

Medical News & Perspectives

Preparing Hospitals' Medical Oxygen Delivery Systems for a Respiratory "Twindemic"

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Regardless of whether another respiratory virus is surging across the US along with SARS-CoV-2—be it the influenza virus or respiratory syncytial virus (RSV)—experts again fear that a **twindemic** or possibly a **tridemic** could be in the making. Mirroring last year, **several hospitals** are reaching their tipping points, which begs the question: can they maintain an adequate supply of medical oxygen for patients experiencing respiratory distress?

Initially, "pediatrics was spared some of the oxygen allocation issues because it was only COVID—it wasn't RSV, it wasn't flu," Daniel Rauch, MD, chief of Pediatric Hospital Medicine at Tufts Children's Hospital, said in an interview. "Now, we're looking at all of them."

A **US surge in COVID-19 cases** after the Omicron variant emerged in autumn included **children**, who made up about 17% of new cases in early January, according to the American Academy of Pediatrics (AAP). And RSV cases—which often exhibit seasonal hikes during colder months and are the leading cause of infant **hospitalization** and **pneumonia** in the US—spiked **earlier than usual** this year and **continue to rise**.

Rauch, who also chairs the AAP's Committee on Hospital Care, is concerned that hospitals won't be able to accommodate everyone in need. "On any given day, we're asking... 'If we have a bed, who gets it? Are we going to accept a transfer, or someone from our emergency room? The adult side is bursting at the seams; are we going to take a young adult? How do we juggle the resource that we have the least of—which apparently, at this point, is capacity?'"

Winter is generally tough on hospitals, bringing with it **an influx of influenza cases**. Although influenza isn't typically a death sentence, it can result in **serious complications**, including pneumonia. According to the US Centers for Disease Control and Prevention (CDC), **it's especially dangerous for young children**.

Influenza cases in the US remained low last winter due to COVID-19-related social

distancing protocols. However, the **CDC warned of a resurgence** this year, **noting** that "reduced population immunity due to lack of flu virus activity since March 2020 could result in an early and possibly severe flu season"—which **has already commenced**. **Influenza vaccination among children is also lower** now than in previous years, while national **cases are increasing**. A **study** by University of Pittsburgh researchers not yet peer reviewed also warns of the risk to young children who likely have little immunity.



"We've had to do a lot of planning and purchase equipment in advance to make sure that we're ready for the [influenza] surge—we do anticipate it coming," Cheryl Adams, LRT, MS, manager of Respiratory Care Services at Children's Minnesota, said in an interview. "Usually, we get our RSV season and our flu season, then you throw in COVID, and it could really be the perfect storm."

According to the **World Health Organization**, lower respiratory tract infections were cumulatively the fourth leading cause of death across the globe in 2019. And a **JAMA article** that analyzed CDC mortality data found that influenza and pneumonia

have been among the 10 leading causes of death in the US since 2015. Then SARS-CoV-2 came onto the scene; the CDC ranked COVID-19 as the **third most lethal condition in the country during 2020**.

Adams said that children hospitalized with COVID-19, RSV, influenza, or pneumonia almost always require supplemental oxygen. But many hospitals find it extraordinarily difficult to handle the current number of patients requiring oxygen therapy—assuming the facilities even have the necessary equipment.

Demand Exceeds Supply

In August, the **Florida Hospital Association (FHA)** reported that 68 Florida hospitals had less than a 2-day supply of medical oxygen for all patients in need.

"It was alarming," FHA President and CEO Mary Mayhew said in an interview. "You had **a number of states** at the exact same time dealing with an unprecedented spike in COVID hospitalizations...along with an extremely high volume of critically ill non-COVID patients who also needed a significant volume of oxygen."

On top of that, distribution companies struggled to find **qualified drivers**. The US Department of Transportation considers medical oxygen a **hazardous material**, meaning that **truck drivers delivering it require special training**.

"When a hospital received their distribution, it was less than what they normally would have received, so they were burning through it faster and were more dependent on more frequent deliveries," Mayhew said.

