



Oxygen Use in the US and Disruptions during Mass Care

Asha Devereaux, MD, MPH, FCCP

Pulmonary/CCM

2002



2005



2007



2015
STATE
OF THE
UNION
#SOTU



2020



2022



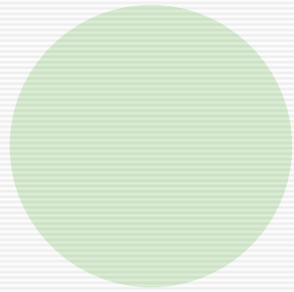
2024



2017



No Conflicts of Interest



Objectives

- Discuss Oxygen and issues in disasters
- Consequences of high oxygen demand during the pandemic
- Some of the mitigation strategies used by State of California during COVID-19 pandemic surge

OXYGEN USE IN U.S. HEALTHCARE

Overview of Annual Oxygen Utilization in Healthcare Settings

TOTAL ANNUAL OXYGEN USE IN U.S. HEALTHCARE

~2.0
BILLION CUBIC METERS
of oxygen per year



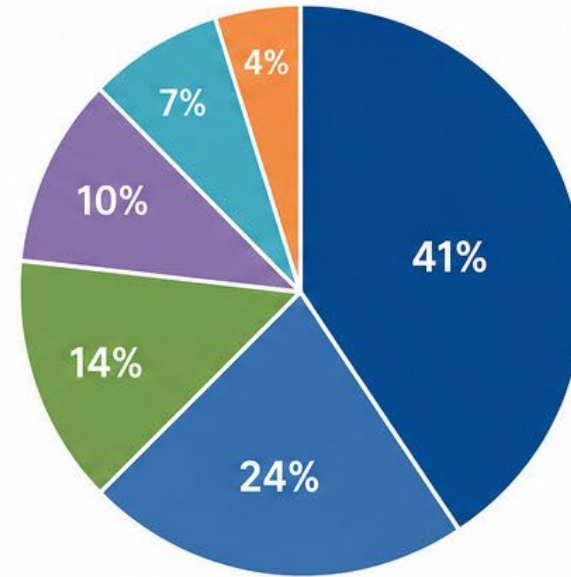
~1.1 BILLION m³ (55%)
On-site generated oxygen
(hospital PSA plants, cylinders,
liquid oxygen)



~0.9 BILLION m³ (45%)
Bulk and liquid oxygen
delivered to healthcare
facilities

Source: American Hospital Association (AHA),
EIGA, and industry estimates (2023)

DISTRIBUTION OF OXYGEN USE BY HEALTHCARE APPLICATION



- Respiratory Therapy (e.g., oxygen therapy, mechanical ventilation)
- Surgery & Anesthesia
- Critical Care
- Diagnostic Imaging (e.g., MRI, PET)
- Other Clinical Uses (e.g., hyperbaric therapy, emergency medicine)
- Other / Support Services (e.g., central supply, laboratories)

TYPICAL OXYGEN USE PER PATIENT



Low-Flow Oxygen Therapy
1–5 L/min
(Variable duration)



Mechanical Ventilation
10–80 L/min
(Continuous)



Anesthesia
0.5–10 L/min
(During procedure)



Oxygen is an essential medical gas used in virtually every area of healthcare, supporting millions of patients across the United States every day.

People in the United States Requiring Supplemental Oxygen



An estimated
1.5 MILLION
people in the United States
require supplemental oxygen.¹



Common Conditions Associated with Need for Supplemental Oxygen



Chronic Obstructive
Pulmonary Disease
(COPD)



Congestive
Heart Failure



Interstitial Lung
Diseases



Pulmonary
Hypertension



Other Chronic
Respiratory or
Cardiopulmonary
Conditions



As the population ages and
chronic diseases increase,
demand for supplemental
oxygen is expected to grow.

Sources:

- Centers for Medicare & Medicaid Services (CMS).
Home Oxygen Therapy (HOT) Reports.
- Make BJ, et al. *Respir Care*. 2020;65(5):614-627.

