Surgical Smoke Evacuators: Making Airway Management a Little Less Scary in the COVID-19 Era

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In the July 2020 *ASA Monitor* article titled "Airway Management in 2020: Different and Scarier," author Karen Sibert, MD, FASA, raises important and provocative questions regarding airway management in the COVID-19 era (*ASA Monitor* 2020;84:25).

One is: Should we be practicing universal precautions during the COVID-19 pandemic and going forward, since the incidence of false-negatives for COVID-19 testing may be as high as 30%? Others have called for universal airborne precautions for the protection of anesthesiology and other health care workers from COVID-19, but such policies have not yet been widely adopted (*Anesth Analg* 2020;131:e102-4).

Dr. Sibert's article points out how extubation can include an alarming display of coughing by the patient. She poses the question of how much concern we should have in terms of aerosol generation during routine airway management in the OR of an asymptomatic patient who tested negative for COVID-19. The author reasons that – assuming a good mask seal, easy ventilation, adequate neuromuscular blockade, an easy intubation on first pass, and a smooth extubation with little or no coughing – the practical risk compared with a critically ill ED or ICU patient with a high viral load who is coughing relentlessly "seems far less." She also offers that "it is still reasonable to wear higher-level personal protective equipment (PPE) than the simple surgical mask and eye protection we wore before COVID-19" but that "wearing full head-to-toe PPE seems wasteful." As clinicians, however, we know too well that those are a lot of assumptions and that not all "routine" airway management scenarios proceed smoothly and routinely.

Dr. Sibert's article also provides an important discussion of the "post-aerosol pause" – the CDC and Anesthesia Patient Safety Foundation-recommended waiting period after intubation and extubation before allowing other personnel into or out of the OR to allow the ventilation system to adequately clear the air (asamonitor.pub/36VojZr). This time period varies, depending on the individual OR's air exchange per hour rate, from "14 to 46 minutes." However, Dr. Sibert expresses the concern that "once elective surgery ramps up again, production pressure and human impatience will bury the post-aerosol pause except for… patients with proven or suspected COVID-19."

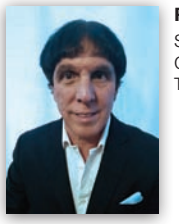
Figure: An early laboratory illustration of one method of using an SSE to divert, collect and reduce respiratory aerosol load generated by patient coughing during intubation or extubation. Note the SSE unit in the background (in this case, built in to the Stryker Neptune Surgical Blood Management Unit, which are already present in every one of the authors' ORs), and the wide-bore 7/8 inch (22 mm) corrugated SSE tubing. In this simulation, the SSE tubing was placed on the patient's chest, and a plastic funnel was attached to the end to attempt to increase the collection capability. Ideally, the end of the SSE tubing should be placed as close as possible to the patient's airway, and aligned if possible with the anticipated direction of the cough. The tubing can be secured on the patient's torso with tape; or held in place by an anesthesia breathing circuit tube tree or gooseneck clamp attached to the OR table; or held by the airway assistant.

Allowing production pressure to dictate our safety practices is a concern, particularly in light of compromises we have already accepted during this pandemic, such as suboptimal PPE due to shortages of N-95 respirator masks or lengthening of the "acceptable" preop COVID-19 testing interval for elective asymptomatic patients in order to reduce cancellations. However, as economic realists, we are all aware of the importance of OR efficiency.

So, in search of creative solutions for practical, inexpensive ways to maximize both efficiency and safety during the COVID-19 pandemic, we remembered a technology that has been commonly available and in widespread use in ORs across the world for decades: the surgical smoke evacuator (SSE) (asamonitor.pub/3p4c4j8; asamonitor.pub/3oY5ACF).

SSEs are FDA-approved devices that consist of 1) a powerful, high-flow, negative-pressure pump that evacuates >25 cubic feet/minute of air, 2) an ultra-low particulate air filter (ULPA), and 3) a disposable plastic suction hose (*J Cutan Aesthet Surg* 2019;12:1-7).

These devices provide very high negative airflow rates 25 to 40 times greater than that of standard hospital wall suction. ULPA filters remove 99.999% of particles 0.1 micron or larger and are more effective than HEPA filters, which remove 99.997% of particles 0.3 micron or larger;



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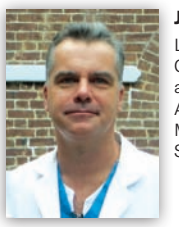

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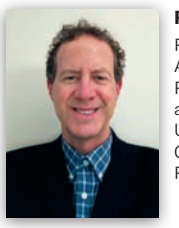

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a very important consideration since coronaviruses are only approximately 0.1-0.12 microns in diameter.