Rich Craig, MBA, vice president of Technical and Regulatory Affairs at the Compressed Gas Association (CGA), echoed Mayhew's sentiments about the supply-chain conundrum. "There's no oxygen shortage; there are plenty of oxygen molecules around," he said in an interview. "I would call it a supply-chain tightness."

Medical oxygen in US hospitals is often sourced from **cryogenic plants**, which distill air at approximately -300°F . The result is

99% pure oxygen—at minimum—in liquid form. According to Craig, “plants are typically no more than 300 miles from their use points” so that the oxygen doesn’t vaporize before it’s delivered. However, “in Florida over the summer, they were delivering product from 500, 600, 700 miles away just to make sure that it was getting there in the quantities that were needed.”

But even if hospitals project a higher-than-usual demand for medical oxygen, there’s only so much they can store. “It’s not like gloves and masks where you buy a lot and put it on a shelf,” Craig said.

Once liquid oxygen reaches a hospital, it’s transferred into storage tanks where it’s vaporized and distributed to patients throughout the facility via an internal piping system. But tanks can only hold so much oxygen. Thus, even with adequate oxygen availability from manufacturing plants, hospitals can’t stockpile a surplus.

Retrofit for the New Normal

Not all hospitals were designed to support the high-flow oxygen needed during peak COVID-19 surges, so some have retrofitted their delivery systems. Oxygen overload may result in the oxygen becoming too cold for pipes and breaking them, especially in older buildings. Then there’s the upgrade itself. Craig mentioned that installing a new tank and vaporizer system may be challenging, because the old system can’t be out of service and removed until the new one is operating.

So why didn’t hospitals originally install larger tanks? Craig said it’s because tank sizes were based on projected demands—and since the pandemic began, the demands have been far greater than anticipated.

“COVID is going to be around for a while,” he noted. “Systems may need to be redesigned or reconfigured to address what everyone calls the new normal.”

In January 2021, the US Army Corps of Engineers began work to update oxygen delivery systems in Los Angeles hospitals when the inability to accommodate COVID-19 oxygen needs with aging equipment became dire.

And patients with COVID-19 use a lot of medical oxygen. For those with hypoxemia, the US National Institutes of Health recommends high-flow nasal cannula (HFNC) oxygen therapy. Standard delivery of oxygen via the nasal cannula is typically prescribed at or below 5 L per minute. Whereas many patients requiring HFNC

oxygen vary in flow rate, those with severe COVID-19 may use up to 60 L per minute routinely. To prevent intubation, some clinicians have reported using up to 200 L per minute, which accelerated rationing protocols in some hospitals.

When Less Is More

Back at Children’s Minnesota, Adams’ greatest concern isn’t a lack of oxygen but rather a scarcity of related apparatuses, such as ventilators. “Last year, we could rent equipment, it was readily available. This year, it’s a struggle.” Shipping delays and backorders have compounded the stress, she added, on top of an influx of patients with respiratory illnesses.

COVID-19 has overwhelmed Minnesota’s hospitals to the point where health care providers from across the state—including Children’s Minnesota—published a newspaper ad in mid-December that beseeched the public to get vaccinated. Furthermore, Minnesota saw an uptick in RSV cases a few months ago that still lingers.

“Children are wonderful, they share a lot of things,” Courtney Herring, MD, MHA, a pediatric hospitalist at Children’s Minnesota, said in an interview. “They’re also good at sharing viruses and disease.” Especially of the respiratory variety.

To ensure that every patient who needs supplemental oxygen gets it, Herring has aided efforts to optimize inpatient respiratory care—and high-flow therapy is a major component. Because it’s most effective when not approached as a one-size-fits-all intervention, Herring and an interdisciplinary team of clinicians met in mid-2020 during the COVID-19 pandemic to reevaluate their oxygen delivery methods.