Estimates vary based on methodology
and population studied.

Cost of Supplemental Oxygen to CMS

Medicare (Fee-for-Service) Expenditures in the United States

\$2.5 BILLION

Total Estimated Medicare Expenditures in 2022
for Home Oxygen Therapy



Beneficiaries

~1.4 MILLION

Medicare beneficiaries receive home oxygen therapy



Per Beneficiary Per Year

\$1,800

Average reimbursement for home oxygen therapy supplies and equipment

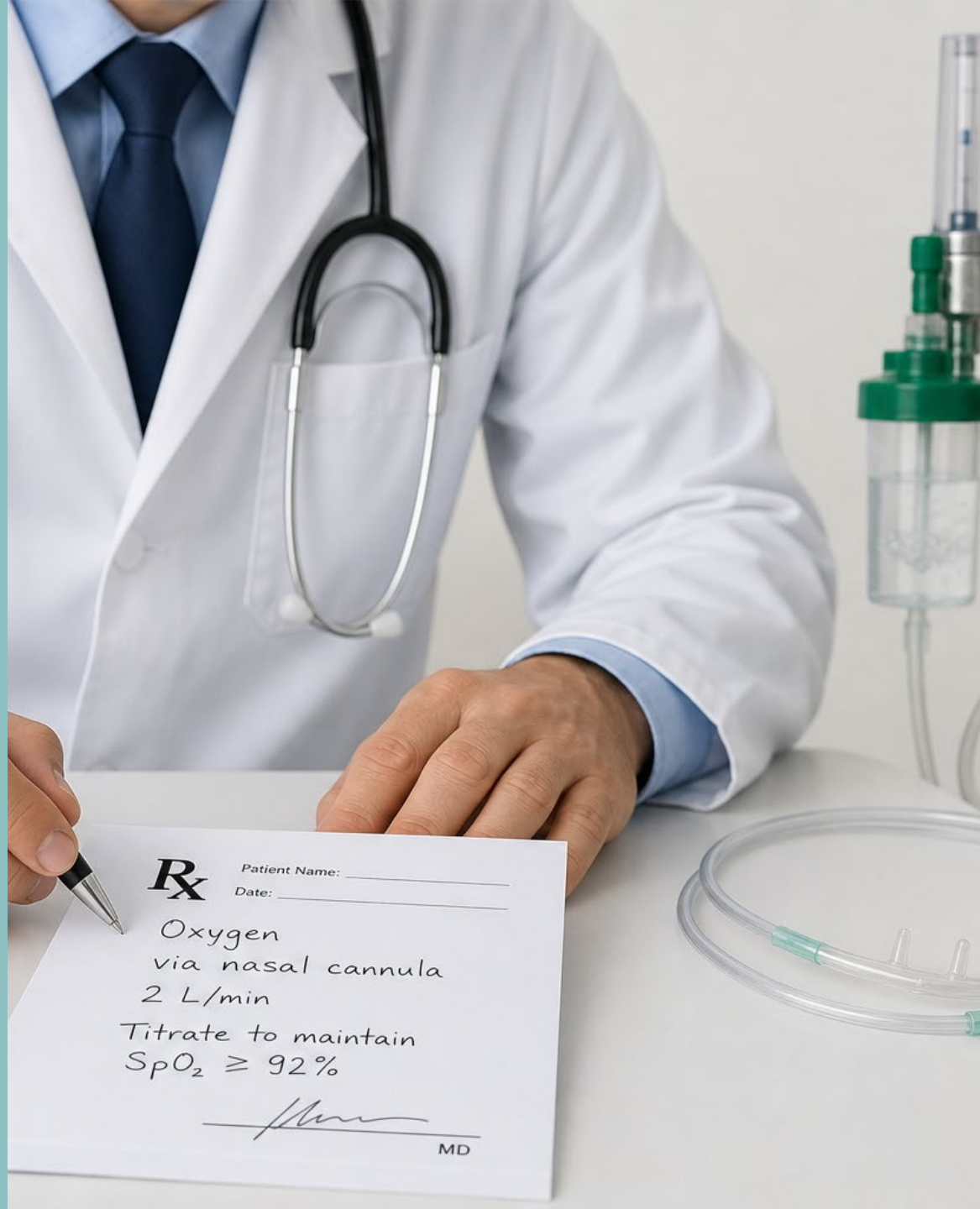


Percent of Total Medicare Spend

~0.5%

Of total Medicare Fee-for-Service expenditures

Source: Centers for Medicare & Medicaid Services (CMS), Office of Inspector General
Report: Home Oxygen Therapy (A-09-21-03001) | Data reflects 2022



O2 delivery: from MD order to patient

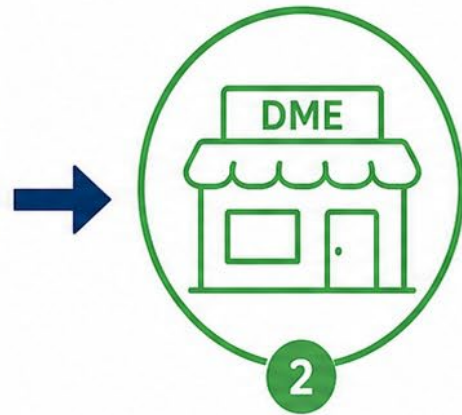
- Must meet criteria and submit according to specific format
- Dx limitations
