Mission Next
FOUNDATION

TECHNOLOGY OVERVIEW: PART OF MULTILAYERED AIR DEFENSE STRATEGY TO DEFEAT COVID

Introduction: With the recognition by the WHO and CDC that COVID is a respiratory threat predominantly spread through the air ("Airborne", whether through droplet nuclei or aerosols), we now have an additional focus on addressing the mode of transmission. We now recognize that traditional Public Health measures such as vaccination, mask wearing, social distancing, or moving activities out of doors when practical can be joined by utilizing safe and established engineering technologies to either increase the air exchanges or air exchange equivalents to decrease the viral load in engineered shared air spaces where opening windows is not practical, or when moving activities out of doors is not a viable option.

This overview of technologies available today for implementation was put together by the Independent Shared Air Strategic Research Board. As Chair of this non-profit group, we do not advocate for any proprietary brand or product. We remain dedicated to finding independent, safe and creative solutions today in the War on COVID today, while investing in resiliency for our society towards future threats. I am pleased to provide this analysis based upon the best available independent science and subject matter expertise. We advocate for applying these technologies together to add levels of redundancy, but also because we as of now do not fully understand which technologies are the most effective in different applications. We welcome feedback and strive to provide the most current science-based analysis as we learn more.

Broad Overview: Airborne pathogens such as COVID travel on droplet nuclei (from coughs, sneezes, and breathing) as well as on small aerosol particles. The recommendations for social distancing and non-medical grade masking while indoors or in close proximity appear most effect in decreasing transmission through the droplet nuclei mechanism.

Based upon best available science dating back to the pandemic of 1918, and continuing to today, we recognize that as we increase the air exchanges in a room with fresh indoor air, we decrease the number of infectious particles that can make people sick. Therefore, to address the aerosol threat our group's first recommendation is to increase air exchanges with fresh filtered air in enclosed spaces. However, for many air handling systems, there is a practical limitation to significant air turnovers, as well as a significant cost in terms of heating and cooling outdoor fresh air.

Once we have increased air exchanges with fresh filtered air, the next step is to treat the air to either kill the pathogen directly, or remove the small particles the small particulate aerosols that the pathogen can travel on. This takes us into the science of engineered Indoor Air Quality (IAQ).

There are two broad categories of technologies that we have identified: **Active** and **Passive** scavenging technologies.

Active Pathogen Scavenging systems create changes in shared air that provides anti-pathogen activity anywhere the air can reach within an indoor structure. Since Active Pathogen Scavenging technologies impart into the air itself the ability to neutralize pathogens or causing particles to clump and fall harmlessly to the surface, this class of technologies can theoretically also provide some impact against not only airborne pathogens, but also kill surface contaminates as well.

Passive Pathogen Scavenging systems require that the airborne contaminants be brought to the device or mechanism to be neutralized, destroyed or at the least captured (filtered out of the air).

ACTIVE PATHOGEN SCAVENGING TECHNOLOGIES

Photocatalytic Oxidation (PCO) Purifiers

Photocatalytic oxidation purification is a process that involves a light-activated catalyst reacting with water molecules in the air to produce hydroxy radicals and super-oxide ions that oxidizes airborne pathogens to transform them into non-toxic substances. The Photocatalytic Oxidation process combines ultraviolet light on a titanium dioxide (TiO_2) catalyst cell resulting in oxidizing products which breakdown organic material into water, carbon dioxide and inert waste. The air purification process of using photocatalytic oxidation often works by using a stand-alone or HVAC installed PCO unit to release low levels of hydrogen peroxide and/or other oxidizing agents into the shared air space. Once present in sufficient quantity within the shared air spaces, the free hydroxy radicals and super-oxide ions (created by UV light and titanium dioxide) can neutralize pathogenic organisms by interfering with the bacteria or virus' biologic processes, destroying the intracellular mass and denaturing DNA/RNA chromosomes.

Ionizer Air Purifiers

Ionizers are also called "ionizer air purifiers," "ionizing air purifiers," "air ionizers," "ion generators" and "ionic air purifiers." Ionizers use high voltage to give an electrical charge (usually negative) to particles that move through the ionizer and into the shared air spaces. These charged molecules are called ions and they are attracted to particles or surfaces with the opposite charge. This causes the particles to clump together, forming larger, heavier particles that settle out of the air onto nearby surfaces. Alternately, particles can be attracted to, and stuck to, charged surfaces like carpet or curtains that have gained a positive charge through static electricity.

