Summary report: Faecal oral transmission and the implications of COVID-19 on sanitation and water services

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There have been no reported cases of COVID-19 due to contact with the faeces of an infected individual, and the WHO states that risk of faecal-oral transmission of COVID-19 is low. Prevention of transmission from respiratory droplets from person to person and via surfaces should be the priority. However, human waste is hazardous and can contain numerous pathogens so should be safely managed in all settings.

In order for transmission via faeces to occur, humans must shed the virus that causes COVID-19 (SARS-CoV-2) in their faeces. Other factors that influence the likelihood of faecal-oral transmission include environmental persistence, the amount of infectious virus shed in faeces, and the infectious dose.

What is faecal-oral transmission?

Faecal-oral transmission refers to the process whereby disease is transmitted via the faeces of an infected individual, to the mouth of a susceptible individual. This transmission can occur through failures in sanitation systems along the sanitation chain (toilet, containment, conveyance, treatment, end use, and disposal) leading to exposure via various routes including food, water, hands, flies, inanimate objects or surfaces, as illustrated below:

Source: [WHO Guidelines on Sanitation and Health](#) (2018).

Faecal-oral transmission can be interrupted by water, sanitation, and hygiene (WASH) interventions.

Can transmission occur via aerosolized faeces?

Faulty plumbing and a poorly designed air ventilation system were believed to be factors in a 2003 Severe Acute Respiratory Syndrome (SARS) outbreak. The system allowed the virus, SARS-CoV-1, to be aerosolized in faecal matter and enter multiple apartments through improperly functioning bathroom drains (WHO report). Given that SARS-COV-2 is very closely related to SARS-CoV-1, there are concerns that COVID-19 might be transmitted in the same way. Faeces could also potentially become aerosolized or released into the air in droplets as a result of mechanized emptying of on-site sanitation systems or toilet flushing. Transmission via aerosolized faeces is possible but unlikely based on current occurrence and survival data of SARS-CoV-2 in faeces.

WHO recommends flushing toilets with the lid down, especially in health facilities treating patients and the use of standard, well-maintained plumbing and wastewater treatment systems. Plumbing systems should include sealed bathroom drains and backflow valves on sprayers and faucets to prevent aerosolized faecal matter from entering the plumbing or ventilation system.

How long can SARS-CoV-2 persist in the environment?

Environmental persistence refers to the length of time a pathogen, like SARS-CoV-2, is capable of surviving outside of the human body; the longer it survives, the more likely it is to cause an infection. The persistence of viruses can be affected by both the type of environment (e.g. surface, water, wastewater) as well as the physical and chemical

properties of the environment (e.g. temperature, pH, humidity, sunlight exposure). Enveloped viruses, like SARS-CoV-2, are less likely to persist in the environment than non-enveloped viruses, such as norovirus and rotavirus.

- **Faeces:** SARS-CoV-1, a related coronavirus and the virus that causes Severe Acute Respiratory Syndrome (SARS), can survive for hours to days in faeces depending on the source (baby versus adult) and characteristics (diarrhoeal vs non-diarrhoeal) of the faeces (Study 1, Study 2).
- **Surfaces:** SARS-CoV-2 can survive for 2 hours to 9 days under laboratory conditions on different surfaces but is susceptible to surface disinfection. Please refer to the Surfaces section for more information.
- **Aerosols:** SARS-Cov-2 can remain viable and infectious in aerosols for at least three hours and possibly up to 16 hours under laboratory conditions.
- **Water**: SARS-CoV-2 genetic material, but not infectious virus, has been detected in surface water directly impacted by untreated or inadequately wastewater or subject to combined sewer overflows (Study 1, Study 2). Currently, no data are available on the survival of SARS-CoV-2 in water although related viruses can survive in untreated water for days to weeks (Study 1, Study 2, Study 3), with longer survival times observed in colder waters. Conventional filtration and disinfection processes at water treatment facilities should effectively remove or inactivate SARS-CoV-2. The WHO states that there is no indication that SARS-CoV-2 can persist in treated drinking water.
- **Wastewater:** SARS-CoV-2 genetic material has been detected in untreated wastewater (Study 1, Study 2, Study 3, Study 4) but there are no reports of the detection or persistence of viable, infectious SARS-CoV-2 in wastewater. Similar viruses can remain infectious for days to weeks in untreated wastewater (Study 1, Study 2, Study 3). Conventional wastewater treatment processes should reduce risk posed by SARS-CoV-2 in wastewater.
- **Temperature:** SARS-CoV-2 is sensitive to heat and will be quickly inactivated (killed) at high temperatures. For example, at temperatures of 70°C or higher, the virus will survive for five minutes or less. At 4°C, the virus is stable and is able to persist for weeks with little reduction in concentration.
- **pH:** Many pathogens are sensitive to large fluctuations in pH (a measure of how acidic or basic an environment or substance is). One study has found that SARS-CoV-2 can survive in a wide range of pH values (pH 3-10).
- **Humidity:** The coronaviruses that cause SARS and Middle East Respiratory Syndrome (MERS), as well as other coronaviruses, seem to survive longer at lower relative humidity though the effect of humidity on virus survival may also depend on temperature.
- **Sunlight exposure:** SARS-CoV-2 may be less persistent in environments exposed to sunlight due to increased temperature (see above) as well as exposure to solar ultraviolet (UV) radiation. Similar to other coronaviruses, SARS-CoV-2 is predicted to

