

Ventilators and COVID-19: what you need to know

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The COVID-19 pandemic has cast a spotlight on ventilators—but few know much about what they do or how they work.

A [ventilator](#) pumps air—usually with extra oxygen—into [patients'](#) airways when they are unable to breathe adequately on their own. If [lung function](#) has been severely impaired—due to injury or an illness such as

COVID-19—patients may need a ventilator. It is also used to support breathing during surgery.

Ventilators, also known as life-support machines, won't cure an illness, but they can keep patients alive while they fight an infection or their body heals from an injury.

Yale Medicine's Lauren Ferrante, MD, MHS, a pulmonary and critical care specialist, explains how ventilators work and why they are sometimes necessary for battling a COVID-19 infection.

How does COVID-19 affect the lungs?

There is much researchers still don't understand about COVID-19, but we do know that many who are infected with the novel [coronavirus](#) get a fever, cough, and sore throat, among other symptoms.

If the body's immune system does not fight off the infection, it can travel to the lungs and cause a potentially fatal condition called [acute respiratory distress syndrome](#) (ARDS). In ARDS, the alveoli (tiny air sacs that allow oxygen to reach the [blood stream](#) and remove carbon dioxide) fill with fluid, which diminishes the lungs' ability to provide vital organs with enough oxygen.

"ARDS entails severe inflammation of the lungs, but the main problem is that it makes portions of the lungs unusable," Dr. Ferrante explains. "It can be very serious, and many of these patients will need to be on a ventilator."

How does a ventilator work?

Normally, when someone takes a breath, their chest wall expands, which

creates [negative pressure](#) (i.e., a vacuum) inside the lungs that draws air in. When a person is sick and weak and can't pull the breaths in on their own, a ventilator creates positive pressure that forces air into the lungs.

A ventilator is typically used in a hospital's intensive care unit (ICU), though those who need it for a longer period of time may be in a different part of the hospital, at a rehabilitation facility, or even at home.

The first step in putting a patient on a ventilator is general anesthesia. Then, a medical professional will place a tube into the mouth or nose and snake it into the windpipe. This is called intubation.

The tube is connected to an external machine that blows air and oxygen into the lungs. The machine can help do all or just some of the breathing, depending on the patient's condition. The ventilator can also help hold the lungs open so that the air sacs do not collapse.

While patients are on a ventilator, doctors will monitor their heart and respiratory rates, blood pressure, and oxygen saturation. Other tests, such as X-rays and blood draws, may be done to measure oxygen and carbon dioxide levels (sometimes called blood gases).

What is it like to be on a ventilator?

The goal is for patients to be awake and calm while they are on a ventilator, but that can sometimes be difficult; many require light sedation for comfort, Dr. Ferrante says.

"Sometimes, patients develop delirium, or an acute state of confusion. And when patients become confused, they might try to pull out their endotracheal tube, which connects them to the ventilator," she says.

"Patients with delirium can be lucid one moment and confused the next. Although we try to avoid sedation as much as possible, particularly in

delirious patients, we may have to give some sedation to prevent people from causing self-harm, like pulling out the breathing tube."

Furthermore, patients with ARDS often feel a natural instinct to take in very big breaths, Dr. Ferrante adds. "Very large breaths can be harmful to an ARDS patient's lungs, so we try to have their breath size match what we have set on the ventilator," she says.

Typically, most patients on a ventilator are somewhere between awake and lightly sedated. However, Dr. Ferrante notes that ARDS patients in the ICU with COVID-19 may need more heavy sedation so they can protect their lungs, allowing them to heal.

What is prone positioning?

As doctors have gained more experience treating patients with COVID-19, they've found that many can avoid ventilation—or do better while on ventilators—when they are turned over to lie on their stomachs. This is called prone positioning, or proning, Dr. Ferrante says.

"Instead of lying on your back, we have you lie on your belly. Because of how the lungs are positioned, this lets you use parts of your lungs that aren't being used when you are on your back," she explains, adding that it reduces pressure from the heart and diaphragm on the lungs. "Often, we see oxygenation improve quickly. We are using this a lot for COVID patients on a ventilator, and for those who are in the hospital on oxygen. It can help COVID patients from needing the ventilator."

