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UCSDH ECMO During COVID-19

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Extracorporeal membrane oxygenation (ECMO) is a life support method to provide cardiovascular and pulmonary support by removing carbon dioxide from the blood and providing oxygen¹. The use of ECMO increases survivability when applied to patients who fail to improve with conventional ventilatory support². In order to expand ECMO capacity, and due to a national shortage of perfusionists, UC San Diego Health (UCSDH) transitioned to a nurse-run ECMO program in January 2018. Nurse-run ECMO has been demonstrated to be as safe as perfusionist-run ECMO with noninferior survival to discharge (52% vs 27.5%; $p = 0.279$)³.

During the pandemic, the primary goal of the UCSDH ECMO program was to rapidly increase ECMO capacity to meet the demand for patients with severe COVID-19 acute respiratory distress syndrome (Table 1). Neighboring regions to San Diego were disproportionately impacted by COVID-19 and local hospitals did not have the resources to place or manage patients on ECMO. UCSDH swiftly simplified their ECMO referral process. Any medical provider can request the UCSDH ECMO program to evaluate for ECMO candidacy by completing referral paperwork. Once received, the coordinator organizes a multidisciplinary clinician conference to determine candidacy within 60 minutes.

If the patient is an appropriate ECMO candidate, bed and staff availability will be determined.

Many patients met criteria for ECMO support but were too unstable to transfer to an ECMO center. To solve this problem, UCSDH established a mobile ECMO team to reach those patients^{5,6}. The mobile ECMO team consists of a cardiothoracic surgeon, pulmonary critical care attending, perfusionist and the ECMO coordinator, a critical care nurse. To prevent strain on the centers visited, the mobile team brings all supplies needed for cannulation, including PPE (personal protective equipment). ECMO cannulas are placed percutaneously at the bedside by

ECMO team surgeon using ultrasound guidance. From April 2020 to January 2021, 22 mobile ECMO cannulations were completed⁴. In 2021, an additional 19 patients were placed on ECMO utilizing the mobile ECMO team.

Prior to the COVID-19 pandemic, an ECMO patient was staffed with two nurses. A primary nurse who focuses on traditional patient care, and an ECMO specialist who monitors and manages the ECMO circuit and adjusts the ECMO settings in response to the patients' clinical picture. All ECMO patients at UCSDH were managed in the Cardiovascular Intensive Care Unit (CVCICU). At the onset of the pandemic, all COVID-19-positive



Table 1: UCSDH ECMO Growth graph describing number of ECMO patients per year. From January 1, 2018, through October 28, 2021, the nurse-run ECMO program cared for 236 patients on ECMO. ECMO= Extracorporeal Membrane Oxygenation. Mobile ECMO = UCSDH ECMO team placing a patient on ECMO and transporting them back to UCSDH.

patients that required ICU level of care were cohorted in Jacobs 3GH medical surgical ICU.

Initially, 3GH ICU patients requiring ECMO were cared for by CVCICU nurses as both the primary nurse and ECMO specialist. However, as the COVID-19 ECMO census grew, staffing shortages necessitated 3GH ICU cross training to assume the primary nurse role, allowing the ECMO specialists to manage two ECMO patients at a time. The ECMO program developed a “Care of the ECMO Patient” class through Zoom with simulation videos for the 3GH ICU nurses. As the demand for ECMO continued to increase, it necessitated an increase to a 3:1 patient to ECMO specialist ratio. A temporary ECMO lead role was also developed as a resource to the ECMO specialists. The ECMO lead is staffed 24 hours a day and does not have a patient assignment.

Between April 2020 to January 2022, the ECMO program received over 700 referrals from both regional and out of state hospitals. With the rapid growth experienced by the ECMO program, it was clear that permanent additional resources were needed. The ECMO lead role transformed into a formal leadership position. The ECMO leads continue to act as a resource, and the role has expanded to assisting with bedside and mobile ECMO cannulations, facilitating the ECMO referral process, and participating in ongoing quality improvement and research.

Moving forward, leads will assist the training of new specialists and primary nurses in the management of ECMO patients and provide continuing ECMO education. This will allow UCSDH to not only increase the quantity of patients placed on ECMO but allow for the advancement of clinical care in this high acuity population. Additionally, the ECMO program is strengthening partnerships with other hospitals to help educate medical staff on the early identification of potential ECMO candidates. As ECMO programs start nationwide, medical centers look to our program leaders for guidance. The UCSDH ECMO team has begun education at medical centers around the United States to train their staff to run ECMO and their physicians on the management of this specialized patient



Authors left to right: Cassia Yi, Sonovia Mauer, Michelle Parrett, and Yelena Ignatyeva

Cassia Yi, APRN, MSN, CNS, CCRN Acute Mechanical Circulatory Support Program Coordinator. She has 16 years of nursing experience, with 12 at UC San Diego Health. Her silver lining of COVID has been the relationships that she has formed in building the ECMO program. Their program has undergone a tremendous amount of growth in a short and stressful period. It was only possible due to tireless and continuous work of their outstanding team.