Photo Electrochemical Oxidation (PECO)

Photo Electrochemical Oxidation (PECO) is a photon-based air purification process. PECO, in a process similar to PCO technology, uses photons of sufficient energy to initiate a chain of reactions by liberating electrons (negative charge) and forming positive charged molecules. PECO differs from PCO by capturing the free electrons, theoretically extending the time positive charged molecules can interact with pathogens in the air.

SURFACE-BASED ACTIVE PATHOGEN SCAVENGING TECHNOLOGIES

Copper and/or Silver Nanofilm Coating

Copper (Cu) and Silver (Ag) applied on surface coatings efficiently inactivate microbes by direct contact. Scientists demonstrated the antimicrobial activity of the surfaces covered with metal ions nanofilms in reducing nosocomial infections involving multiple organisms including *Bacillus anthracis*, a bacteria with possible implication in bioterrorist attacks. Copper covered surfaces proved to have better antimicrobial activity than Silver coated surfaces. Further studies on the antimicrobial effects of these metallic coatings will provide better understanding of the mechanisms of Silver and Copper nanofilms antimicrobial activity.

Titanium Dioxide Thin-film Coating activated by UV-A Light

Titanium Dioxide (TiO_2) is applied as a thin-film coating on walls, ceilings, and other surfaces and is activated by UV-A light to cause a photocatalytic reaction like PCO. TiO_2 catalyzed end products can destroy both bacteria and viruses. Titanium based structures are one of the most popular photocatalysts used due to their great photo-oxidation of organic compounds, excellent chemical stability, strong oxidizing power under UV-A radiation, and excellent chemical resistance and photostability.

PASSIVE PATHOGEN SCAVENGING TECHNOLOGIES

HEPA Filtration

HEPA stands for "high efficiency particulate air." A HEPA filter generally uses a mat of dense fibers to trap

particles moving through it. In order to meet the HEPA specification, an air filter must trap 99.97 percent of all particles that are 0.3 microns in diameter. It can trap smaller particles (and is generally very effective at trapping larger particles as well), but its effectiveness declines as the particles get smaller.

UV Light Air Purifiers
UV air purifiers are designed to use short-wave ultraviolet light (UV-C light) to inactivate airborne pathogens and microorganisms like mold, bacteria and viruses. They have the same ultimate goal of all air purifiers: to reduce indoor air pollutants. UV-C air purifiers are currently sold as stand-alone, freestanding devices or as systems installed into pre-existing residential or commercial HVAC units. As air is forced through the device, it passes UV lamps, which directly attempt to disinfect the air by means of germicidal irradiation. The biggest safety concern is that ozone may be generated during this process and that humans cannot be exposed to the UV-C light. Rarely a stand-alone product, UV-C light air purifiers often require additional systems for full effectiveness and are most often included in larger HEPA air filtration systems. In fact, the EPA says that a UV-C air purifier does not seem effective as a stand-alone unit because it cannot trap or remove particles.

HEPA Filtration with UV-C Light
Combines the efficiency of both technologies; HEPA filtration and UV-C light. Air is pulled into an appliance and passes through a HEPA filter. The air then passes through a small internal chamber where it is exposed to UV-C light. The UV-C light is not released into the room, so you won't see it nor will you be exposed to it.

HEPA Filtration with UV-C Light and Ionization
Combines the efficiency of three technologies; HEPA filtration, UV-C light, and Ionization.

HEPA Filtration with UV-C Light, Ionization, and PCO
Combines the efficiency of four technologies; HEPA filtration, UV-C light, Ionization, and Photocatalytic Oxidation.

We advocate for these technologies to be deployed as part of the protocols that our group has developed. These start first with a firm foundation of education, traditional public health measures, and optimization of current air handling systems, followed by additional technologies when appropriate. The most current protocols may be found at https://mission-next.com/current-protocols/

We look forward to partnering with you and your organization to help win the War on COVID and enhance the resiliency of our nation together. Thank you.

Lt. Gen. (ret) Dr. PK Carlton, Jr.
17th Surgeon General of the US Air Force
Co-Chair, The Independent Shared Air Strategic Research Board
Collaborative Partner, Puerto Rico Leads Las Americas

*All protocols are subject to change based on emerging science and practice. Visit mission-next.com/irb for latest protocol version

Contact: Mission-Next LLC
426 S. Lamar Blvd., Suite 13
Oxford, MS 38655
mission-next.com