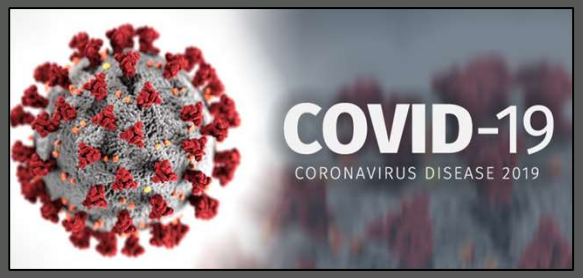
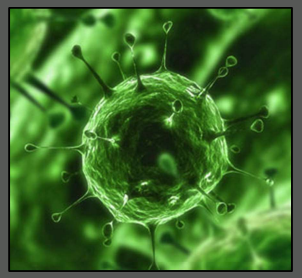
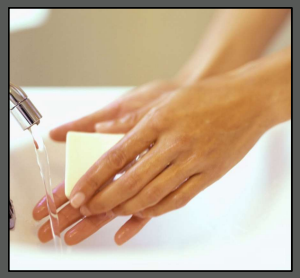
Navigating COVID-19



The latest on the virus, disinfection protocols, and emerging technology

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Presentation prepared September 15, 2020 – subject to change as new information becomes available

CTEH®

Surface Transmission and Surface Survivability of SARS-CoV-2

CTEH®

SURFACE TRANSMISSION

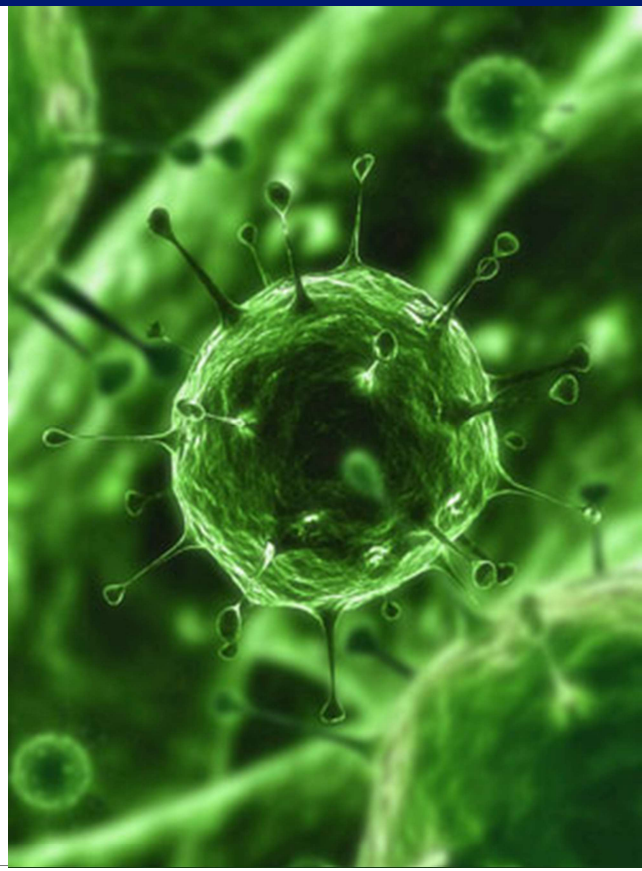
Surface Survivability

Fomite Transmission refers to the transmission of infectious diseases by contaminated objects

Transmission of COVID-19 to persons from surfaces contaminated with the virus has not been documented[1]; however, it may be possible.

Current evidence suggests that the virus may remain viable for hours to days on surfaces.

[1] https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/cleaning-disinfection.html



SURFACE SURVIVABILITY OF SARS-COV-2

Surface Survivability

Table: Survival of SARS-CoV-2 on Environmental Surfaces

Environmental Surface	Survival Time[1]	Reference(s)
Cardboard	24 hours	van Doremalen 2020
Cloth	24 hours	Chin 2020
Copper	4 hours	van Doremalen 2020
Glass	2 days	Chin 2020
Paper (printing/tissue)	30 minutes	Chin 2020
Plastic	3 - 4 days	van Doremalen 2020; Chin 2020
Stainless Steel	3 - 4 days	van Doremalen 2020; Chin 2020
Wood	24 hours	Chin 2020

[1] Study authors reported that infectious virus was detectable up to this point in time

CDC MMWR – Diamond Princess

Surface Survivability

Morbidity and Mortality Weekly Report

Public Health Responses to COVID-19 Outbreaks on Cruise Ships — Worldwide, February–March 2020

Leah F. Moriarty, MPH[1]; Mateusz M. Plucinski, PhD[1]; Barbara J. Marston, MD[1]; Ekaterina V. Kurbatova, MD, PhD[1]; Barbara Knust, DVM[1]; E
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Beth Wittry, MPH[1]; Amy Freeland, PhD[1]; Sara Naramore, MPH[3]; Ryan T. Novak, PhD[1]; David Daigle, MPH[1]; Michelle Weinberg, MD[1]; Anna Acosta,
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Elizabeth Kurylo, MCM[1]; Stefanie Campbell, DVM[1]; Rachel Murray, MPH[1]; Paul Weidle, PharmD[1]; Martin Cetron, MD[1]; Cindy R. Friedman,
CDC Cruise Ship Response Team; California Department of Public Health COVID-19 Team; Solano County COVID-19 Team

