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# Ventilators are key to preventing coronavirus deaths —but does the world have enough of them?

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For some critically-ill COVID-19 patients, mechanical ventilation can be the difference between recovery and death.

Ventilators assist or replace respiratory functions, pumping oxygen into the blood for vital organs. They are "the main supportive treatment" for patients in the critical stage of COVID-19, when the mortality rate is 61.5%, a Feb. 24 *Lancet* medical journal [study](#) found from a sample of 52 patients in a hospital in Wuhan.

In China, where the coronavirus first hit and the most cases have occurred, 6.1% of all patients became critically ill, while 5% required medical ventilation in intensive care, according to data from the [World Health Organization](#).

But this life-saving equipment—and the trained specialists who operate it—are in finite supply.

On Monday, U.S. President Donald Trump alluded to the need for more of the

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devices, telling [state governors](#) they should obtain "respirators, ventilators, all of the equipment" themselves. "[The federal government] will be backing you," he said, "but try getting it yourselves."

Most hospitals' intensive care units or ICUs have enough ventilators to meet demand in a regular flu season but don't have extras in case demand suddenly jumps. A surge of COVID-19 infections in the U.S.—there were over 4,400 as of Monday—has experts worried that cases could overwhelm hospitals there and force doctors to implement triage systems to decide who gets ventilation treatment and who doesn't. In Italy, where there are too few ventilators, doctors are [already grappling](#) with this grim reality.

## Countries try to cope

Critically-ill coronavirus patients require invasive mechanical ventilation. A tube is inserted into a patient's windpipe to provide lungs with oxygen and flush out carbon dioxide, ensuring that oxygen circulates in the blood so respiratory failure and organ failure do not occur.

Because these ventilation devices are reserved for patients at the most serious stage of illness—when their lungs stop supporting them—the equipment is housed in hospitals' ICUs.



Dr. Karina Glick at Samson Assuta Ashdod University Hospital in Israel gives a press presentation of a ventilator that can treat future coronavirus patients on March 16, 2020.

JACK GUEZ—AFP VIA GETTY IMAGES

ICU ventilators are bulky and expensive, so hospitals usually don't have a surplus. A Medtronic ICU ventilator can cost between \$25,000 and \$50,000, according to the company's [website](#). One ICU ventilator manufactured by Germany company Draegerwerk [weighs](#) close to 130 pounds, including its wheeled trolley.

Italy has [3,000 ventilators](#), and it appears that's not enough, as hospitals are being forced to triage the rising number of critical cases. Total cases in Italy neared 28,000 on Tuesday, and almost 2,200 people have died, the second-highest number of deaths after China, where 3,200 have passed away.

Italy may have less than a quarter of the ventilators necessary to meet demand, Reuters [reported](#) on Saturday. It tendered for 5,000 ventilators; a spokesperson for medical technology company Getinge told Reuters that "a mix" of companies would likely fill Italy's order because no one company could do it alone.

The Italian [government also asked](#) the country's sole ventilator manufacturer, Siare Engineering, to increase production from 125 ventilators a month to 500 per month.

There's worry at the WHO that Iran is also critically low on ventilators. A WHO official said in early March that doctors and nurses in Iran were concerned they did not have enough medical equipment, including ventilators, to treat patients. Iran has one of the highest numbers of COVID-19 cases in the world at nearly 15,000, even before taking into account the [concerns](#) that cases are going unreported.

Some companies that supply ventilators have stopped deliveries to Iran because banks are refusing to carry the payments, the *Wall Street Journal* [reported](#). U.S. government sanctions on Iran do not directly apply to humanitarian aid, but many banks do not want to facilitate payments to Iran, [hindering](#) its ability to purchase life-saving medical equipment like ventilators.

U.K. Prime Minister Boris Johnson on Monday [urged](#) manufacturing firms and even carmakers like Jaguar to mobilize to produce as many ventilators as possible. The U.K. has 5,000 ventilators but will need "many times more than that" if cases continue to rise, the health secretary [said](#).

