



Disinfectant Exposure Monitoring and COVID-19: When Worlds Collide





Brian Petuch, ISS Inc.

India employs
disinfection tents to
slow COVID-19
spread



- Indiscriminate use of disinfection for Covid19
 - Tunnel with spray
 - Manual spray in offices with pumps
 - Wiping
- Controlled use of disinfection in pharma industries
 - Biopharma sites
 - Other disinfectants
 - Less attention compared to highly potent compounds
- Overexposure identified as a concern
- Potential impact on occupational health





Disinfectants Used

- Sporklenz
 - Hydrogen peroxide 1%
 - Peracetic acid (PAA) 0.08%
 - Acetic acid <10%
- Sporklenz wipes
 - H₂O₂ >3%
- 70% IPA
- Hydropure
 - Hydrogen peroxide 6%
- Classic Perform EP (25% ethanol, 35% IPA)
- Klercide 70/30 (70% Ethanol)
- Prochlor, Calcium hypochlorite 0.2%, emits chlorine



Disinfectants

- Decon-Spore Plus 200
- Hydrogen peroxide 25%-29%
 - Peracetic acid (PAA) 5%- 6%
 - Acetic acid 5%-10%
- Steri-Perox 6%
 - H₂O₂, 2.2%, 6.9%
- Perform Classic PAA (1% solution used for walls and floors)
- PAA – 6.2%
 - H₂O₂ – 20% to 30%
 - Acetic acid 10% to 25%



Other Disinfectants Used

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Name	Ingredients	Percentage
Sanosil S003	Hydrogen peroxide	0-1.5%
	Orthophosphoric acid	0-0.1%
Byotrol	Dodecyl dipropylenetriamine	1-5%
	Lactic acid	1-5 %
	Polyhexamethylene biguanide hydrochloride	<1 %
Sanitas Procsan	2-aminoethanol (ethanolamine)	1-<25%
	Quaternary ammonium compounds - Didecyldimethylammonium chloride	1-<25%
	Propan-2-ol	1-25%
Steri-7- concentrate	Propan-2-ol	1-10 %
	Diethanolamine	1-10%
	Quaternary ammonium compounds - Didecyldimethylammonium chloride	1-10%
	Polyhexamethylene biguanide hydrochloride	<1 %
	Quaternary Ammonium Compounds, Benzyl-C12-16- Alkyldimethyl, Chlorides	< 1%
Germocid Inodore	Quaternary Ammonium Compounds- Benzalkonium chloride	10%
	O-phenyl phenol	1%
AntiSapril	Sodium hypochlorite	2.80%
	Sodium hydroxide	0.50%
Virosil	Hydrogen peroxide	5% or 10%

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Hydrogen Peroxide Health Effects and OEL

Health Effects	Acute pulmonary edema, irritation to eyes, nose, throat; corneal ulcer; erythema (skin redness). Skin blisters, gastritis and esophagitis.
Occupational Exposure Limit (OEL) – Time Weighted Average (ACGIH-TLV)	1 ppm
Short Term Exposure Limit (UK-Health & Safety Executive)	2 ppm



Peracetic Acid Health Effects and OEL

Health Effects	Burning sensation. Cough. Laboured breathing. Shortness of breath. Sore throat. Skin Redness, blisters and skin burns
Occupational Exposure Limit (OEL) – Time Weighted Average (ACGIH-TLV)	NA
Short Term Exposure Limit (ACGIH-TLV)	0.4 ppm



Acetic Acid Health Effects and OEL

Health Effects	Irritation to eyes, skin, nose, throat; skin burns; skin sensitization; dental erosion; black skin, hyperkeratosis; conjunctivitis, lacrimation (discharge of tears); pharyngeal edema, chronic bronchitis
Occupational Exposure Limit (OEL) – Time Weighted Average (ACGIH-TLV)	10 ppm
Short Term Exposure Limit (ACGIH-TLV)	15 ppm



Isopropyl Alcohol Health Effects and OEL

Health Effects	Irritation to eyes, nose, throat; drowsiness, dizziness, headache and dry cracking skin
Occupational Exposure Limit (OEL) – Time Weighted Average (ACGIH-TLV)	200 ppm
Short Term Exposure Limit (ACGIH-TLV)	400 ppm