On March 23, 2020, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

An estimated 30 million passengers are transported on 272 cruise ships worldwide each year* (*1*). Cruise ships bring diverse populations into proximity for many days, facilitating transmission of respiratory illness (*2*). SARS-CoV-2, the virus that causes coronavirus disease (COVID-19) was first identified in Wuhan, China, in December 2019 and has since spread worldwide to at least 187 countries and territories. Widespread COVID-19 transmission on cruise ships has been reported as well (*3*). Passengers on certain cruise ship voyages might be aged ≥65 years, which places them at greater risk for severe consequences of SARS-CoV-2 infection (*4*). During February–March 2020, COVID-19 outbreaks associated with three cruise ship voyages have caused more than 800 laboratory-confirmed cases among passengers and crew, including 10 deaths. Transmission occurred across multiple voyages of several ships. This report describes public health responses to COVID-19 outbreaks on these ships. COVID-19 on cruise ships poses a risk for rapid spread of disease, causing outbreaks

cruise ship travel worldwide for those with underlying conditions and for persons aged ≥65 years. On March 1 Cruise Lines International Association announced a 3 voluntary suspension of cruise operations in the United (*5*). CDC issued a level 3 travel warning on March 17, r mending that all cruise travel be deferred worldwide.†

Diamond Princess

On January 20, 2020, the Diamond Princess cruis departed Yokohama, Japan, carrying approximately passengers and crew (Table). On January 25, a sympto passenger departed the ship in Hong Kong, where he was ated; testing confirmed SARS-CoV-2 infection. On Febru the ship returned to Japan, after making six stops in countries. Japanese authorities were notified of the COV diagnosis in the passenger who disembarked in Hong and the ship was quarantined. Information about soci tancing and monitoring of symptoms was communica passengers. On February 5, passengers were quarantin their cabins; crew continued to work and, therefore, could not

of asymptomatic infections at the time of testing. Available statistical models of the Diamond Princess outbreak suggest that 17.9% of infected persons never developed symptoms (*9*). A high proportion of asymptomatic infections could partially explain the high attack rate among cruise ship passengers and crew. SARS-CoV-2 RNA was identified on a variety of surfaces in cabins of both symptomatic and asymptomatic infected passengers up to 17 days after cabins were vacated on the Diamond Princess but before disinfection procedures had been conducted (Takuya Yamagishi, National Institute of Infectious Diseases, personal communication, 2020). Although these data cannot be used to determine whether transmission occurred from contaminated surfaces, further study of fomite transmission of SARS-CoV-2 aboard cruise ships is warranted.

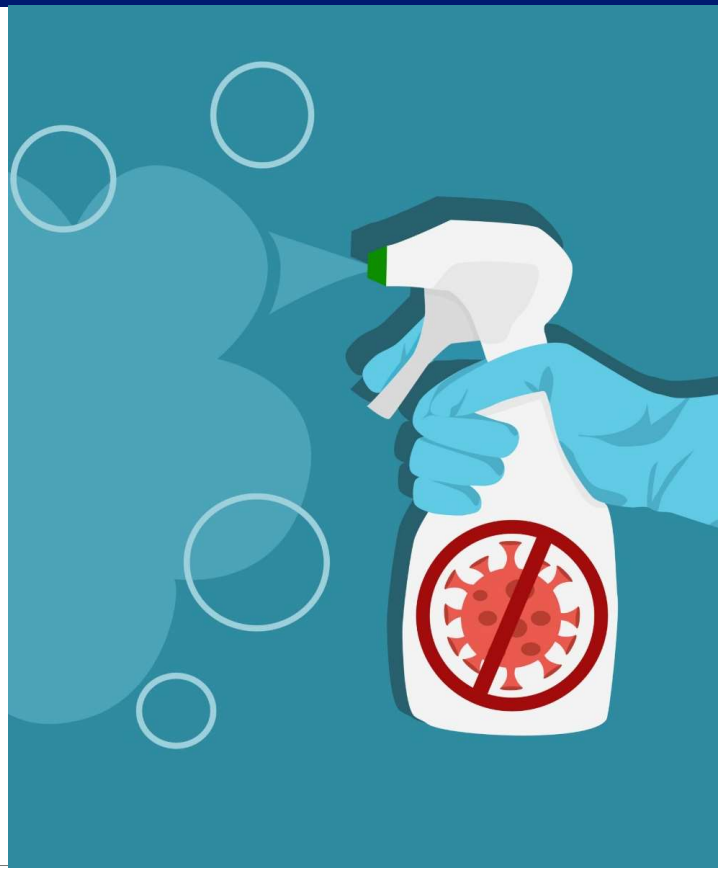
Cleaning and Disinfection

LEVEL 2 CLEANING AND DISINFECTION

LEVEL 2 - Enhanced cleaning and disinfectant application in areas potentially impacted by:

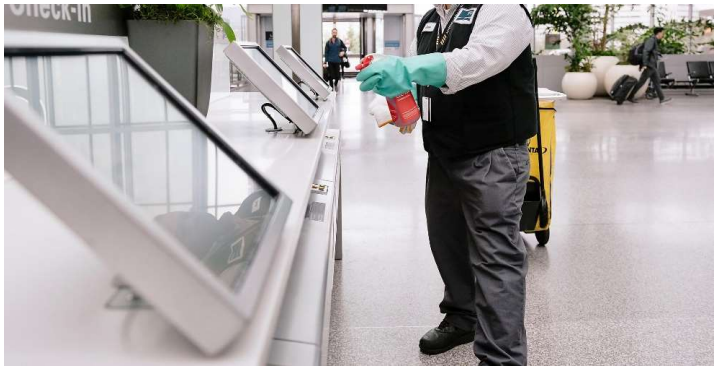
1) Individual who had close contact with a confirmed COVID-19 case <14 days ago, or

2) Individual identified as a confirmed COVID-19 case, but it has been *more than 72 hours* since they have been in the building



Level 2 Cleaning and Disinfection

- Address **High Contact Surfaces**: doorknobs, elevator buttons, security desks, handrails, computer equipment, telephones, etc.
  - Move from one end of the space to the room exit
  - Wear appropriate PPE per SDS
- Disinfectant must meet the EPA's criteria for use against SARS-CoV-2[2]
- Widespread fogging/spraying not necessary for Level 2



[2] https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2-covid-19

LEVEL 3 CLEANING AND DISINFECTION

LEVEL 3 – Deep cleaning and disinfectant application in areas potentially impacted by:

1) Individual identified as a confirmed COVID-19 case, and it has been less than 72 hours since they have been in the building

LEVEL 3 CLEANING AND DISINFECTION

- Address **High Contact and Low Contact Surfaces**
- Low Contact refers to material surfaces where direct contact may not exist but may have been proximal to the infected person (e.g., floors, walls, chairs, tables, stairs, light fixtures)
  - 3rd Party Cleaning Contractor Recommended
  - Move from one end of the space to the room exit
  - Wear appropriate PPE per SDS

FOGGING/ELECTROSTATIC APPLICATION

EPA FAQ: Can I use fogging, fumigation, or electrostatic spraying to help control COVID-19? [3]

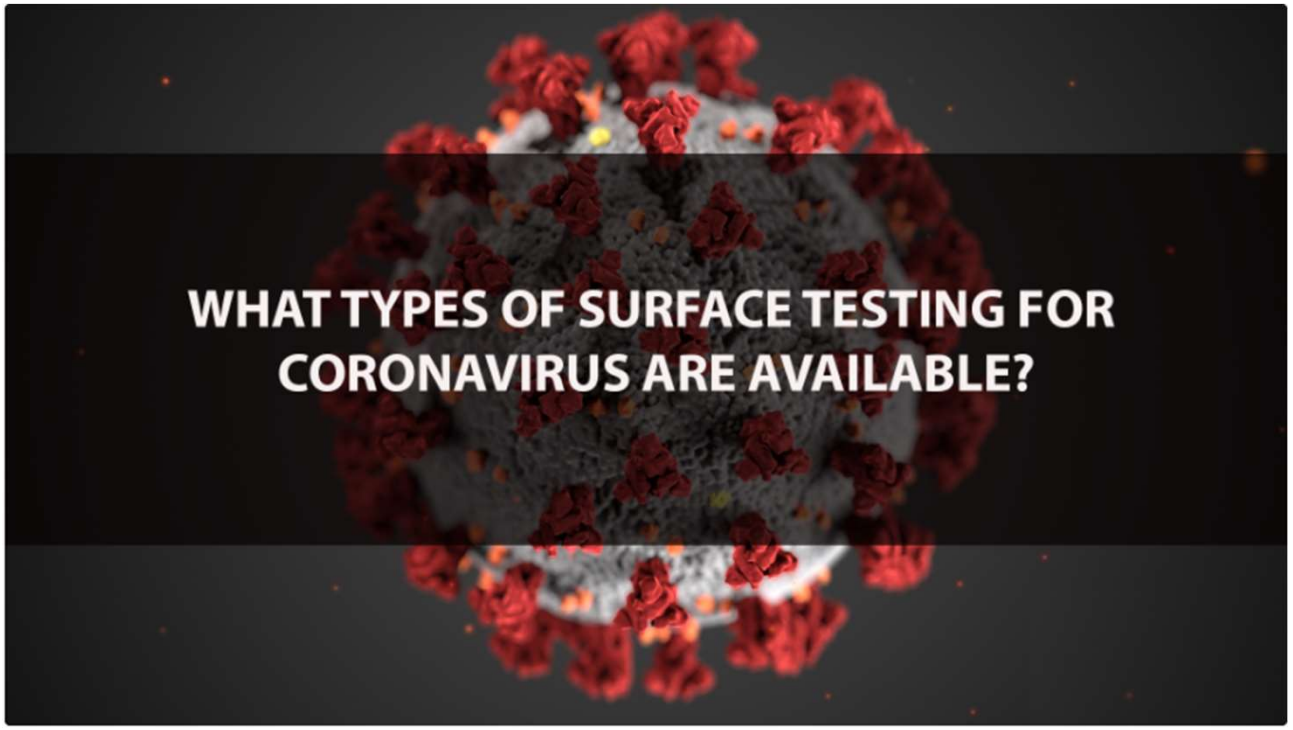
Unless the pesticide product label specifically includes disinfection directions for fogging, fumigation, or wide-area or electrostatic spraying, EPA does not recommend using these methods to apply disinfectants. EPA has not evaluated the product's safety and efficacy for methods not addressed on the label.

