EDITORIAL

COVID-19 and the OR Staff: Protecting against viral aerosolization

The COVID-19 pandemic has already infected over 390 million people around the world and claimed the lives of more than 5.7 million people. By WHO estimates, from January 2020 to May 2021, COVID-19 could have caused between 80,000 and 180,000 deaths among healthcare workers, with an estimated 115,500 deaths overall.[1] As the healthcare community works to combat the virus's sweeping global spread, areas of practice and evidence-based care are continuously adapting to an ever-evolving disease.

The size of the coronavirus-shaped spherical particles was estimated to be about 0.125 microns (125 nm) and is between 0.06 and 0.14 microns.[2] Droplet infections are by larger particles in the air, generally above 5 microns, which are subject to gravitational forces, and aerosol-mediated transmission occurs with smaller respiratory particles, generally below 5 microns circulated in the air.

Although, droplet infections are contact-dependent, and therefore hand washing and gloves are highly effective against these types of infections, viral particles transmitted through aerosols generated during laparoscopic and endoscopic surgery, can be absorbed across the respiratory mucosa, and potentially reach the eyes. Hence, the exposure to Covid 19 viral particles during surgery for the surgeon and staff may be disproportionately increased.[3]

During the early days of the pandemic in March 2020, when many theatre staff were lost, there was debate on what option to choose between open and laparoscopic surgery in order to reduce transmission from patients to medical staff.[4-8] The term "fugitive emissions" have come to be applied to aerosols containing viral particles that may secondarily infect medical staff during procedures for patients.[9] To ensure that all surgical teams and theatre personnel are protected from the coronavirus, and to prevent the spread of the virus throughout the hospital, surgeons and policy makers need to be updated about new infection-prevention strategies.

Researchers used the Schlieren effect—characterized by a visual distortion created when air flows over an object—to visualize fugitive emissions from unintended surgical gas leaks through and around laparoscopic trocars and ports. This set the stage for innovation, based on the optical technology, to address this problem.

In 2017, Conmed, the manufacturer of the Airseal Insufflation and Access System (AISA), stated that the system had unexpected behaviors. During the 2019 virus pandemic, widespread concerns over the hazards of aerosolized pathogens prompted Conmed to reemphasize its warnings and precautions.[10]

At this time also, Cahill and his colleagues decided to investigate and better understand the mechanics behind gas leaks during minimally invasive surgery.[11] They went on to perform a series of clinical and experimental explorations regarding surgical airflow around laparoscopic, robotic and transanal access sites. They carried out clinical qualitative assessment using a near-infrared camera, that enabled visualization of carbon dioxide from leaking sites, to observe both elective and emergency surgery performed by standard and robotic-assisted laparoscopy and trans-anal minimally invasive surgery. They also characterized and quantified gas leaks by applying high-speed Schlieren optical imaging at three different pneumoperitoneal pressures (8, 12 and 25 mmHg) using three different brands of trocar in separate models. They recorded this phenomenon with monochromatic camera.

Thus, Cahill et al,[11] classified leaks into three categories. The first is intentional e.g., venting trocar into the room to clear smoke which can be mitigated by adhering to best practice. The second category occurs inadvertently, commonly occurring at skin–trocar interface placement sites, aggravated when the incision is too big. Finally, gas leak occurs because of the inbuilt mechanism in minimally invasive instrumentation, where leaks occur through trocars or instruments either by design or mechanical failure/fatigue, optical trocars used with insufflation to initiate pneumoperitoneum, obturator used to place trocars during procedure, in robotic instrumentation, energy devices, instrument exchange and leaky valve leaflet.

Gas leaks are occurring all the time during laparoscopic surgery. The gas is not only important in carrying fugitive emissions, but a lot of particles are also propelled out through the trocars into the surgical teams' breathing zone. Up to 8 million particles/m^3 have been estimated to be propelled into the operative air space during laparoscopic cholecystectomy.[11]

Healthcare workers performing aerosol-generating procedures such as Esophagogastroduodenoscopy may also be at increased risk of viral infection.[12,13] Moreover, a prospective study has demonstrated that there are risks of unrecognized infectious-particle exposure from the gastrointestinal tract during procedures performed by endoscopists.[14,15] Furthermore, various volatile organic compounds (VOCs) have been proven to be produced during surgery, including endoscopy.[16] Several carcinogenic and non-carcinogenic VOCs were detected at levels higher than the reference "safe" values during endoscopic submucosal dissection (ESD).[17,18]

Until recently, there has been little concern about gas pollution in the operating room.[19,20] To support the fight against Covid 19, in the middle of 2020, the European Union issued a call to action for technological innovation. Subsequently, several projects were launched by the EU Commission to protect OR staff from aerosolized virus. Among the objectives set for these projects are to characterize the nature of fugitive emissions in the O.R, to complete the design and verification of devices to be used in laparoscopic and endoscopic surgeries, to obtain regulatory approvals, manufacture the devices and validate their functionality clinically. This could then be followed by mass production and promotion around the world.

Medical innovators have designed a new tool to capture gas leaks during laparoscopic procedures called the Leaktrap. The Leaktrap contains rings at the top and bottom of the trocar and is connected to a vacuum source. Gas from pneumoperitoneum containing these emissions is passed through an Ultra-Low Particle Air (ULPA) filter connected to the Leaktrap. The device has been approved by the FDA and is awaiting CE certification.

The second device that has been invented is the Endotrap, a face mask adaptor that functions to trap fugitive emissions in insufflation gas and exhaled breath from patients during endoscopy. It is a passive device, requiring no vacuum source connection and is intended to be used in conjunction with a single-port anesthesia mask and a viral filter. It forms a protective barrier around the patient's nose and mouth, and the endoscope passes through the sleeve. The sleeve prevents gases escaping along side the scope, and thus, protects the operator and endoscopy room staff against recognized or unrecognized airbone particles during endoscopy procedures. It is FDA registered and has obtained CE clearance.

The importance of these developments is that management of aerosolized Covid 19 virus has revolutionized in theater and operation room (OR) staff protection against potential fugitive emissions. In the future there may be new infectious hazards, even if not at the level of a pandemic, that could be potential threat to normal surgical workflow. It is important for policy makers and health care managers to take precautions to prevent infection, because if providers become ill or die, the delivery of health care will be disrupted as we have seen during the peak of the coronavirus pandemic.

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