Prepandemic, HFNC oxygen rates were often based on a child’s weight. However, research published in *Hospital Pediatrics* found a nationwide increase in HFNC oxygen use without significant improvement in hospital outcomes for bronchiolitis. Herring said her team believes there are better ways of determining not only flow rate, but also whether supplemental oxygen is even necessary. For example, Herring said, it’s important to assess physiological responses, such as whether a patient is experiencing respiratory distress or even hypoxemia, and to define those responses by standardized clinical measures.

Rauch agrees. “Just because a child’s oxygen saturation is a bit low doesn’t mean

they need supplemental oxygen,” he said. “It’s hard to not do things, but we have to remember [the] negative of overtreatment, and hopefully, if we give the right treatment for the right amount of time, we’ll be able to deal with the surges that we’re anticipating.”

Although the pandemic was the impetus for oxygen optimization at Children’s Minnesota, it also threw a wrench into finalizing the new guidelines this year. High patient volume and staffing shortages left little time for anything except round-the-clock care.

“Our pediatric [intensive care units] have been full,” Herring said, noting that Children’s Minnesota doesn’t turn away patients and often places them in units wherever there are unoccupied beds. “At the same time, we’re adapting how we push the limits of what our current guidelines are in regard to flow rates from a nasal cannula standpoint, [and] it’s been necessary to care for patients with escalated respiratory needs.”

Their efforts have paid off. Despite the high volume of patients at Children’s Minnesota, neighboring hospitals have been struggling even more, to the point where no beds were available. So, Children’s Minnesota began admitting adults—many of whom required supplemental oxygen.

“We were taking patients up to 30 years [old], trying to alleviate some of the overflow from our adult counterparts in the Twin Cities,” Herring said. “We had a lot of room to optimize how we look at physiologically supporting patients with respiratory disease, whether it be in our neonatal range or our adult patients.”

Reevaluating and Revising

Children’s Minnesota isn’t alone in reexamining guidance for oxygen delivery systems. The CGA has published guidance for increasing flow rates via existing systems while also ensuring such upgrades don’t fail or become hazardous. On finding that Florida hospitals needed more medical oxygen, the FHA also followed up with oxygen conservation strategies. But deciding how much oxygen each facility requires is less centralized.

Rauch said that US hospitals don’t have national guidelines outlining how much oxygen to retain—they often estimate needs based on annual patterns and attempt to predict whether winter will come with an especially high surge of certain respiratory cases.

"Our guesstimates are really guesses this year, and we have all the supply-chain issues, so if you're wrong and you've undercounted, it's hard to get stuff," Rauch added. "I'd rather be prepared for lots of bad things coming and have them not happen than prepare for nothing coming and be inundated ...[but] we're trying not to fall back into bad habits of overutilizing resources."

Reassessment of medical oxygen delivery is gaining traction worldwide. [The Bureau of Investigative Journalism reported](#) that several countries—many across Asia and South America—experienced severe shortages of medical oxygen in 2021. PATH, a nonprofit dedicated to global health equality,

was on the frontlines of [getting oxygen supplies to patients with COVID-19 in India](#) as cases flooded the country. To help low- and middle-income countries, [PATH has developed a toolkit](#) on how to determine their oxygen-supply needs. Lisa Smith, MPH, MSW, director of PATH's COVID-19 Respiratory Care Response Coordination project, said that the nonprofit has seen other countries focus intensely on strengthening their delivery systems. For example, Malawi drafted a governing strategy during the pandemic that includes [an oxygen roadmap](#); [Ethiopia](#) and [Nigeria](#) conceived similar plans before COVID-19 existed.

"The pandemic created its own unique challenges that these countries had to re-

spond to, but their health systems were able to react in thoughtful ways," said Smith, who manages a grant awarded to PATH from the Bill & Melinda Gates Foundation for COVID-19 respiratory care response coordination. "They understand how critical oxygen is, and they understand how challenging it is to provide it reliably, so they have responded quickly and comprehensively."

Despite the stressful conditions, hospitals have made progress. "[F]rom all of this has emerged further refinement of best practices and appropriate management of oxygen use within the hospital," Mayhew said. ■

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