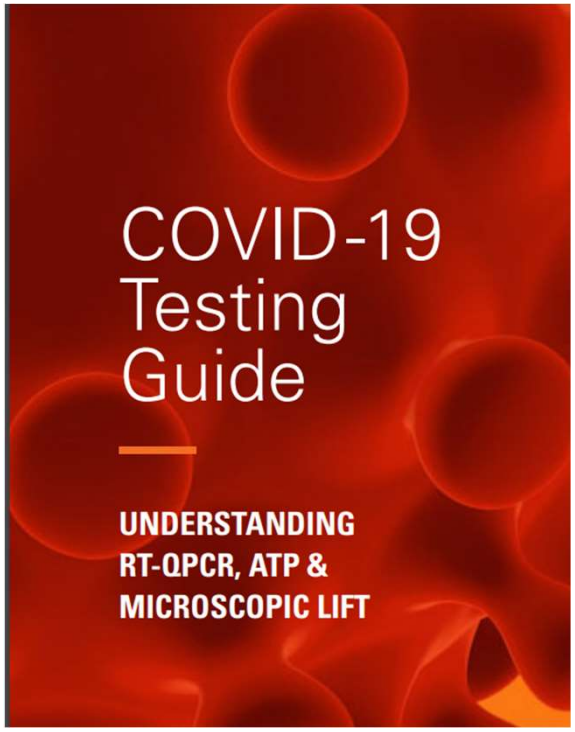
A disinfectant product's safety and effectiveness may change based on how you use it. If a pesticide product's label does not include disinfection directions for use with fogging, fumigation, wide-area, or electrostatic spraying, EPA has not reviewed any data on whether the product is safe and effective when used by those methods.

[3] https://www.epa.gov/coronavirus/frequent-questions-about-disinfectants-and-coronavirus-covid-19

Surface Testing for Cleaning Verification

Surface Survivability

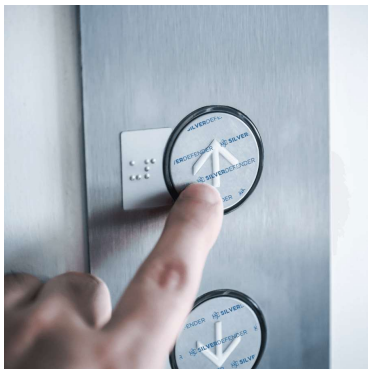




Emerging Technology

Antimicrobial and Self-Cleaning Surfaces

Emerging Technology



ANTIMICROBIAL SURFACES

Emerging Technology

Antimicrobial is a term that broadly refers to products that act against bacteria (antibacterial), fungi (antifungal), and viruses (antivirus).

- It cannot be assumed that an antimicrobial product that is effective against bacteria will also be effective against SARS-CoV-2.
- Does the product have an EPA-approved label indicating it is effective at killing viruses?

Pros:

- Can effectively disinfect viruses on high-touch surfaces if the product is EPA-registered and has an emerging viral pathogen claim
- May kill other, non-viral infectious agents (such as bacteria) on high-touch surfaces
- Provides a cleaner-looking surface appearance
- Low maintenance and continuously functioning

Cons:

- Limited evidence that antimicrobial surfaces are effective against viruses, including the SARS-CoV-2 virus
- Routine manual cleaning and disinfectant application will still need to be performed on antimicrobial surfaces that are not EPA-registered as effective against SARS-CoV-2
- Antimicrobial products may contain potentially hazardous chemicals (e.g., quaternary ammonium)

ANTIMICROBIAL SURFACES

Emerging Technology

SurfaceWise^2 Antiviral Surface Coating

- EPA approved public health emergency waiver (currently for use in Texas)
- Per EPA – inactivates viruses within 2 hrs and effective for up to 7 days.

surfaceWISE

"Independent lab studies conducted ahead of the emergency waiver approval by leading infectious disease expert Dr. Charles Gerba found SurfaceWise^2 to be effective against Human Coronavirus 229E, the EPA approved surrogate, for 90 days." [4]

[4] https://www.alliedbioscience.com/pressroom/surfacewise2-becomes-first-antiviral-surface-coating-approved-by-epa-to-continuously-protect-against-covid-19-with-a-single-application/

Self-Cleaning Surfaces

Emerging Technology

Self-cleaning surfaces use materials that reflect light to degrade organic material deposited on their surface.

- Unlike antimicrobials, these products do not require registration with the EPA and will not have an EPA product label claiming they are effective against viruses.

