Best Practices for Managing COVID-19 Waste

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COVID-19 in Context

COVID-19 is transmitted primarily through

- **Respiratory droplets** (and possibly **airborne aerosols**) from an infected person’s sneeze, cough, (and possibly speech), and
- **Touching a contaminated surface** and transferring the virus to the mouth, nose or eyes.

COVID-19 is

- **MORE contagious** than Ebola ... but much **LESS contagious** than polio, mumps, rubella, diphtheria, pertussis, or measles \(^1\)
- **MORE deadly** than the seasonal flu ... but much **LESS deadly** than MERS, H5N1 influenza A, Ebola, or untreated tetanus or rabies

1. Based on comparisons of published R0 values; 2. Based on estimates of average case fatality rates.
<table>
<thead>
<tr>
<th>Material</th>
<th>Infectious Duration</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper, tissue paper</td>
<td>3 hours</td>
<td>at 22°C and 65% relative humidity</td>
</tr>
<tr>
<td>Copper</td>
<td>8 hours</td>
<td>at 21-23°C</td>
</tr>
<tr>
<td>Aerosols in air</td>
<td>11 hours</td>
<td>at 21-23°C and 65% relative humidity</td>
</tr>
<tr>
<td>Cardboard</td>
<td>35 hours</td>
<td>at 21-23°C</td>
</tr>
<tr>
<td>Wood</td>
<td>2 days</td>
<td>at 22°C and 65% relative humidity</td>
</tr>
<tr>
<td>Cloth</td>
<td>2 days</td>
<td>at 22°C and 65% relative humidity</td>
</tr>
<tr>
<td>Glass</td>
<td>4 days</td>
<td>at 22°C and 65% relative humidity</td>
</tr>
<tr>
<td>Stainless steel</td>
<td>7 days</td>
<td>at 22°C and 65% relative humidity</td>
</tr>
<tr>
<td>Plastic</td>
<td>7 days</td>
<td>at 22°C and 65% relative humidity</td>
</tr>
</tbody>
</table>

Based on undetectable titre or 10 x half-life from TCID<sub>50</sub> data from laboratory studies: Chin et al., Lancet Microbe 2020; and Doremalen et al., N Engl J Med, 2020.
Key Point about COVID-19 Virus

SARS-CoV-2
(the coronavirus responsible for COVID-19)
is among the easiest pathogens to destroy.
## Hierarchy of Microorganism Resistance to Thermal and Chemical Disinfection

<table>
<thead>
<tr>
<th>MICROORGANISM</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prions</td>
<td>PrP responsible for Creutzfeldt-Jakob disease, mad cow disease, scrapie</td>
</tr>
<tr>
<td>Bacterial spores</td>
<td>Geobacillus stearothermophilus, Bacillus atrophaeus, B. anthracis spores</td>
</tr>
<tr>
<td>Coccidia</td>
<td>Cryptosporidium</td>
</tr>
<tr>
<td>Mycobacteria</td>
<td>Mycobacterium tuberculosis, M. terrae, M. phlei, M. bovis</td>
</tr>
<tr>
<td>Non-lipid or small viruses</td>
<td>Polio virus, Hepatitis A virus, MS-2 bacteriophage, coxsackievirus, norovirus, parvovirus, rhinovirus, adenovirus</td>
</tr>
<tr>
<td>Fungi</td>
<td>Aspergillus niger, Candida albicans, Penicillium chrysogenum</td>
</tr>
<tr>
<td>Vegetative bacteria</td>
<td>Staphylococcus aureus, Pseudomonas aeruginosa, Streptococcus pneumonia, E. coli, Salmonella spp., Enterococci</td>
</tr>
<tr>
<td>Lipid or medium-sized viruses</td>
<td>Human immunodeficiency virus (HIV), Hepatitis B virus, Influenza virus, Ebola filovirus, coronaviruses including <strong>SARS-CoV-2 virus</strong></td>
</tr>
</tbody>
</table>
What disinfectants (and contact time) inactivate SARS-CoV-2?