## A stockpile in the U.S.

The U.S. had enough ventilators to meet demand during the swine flu outbreak of 2009 and 2010, [a report from the Centers for Disease Control and Prevention said](#), but the number of patients who required them then was no greater than recent seasonal flu numbers.

One 2015 [study](#) published in the *Disaster Medicine and Public Health Preparedness* journal found that a maximum of 135,000 ventilators could be put to use in the U.S. in the event of a public health crisis. The estimate was based on the number of ICU beds, ventilators in hospitals, and respiratory therapists.

The 135,000 estimate would meet demand during a moderate outbreak like the 1958 or 1968 flu pandemics, wherein 65,000 people would need ventilation, according to a 2018 [analysis](#) by the Johns Hopkins Center for Health Security (JHCHS).

Included in that total is the U.S.'s [Strategic National Stockpile](#) or SNS of medical resources, first launched in 1999 as a precaution against bioterrorism threats. An [estimated](#) 10,000 ventilators are in that reserve. (The official number is not publicly disclosed.) Health care facilities can request supplemental ventilators from the stockpile through local and state public health departments; state governors then request federal assistance. A

spokesperson for SNS said the agency is not able to discuss "specific requests for products at this time."

But even that additional supply "might not suffice to meet demand during a severe public health emergency," the CDC said in a white paper three years ago.



New ventilators are seen at the Columbus Covid2 Hospital on March 16, 2020 in Rome, Italy. Patients infected with COVID-19 have inundated the country's health care system.

MARCO DI LAURO—GETTY IMAGES

If COVID-19 reaches the level of a severe outbreak—like the 1918 pandemic, in which 675,000 Americans died—the JHCHS study estimates that 742,500 people in the U.S. would need mechanical ventilation, far outstripping the health system's estimated capacity.

"It is most likely that in areas [of the U.S.] where COVID-19 infections are widespread, hospitals will not have enough ICU beds and ventilators to treat all of the critical cases," said Timothy Lant, one of the authors of the 2015 study.

The virus's spread in the U.S. is still unclear due to the continued lack of testing, Lant said. "There are many, many people with cold, flu, and COVID symptoms that are not being tested still," he said.

Areas with apparent widespread community transmission— Washington State, New York, Boston, and California—as well as other places where infections may be going undetected, "will see shortages," Lant said. "[T]hings are likely to get worse day by day."

Some states, like Minnesota, have existing "crisis standards of care" for public health crises, outlining ways to allocate ventilators to patients based on health status and age. Such directives provide guidance on how doctors should confront the kinds of triage scenarios hospitals in Italy are dealing with right now.

"The biggest, most dreadful thing we might face is rationing or triaging who gets ventilators," Gabe Kelen, the director of the Office of Critical Event

Preparedness at Johns Hopkins University, [told](#) the *New York Times*.

In the [early days](#) of the outbreak in Wuhan, China, the health care system was [overwhelmed](#), and ventilators were in short supply. [As a result](#), the death rate in Hubei Province, where Wuhan is located, was higher than the rest of China.

Should a "Wuhan-like" outbreak occur in the U.S.—with a city seeing the same share of infection and critical cases as the epicenter of the outbreak—ICU needs could exceed hospital capacity, even with social distancing measures as strict as the lockdown in Wuhan, says a recent [study](#) by researchers at Harvard University, Johns Hopkins University, and Nanjing Medical University.

"Exceeding health care capacity may also lead to decreased quality of care, such as not being able to get access to a ventilator," which would lead to more deaths, the study said.

In a Fox News television interview last week, Seema Verma, the administrator of the Centers for Medicare and Medicaid Services and a member of the federal coronavirus task force, [would not say](#) whether the U.S. has enough ventilators and ICU beds for a surge in cases. When host Martha MacCallum asked Verma if she could assure Americans that there is no shortage of the supplies, Verma dodged the question.

"That is why the president has taken such a bold and decisive action," Verma responded, citing "mitigation strategies" like the travel restrictions on Europe, with no mention of ventilators.