How long does someone typically stay on a ventilator?

Some people may need to be on a ventilator for a few hours, while others may require one, two, or three weeks. If a person needs to be on a

ventilator for a longer period of time, a tracheostomy may be required. During this procedure, a surgeon makes a hole in the front of the neck and inserts a tube into the trachea. The tube is connected to the ventilator.

The tracheostomy tube is inserted below the vocal cords, making it difficult to talk. As patients are weaned from the ventilator, they can start to talk again, using a device called a speaking valve.

Most tracheostomies are not permanent; they are often used to help wean a patient off a ventilator after [long-term use](#), Dr. Ferrante says. However, not everyone will be able to come off a ventilator and breathe successfully on their own—and that reality can prompt important discussions for families, Dr. Ferrante says.

"Many people may be okay with being on the ventilator for a few weeks, trying to get better from an acute illness, but they may not be willing to stay on a ventilator permanently," she says. "Many find that unacceptable. This is why it is good for patients and their families to have advance care planning discussions."

How does someone come off a ventilator?

A patient can be weaned off a ventilator when they've recovered enough to resume breathing on their own. Weaning begins gradually, meaning they stay connected to the ventilator but are given the opportunity to try to breathe on their own.

"When someone is on a ventilator, especially with COVID-induced ARDS, they are often on very high levels of support," Dr. Ferrante explains. "As you improve, the support comes down to what we call 'minimal vent settings,' meaning you don't need a lot of oxygen through the ventilator, and you don't need higher pressures."

When a certain threshold is reached, doctors will have patients try daily spontaneous breathing trials. "The way we test is by having you breathe for 30 minutes on your own while still connected to the ventilator," she says. "There are certain numbers we track to let us know if you have passed the spontaneous breathing trial. You also have to be awake and, ideally, interacting with us."

When those milestones are achieved, the doctors may decide to try taking the patient off the ventilator for a trial. If it's not successful, weaning can be attempted another time.

For patients with acute respiratory or cardiopulmonary failure, another therapy called ECMO (extracorporeal membrane oxygenation), may be necessary. ECMO is a highly specialized form of life support that can take over the work of the heart and lungs, allowing them to rest and heal.

What are the risks of being on a ventilator?

There are risks associated with ventilator use. "It's not natural to have positive pressure forcing air into your lungs," Dr. Ferrante notes. "But a big part of our training as critical care physicians is on the proper use of a ventilator, so that we're giving a patient as much benefit as possible while also minimizing harm."

Infection is one potential risk associated with being on a ventilator; the breathing tube in the airway can allow bacteria to enter the lungs, which can lead to pneumonia. A ventilator can also damage the lungs, either from too much pressure or excessive oxygen levels, which can be toxic to the lungs.

Delirium is another concern, and fits in with what is called post-ICU syndrome (PICS), a collection of problems that can present—and linger—after a critical illness.

With a critical illness, and particularly with ventilator use, "the three domains we worry about are impairments in physical function, cognitive function, and mental health," Dr. Ferrante says, adding that the lack of movement during hospitalization can present other challenges after a patient is discharged.

"It can take months to recover," she explains. "Continuing physical therapy and occupational therapy after you go home is very important." (At Yale New Haven Hospital, an ICU-based mobility program has physical and occupational therapists working with patients to get them moving, even while they are on a ventilator.)

Dr. Ferrante says that older patients, in particular, are likeliest to experience a decline in their physical and cognitive function. "ICU survivors may feel like their thinking and processing isn't as quick as it was before they were in the ICU," she says. "When you take someone out of their home environment, put them in an unfamiliar place, and give them medications they don't normally take, it can put them at a higher risk for delirium. And if they experienced delirium or needed sedatives in the ICU, that may lead to cognitive problems after an ICU stay. Patients may also experience mental health issues, such as PTSD [post-traumatic stress disorder]."

Nonetheless, ventilators can be life-saving and, indeed, many of those who've survived severe cases of COVID-19 would be unlikely to have made it without one.

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