be sensitive to UV rays and is estimated to survive for only minutes during midday summer sun and up to a day during the winter in most regions. No data are currently available on the effectiveness of solar irradiation on inactivating SARS-CoV-2 specifically.

How much infectious virus is shed in faeces and what is the infectious dose?

In addition to the environmental persistence of SARS-CoV-2, the amount of virus entering the environment and number of viruses required to cause infection (infectious dose) may influence the likelihood of transmission.

Generally, the greater the amount of pathogen entering the environment (e.g. when an infected individual sneezes, coughs, or defecates), the greater the risk of exposure or contact with that pathogen.

Currently, there are no measures of the concentration of live, infectious SARS-CoV-2 shed in faeces or the duration of shedding. The concentration of SARS-CoV-2 genetic material in stool can vary widely among different individuals as well as over the course of the disease in a single individual. There is currently no evidence that presence or concentration of SARS-CoV-2 genetic material in stool is influenced by disease severity or even the presence of symptoms. The duration of shedding of SARS-CoV-2 genetic material has not been fully characterized and may begin 3-5 days prior to symptom onset and persist for days to weeks after symptoms begin (Study 1, Study 2, Study 3). Future research should measure the concentration and duration of shedding of viable, infectious SARS-CoV-2 in faeces from individuals with a range of symptoms and disease severities.

The number of viruses needed to cause infection in the majority of people (known as the infectious dose) is not known for SARS-CoV-2. Generally, the lower the infectious dose, the higher the risk of transmission. This section will be updated as we learn more about the shedding patterns in stool and the infectious dose.

Has SARS-CoV-2 been detected in human faeces?

Several studies in different countries have detected SARS-CoV-2 genetic material in the faeces of individuals with COVID-19 (Study 1, Study 2, Study 3, Study 4, Study 5). SARS-CoV-2 genetic material has been detected in the stool of COVID-19 patients with and without gastrointestinal symptoms (Study 1, Study 2, Study 3, Study 4) and in recovered individuals who no longer have any symptoms (Study 1, Study 2, Study 3).

However, the presence of SARS-CoV-2 genetic material in stool does not necessarily indicate infection or disease. A few studies have attempted to detect viable, infectious virus from stool with mixed results; three studies reported the detection of live virus (Study 1, Study 2, Study 3) in stool and one reported no detection of live virus despite

detection of SARS-CoV-2 genetic material (Study 3). There is some evidence the virus may be inactivated by the harsh conditions present in the human colon. Please refer to this resource which explains how the virus is detected in faeces, this resource to understand why a respiratory virus would be detected in faeces, and this resource to understand the risk of faecal-oral transmission of COVID-19.

How do we detect COVID-19 in human faeces?

The disease COVID-19 is caused by the virus SARS-CoV-2 which can be detected in faeces. Current detection methods rely largely on molecular techniques to identify unique genetic material for the virus, SARS-CoV-2 . Genetic material can be detected in both viable ("living") and non-viable or inactivated ("killed") viruses so its detection does not mean the individual is necessarily infected or that the faeces is infectious.

It is possible to detect viruses using culture-based techniques, which provide information on the viability of the virus, but these methods are more difficult, particularly for SARS-CoV-2, and time-consuming than most molecular techniques, which is why they are less frequently used.

How do we conduct surveillance for COVID-19 in wastewater and sludge?