## A shortage of specialists

The absolute number of ventilators is one concern amid the outbreak; another is the number of workers trained to operate them.

The 2015 study Lant coauthored found respiratory therapists to be the "limiting resource" that capped ventilator availability in the U.S. at the estimated 135,000.

"As these individuals are in front of patients with COVID-19, they are likely to get sick too, so that [ventilator] may not be able to be used due to health care workforce shortages," Lant said.

There are currently around 150,000 licensed respiratory therapists in the U.S., said Timothy R. Myers, chief business officer for the American Association of Respiratory Care. It's one of the fastest-growing professions in the U.S., with a projected employment growth rate of 21% between 2018 and 2028, compared to the 5% average for all occupations, according to [data](#) from the U.S. Bureau of Labor Statistics.

In the U.S., respiratory therapists require an associate's degree from an accredited respiratory care program, and they must pass a national crediting exam. After they are credentialed, they apply for a license—all U.S. states except Alaska require one—and then receive additional training at their place of employment.

"Respiratory therapists are the only medical profession to receive didactic and clinical education on the art and science of mechanical ventilation," Myers said. Licensed physicians and nurses are also permitted to provide mechanical ventilation, Myers said, but training depends on individual hospitals' policy.

In many European countries, respiratory therapist is not its own profession, so doctors and nurses assume the responsibilities, creating "an additional workload burden on an intensive care staff during a pandemic like COVID-19 with critically ill patients," Myers said. The U.K., for its part, is currently bringing doctors out of retirement and [retraining specialists](#) in other fields to use ventilators.

"While that burden of care does not necessarily exist in the United States with respiratory therapists, a compromised staff that has tested positive or a lack of equipment can create a resource burden," Myers said.

## Companies behind the machines

Several large multinationals, including Medtronic, Draegerwerk, Vyaire Medical, Hamilton Medical, Getinge, and Philips dominate the [ventilator market](#).

"There's a huge discrepancy between available ventilators and the need," Andreas Wieland, chief executive of Hamilton Medical, [told](#) Reuters, referring to the uptick in demand caused by the coronavirus pandemic. Wieland said Hamilton has increased production by up to 40% in response to orders for ventilators from China, Turkey, the U.S., and elsewhere. "[E]veryone is ordering," he said.

Getinge made 10,000 ventilators in 2019, a company spokesperson said. Getinge ventilators are made in Sweden, and production time is two days. The company makes [a range of devices](#), including portable, invasive, and non-invasive ventilators.

"In critical situations like this there is a global increased demand for ventilators and Getinge's production is currently up to full speed to supply our customers," the spokesperson said.

Getinge sells ventilators to the U.S. market, and the spokesperson said demand has increased during the coronavirus outbreak but could not comment on sales numbers for the ongoing quarter.

Draegerwerk's normal annual production is also 10,000 ventilators. The company [told](#) Reuters that the German government placed a single order for 10,000 intensive care ventilators last week.

A spokesperson for Medtronic said ventilator demand in China increased during the COVID-19 outbreak, and said Medtronic "is meeting all current customer demand globally" and has not experienced disruptions to ventilator production.

## Flattening the curve

Whether the U.S. ultimately has enough ventilators "still depends on what [Americans] do" to respond, Lant said, citing calls by public health experts and a trending Twitter hashtag to "[flatten the curve](#)" of infections so hospitals don't get overwhelmed.

"The public health priority should be for people to enact social distancing techniques now to avoid surges on the hospital system in the coming days and weeks," Lant said.

Preventative measures like hand-washing, social distancing, and self-quarantine are crucial—they might not prevent cases outright, but they will delay a surge of simultaneous cases and give hospitals "time to prepare and manage," Drew Harris, a population health and health policy expert at Thomas Jefferson University, [said](#) on Twitter.

Such steps, he said, may be the difference "between finding an ICU bed [and] ventilator or being treated in the parking lot tent."

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