Ethyl Alcohol Health Effects and OEL

Health Effects	Irritation to eyes, skin, nose; headache, drowsiness, lassitude (weakness, exhaustion), narcosis; cough; liver damage; anaemia; reproductive, teratogenic effects. Confirmed Animal Carcinogen.
Occupational Exposure Limit (OEL) – Time Weighted Average (ACGIH-TLV)	NA
Short Term Exposure Limit (ACGIH-TLV)	1000 ppm



Chlorine Health Effects and OEL

Health Effects	Burning of eyes, nose, mouth; lacrimation (discharge of tears), rhinorrhea (discharge of thin nasal mucus); cough, choking, substernal pain (occurring beneath the sternum); nausea, vomiting; headache, dizziness; pulmonary edema; pneumonitis; hypoxemia (reduced O ₂ in the blood); dermatitis
Occupational Exposure Limit (OEL) – Time Weighted Average (ACGIH-TLV)	0.1 ppm
Short Term Exposure Limit (ACGIH-TLV)	0.4 ppm



Diethanolamine Health Effects and OEL

Health Effects	As per IARC - possibly carcinogen to humans (Group 2B). Irritation to eyes, skin, nose, throat; eye burns, corneal necrosis; skin burns; lacrimation (discharge of tears), cough and sneezing. Confirmed Animal Carcinogen as per ACGIH.
Occupational Exposure Limit (OEL) – Time Weighted Average (ACGIH-TLV)	1 mg/m ³
Short Term Exposure Limit (ACGIH-TLV)	NA



O-benzyl-p-chlorophenol Health Effects (LpH and Vesphene)

Health Effects	As per US EPA - Possible Human Carcinogen (group C), Burning pain in mouth & throat. White necrotic lesions in mouth, esophagus & stomach. Pallor, sweating, weakness, headache, dizziness and tinnitus
Pharmaceutical company recommended Occupational Exposure Band	OEB-3



Disinfectant Exposure Study

- Reviewed
 - 2000+ results
- Identified and analysed
 - 99 similar exposure groups with about 936 personal breathing zone results
- Sorted
 - Removed all area samples
 - Removed all direct reading measurements



Lessons -Disinfectant of Choice

- Prochlor is preferred over all other disinfectants
 - 98% of tasks with chlorine exposures below short term limit
 - Long-term chlorine exposures have potential to exceed long term exposure limits – this is concern at 3 of 15 sites studied
 - Cost less
 - No fire potential risk unlike IPA/Ethanol
- Avoid Hydropure (6% Hydrogen Peroxide), Classic Perform EP (25% ethanol) and Klercide (70% ethanol)
 - >75% hydrogen peroxide and ethanol exposures above exposure limits
- Avoid disinfectants with high % of hazardous chemicals
 - Decon-Spore Plus 200 containing 25%-29% hydrogen peroxide and 5% to 6% PAA%

Disinfectant
of choice in
order of
priority:

Prochlor



IPA wipes



Sporklenz



Lessons : Material/Equipment Vs Room Disinfection

- High exposure in material disinfection compared to room disinfection
- 90% of room disinfection exposures with Prochlor, Sporklenz below STEL
- 90% of room and material disinfection with Hydropure above STEL
- Initial indication: % of fresh air and Air Exchange Rate (ACH) did contribute to exposure



Lessons: Other Disinfectant Exposures

- Peracetic acid: Minimal exposure potential to exceed OEL – recent concerns for health effects
- LpH Ingredient Phosphoric Acid: Exposure is unlikely to be above OEL
- Vesphene Ingredient O-Phenyl Phenol:
- Exposure is unlikely to be above OEL

One of the Vesphene/LpH ingredients recently identified as reproductive hazard. Health risk assessment indicate minimal inhalation exposure potential



Lessons-Work Practices

- Exposure potential reduced significantly with work-practices controls
 - Less exposure with wipe than spray (except hydrogen peroxide wipe)
 - Discard wipes in self-closing container
 - Avoiding surfaces for wiping (e.g., dedicated items such as pallets in Grade C)
 - Use pre-impregnated or in-situ impregnated wipes to reduces exposures (for IPA, Prochlor; not for hydrogen peroxide)
 - Do not spray from a sprayer for room cleaning
- Do not enter area being disinfected without RPE
- Remove RPE after disinfection in area which is not contaminated