Research is underway to develop and test methods for surveillance of genetic material from SARS-CoV-2 in wastewater and sludge. In contrast with case-based surveillance which generally only detects symptomatic COVID-19 cases, surveillance of wastewater and sludge would detect SARS-CoV-2 originating from both symptomatic and asymptomatic cases. Such surveillance can potentially be used to estimate prevalence at community level, identify a future surge or second wave of cases, identify regions where individual-level testing is inadequate, and eventually monitor uptake of vaccines. Similar techniques have been used in the global effort to eradicate polio. However, further research on methodology (sampling, analytical techniques, modelling) and interpretation of data is needed before this approach can be used to inform public health strategies. This approach is a complement to and not an alternative to testing in humans which remains important. To learn more about environmental surveillance of SARS-CoV-2 in wastewater, please read the WHO technical brief.

If COVID-19 is a respiratory disease, why would it be detected in faeces?

Many viral respiratory infections (e.g. Severe Acute Respiratory Syndrome [SARS], Middle East Respiratory Syndrome [MERS], Influenza, Adenovirus) are detectable in faeces as these viruses can cause infection in the gastrointestinal system. Individuals may also ingest the virus by swallowing their own nasal or respiratory secretions (if infected) or

those of an infected individual, or by swallowing material from contaminated environments, such as food or water.

There is presently inconclusive evidence as to whether infection of the GI system with SARS-CoV-2 occurs. Several studies have shown that infection of the GI system appears to be possible (Study 1, Study 2, Study 3) and one study has detected SARS-CoV-2 genetic material in samples of the oesophagus, stomach, duodenum and rectum of two patients with severe cases of COVID-19. Reports of GI symptoms from COVID-19 patients also suggest the virus may infect the GI system. There is some evidence that SARS-CoV-2 may not survive the harsh conditions of the gastrointestinal tract (specifically the colon), potentially explaining why few studies have detected infectious virus in faeces. More evidence is needed to confirm if and to what extent COVID-19 is transmitted by faecal-oral routes. However, even if faecal-oral transmission is possible, its relative importance as a transmission route is likely to be limited compared with person to person transmission via respiratory droplets and surfaces.

Are there special considerations for sanitation and COVID-19?

The World Health Organization (WHO) Guidelines on Sanitation and Health should always be followed. At present, no additional measures specific to COVID-19 are recommended by WHO, U.S. Centers for Disease Control and Prevention (CDC), or Occupational Health and Safety Administration (OSHA). While the genetic material of SARS-CoV-2 has been widely detected in untreated wastewater, there have been limited reports of SARS-CoV-2 detection in partially treated wastewater and receiving waters impacted by untreated or partially treated wastewater. There are no reports of SARS-CoV-2 being transmitted via treated or untreated wastewater.

Properly designed and functioning wastewater treatment plants (WWTP) and on-site sanitation systems that include safe disposal in-situ or an emptying and transport service chain to a faecal sludge treatment plant, should reduce the risk posed by faecal pathogens, including SARS-CoV-2. As an additional precaution, WWTPs might consider adding a final disinfection step (often known as tertiary treatment) to further reduce risk posed by viral pathogens like SARS-CoV-2 before discharge. Chlorine disinfection of wastewater effectively inactivates the SARS-CoV-1 (the virus responsible for SARS) at low concentrations (0.5 mg/L free chlorine residual) though standard dosing recommendations should be followed. Chlorine disinfection is not recommended for wastes containing large amounts of solid organic matter (like sludges or pit latrine contents) as it is less effective in these types of waste. Where WWTPs are not available, properly managed waste stabilization ponds are a simple treatment alternative that can effectively reduce pathogen loads. Wastewater treatment processes, including a final disinfection step, may not completely eliminate infectious viruses from effluent or treated sludge and safe disposal remains important.

For information on special considerations for sanitation workers during COVID-19, please see the resource "COVID-19 preventative measures that should be adopted by sanitation workers."

Can water sources be contaminated with SARS-Cov-2?

SARS-CoV-2 has not been detected in drinking water sources and there is currently no evidence suggesting waterborne transmission of COVID-19 or other related coronaviruses. SARS-CoV-2 genetic material has been detected in surface waters which receive untreated or partially treated wastewater or combined sewer overflows (Study 1, Study 2). Both conventional wastewater and water treatments are expected to be effective against SARS-CoV-2. The US Centers for Disease Control and Prevention currently consider the risk of transmission of COVID-19 through water to be low. At this time, standard water safety guidance should be followed and no additional COVID-19 precautions are recommended by WHO or other organizations.

Are specialised water treatment processes necessary?