- Needs to include type of equipment and use
- Pt. preference may not be always be achieved
- Delays are common

Barriers to Patient Access to Oxygen



INSURANCE BARRIERS

- Prior authorization requirements
- Limited coverage or restrictive policies
- Documentation and diagnostic criteria
- Delays in approval or denials



DME COMPANY BARRIERS

- Limited network providers
- Long wait times for setup or delivery
- Complex intake and paperwork processes
- Inconsistent communication and follow-up



SUPPLY SHORTAGES

- Limited availability of concentrators and tanks
- Backorders and delivery delays
- Geographic disparities in supply
- Equipment maintenance and repair delays



EDUCATION BARRIERS

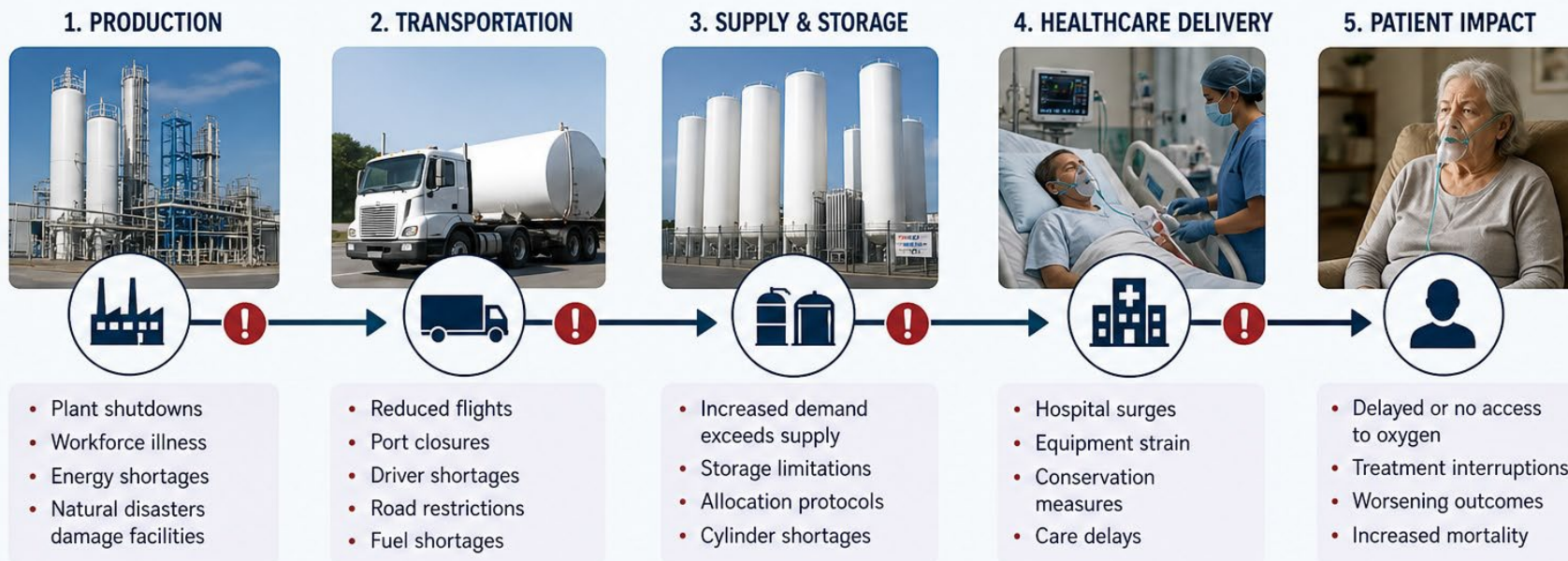
- Lack of patient understanding of need and benefits
- Unclear instructions on use and safety
- Low health literacy
- Limited follow-up education and support



