May 2020

Reopening Operating Rooms – A Protective Airflow Verification Solution

Wagner JA Ph.D., CIC and Greeley DG, PE, CEM, HFDP, CBCP, EDAC, CHFM

The SARS-COV-2 pandemic has called attention to the need for understanding the risk of potentially aerosolized particles during intubation, extubation and other procedures that could infect operating room personnel (1). SARS-COV-2, an enveloped RNA virus, has the potential to exist in both droplet and aerosol forms. It has also been studied and confirmed to be infective six to seven feet from the source (2-8). The Center for Disease Control recommends that aerosol-generating procedures (AGPs) on infected or suspect patients should be performed in an airborne infection isolation room (9). In many hospitals, existing negative pressure rooms are already fully utilized, so staff have been converting operating rooms (which are normally positively pressurized) or ICUs (with no pressure requirement) to use for these procedures under COVID surge conditions.

ASHRAE's Position Document on Airborne Infectious Diseases recommends that airborne infectious disease transmission be reduced using dilution ventilation, directional ventilation, in-room airflow regimes, and room pressure differentials (10). Operating rooms provide positive pressure, 15-20 air changes per hour (ACH) with 3-4 outside and return air exchanges that are recirculated or exhausted directly to the outside (11,12). The BEACON™ analytics database (OnSite LLC, Indianapolis, IN) tracks procedures with the highest rates of aerosolized particles by case type (Chart 1).

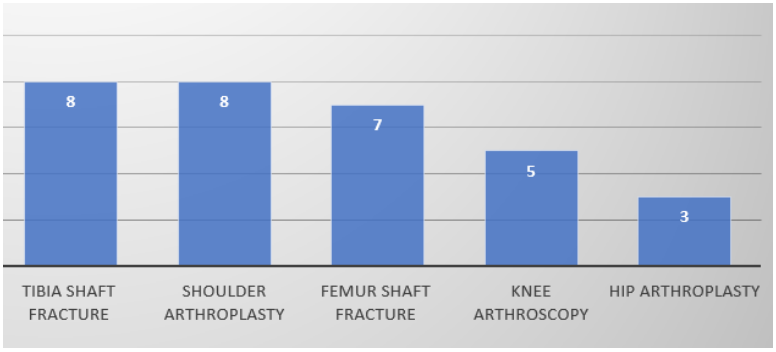

Chart 1. Particle Counts at 15 Min Intervals During Procedure Exceeding 10,000 p/ft3

In addition, ventilated air should move from clean to less clean areas while continuously exhausting or HEPA filtering potentially contaminated aerosols nearest to their source, to protect the surgical team members and uninfected surgical patients in surrounding areas from accidental exposure. This is achieved through directional flow of filtered supply air that carries infectious particles from their source to an exhaust inlet location. Since air is invisible, an alternate method is needed for visualizing how the directional air flows within the room, in real time or as frequently as possible. New technology exists to enable safety, facility, or clinical rounding teams to 'visualize' this airflow. The AirStatEQI™Airflow Visualization Device* quickly 'maps' the directional flow in each operating room, to determine if any risks exist for either the surgical patient or the surgical team members (Figure 1). If risks are identified, clinical teams can then make alterations to work or patient care flows to mitigate these in-room risks. Facilities teams can also check for risks of potentially contaminated air escaping to hallways and adjacent spaces.

This hand-held technology allows the user to input space identification information, room temperature, and specific humidity. It measures the velocity and direction of the air at various points within the OR space, and using a contamination risk mapping algorithm (13-18), it produces a 'risk map'. The numerical risk readings are color-coded green (ok), yellow (below target) and red (critical) on the map for easy reference by the team

member collecting the data. The risk readings are uploaded to an interactive floor plan of the OR, that indicates the location of the surgical table, back table(s), anesthesia station, case carts, and circulator desk in relation to the team member collecting the readings (Figure 2). In this figure, the AirStatEQI™ device is depicted in blue and the orientation of the device is indicated for downdraft or cross draft readings at each specific location. Each reading (2-10 per room) takes approximately 20 seconds, minimizing disruption to patient care processes or procedures. Data from each reading is stored, enabling analytics and trending of historical conditions.