Pros:

- Provides a cleaner-looking surface appearance
- Low maintenance and continuously functioning

Cons:

- Not EPA-registered; routine manual cleaning and disinfectant application will still need to be performed with an EPA-registered disinfectant that meets their criteria for use against SARS-CoV-2
- No EPA-product label with instructions for use against SARS-CoV-2 or human coronaviruses
- Limited evidence that self-cleaning surfaces are effective against viruses

ELECTRONIC AIR CLEANERS

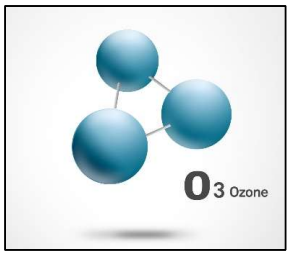
Emerging Technology

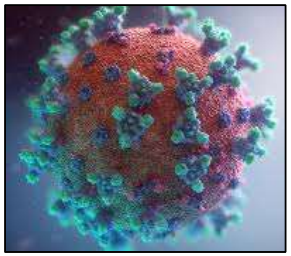
Non-thermal Plasma Air Cleaner

Emerging Technology

These devices use electricity to produce a plasma field that converts oxygen molecules into oxygen-based oxidizing molecules, including **ozone** and reactive oxygen species (ROS).

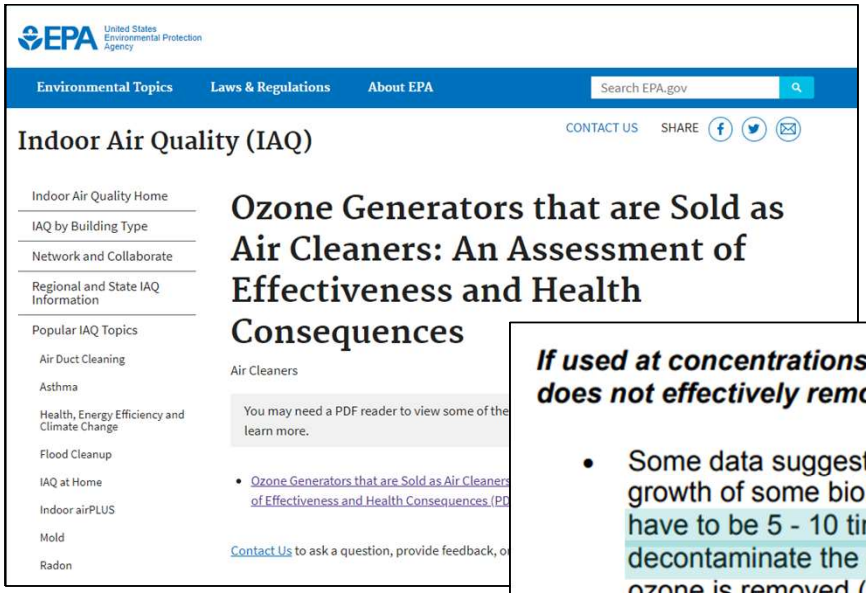
- Ozone and ROS are highly-reactive compounds that, when present at high concentrations, can disrupt components of various microorganisms, such as the cell wall of bacteria or the membrane capsule of a virus, rendering these pathogens inactive.
- Ozone is harmful to health and exposure can create risk for a variety of symptoms and diseases of the respiratory tract





OZONE GENERATORS

Emerging Technology



If used at concentrations that do not exceed public health standards, ozone applied to indoor air does not effectively remove viruses, bacteria, mold, or other biological pollutants.

- Some data suggest that low levels of ozone may reduce airborne concentrations and inhibit the growth of some biological organisms while ozone is present, but ozone concentrations would have to be 5 - 10 times higher than public health standards allow before the ozone could decontaminate the air sufficiently to prevent survival and regeneration of the organisms once the ozone is removed (Dyas, et al.,1983; Foarde et al., 1997).

- Even at high concentrations, ozone may have no effect on biological contaminants embedded in porous material such as duct lining or ceiling tiles (Foarde et al, 1997). In other words, ozone produced by ozone generators may inhibit the growth of some biological agents while it is present, but it is unlikely to fully decontaminate the air unless concentrations are high enough to be a health concern if people are present. Even with high levels of ozone, contaminants embedded in porous material may not be affected at all.

[5] https://www.epa.gov/indoor-air-quality-iaq/ozone-generators-are-sold-air-cleaners-assessment-effectiveness-and-health

Non-thermal Plasma Air Cleaner

Emerging Technology

Pros:

- At high concentrations, ozone and ROS can disrupt the membranes of microorganisms such as bacteria and encapsulated viruses, rendering them inactive.
- Building occupants and prospective clients may view installation of these products positively in the current climate, providing a marketing benefit to buildings that install these systems regardless of how effective they are.

Cons:

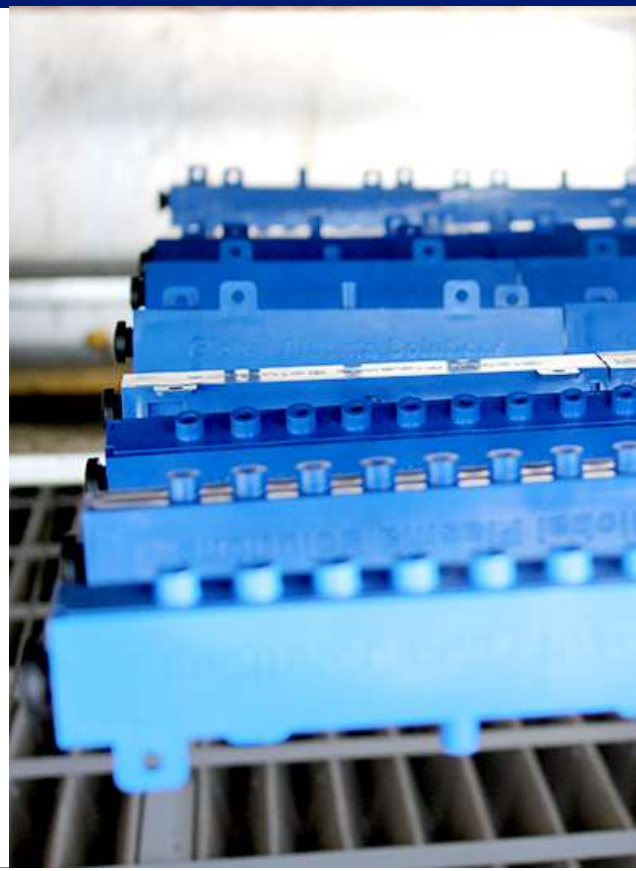
- Limited evidence that these products are effective against viruses, including the SARS-CoV-2 virus
- These systems generate ozone that is harmful for health and can create risk for a variety of symptoms and diseases of the respiratory tract. This could be an issue particularly in urban environments that already have elevated ozone levels.
- To be effective against viruses or other biological pollutants, these systems would likely need to generate much greater ozone and ROS concentrations that would be a health concern if people are present.
- Ozone-generating air cleaners can also negatively impact air quality by creating ultrafine particulates and aldehydes.

NEEDLEPOINT BIPOLAR IONIZATION

Emerging Technology

When installed in an HVAC system, these devices produce ions that can attach to airborne particles and allow them to grow in size to be filtered out of the air.

- Can improve indoor air quality by removing dust and other particle pollutants (smoke, allergens)
- Can improve performance of HVAC system
- Produce less ozone, some certified as “ozone free”
- Little potential to address infectious droplets in an occupied space



Needlepoint Bipolar Ionization

Emerging Technology

Pros:

- Needlepoint bipolar ionization systems can provide general air quality improvements through the reduction of airborne particle pollutant levels.
- Products with UL 867 and UL 2998 certifications emit less ozone than other ionizing air cleaners (e.g., corona discharge).
- Building occupants and prospective clients may view installation of these products positively in the current climate, providing a marketing benefit to buildings that install these systems regardless of how effective they are for COVID-19.

Cons:

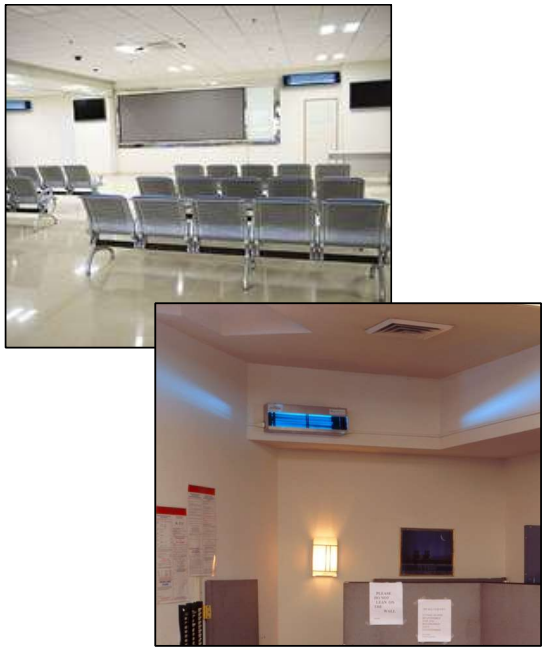
- Limited evidence that needlepoint bipolar ionization systems are effective against viruses, including the SARS-CoV-2 virus.
- When installed in an HVAC, these systems will have little potential to address the main way COVID-19 spreads (person-to-person spread by respiratory droplets).
- These systems generate ozone (albeit much less than other ionizing air cleaners) that is harmful for health and can create risk for a variety of symptoms and diseases of the respiratory tract. This could be an issue particularly in urban environments that already have elevated ozone levels.
- Some evidence that electronic air cleaners can negatively impact air quality by creating ultrafine particulates and aldehydes.

GERMICIDAL ULTRAVIOLET PRODUCTS

Emerging Technology

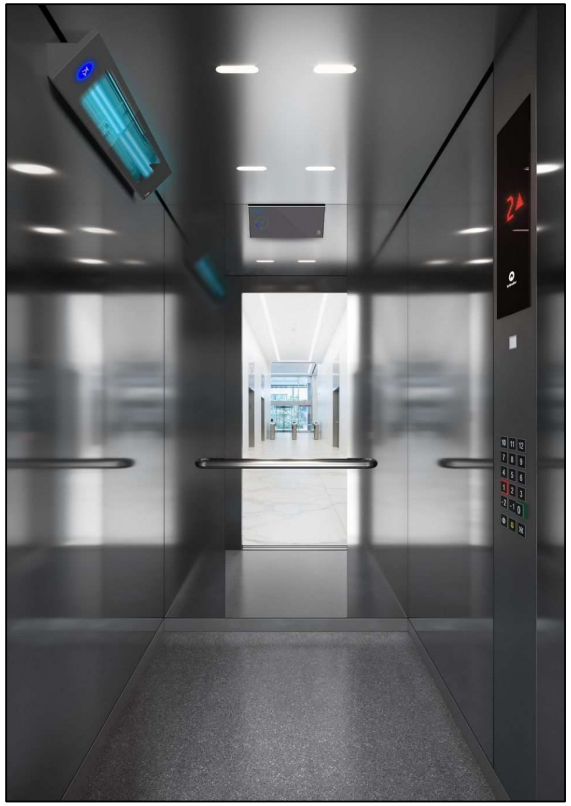
Germicidal ultraviolet (GUV) products use UV energy to inactivate viruses, bacteria, mold, spores or fungi.

