Residents' Review

Innovation and Collaboration During a Pandemic: Thinking Outside the Box in Times of Need

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The COVID-19 pandemic began during my intern year of categorical anesthesiology residency at the University of Connecticut. The anesthesiology department formed a special COVID airway team and had to optimize which PPE should be used based on supply and the understanding of viral transmission at the time. The graduate medical education office created backup teams to replace house staff who became ill with COVID. I was rotating in the emergency department and witnessed triage tents being set up; there were constant discussions of how to handle the waves of sick patients that were beginning to come in. It was impressive to watch doctors from multiple specialties collaborating and discussing the physical layout of the hospital to plan how they would handle the looming increase in the emergency department and inpatient censuses. Parts of the hospital had been built with disasters in mind, but handling the number of sick patients who would arrive due to COVID brought a new set of challenges, requiring physician input on the use of dividers and ventilation systems, to name a few. Mobile heaters were installed for the outside tents, and I saw a few clinicians helping to calculate the electrical load and length of the wires needed to supply power and network connections to the tents. Physicians were thinking like engineers, taking on roles they had never trained for in medical school. As always, the overall best interest of their patients was the top priority. The pandemic has taken a terrible toll on everyone, but it is remarkable to see how we can think outside the box and come together in times of need.

My own experience in being involved with innovation was using 3D design software and 3D printers to improve upon existing PPE items and create new ones. Since PPE shortages were being featured daily on the news, we were beginning to reuse N95 respirators and face shields that previously had been single-use items. Our concern was that we would run out entirely because the supply chain had been disrupted. The CDC began recommending homemade masks as a last resort. I decided to use my experience with 3D design and printing to create an alternative mask by improving upon designs already available for open-source use on the internet and creating YouTube tutorials for others to follow (bit.ly/CVmasksYT). Using electrostatic furnace filters, which were still in stock in local stores, I began to release mask designs for free online. We produced masks, face shields, and reinforcement frames and shipped them to medical facilities in need of a backup supply throughout New York, Connecticut, and Massachusetts. My team of volunteers from multiple residency specialties collaborated with researchers from Yale, UConn, MIT, Harvard, and the U.S. Coast Guard Academy. We tested and verified the filtration efficacy of a certain combination of filters, that the mask was breathable, and that it exceeded the 95% filtration of 0.3 micron particles necessary to qualify as N95 substitutes. The designs were considered for emergency use by multiple community and academic institutions (*J Bone Joint Surg Am* 2020;102:e95).

There are now many free masks to download and print, ready to assist in a future supply chain disruption. Though there are downsides to this mode of production, such as the manual labor required for assembly and the slow speed of 3D printing, this technology served a temporary purpose, and will continue to be valuable for rapid prototyping of new PPE and medical device design in general. The NIH 3D Print Exchange, which hosted some of our designs, has been around for almost a decade and expanded rapidly during the COVID pandemic. Their website accommodates and recommends various PPE items for clinical and community use, allowing designers from all fields, including medicine, to pool ideas and share open-source material (*ACS Chem Health Saf*;27:335-40).

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Anesthesiologists historically have been an innovative group. The COVID pandemic has required doctors from many specialties to take on non-medical roles to help their patients. Collaboration was essential, and I am proud to have been part of our local and widespread efforts. Anyone can be an innovator. While some anesthesiology residency research programs have dedicated entrepreneurial anesthesiology research tracks (*Anesth Analg* 2017;124:998-1004), most do not. Yet, time after time, those from our field find ways to change and improve upon what exists today, for an improved tomorrow. I am grateful to everyone who worked hard to make a difference during the pandemic, and I encourage anyone with an idea for an improvement or something new in medicine to pursue that idea. Ask for help from others, form a team, and uniquely contribute to the future through innovation in medicine. ■

Dr. Chris Wiles at work in his team's 3D printer factory during the height of the pandemic.