a change has impacted distribution of resources.

## Conclusion

Institutional inequity rooted deeply in American history has given rise to unequal distribution of resources at every level of society, and life-saving treatments such as ECMO are no exception. However, in recognizing the problem, analyzing its origins, and exploring possible solutions, the medical and public health communities can take steps toward closing the gap and providing more equitable care for all patients.

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