Re-entry after Disinfection

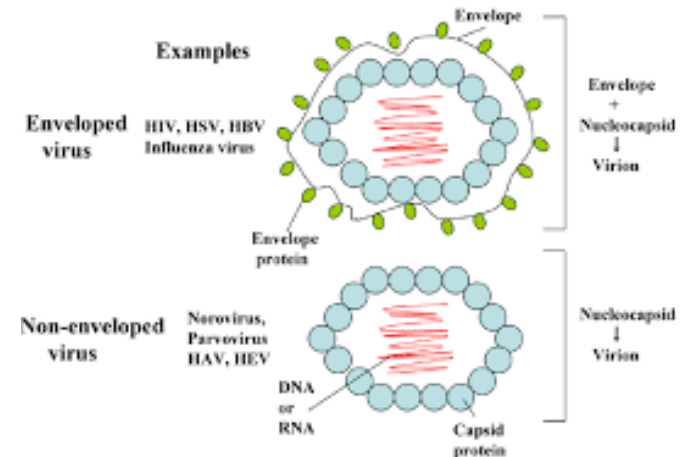
- Harmonization of re-entry time after disinfection based on area concentrations
- Re-entry time varies from immediately after disinfection to 3 hours after disinfection
- Conduct monitoring before re-entry with a direct reading instrument



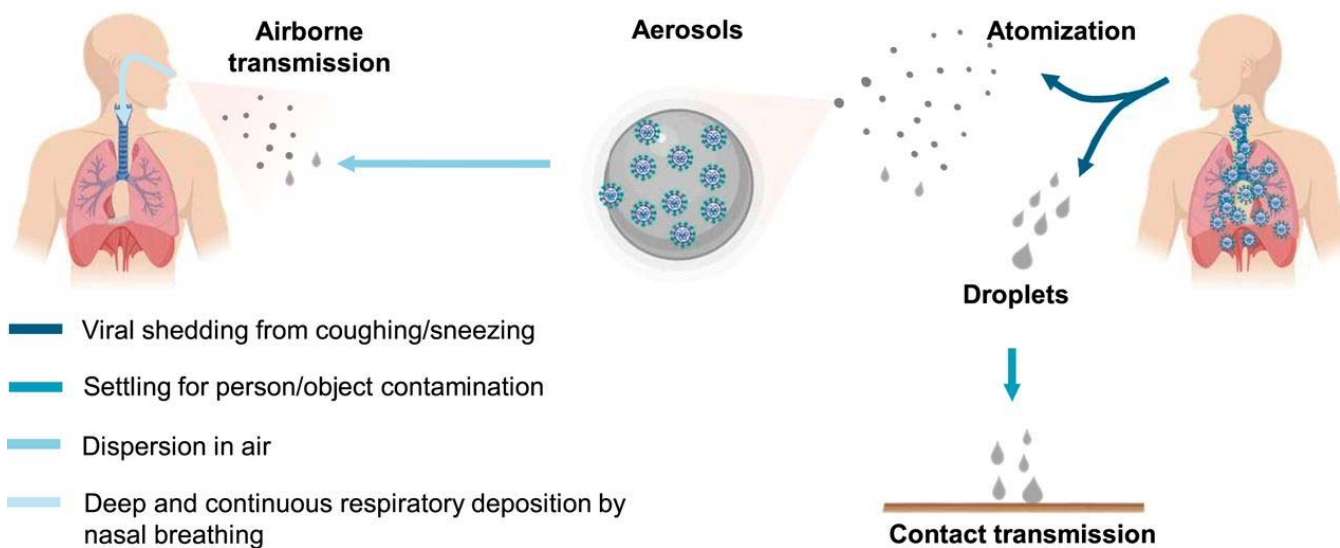


COVID-19 Disinfection

- COVID-19 is an enveloped virus.
- Envelope removal inactivates the virus particle.
- Lipid envelope easily damaged by soap & water, quaternary disinfectants and 1:10 diluted bleach.



