# Personalized oxygenation could improve outcomes for patients on ventilators

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Supplemental oxygen is among the most widely prescribed therapies in the world, with an estimated 13 to 20 million patients worldwide requiring oxygen delivery by mechanical ventilation each year.

Mechanical ventilation—a form of life support—is a technology that moves breathable air into and out of the lungs, acting like a bellows. Ventilators have moved far beyond the "iron lung" machines some people might picture; now, apparatuses have progressed to sophisticated, compact digital machines that deliver oxygen through a small plastic tube that goes down the throat.

Despite technological advancements, the correct amount of oxygen to deliver to each patient has remained a guessing game. Clinicians prescribe oxygen levels by using devices that record $SpO_2$ saturation, which measure the amount of oxygen in a patient's blood. However, prior research has been unable to establish whether a higher or lower $SpO_2$ target is better for patients.

"The standard of care is to maintain oxygen saturation between 88 and 100; within that range, doctors have had to choose an oxygen level for ventilation without having high-quality data to inform their decision-making," said Kevin Buell, MBBS, a pulmonary and critical care fellow at the University of Chicago Medicine. "Whether we like it or not, making that decision for each patient exposes them to the potential benefits or harms of the chosen oxygen level."

To take the guesswork out of ventilation, Buell and a group of other researchers used a machine learning model to study whether the effects of different oxygen levels depend on individual patients' characteristics. The results, published in *JAMA*, suggest that personalized oxygenation targets could reduce mortality—which could have far-reaching impacts on critical care.

Previously, some research groups conducted randomized trials to investigate whether higher or lower oxygen levels are better for patients overall, but most produced no clear answer. Buell and his collaborators hypothesized that instead of indicating that oxygen levels don't affect patient outcomes, the neutral results might indicate that the treatment outcomes for different oxygen levels varied by patient and simply averaged to zero effect in randomized trials.

As personalized medicine continues gaining traction, there is a growing interest in using machine learning to make predictions for individual patients. In the context of mechanical ventilation, these models could potentially use specific patient characteristics to predict an ideal oxygen level for each patient. These characteristics included age, sex, heart rate, body temperature and reason for being admitted to an Intensive Care Unit (ICU).

"We set out to create an evidence-based, personalized prediction of who would benefit from a lower or higher oxygen target when they go on a ventilator," said Buell, a joint first author on the study.

Those previous randomized trials didn't go to waste—Buell and his collaborators used data from those studies to design and train their machine learning model. After the model was developed using trial data collected in the U.S., the collaborators applied it to data from patients across the world in Australia and New Zealand. For patients who received oxygenation that fell within the target range that the machine learning model predicted to be beneficial for them, mortality could have decreased by 6.4% overall.

It's impossible to generalize predictions based on a single characteristic—for example, not all patients with brain injuries will benefit from lower oxygen saturation even though the data skew in that direction—which is why clinicians need a tool like the researchers' machine learning model to piece together the mosaic of each patient's needs. However, Buell pointed out that although the algorithm itself is complicated, the variables health care teams would input are all familiar clinical variables, making it easy for anyone to implement this kind of tool in the future.

At UChicago Medicine, health care teams can already use algorithms directly integrated into the electronic health record (EHR) system to inform other areas of clinical decision-making. Buell hopes mechanical ventilation can one day function the same way. For hospitals that might not have the resources to integrate machine learning into an EHR, he even envisions creating a web-based application that would allow clinicians to type in patient characteristics and obtain a prediction that way—like an online calculator. A lot of validation, testing and refinement must happen before clinical implementation can become a reality, but the end goal makes that future research well worth the investment.

In an editorial that accompanied the article's publication, critical care expert Derek Angus, MD, wrote, "If the results are true and generalizable, then the consequences are staggering. If one could instantly assign every patient into their appropriate group of predicted benefit or harm and assign their oxygen target accordingly, the intervention would theoretically yield the greatest single improvement in lives saved from critical illness in the history of the field."

**More information:** Study: Kevin G. Buell et al, Individualized Treatment Effects of Oxygen Targets in Mechanically Ventilated Critically Ill Adults, *JAMA* (2024). DOI: 10.1001/jama.2024.2933

Editorial: Derek C. Angus, Your Mileage May Vary, *JAMA* (2024). DOI: 10.1001/jama.2024.0972