Q&A: Permanente doctor helps create open-source O2 concentrator

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Family physician Ted O’Connell, MD, wants COVID-19 patients around the world to have access to unlimited oxygen if they need it. Anticipating that oxygen-equipment shortages would get to crisis levels during the pandemic, he provided clinical expertise for a small team of experts to help conceive an oxygen-concentrator kit—dubbed OxiKit—that people could use anywhere, with locally sourced materials.

The idea in developing OxiKit was: “How could you do it cheaply and from readily available materials? If it’s going to be built out in communities and in other parts of the world, it must be with things that you could buy at the local hardware store,” said Dr. O’Connell, a family physician with The Permanente Medical Group and chief of the Department of Family and Community Medicine for Kaiser Permanente Vallejo in California.

The concentrator isn’t a medical device—this is an open-source approach, he emphasized. It means that builders and individual communities facing oxygen crises have ready access to written
instructions on how to build and produce it.

In a sense, the OxiKit project complements what Permanente is all about: evidence-based and technology-enabled care, said Dr. O’Connell. “It’s very much in line with my work in Permanente Medicine, which is health care with humanity. This oxygen concentrator was an effort to truly help humanity during this pandemic crisis.”

Dr. O’Connell recently won a President’s Volunteer Service Award from the White House and AmeriCorps for his role in developing the oxygen concentrator. In an interview with AMA, he went into depth about OxiKit’s conception, how it has spread through social media, and how it is helping to save lives in parts of the world where oxygen concentrators are in short supply.

The Permanente Medical Group is a member of AMA Health System Program, which provides enterprise solutions to equip leadership, physicians and care teams with resources to advance their programs.

AMA: Why was there a need for this technology?

Dr. O’Connell: At the start of the COVID-19 pandemic, a lot of scientific information was coming out on a daily basis. So much was unknown, and I was getting a lot of questions from patients and family members and friends. To combat misinformation, I decided to launch a podcast on the topic of the coronavirus and how it was affecting not just medicine and science, but various aspects of society. Along the way, I made connections with individuals who were trying to do their part to contribute through science and business and social media and public health.

In that process, I was introduced to a small group of people who were exploring what would happen if our health care system truly became overwhelmed and there weren’t enough hospital beds and ICU beds available for individuals. What do we do to mitigate that type of crisis?

Access to oxygen could become a significant issue. When COVID patients get sick, they get very low oxygen levels. One of the mainstays of treatment, especially in those early phases, was high-flow oxygen therapy. Determining that oxygen resources could potentially run out, we began to envision ways that people could get oxygen outside of hospital settings. That’s what led us to develop the idea for this concentrator.

Maher Daoudi, an entrepreneur, connected us with Ed Mousselli, a brilliant engineer who came up with this simple and elegant design that has blown away engineers around the world. Nobody had really thought to do this before.
AMA: Can you describe how it works?

Dr. O’Connell: The concentrator draws in atmospheric air that we all breathe through a filter, then uses an oil-free compressor to pressurize that air. The pressurized air goes into a copper coil, which cools it. The compressed, cooled air is pumped into PVC [polyvinyl chloride] sieves filled with a mineral called zeolite, which absorbs the nitrogen out when it’s under high pressure.

So, you’re essentially generating higher percentages of oxygen. The oxygen is stored in a reservoir. A flow meter on the device allows it to be released for use in providing higher concentrations of oxygen at high flow rates, which is what patients with COVID need.

After we developed this OxiKit, we validated that we could get up to 92% oxygen at a flow rate of 20 liters per minute. We had a third party, Tata Consulting Engineers in Mumbai, India, take up the case and they validated this for us.

AMA: How did you distribute the plans for technology? My understanding is high school students posted a how-to video on YouTube.

Dr. O’Connell: We had already put all the information on a website, in terms of the designs for the project and schematics for it. Our engineer did a whole series of videos demonstrating the build process. The high school students released a time-lapse video, going through the process of the build. This was to show that the design was elegant and simple enough that a couple of teenagers in their garage could put this together.

We wanted to give people the confidence that they could—in their communities or wherever they were around the world—get together and build one of these in a matter of days, and then potentially save lives in their community.

AMA: What parts of the world are using this device right now?

Dr. O’Connell: In many developing countries, there isn't the same access to oxygen support that we see here in the United States. A community clinic or a hospital may be relying on a shipment of oxygen tanks or enough large oxygen bladders. The amount that they could get or distribute is very limited.

COVID is unique because a typical respiratory or cardiac condition might require two or five, or maybe even 10 liters per minute of oxygen. But somebody who gets critically ill with COVID infection and requires oxygen often requires very high flow rates of oxygen, maybe 20 to 60 liters per minute.
OxiKit creates its own concentrated oxygen just from room air. It doesn't rely on distribution or have issues with limited access to resources because room air is bountiful.

Engineers in these countries used our open-source design to further develop the project and to optimize it for humidity levels and atmospheric levels and all kinds of different factors that are unique in various parts of the world.

It’s being used throughout India. It's being built and distributed across many different countries on the African continent. It's being built in Afghanistan and Indonesia, down in Central and South America. It's hard for us to track it because we put it out as open-source information.

We don't always get reports about where it’s being built and utilized, but we do know that it's being built by several hundred different building groups and groups of engineers. There are at least 20 hospitals in developing countries that are actually utilizing some form of this device.

**AMA:** Have you gotten any reports on whether it works and whether it's saved lives?

**Dr. O'Connell:** We do have reports that it has been used in at least dozens of patients. Oxygen is not the only factor that saves lives, but it's a contributor. It’s being used in several chest and pulmonary respiratory hospitals across India, and we have reports from physicians there that it has been used successfully.

**AMA:** What's your reaction when you hear that?

**Dr. O'Connell:** It's humbling, and it's incredibly gratifying. I'm thankful that the U.S. health care system has never hit those crisis stages where something like this was needed. It was also eye-opening for me to learn that so many of these developing countries don’t have regular access to oxygen equipment. People who have disease processes like pneumonias or lung disease or heart attacks—who can survive those issues in the United States—often don’t because these other countries just don't have access.

**AMA:** Do you plan on using this for purposes other than COVID? What do you think this technology could achieve over the long term?

**Dr. O'Connell:** I'm hopeful that it will be an additional resource in these under-resourced environments, and that it will provide the oxygen that's needed for other medical conditions—pneumonias and lung diseases like chronic obstructive pulmonary disease.