COVID-19 Aerosol Transmission



Renyi Zhang et al. PNAS 2020;117:26:14857-14863

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Surface Testing

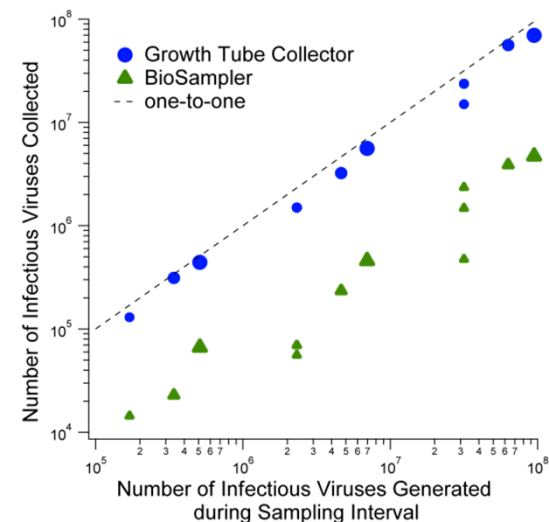
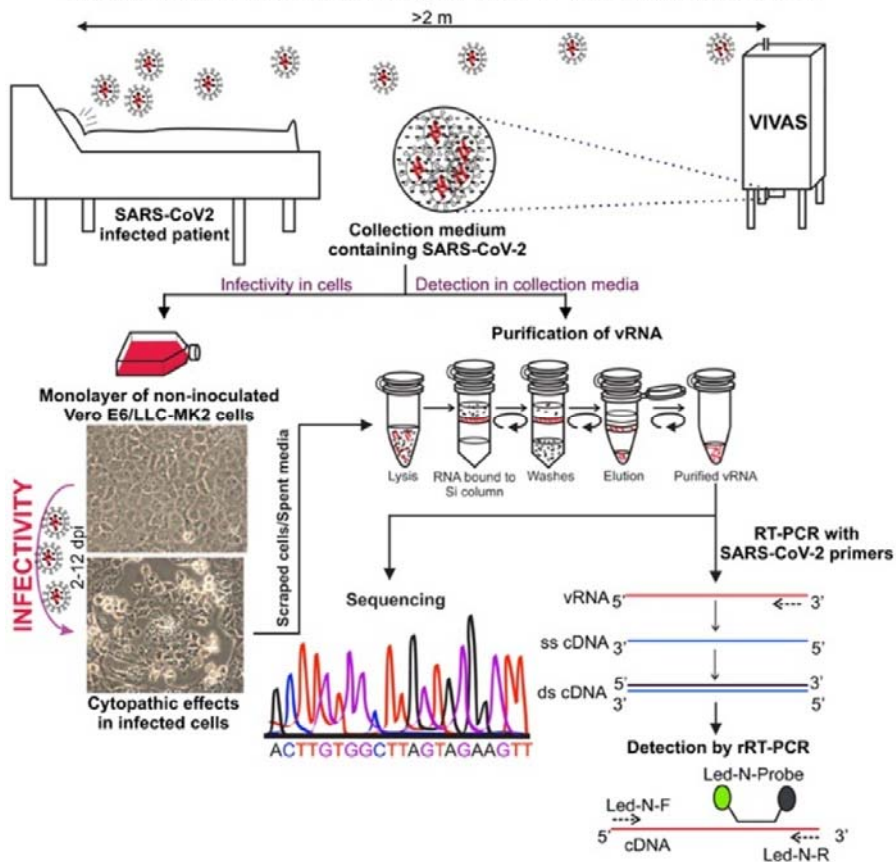
- Following cleaning, is surface testing needed?
Should we test to confirm COVID-19 is disinfected?
 - **NO**
 - PCR is most common test; tells you COVID-19 was there, based on genome fragments.
 - ATP luminescence swabs will not detect infectious virus.
 - Effectiveness determined by recovery of live virus, which requires advanced techniques.



Air Testing

- Can we test for COVID-19 in air samples, as done for bacteria and fungi?
 - NO
 - Air sampling is difficult, as capture methods disrupt viral envelope.
 - Viruses cannot be cultured on solid media.
 - Must be grown on specific mammalian cell lines; cell culture is beyond the capability of general environmental lab.
 - COVID-19 culture requires a BSL-3 facility due to infection risk.

CAN SARS-CoV-2 BE TRANSMITTED BY AEROSOL ?



HOW IT WORKS:

VIVAS uses the water-condensation growth tube to gently enlarge submicrometer airborne particles to form micrometer-sized droplets that are gently deposited into liquid. (<https://aerosol.us/vivas>, accessed 9/17/2020).



COVID-19 Aerosol Transmission

Mitigation Methodology

- HEPA Filtration
- UV-C Lights
- Air Recycle
- Local Exhaust
- Air Changes per Hour