- **Chlorine (bleach or sodium hypochlorite)**
  - 1% and 2% bleach - within 5 minutes

- **Alcohol**
  - 70% ethanol - within 5 minutes
  - 50% isopropanol – about 10 minutes for coronaviruses

- **0.5% Hydrogen Peroxide** – about 10 minutes for coronaviruses

- **Other Disinfectants**
  - 7.5% povidone-iodine – within 5 minutes
  - 0.1% benzalkonium chloride – within 5 minutes
  - Chlorine dioxide, phenols, peroxyacetic acid

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3. WHO: Laboratory biosafety guidance, February 12, 2020
What disinfectants (and contact time) inactivate SARS-CoV-2?

Soap

- Hand soap (about 2% in water) – some virus detected after 5 minute soaking, no virus detected after 10 minutes soaking

1. A. Chin et al., *Lancet Microbe*, April

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What disinfectants (and contact time) inactivate SARS-CoV-2?

- **Soap**
  - Hand soap (about 2% in water) – within 10 minutes of soaking

Micelles trap remnants of the virus

At what temperature (and time) is SARS-CoV-2 inactivated?

Based on laboratory tests with the COVID-19 virus:

<table>
<thead>
<tr>
<th>TEMPERATURE</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 °C</td>
<td>Within 2 weeks</td>
</tr>
<tr>
<td>37 °C</td>
<td>Within 2 days</td>
</tr>
<tr>
<td>56 °C</td>
<td>Within 30 minutes</td>
</tr>
<tr>
<td>70 °C</td>
<td>Within 5 minutes</td>
</tr>
</tbody>
</table>

A. Chin et al., *Lancet Microbe*, April 2, 2020
If 70°C or 1% bleach inactivates CoV-2 in 5 minutes, then so will …

Any of the following medical waste treatment technologies ¹, ²

Gravity-Flow Autoclaves that typically operate between 121°C to 149°C for 60 to 30 minutes

Vacuum Autoclaves that typically operate at 121°C for 45 minutes or 135°C for 30 minutes

Hydroclaves that fragment and sterilize at 121°C for 30 minutes

Microwave units that typically operate at around 100°C for 30 minutes or more

Dry heat treatment systems that typically operate at 185°C for 90 minutes

Chemical disinfection methods with sodium hypochlorite (bleach) or non-chlorinated chemical disinfectants

Validation: > 4 Log kill of *Geobacillus stearothermophilus* or *Bacillus atrophaeus* spores

². Y. Chartier, J. Emmanuel et al., Safe management of wastes from health care activities, WHO, 2014
Do we need INCINERATION or PLASMA PYROLYSIS for COVID-19 waste?

Bio-Medical Waste Management Rules require incineration or plasma pyrolysis at $800^\circ C + 1050^\circ C$ or at $>1200^\circ C$ for:

- Anatomical waste, pharmaceutical waste, and chemical waste

But this is overkill and could worsen the situation for bio-medical wastes that can be treated using autoclaves, microwaves, dry heat, chemical disinfection, etc.

Sharps, wastes contaminated with blood and body fluids, contaminated linens, microbiological cultures and stocks, contaminated recyclable waste, and contaminated glassware.
Two Pressing Side Issues

Why could Incineration, Pyrolysis and Gasification of biomedical waste worsen the situation?

1. Recent findings regarding emissions from incinerators, pyrolysis and gasification technologies
   - Continuous monitoring of highly toxic dioxins/furans is essential to protect public health but this is not required in India and most developing countries

2. Very recent findings regarding toxic air pollutants from incineration, pyrolysis and gasification in relation to COVID-19
Particulate Matter and COVID-19 Mortality

- Particulate Matter (PM) limit for incineration/pyrolysis under Bio-Medical Waste Management Rule:
  50 mg/Nm$^3$ (or 50,000 μg/Nm$^3$)

- Particulate Matter and COVID-19 Mortality Rate:

  “A small increase in long-term exposure to PM$_{2.5}$ leads to a large increase in the COVID-19 death rate.”

  “… [A]n increase of only 1 μg/m$^3$ of PM$_{2.5}$ is associated with an 8% increase in the COVID-19 death rate ....”

X Wu, RC Nethery, BM Sabath, D Braun, F Dominici. Exposure to air pollution and COVID-19 mortality in the United States: A nationwide cross-sectional study. medRxiv 2020.04.05.20054502; doi: https://doi.org/10.1101/2020.04.05.20054502

Follow basic standard procedures

**Rigorous segregation at the point of generation** (separate infectious from non-infectious wastes in proper color-coded, marked bins)

**Regular cleaning and disinfection** (disinfect surfaces of commonly touched items such as waste containers, trolleys, door handles, etc.)