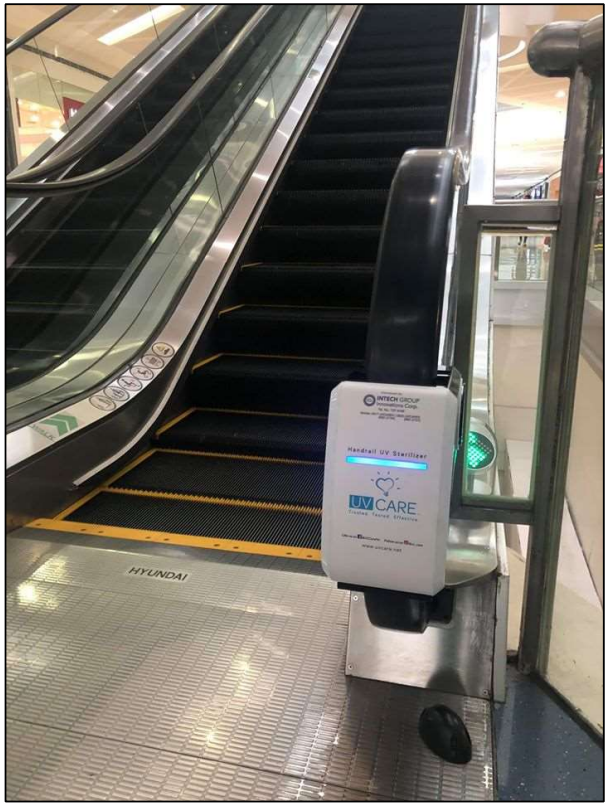
- UV-C photons interact with genetic material of a virus to render it non-infectious
- Effective ONLY if it directly illuminates the virus at a dose (i.e., intensity and contact time) sufficient to damage the genetic material.
- Most effective of these methods is upper-room GUV
- GUV in air ducts and in-room air cleaners (e.g., elevators) do not typically offer satisfactory disinfection results



GERMICIDAL ULTRAVIOLET PRODUCTS

Emerging Technology





GERMICIDAL ULTRAVIOLET PRODUCTS

Emerging Technology

Pros:

- In the appropriate dose, GUV has been shown to be capable of inactivating viruses such as SARS-CoV-2
- GUV can treat large quantities of air in a relatively short amount of time using an upper-room GUV.
- GUV can provide a secondary means of treatment and disinfection following use of traditional cleaning methods.

Cons:

- Use of GUV-products requires expertise to design, install, and maintain to ensure both adequate disinfection and proper safety procedures are effective.
- Use of UV-C technologies can introduce an occupational hazard if appropriate engineering and administrative controls are not applied.
- Use of GUV surface cleaning may require prolonged contact time or pre-cleaning to remove dust to be effective.
- GUV, specifically UV-C light can cause degradation of surrounding materials (i.e. paint and plastics) located in the treatment area

Vaccine Progress

VACCINES

Vaccine Progress

More than 170 vaccines are being tested in animal labs and lab experiments

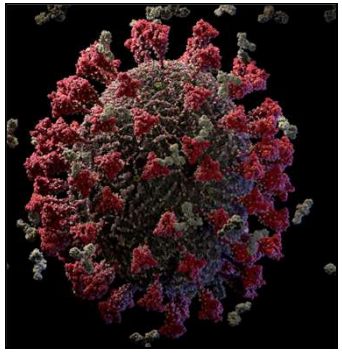
- 15 vaccines are being tested in a small number of healthy, young people to assess safety and correct dose (Phase 1)
- 3 vaccines are broadened to a larger group of people, including people of higher risk of illness (Phase 2)
- 7 vaccines are being tested in thousands of people to check their effectiveness and safety (Phase 3)
- No vaccines have been approved for use in the U.S.

https://www.washingtonpost.com/graphics/2020/health/covid-vaccine-update-coronavirus/

VACCINE PROSPECTS

Vaccine Progress

Moderna Therapeutics: mRNA-1273



- **Who**: A Massachusetts-based biotech company, in collaboration with the National Institutes of Health (NIH)
- **What**: Candidate relies on injecting *viral messenger RNA (mRNA)* into human cells. They create viral proteins that mimic the coronavirus's spike proteins, training the immune system to recognize its presence. This technology has never been licensed for any disease. If successful, it would be the first mRNA vaccine approved for human use
- **Status**: Started the third phase of its clinical trials on July 27, even as phase two results were still being monitored. Phase one findings showed that healthy subjects—including elderly patients—produced coronavirus antibodies and a reaction from T-cells, another arm of the human immune response. Phase three will test the vaccine in 30,000 U.S. participants. Moderna says it is on track to deliver at least 500 million doses per year beginning in 2021, thanks in part to their deal with Swiss manufacturer Lonza that will allow it to manufacture up to one billion doses a year.