Sonovia Mauer, BSN, RN, CCRN and is an ECMO Lead CVCICU. She has 14 years of experience with 3 years at UC San Diego Health. Her silver lining of COVID is that she has been able to form close relationships with her neighbors and all her children learned to ride bikes.

Michelle Parrett, BSN, RN, CCRN is an ECMO Lead CVCICU and a CNIII. She has 11 years of nursing experience with 9 years at UC San Diego Health. Her silver lining of COVID is twofold. Professionally, she has learned so much about the disease process of COVID, the patient population, and how to best care for them. At home, she has enjoyed her husband being able to work from home as their newborn became a toddler.

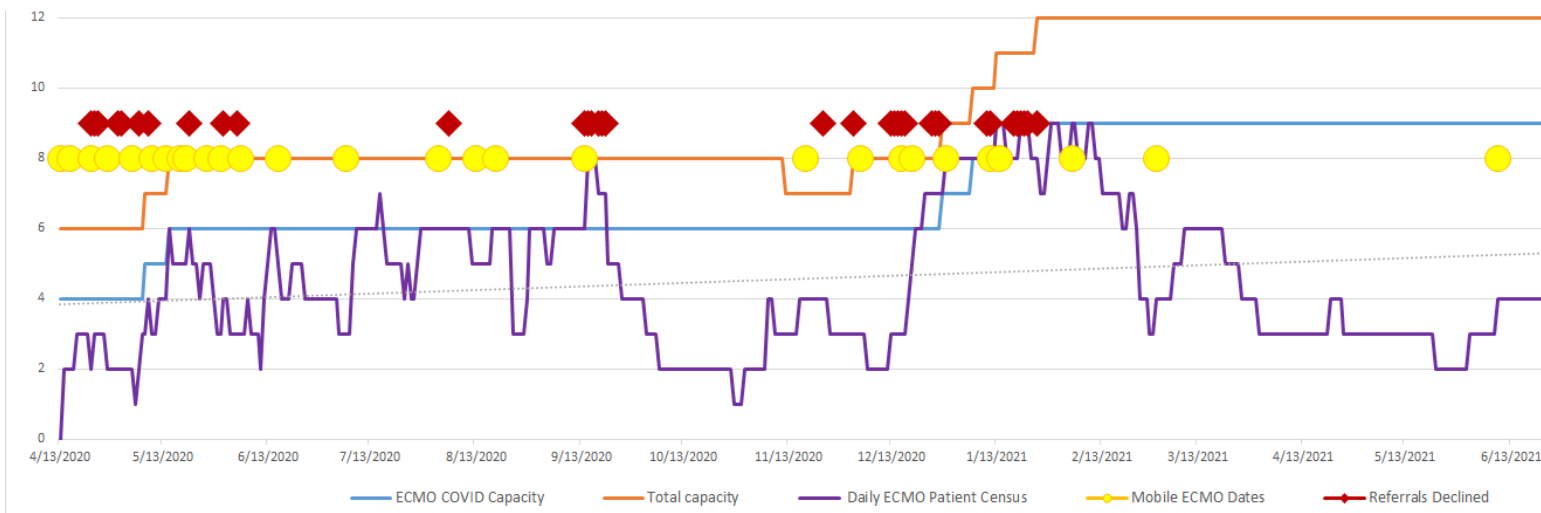
Yelena Ignatyeva BS, RN, CCRN and has been ECMO lead for CVC/ICU and has 28 years of experience. She has spent the last 13 years with UC San Diego Health and is currently a CNIV. Her silver lining of COVID-19 is her two college kids are spending more time at home. She is happy to have them around a bit longer.

population.

Some of the challenges experienced in caring for the COVID-19 ECMO population are not unique to ECMO patients. Caregivers were faced with PPE and supply shortages, fear of infection from the novel virus, high patient mortality, and staffing shortages which lead to increased burnout. During the pandemic, the mortality rate for ECMO patients in the United States was 45.9% (Odish, Yi, Tainter, et al., 2021). This created an emotional strain for those working closely with the patients at the bedside. Other challenges included adjusting to the frequent changes required by the rapidly growing ECMO program, working in a new environment, and caring for an increased number of highly acute ECMO patients. Meeting these

challenges required nurses to display high levels of resiliency, adaptation, and courage.