Provide **personal protection equipment** (mask, face shield, heavy duty gloves, long-sleeve gown and boots) to waste workers and train them in frequent hand hygiene and **hand hygiene after PPE removal**

Use **environmentally sound treatment methods**

- Use autoclaves, microwaves, hydroclaves, dry heat systems, and other environmentally sound treatment methods where possible
- Follow validation procedures to ensure high level disinfection

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1. WHO: Water, sanitation, hygiene and waste management for COVID-19 virus, April 23, 2020

Environmental Cleaning

**Blood spills:** 1% bleach $^1$

**General surface cleaning:** 0.5% or 0.1% bleach $^{1,2}$

**General cleaning of non-critical items:** 0.05% bleach for 10 minutes

**Washing of contaminated linen:** soak in 0.05% bleach for 30 minutes $^{2,3}$ and then wash in soap and hot/warm water

NOTES regarding bleach (sodium hypochlorite):

- Organic matter such as body fluids can inactivate bleach.
- High concentrations can be corrosive to the eyes, skin and respiratory tract. Mixing with acids releases deadly chlorine gas.
- Bleach degrades with time, heat, and when exposed to the sun. Prepare fresh bleach solutions regularly.

Spent or used bleach solutions can be used to disinfect toilets or clean-up blood spills. They can be neutralized, left under the sun to decompose or otherwise properly disposed of.

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1. WHO: Laboratory biosafety guidance, February 12, 2020

- Disposable PPE wastes (especially face masks and gloves) are now a major source of pollution on land and in the world’s seas and oceans \(^1\)

- Possible Solutions:
  - **Use reusable PPE masks** (elastomer respirators with replaceable cartridges, powered air-purifying respirators, etc.) &
  - **Provide guidelines and training on proper disinfection, fit testing, and use of reusable respirators**

1. PPE found in global seas and ocean (Opération Mer Propre, France); masks found off Hong Kong coasts (OceansAsia); masks and gloves floating and scattered across seabeds (Plastic Soup Foundation); a lot of PPE ending up in the ocean (The Ocean Foundation).

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\(^1\) PPE collected from the sea.

NOTES ON PPE REUSE FOR FRONTLINE HEALTH WORKERS

1. Respirators (including N95 facemasks) are recommended for use during aerosol generating procedures and other high risk activities. High filtration efficiency and fit testing to ensure facial seal are important.

2. Single-use “filtering facepiece respirators” (such as N95, N99, N100 in the US; FFP2 and FFP3 in Europe; KN95, KN99, KN100 in China; P2 and P3 in Australia, New Zealand and Brazil; or DS2 and DS3 in Japan) CANNOT be treated for reuse using bleach, soap & water, autoclaving, alcohol, etc. since they degrade the electret (surface charge essential for achieving high filtration efficiencies) and could degrade the non-woven polymer fibers of the mask.

3. Some treatment methods (e.g., vapor hydrogen peroxide, ultraviolet germicidal irradiation, dry heat) may allow decontamination and reuse of single-use N95 or FFP2 masks but only for a limited number of decontamination cycles.

Other Possible Solutions:

- Provide guidelines on decontamination and safe reuse of other reusable PPE (face shields, nitrile gloves, reusable gowns, cloth masks, etc.) and training on proper disinfection, storage, and reuse.

Sample procedure for decontamination:

1. Soak in soap and hot/warm water (water temperature depends on material) for 30 minutes
2. Rinse well
3. Soak in 1% bleach for another 30 minutes
4. Rinse to remove bleach
5. Dry under the noon-day sun for two hours

1. Experiments with SARS-CoV-2 in simulated saliva and culture medium showed that 90% of the virus was inactivated every 6.8 – 14.3 minutes under simulated sunlight. Ratnesar-Shumate et al. J Infectious Diseases 2020; Schuit et al. J Infectious Diseases 2020.

2. Theoretical studies indicate a 90% infectivity reduction of SARS-CoV-2 under the noon day sun in 11 minutes and 99% inactivation in 2 hours for Mumbai, India. Sagripanti and Lytle. Photochemistry and Photobiology 96: 731-737, 2020.
I hope this information has been useful.

Stay safe.