Conventional centralized water treatment systems which include filtration and disinfection steps should effectively remove or inactivate SARS-CoV-2. Water treatment processes including UV and chlorine disinfection (Study 1, Study 2) are effective against SARS-CoV-1. Centralized systems using chlorine disinfection should ensure a free chlorine residual of at least 0.5 mg/L after 30 minutes of contact time at pH <8.0. A chlorine residual should be maintained throughout the distribution system, whether the system includes piped delivery or delivery via an alternative system like tanker trucks. Where such systems are unavailable, household water treatment (HWT) coupled with safe water storage can be employed to ensure the safety of household stored drinking water. Household water treatment options include boiling, chlorination, ultra- or nanofiltration technologies, and solar or ultraviolet irradiation. Chlorination and irradiation treatments are less efficient in turbid water containing organic matter (soil, other particles) and should be used in combination with technologies which first reduce turbidity (filtration and coagulation/flocculation), or should account for turbidity during dosing. Not all filtration technologies, such as ceramic pot filters, effectively remove viruses from water; ceramic pot filters or biosand filters should therefore be coupled with additional treatment options such as disinfection with chlorine or irradiation. Before promoting any specific HWT technology, ensure it has demonstrated effectiveness against a range of viruses, including human coronaviruses where possible. The WHO has evaluated many HWT options and provides an overview of their performance against different types of pathogens in this report. Benefits and drawbacks of different technologies are also summarized on the CDC website.

Why is water quantity important during outbreaks and what considerations should I take for distribution?

Reliable access to safe water supplies for hygiene and cleaning purposes is extremely important to help prevent the spread of COVID-19. The SPHERE Handbook recommends at least 15 litres per person per day for drinking and domestic hygiene. This summary provides estimated water volumes required for non-domestic uses in emergency settings (e.g. 100 litres per isolation room for a SARS patient). A single handwashing session may require between 0.2 - 2 litres of water, with some evidence suggesting that larger volumes are associated with greater removal of viruses.

Where reliable, safe water supplies are not currently available, action should be taken to increase access. Short-term or immediate solutions include mobilization of water tanker trucks and construction of new protected boreholes. Where possible, an extension of existing water distribution networks can help increase access.

Due to the pandemic, many buildings have been temporarily closed for a period of weeks to months, causing unused water to sit stagnant in distribution pipes. The chemical and microbial quality of this water may deteriorate over time. Prior to opening, each building should ensure their water system is completely flushed and refilled with fresh water. Hot water systems should be maintained at 60°C or higher (50°C circulating temperature) and cold water systems at 25°C or less to limit microbial risks. Water stored on-site during building closures may need to be treated prior to use. Testing water prior to building re-occupation can help ensure it is safe and meets all country-level water quality regulations.

Workers involved in water distribution, water treatment, or increasing water access should be considered essential and allowed to continue their work even if movement restrictions are implemented. Workers should continue following standard safety precautions including wearing appropriate personal protective equipment and should be trained on general COVID-19 preventative measures including mask use, physical distancing, and frequent hand hygiene. Workers should be encouraged to stay home if they or one of their household members are ill to avoid transmitting the virus to others at work. Due to the low risk of transmission from water, no additional safety measures related to COVID-19 are necessary. Because water access is so essential, water utilities and treatment plants should consider making contingency plans to ensure water services are not interrupted. This may include making sure there is an adequate number of trained staff members to operate and maintain facilities, distribution networks and other infrastructure, maintaining a stock of necessary supplies (for water treatment, water quality monitoring, and maintenance of infrastructure), and ensuring any disruptions to supply chains can be quickly addressed.

COVID-19 preventative measures that should be adopted by sanitation workers

Do sanitation workers need to take special precautions while handling faecal waste?

While the genetic material of SARS-CoV-2 has been detected in untreated wastewater and in sewage systems in many countries worldwide, it is still unclear whether any of the detected virus is infectious, and no cases of COVID-19 due to contact with wastewater have been reported. The WHO states that risk of faecal-oral transmission of COVID-19 is low. However, human waste is hazardous and can contain numerous pathogens and should be safely managed in all settings. For more information on the survival and persistence of SARS-CoV-2 and related viruses in the environment, including in wastewater, please see this section.