UCSDH joined the three other ECMO centers in San Diego to create the Southern California ECMO Consortium, a group comprised of physicians and nurse ECMO coordinators (Odish, Yi, Eigner, et al., 2021). Using the “3S System for Surge Capacity”, “staff, stuff, and structure”, the ECMO program maximized the potential benefit of this scarce resource countywide⁴. Specific criteria were created to determine ECMO candidacy for each of the three ECMO pandemic crisis phases: Conventional, contingency and crisis phases. If a patient met criteria, they would be placed at a center that had capacity. If criteria were not met, exclusion would be applied



- March:** Start of COVID ECMO Emergency Planning.
- March:** Creation of San Diego County ECMO Consortium
- March:** Initiation of Daily COVID ICU ECMO pre-screening for ECMO.
- April 13:** First ECMO patient to be cared for outside of CVC ICU.
- April 23:** First Mobile ECMO patient
- April 13:** Primary and ECMO specialists role both staffed with 1:1 ECMO specialist
- May 7:** Staffing model moved away from ECMO staffing primary RN role
- May 7:** Cardiohelp borrowed from RCH
- May 1:** Initiation of Daily COVID ICU ECMO screening lists on EPIC
- May 15:** Rotoflow swapped for Cardiohelp from Scripps
- May 13:** ECMO specialist Staffing model adjusted to 2:1 ratio
- July 1:** Staffing model opened to ECMO specialist to be specialist and primary role for patients not in isolation
- July-Dec:** Primary RN ECMO Training initiated for primary RNs in 3gh and CVC ICU
- Nov 15:** 3:1 ECMO specialist Trial began
- Dec 28:** Borrowed Cardiohelp from Radys
- Jan 4:** Moved to 3:1 Specialist Ratio
- Jan 6:** Borrowed Cardiohelp from Sharp Chula Vista



Dr. Jay Buenafior: 52 days on ECMO

across all centers. Resources were shared between the three normally competing healthcare systems. ECMO machines could be swapped between centers quickly to maximize capacity. Machines were swapped between centers 30 times as the patient censuses fluctuated. As a result, from March 1 to November 30, 2020, 97 patients were placed on ECMO. Ten referrals were received from outside consortium counties, nine referrals were sent to another center within the consortium due to capacity limitations and one referral was sent to an outside center. No eligible patients were refused ECMO due to a lack of capacity⁴. From March 2020 to November 2020, UCSDH's survival to hospital discharge was 48.5% and increased to 55% from December 2020 to April 2021³.

The sustainability of the ECMO program post-pandemic is undeniable. The number of patients placed on ECMO has continued to grow². With the Mobile ECMO program, patients

who are too unstable to travel can be placed on ECMO at their current facility and transported to UCSDH for higher level of care which was previously thought to be unattainable^{5,6}. The advancements made with the program have greatly increased UCSDH's ability to bridge patients to transplant. The consistency of having an ECMO lead as a permanent leadership fixture in-house 24 hours a day allows continued focus on all aspects of the growing program. In addition, ECMO specialists' clinical knowledge has grown dramatically during the pandemic due to the sheer number of hours spent managing this population. They encountered previously unforeseen situations and were able to share their learning experiences with each other in real time and make changes to practice. They adapted to challenges and the ever-changing reality of COVID-19 nursing, which rapidly grew their practices and allowed them to practice

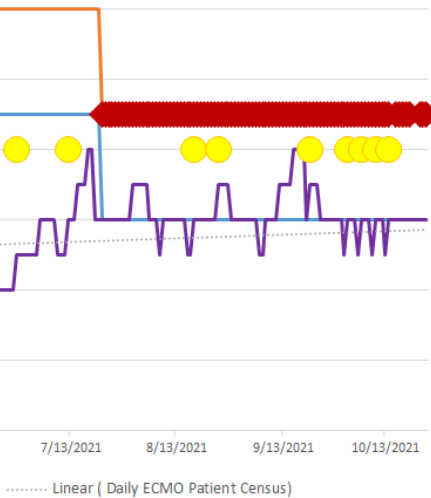


Table 2: This graph depicts ECMO growth specific to COVID-19. The purple line represents the daily ECMO patient census and reflects the COVID-19 surges in San Diego County. The red line represents UCSDH declined referrals of eligible patients due to lack of equipment and staff.

May 1:
All borrowed equipment returned

July 6:
COVID ECMO census capped at 6 due to primary RN staffing

Jan 13:
Rented 2 Sorin pumps from Specialty care, and then swapped a rotoflow for a Cardiohelp from Scripps

October 10:
Swapped rotoflow for Cardiohelp with Scripps due to mobile demand

July 1:
Rented 2 Rotoflows in preparation surge



Benjamin Romero survived COVID after 43 days on ECMO.

at the top of their field.

Seeing the growth of the ECMO program has been extremely rewarding. The program has increased from 12 ECMO patients in 2016, to 85 in 2021. The multidisciplinary teamwork throughout the entire progression has been exceptional, and the ECMO team has touched many lives. A mother pregnant with twins was placed on ECMO as she battled against COVID-19 and is now safely home with her babies. A pediatrician who contracted COVID-19 caring for patients was on ECMO for 52 days and is now back home with his children and able to continue practicing medicine. An Uber driver placed on ECMO is now back at work and able to help provide for his family. These are just a few of the patients whose lives were greatly impacted by the ECMO program and continue to be the motivation behind our work.

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