The use of SSEs became widespread in the 1990s as evidence began to accumulate that contagious human papillomavirus could be cultured from the smoke and aerosol plume generated by laser excision of papillomas. At our institution at the time (the University of Pittsburgh Medical Center), we created a protocol whereby the patient end of the SSE hose was affixed near the patient's airway at the surgeon's rigid laryngoscope to capture the smoke and aerosol plume from the vaporized laryngeal papillomas. Our urologists, gynecologists, and plastic surgeons also began to use an SSE near the surgical field to capture the plume during venereal papilloma excisions. The amount of smoke plume was dramatically reduced by the use of the SSE.

Over subsequent decades, evidence accumulated that potentially harmful chemicals, as well as other viruses and bacteria, are aerosolized in surgical electrocautery smoke, prompting the CDC, NIOSH, and the Association of periOperative Registered Nurses (AORN) to recommend the routine use of SSEs for all laser and electrocautery procedures (asamonitor.pub/36V0NM0; *AORN J* 2017;105:498-500).

As a result, although it may be underappreciated by the anesthesiology community, SSEs are already quite ubiquitous in many ORs, either as freestanding units or, as is the case in many institutions, built

in to the surgical blood and fluid suction units. An example is the Neptune Surgical Waste Management System, which is in every OR in each of the three authors' respective institutions. There are numerous other manufacturers of FDA-approved SSEs (asamonitor.pub/3aKYQTA).

Because the coronavirus has been found in the GI tract, blood, bile, and feces, and because of potential viral aerosolization during surgery, the Society of American Gastrointestinal and Endoscopic Surgeons recently issued a statement that "currently, the best practice for mitigating possible infectious transmission during open and laparoscopic surgical procedures is a multi-faceted approach which includes: proper operating room ventilation and filtration, appropriate PPE, and surgical smoke evacuation" (asamonitor.pub/3aKYQTA).

Similarly, an SSE can also be used to divert much of the aerosolized viral load generated during intubation and extubation away from the anesthesia staff performing airway management at the head of the OR table and to capture it in its ULPA filter (*AORN J* 2017;105:498-500). This can be accomplished by simply affixing the patient end of the 7/8-inch SSE hose near the patient's airway during intubation until the cuff is inflated and the endotracheal tube or laryngeal mask airway is connected to the anesthesia breathing circuit, and again at extubation until the patient stops coughing or retching. Then a plastic oxygen mask or surgical mask is placed over the patient's nose and mouth for transport to the PACU.

For maximal cost-effectiveness, a single SSE can be used by the anesthesia team for intubation, shared with the surgical team for smoke capture during the procedure, and then again by the anesthesia team for extubation.

The concept of the SSE as a personal vacuum cleaner or air scrubber for the aerosol cloud generated during intubation and extubation is consistent with the well-accepted infection control principles of "source control" and "negative-pressure respiratory isolation."

The SSE can also supplement and complement all the other currently used COVID-19 risk-reduction strategies, including optimal PPE and good OR ventilation. In addition, the SSE is totally compatible with mechanical barrier techniques (such as clear plastic drapes, tents or igloos, or rigid clear plastic "intubation boxes") that have been developed and are being used by many anesthesia providers in response to the COVID-19 pandemic. In fact, the most effective method for reducing the environmental viral load generated by intubation and extubation may be the combination of a disposable clear plastic drape intubation tent with the SSE hose placed under the drape tent and taped on the patient's chest just below the chin (asamonitor.pub/3jtpW5A). The total volume of air under a clear plastic drape tented over the head and torso of an adult patient is approximately 12 cubic feet (2 feet x 2 feet x 3 feet). At vacuum rates of >25 cubic feet/minute, an SSE can evacuate and scrub all of the air under the plastic drape in only 30 seconds.

Since most SSE units are portable, they can be placed in or transported to other units in the hospital, where intubation, extubation, or other aerosolizing procedures might be performed. A small SSE could even be placed on a portable airway cart.

If an SSE is already available in the OR, there is no capital outlay required. The only costs associated with using an SSE in this situation would be the disposable plastic hose (<$5 per patient for the SSEs used in the authors' ORs) and the replaceable ULPA filter (approximately $200), which typically have long lives of approximately 80 hours of continuous run time per filter (Stryker Corporation, personal communication, May 22, 2020). This is a modest cost compared to a 14-46 minute "post aerosol pause" in the OR after each intubation and extubation. In the opinion of the authors, this is also a modest cost compared to the morbidity and mortality that can accompany COVID-19 or with the steep staffing costs of time missed from work by health care workers infected with COVID-19 and their contacts.

In summary, SSEs could provide additional safety to health care workers in the OR. While no single measure can provide total protection, a combination of multiple complementary risk-reduction measures may represent the best strategy and best practice. As such, SSEs are potentially valuable supplemental tools in the airway management of patients with infectious respiratory pathogens such as COVID-19 and can move us one step closer to providing universal precautions against COVID-19 and other aerosol and airborne viruses. Use of an SSE could make airway management in the COVID-19 era a little less scary. ■

Disclosures:
Drs. Gonzalez, Schaefer, and Krohner report no relevant financial disclosures nor any conflicts of interest.