These barriers can lead to delayed therapy, worse outcomes, and decreased quality of life.

OXYGEN DISRUPTIONS DUE TO PANDEMIC AND DISASTERS

Global crises can impact every step of the oxygen supply chain, leading to shortages, delayed delivery, and risk to patient care.



EXAMPLES OF DISRUPTIONS



PANDEMIC (e.g., COVID-19)

- Sudden, massive increase in oxygen demand
- Supply chain and manufacturing strain
- Export restrictions and global shortages
- Healthcare system overwhelmed



DISASTERS (e.g., Hurricanes, Earthquakes, Floods, Wildfires)

- Damage to production plants and infrastructure
- Power outages disrupt oxygen generation
- Transport and delivery interruptions
- Displacement of patients and providers

KEY TAKEAWAY



Resilient oxygen systems, emergency preparedness, and strong supply chains are critical to ensure continuous oxygen access during crises.

10 emergency preparedness tips for Oxygen users

- Keep doctor and durable medical equipment (DME) provider's info in your phone, wallet and carrying case at all times. The DME provider will be your source for oxygen replacement and will send out extra tanks when possible.
- Ask DME provider for a portable tank of oxygen to have on hand in preparation for a possible disaster.
- Regularly check the O2 gauge on your equipment to ensure you have enough in case of emergency.
- Inform the electric company of your need for DME equipment. In many areas, regional power outages can be limited to avoid your section. Discounts may also be available.
- The local police and fire departments may be able to provide emergency services or help restore power more quickly when power is lost.
- Tell your friends, family members and loved ones about your oxygen use so that they can assist you during power outages and other emergencies.
- Maintain a mini go-bag at all times with a small supply of your medications, nebulizers, cannulas and inhalers.
- Evacuate early. Most disasters result in some aspect of power limitation, poor air quality, and disruption of supply chains. Shelters, hotels and family members will have people and backup power to assist you.
- Make sure you have charged batteries for any portable device and consider purchasing an emergency generator, especially if you are in a remote location and assistance might be delayed in reaching you.
- Keep a flashlight handy by your bed.

    **2 patients die after brief disruption in oxygen supply at Doctors Community Hospital**

By FOX 5 Digital Team | Published 17 hours ago | Health | FOX 5 DC

LANHAM, Md. (FOX 5 DC) - Two patients have died after a temporary disruption in the oxygen supply to the Intensive Care Unit (ICU) and a non-critical care unit at Doctors Community Hospital Center in Lanham earlier this



The New York Times | <https://www.nytimes.com/2021/01/05/world/california-covid-oxygen-coronavirus.html>

[Virus Has Recently Infected 1 in 50 in England >](#)

As the coronavirus rages in California, L.A. medics are told to ration oxygen.

By Anushka Patil

Jan. 5, 2021

“A disaster is characterized by an imbalance between needs and supplies” B. Domres 2001

How do we "run out of oxygen"?