https://www.nationalgeographic.com/science/health-and-human-body/human-diseases/coronavirus-vaccine-tracker-how-they-work-latest-developments-cvd/

VACCINE PROSPECTS

Pfizer: BNT162b2

- **Who**: Large pharmaceutical company in collaboration with German biotech company BioNTech
- **What**: Pfizer and BioNTech are also developing an *mRNA vaccine* based on the German company's earlier efforts to use the technology in experimental cancer vaccines. Pfizer has signed a nearly $2 billion contract with the U.S. government to provide 100 million doses by December 2020—an agreement that goes into effect when and if the drug is approved and delivered.
- **Status**: Trial that combines phases two and three was launched on July 27. It will examine the vaccine's effect in 30,000 people from 39 U.S. states and from Brazil, Argentina, and Germany. The project is aiming to seek regulatory review as early as October 2020 to meet the December deadline—and hopes to supply 1.3 billion doses by the end of 2021. Preliminary results of phase one/two data show the vaccine produces antibodies and T-cell responses specific to the SARS-CoV-2 protein.

https://www.nationalgeographic.com/science/health-and-human-body/human-diseases/coronavirus-vaccine-tracker-how-they-work-latest-developments-cvd/

VACCINE PROSPECTS

Vaccine Progress

University of Oxford and Astrazeneca: ChAdOx1 nCoV-19

- **Who**: UK university in collaboration with biopharmaceutical company Astrazeneca
- **What**: This candidate is a *viral vector vaccine*. The coronavirus's spike proteins have been transferred to a weaker virus that causes the common cold. When injected into humans, the spike proteins can trigger an immune response. Group plans to produce a billion doses.
- **Status**: First two clinical trial phases showed strong immune response, including increased antibodies and responses from T-cells—with only minor side effects such as fatigue and headache. It is in phase three of clinical trials, aiming to recruit up to 50,000 volunteers in Brazil, the United Kingdom, the United States, and South Africa. On September 8, AstraZeneca paused the trials for a safety review due to an adverse reaction in one participant in the U.K. After an investigation by independent regulators, the trials resumed on September 12.

https://www.nationalgeographic.com/science/health-and-human-body/human-diseases/coronavirus-vaccine-tracker-how-they-work-latest-developments-cvd/

UNCERTAINTIES

Safety Concerns – Adverse Reactions

- It's not uncommon that adverse reactions are observed during a clinical trial. The trials may continue following an evaluation of the severity of the event.
  - Astrazenca vaccine development temporarily paused due to report of spinal cord inflammation
- Scientists and authorities have to weigh the risk of uncommon side effects against a vaccine that can curb the pandemic.

How/when will they be distributed, and will there be sufficient supply?

- It's unclear how they will be distributed in US, however the US has begun purchasing doses
- FDA has promised to fast-track the approval process, while the CDC has asked governors to fast-track permits and licenses for vaccine distribution sites so that they can be operational by November 1, 2020.

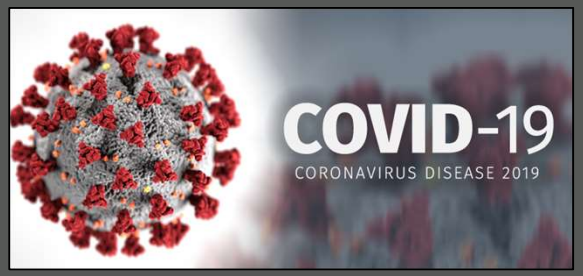
Public uptake

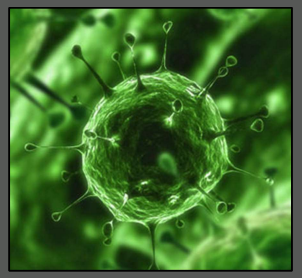
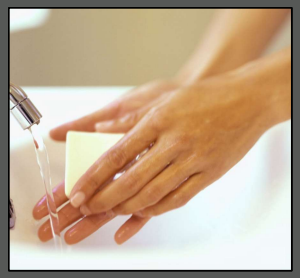
- Public will need convincing to take the shot
- WHO, US National Institute of Allergy and Infectious Diseases goal is to establish immunity in 70 percent of population
- Minimum acceptable would be a vaccine that was 50 percent effective (70-75 percent goal)

How long will protection last?

- Only a handful of vaccines generate lifetime immunity for most people
  - Ex: Measles (96% effective - 1 dose); Polio (100% effective – 3 doses)
- Understanding how long a shot protects against re-infection can take months or years of study
- Because the COVID-19 vaccine trial phases are being compressed to expedite delivery, less will be known about durability of immunity than normal
- Growing number of studies suggest patients have a robust immune response while fighting COVID-19 - although antibody levels may decline over weeks to months
  - Preliminary results of Moderna, Pfizer, and Astrazeneca vaccines are demonstrating promising immune responses

Q&A



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