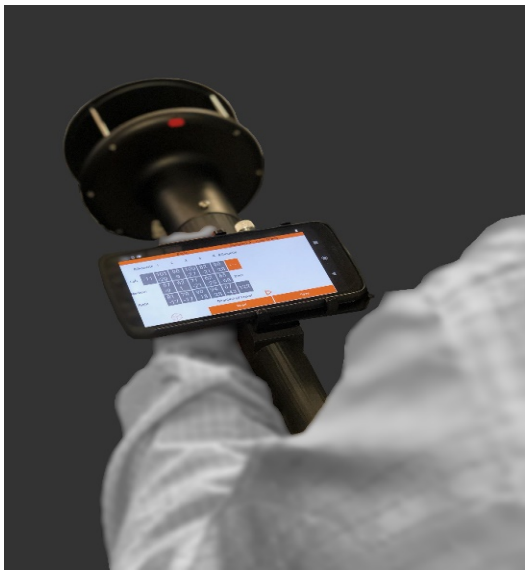

Figure 1. AirStatEQI™ Airflow Visualization Device

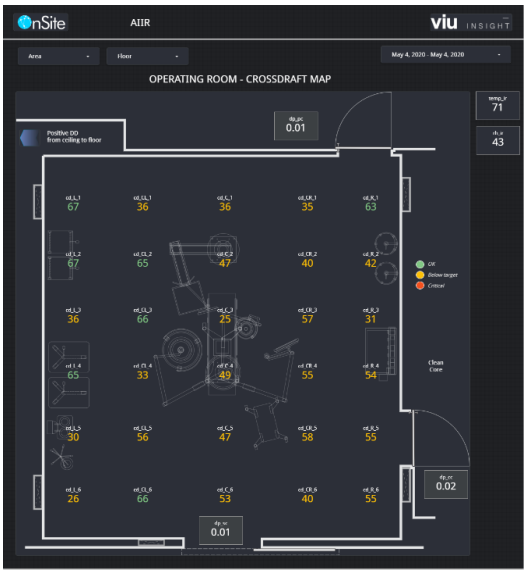

Figure 2. Interactive Room Risk Map

AirStatEQI™ technology* is part of the OnSite BEACON™ Comprehensive Safety and Environmental Quality Performance Validation Program, which is designed to help restore patient and stakeholder confidence in healthcare organizations.

With a focus on risk prevention, identification and mitigation, the OnSite team works alongside an organization's executive, infection prevention and quality/safety leaders, environmental and facilities teams and engineers to help create a safer healthcare environment with heightened protection from infectious diseases (including infectious aerosols like SARS-CoV-2). Modules of the program include:

Beacon Prevent™ Assessment: Real-time in-room monitoring algorithms correlate the data from multiple in-room sensors to predict areas of elevated infection risk.

Beacon Identify™ Analysis: Powerful analytics help quality improvement teams recognize the risk trends and areas they should focus on for safety improvement initiatives.

Beacon Mitigate™ Data: Informatics help quality improvement teams assess root causes of adverse events and set targets to reduce defect rates and improve in-room environmental quality.

*AirStatEQI™ is a joint endeavor between OnSite-LLC and VIU Insights, Inc.

References

1. "COVID-19: Considerations for Optimum Surgeon Protection Before, During, and After Operation." American College of Surgeons, www.facs.org/covid-19/clinical-guidance/surgeon-protection.
2. Santarpia JL, Rivera DN, Herrera V, Morwitzer MJ, Creager H, et al. Transmission Potential of SARS-CoV-2 in Viral Shedding Observed at the University of Nebraska Medical Center. doi: https://doi.org/10.1101/2020.03.23.20039446
3. Ghia U, Gressel M, Konangi S, Mead K, Kishore A. Assessment of Health-Care Worker Exposure to Pandemic Flu in Hospital Rooms. *ASHRAE Trans*. 2012; 118(1): 442–449.
4. Nicas M and Jones RM. Relative Contributions of Four Exposure Pathways to Influenza Infection Risk. Risk Analysis, Vol. 29, No. 9, 2009 DOI: 10.1111/j.1539-6924.2009.01253.
5. The Centers for Disease Control and Prevention. Infection Control Recommendations. https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html.
6. Association for Professionals in Infection Control. Coronavirus Infection Control Guidance. Retrieved from https://apic.org/news/coronavirus-infection-control-guidance/.
7. van Doremalen N, Bushmaker T, Morris DH, Holbrook G, Gamble A, et al. Aerosol and surface stability of HCoV-19 (SARS-CoV-6 2) compared to SARS-CoV-1 https://doi.org/10.1101/2020.03.09.20033217.
8. Hui DS. Severe acute respiratory syndrome (SARS): lessons learnt in Hong Kong. J Thorac Dis. 2013 Aug; 5(Suppl 2): S122–S126. doi: 10.3978/j.issn.2072-1439.2013.06.18.
9. The Centers for Disease Control and Prevention. Engineering Controls Recommendations. https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html#engineering_controls
10. ASHRAE. Ventilation of healthcare facilities (Standard170-2017).
11. ASHRAE Position Document on Airborne Infectious Diseases Approved by ASHRAE Board of Directors January19,2014 Reaffirmed by Technology Council February 5, 2020 Expires August 5, 2020, www.ashrae.org
12. ASHE, ASHRAE Technical Committee for Healthcare and ASHRAE 170. COVID19 Guidance Power Point Presentation. DOI https://tlc-engineers.com/content/uploads/COVID-19-GUIDANCE-TLC_Current_Version.pdf
13. Gormley T, Greely D, Wagner JA, et al. Methodology for Analyzing Environmental Quality Indicators (EQIs) in a Dynamic Operating Room Environment. Am J Infect Control. 2017;24: 354-359.
14. Markel T, Gormley T, Greeley D, et al. Covering the Instrument Table Decreases Bacterial Bioburden: An Evaluation of Environmental Quality Indicators. Am J Infect Control. 2018. DOI: https://doi.org/10.1016/j.ajic.2018.02.032.
15. Gormley T, Greely D, Markel T, et al. Cost –Benefit Analysis of Different Air Change Rates in an Operating Room Environment. Am J Infect Control. 2017; 45:1318-1323.
16. Wagner J, Gormley T, Greeley D, et al. EQI Method to Compare Air Delivery Methods in Functional ORs During Dynamic Simulated Surgical Procedures. Am J Infect Control. 2018. DOI https://doi.org/10.1016/j.ajic.2018.07.020.
17. Markel T, Gormley T, Greeley D, et al. Ostojic, J. Hats Off: A Study of Different Operating Room Headgear Assessed by Environmental Quality Indicators. J Am Coll Surg. 2017a;225 (5):573-581.
18. Markel T, Gormley T, Greeley D, et al. Wearing long sleeves while prepping a patient in the operating room decreases airborne contaminants. Am J Infect Control. 2017b. DOI: https://doi.org/10.1016/j.ajic.2017.10.016.