Sections  **The Washington Post** *Democracy Dies in Darkness* [Get one year for \\$29](#) ashadevereaup

Coronavirus Latest news U.S. map World map Vaccine tracker Symptoms Vaccine FAQ Coronavirus Living

Health

Los Angeles is running out of oxygen for patients as covid hospitalizations hit record highs nationwide

States in West and South have highest shares of residents hospitalized as Los Angeles hospitals turn away ambulances

1.8.21

The New York Times

MIDDLE EAST *Egypt Denied an Oxygen Failure Killed Covid Patients. We Found That It Did.*



OXYGEN LINE

FLATLINED MONITOR

Ahmed Nafei via Facebook

Egypt Denied an Oxygen Failure Killed Covid Patients. We Found That It Did.

For many Egyptians, a video offered a rare and uncensored view of the coronavirus's real toll at the peak of Egypt's second wave of the pandemic.

<https://www.nytimes.com/2021/01/18/world/middleeast/egypt-hospital-oxygen-covid.html>

1.18.21

Journal of Disaster Medicine and Public Health
Preparedness



onlinelibrary.wiley.com/doi/10.1111/dmp.12677

Articles in Disaster
Preparedness

Article: Devereaux AV, Backer H, Wright C, Christensen K, Rice K, Jakel-Smith C, Metzner M, Bains J, Staats K, Branson R, Pierce M, Noste E, Duncan D. Oxygen and ventilator logistics during California's COVID-19 surge: when oxygen becomes a scarce resource. *Disaster Medicine and Public Health Prep.* doi: <https://doi.org/10.1111/dmp.12677>

Keywords: ventilators; mass care; logistics; surge; COVID-19

Oxygen and Ventilator Logistics During California's COVID-19 Surge: When Oxygen Becomes a Scarce Resource

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▸ Icing of external hospital coils as demand increased.



LA County

Smaller and Older hospital systems



OXYGEN DEPOT ASSETS



Stake Bed Truck



DMSU-Disaster Medical Support Unit



Deployable Oxygen Concentration Systems

DOCS 120
(i.e produces 120 LPM O₂)



Hospital Oxygen Back-up Supply (HOBS)



DOCS 500

- ▶ Need O2 cylinders bed-cot side
- ▶ Monitor # of concentrators in use and distribute evenly throughout facility to minimize load.
- ▶ Power Outages due to load on circuits-Impacts both hospitals and ACS...ALWAYS anticipate power limitations



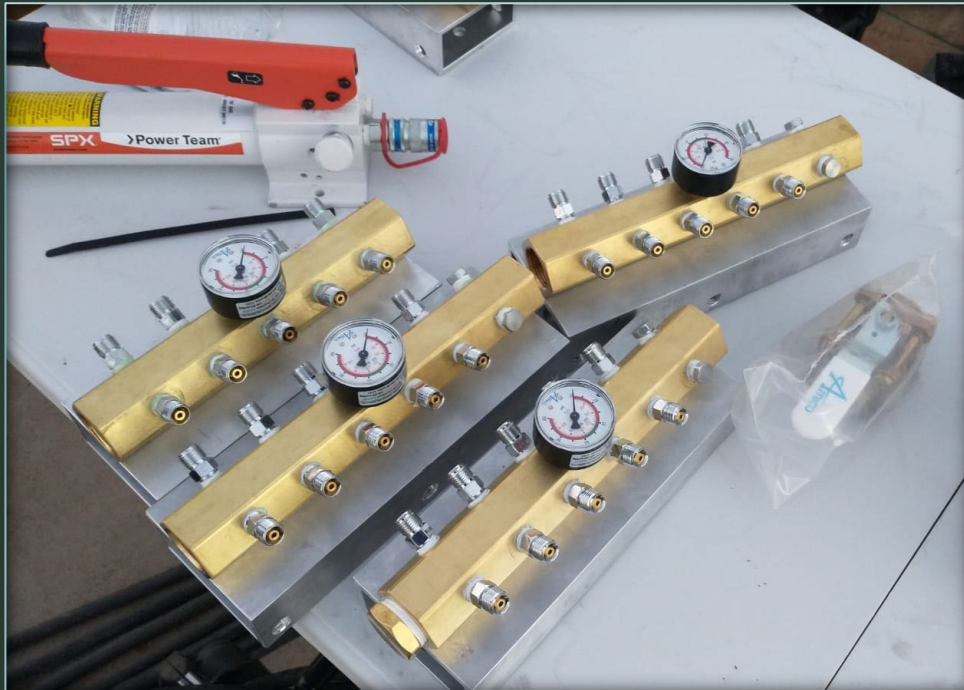
lege ACS 2021.



O2 Concentrators and equipment need frequent maintenance and repair



Many SNF, ACS, tents next to hospitals do not have access to LOX as it is mainly used in hospitals on the in-line wall system.

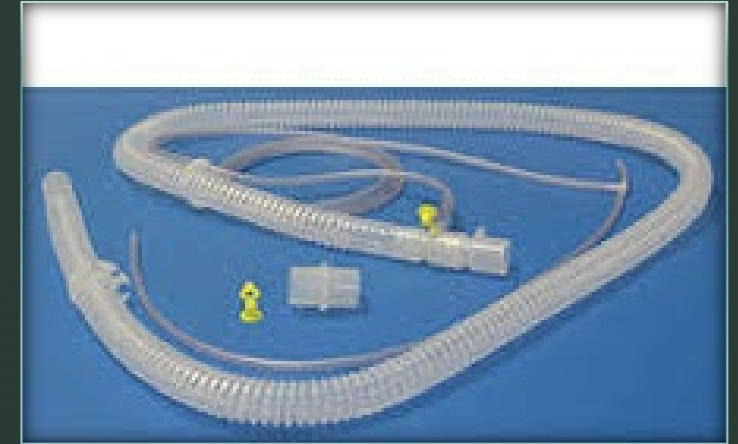


- LOX is readily available, can be placed where it is needed, and the lines can be plumbed to patient beds.

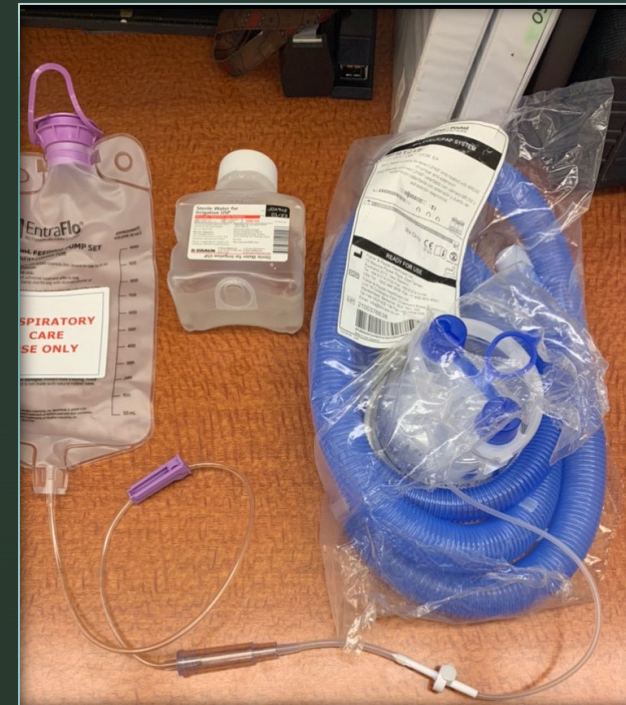
Hi-Flow and Bi-PAP circuits were consumed rapidly

- EMSA received HFNC tubing to distribute to hospitals

- Hospitals were running out and can order on allocation only



Shortage of sterile water for humidification for oxygen systems

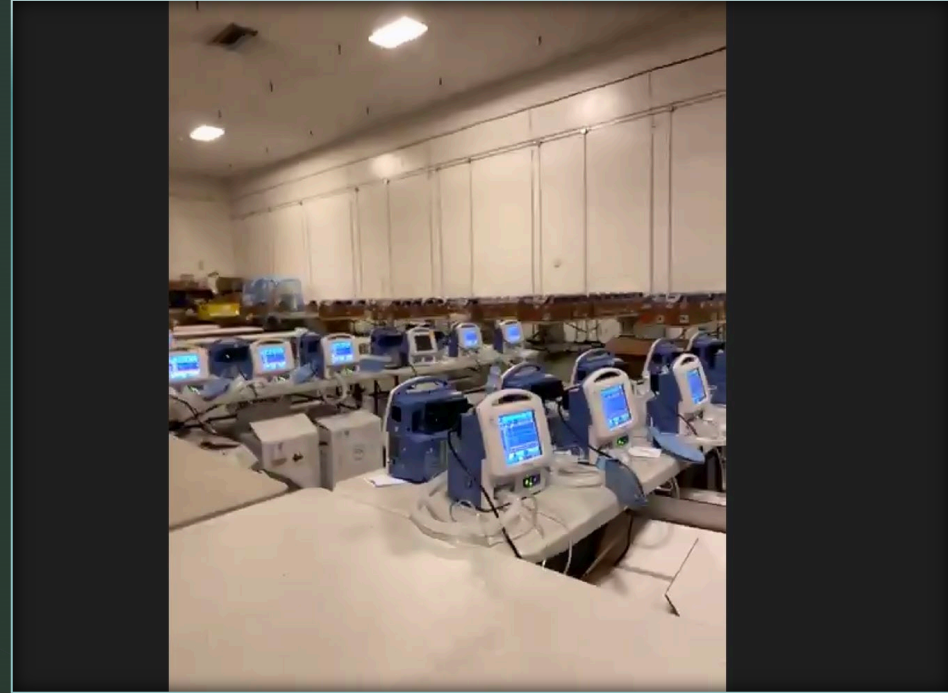


Ray Daniels RT-Sharp Coronado

Discharge O2 program – Calif. State purchased O2 concentrators

- A shortage of regulators was limiting this program. Some came from Minnesota.
- Remember to have keys ready
- Don't lay cylinders w/regulators on their side (break)





Ventilators ARE different and do require oxygen lines. Some older ventilators need an air source in addition to an oxygen line to blend the oxygen. Older hospitals do not have air hook ups at all beds, so they cannot use some older ventilators that do not have an internal blender



Oxygen Conservation strategies implemented

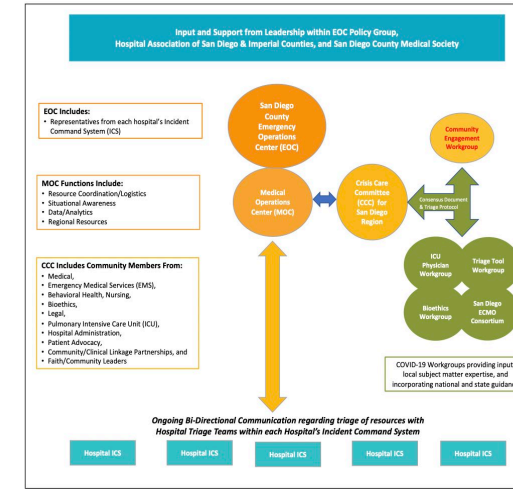


CAL-MAT/EMSA (2020-2021)

- 5 state ACS
- Largest fires in CA hx
- Deployed for nearly 18 months
- Cared for >2000 patients
- Transferred over 500 pts/1 month throughout state
- Deployed 2000 vents
- Oxygen Depot system created

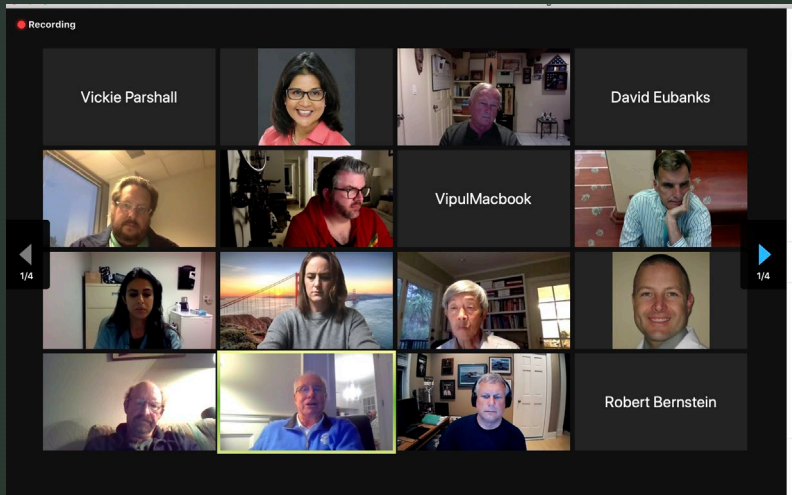
STATE

Figure 2: Organization Chart for Regionalization



DMPHP 9/2020 Devereaux et. al.

LOCAL



STATE ICUs Surge

Jan. 2021

OXYGEN CONSERVATION STRATEGIES

Surges of patients with COVID-19 have led to oxygen shortages in many hospitals.

How can we wisely conserve oxygen at the bedside while providing optimum patient care?

Hospital Interventions

Look for equipment leakages.



Anesthesia machines may have slow leaks if left plugged in when not in use; rooms may have piped-in oxygen that has been left on.

Use NIV or HFNC, not both



When possible, attempt to conserve circuits by using either HFNC or noninvasive ventilation on a given patient who does not immediately require invasive ventilation.

Use a mask over high-flow cannula to reduce O2 loss



Placing a mask (like an O2 facemask or a surgical mask) over HFNC will reduce loss, may improve oxygenation, and could have infection control benefits in Covid-19 patients.

Alternate Care Site Interventions

Use liquid oxygen (LOX).



The ratio by volume of LOX to non-compressed oxygen is 860:1, so a lot of LOX can be stored in a small space.



Use an Oxymizer to conserve oxygen.



Its higher luminal diameter and reservoir can deliver up to 15 LPM while using 1/2 of the oxygen from the tank.

Substitute distilled water for sterile water for humidification.



If sterile water is in shortage, the sterile water bottle can be filled with distilled water or sterile flush solutions instead.

Target conservative oxygen saturations.



Patients do not benefit from O2 saturations of >98%. Target 92-94% (rec 90%) for most patients.

Use one oxygen supply for multiple patients.



A Y-connector or an emergency manifold can connect multiple patients to a common cylinder or portable concentrator when necessary.

Contributors: Richard Branson, Chuck Wright, Arzoo Salami, Christian Sandrock, Dennis Amundson, Asha Devereaux, Ray Daniels, Howard Backer, Kate Christensen, Doug Orloff, and Jeffrey Dichter



NATIONAL Collaboration

Table 1. List of issues faced during the COVID-19 pandemic regarding oxygen and ventilators

Problems
1. Icing of external hospital liquid oxygen coils as demand increases due to patient volumes and increased HFNC use
2. Rapid consumption of oxygen from cylinders during transport of patients
3. Oxygen concentrators and equipment support at ACSs exhausted
4. Load on circuits and power outages required patient placement and oxygen (O ₂) use calculations
5. Discharge to home oxygen supply issues/bottlenecks
6. Vendors unable to provide re-supply of oxygen to hospitals
7. Durable medical equipment support was challenging: notably after hours, weekends, and holidays
8. Home oxygen services; maintenance of pre-existing structures and new patients
9. Sole-source suppliers and contracts unsupported due to multiple simultaneous demands from hospitals
10. Inability or limited capacity for transport of patients on HFNC systems
11. Shortages of oxygen regulators, tubing, and masks
12. Staffing shortages
13. Ventilators depleted at many hospitals
14. HFNC circuits, cannulae, and humidifiers were rationed (on allocation)
15. Sterile water for humidification depleted in the state

References and Resources

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THANK YOU!