While additional precautions are necessary to prevent person-to-person and surface transmission of COVID-19 among sanitation workers (see section "Do sanitation workers face other risks that require preventative actions?"), the US Centers for Disease Control and Prevention (CDC) and US Occupational Health and Safety Administration have stated that no additional COVID-19 specific measures are necessary to mitigate the risks due to occupational exposure to human waste. Sanitation workers should follow standard safety precautions and hygiene practices, including routine administrative and engineering controls, when handling or working near human waste.

Do sanitation workers face other risks that require preventative actions?

During the COVID-19 pandemic, sanitation workers should be considered essential or key workers, and allowed to continue their work even if movement restrictions are implemented. COVID-19 related precautions are necessary to prevent person-to-person and surface transmission while this essential work continues. Examples of such precautions include practising physical distancing and hand hygiene at additional key moments such as after interacting with coworkers and clients.
The WHO (Guidelines on Sanitation and Health, section 3.4-3.6), the US CDC, provide general recommendations for reducing health and safety risks to sanitation workers and these recommendations should continue to be followed during the COVID-19 pandemic. The Pan American Health Organization (PAHO) and the Pan-African Association of Sanitation Actors/Centre for Affordable Water and Sanitation Technology provide some COVID-19 specific guidance for sanitation workers. A brief summary of these general and COVID-19 specific health and safety recommendations is provided below:

Staff training & preparation

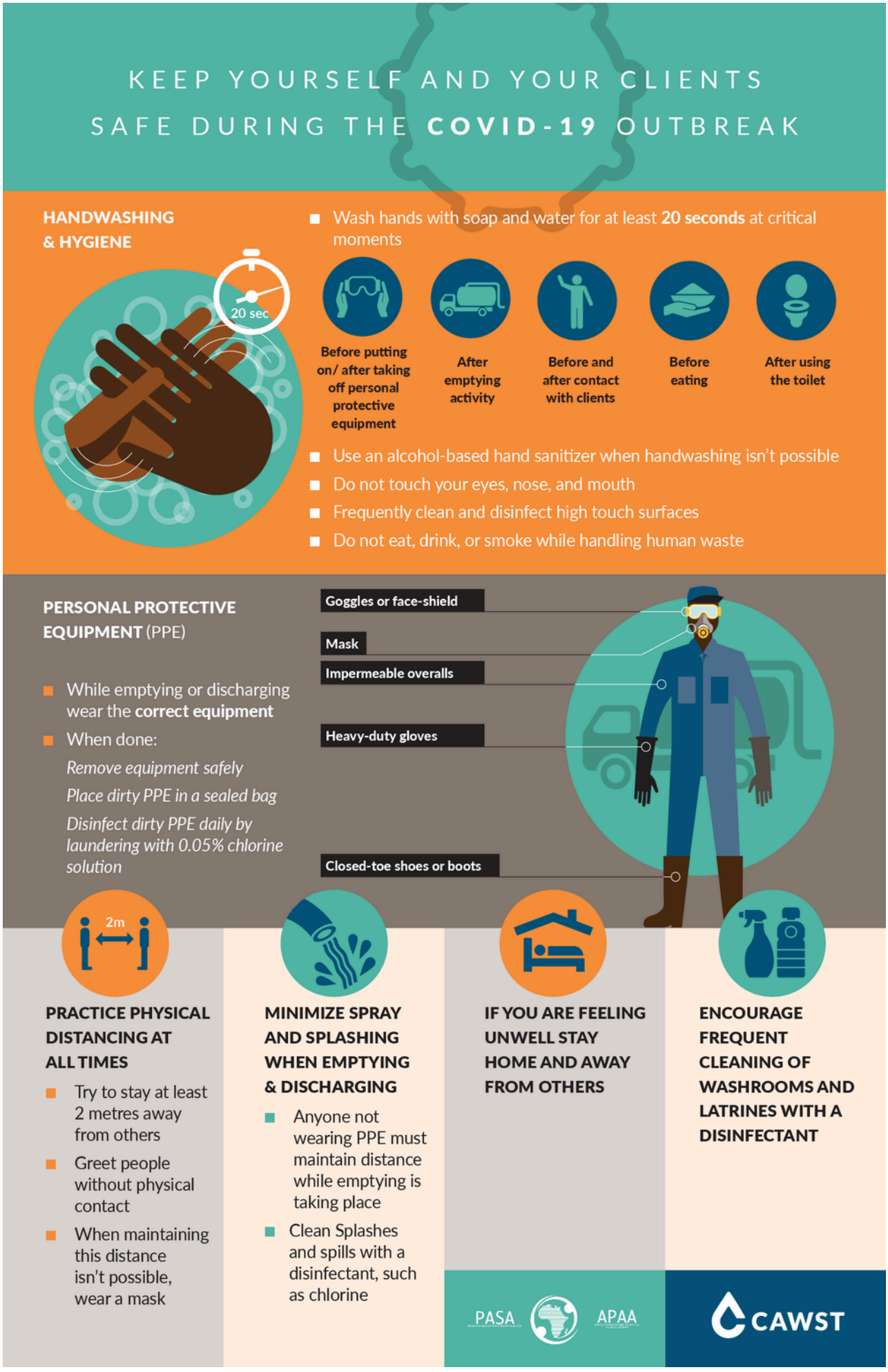
Prior to starting work, all sanitation workers should receive training and information on the following topics to ensure a safe working environment:

- **The health risks of working with sanitation systems and contacting human waste**. Human waste can contain numerous pathogens, not just SARS-CoV-2, and workers should be made aware of the health risks associated with contact with human waste. While no COVID-19 vaccination is currently available, sanitation workers should receive other setting-appropriate vaccinations before beginning work. Local health authorities can offer guidance on identifying necessary vaccinations.
- **General disease prevention strategies.** Routine health and safety training may include information on the safe handling of human waste, the engineering and administrative controls used to limit exposure to untreated waste, facility cleaning and disinfection practices, worker hygiene practices, the proper use of PPE. Disease prevention strategies may vary depending on the context and type of sanitation systems commonly encountered. In all settings, workers should be trained on the engineering and administrative controls used to limit the frequency and duration of worker contact with sewage. In settings where some handling of untreated waste cannot be avoided (e.g. where on-site systems like pit latrines or container-based sanitation are common), training on safe handling procedures may also be prioritized.
- **COVID-19 specific prevention strategies.** During the COVID-19 pandemic, health and safety plans for sanitation workers should be expanded to allow workers to physically distance from the people they serve. This may include adjusting shifts or working hours, limiting certain areas to essential personnel, and offering contactless payment options.
- **Standard operating procedures for proper use of machinery, equipment, and tools.** The proper and effective use of appropriate equipment can help to reduce sanitation workers' exposure to pathogens contained in human waste. Workers should be trained on the protocols for the safe cleaning and disinfection of equipment. During the COVID-19 pandemic, the frequency of cleaning high-touch surfaces may be increased to limit potential surface transmission.

Personal Protective Equipment

- Workers should always wear appropriate personal protective equipment (PPE) including heavy-duty waterproof gloves, goggles and/or a face shield, face masks, rubber boots, and water-repellent clothing coverings (coveralls). During the COVID-19 pandemic, PAHO recommends that sanitation workers exposed to aerosol generating processes, such as certain cleaning processes in treatment facilities, wear N95 respirators (for more information see section 'What is a N95 respirator and who should use one?'). Certain other processes performed by sanitation workers, such as the mechanized emptying of on-site systems, may also produce aerosols. Depending on availability, use of a N95 respirator may be appropriate during such procedures.

The below infographic developed by the Pan-African Association of Sanitation Actors and CAWST illustrates the use of appropriate PPE during sanitation work.



Source: CAWST

- Work clothing and PPE should be carefully removed and decontaminated immediately after use or stored in a sealable plastic bag until decontamination. Dirty work clothing should not be worn home. Heavy-duty reusable gloves, boots, and plastic or rubber coveralls/aprons should be cleaned with soap and water and decontaminated with 0.5% chlorine after use. Household bleach or sodium hypochlorite solutions (typically 5% chlorine) can be diluted to achieve a 0.5% chlorine solution (1 part bleach to 9 parts water). Work clothing should be machine laundered at 60-90°C with standard laundry detergent. Alternatively, soiled work clothing can be manually washed with soap and hot water (in a large container with a stick for stirring) and then soaked in a 0.05% chlorine solution for 30 minutes before rinsing and drying. Household bleach or sodium hypochlorite solutions (typically 5% chlorine) can be diluted to achieve a 0.05% solution (1 part bleach to 100 parts water). Greywater used for decontamination should be safely disposed of in drains connected to sewers, soak-away pits, or septic tanks.

Hygiene Practices

1. Handwashing facilities should be provided in convenient locations to enable workers to frequently wash their hands with soap. Alternatively hand sanitiser with 70% ethanol can be used.
2. Sanitation workers should always be encouraged to wash their hands and other exposed areas of skin at the following times: after contact with human waste, after touching equipment used to contain human waste, before and after putting on PPE, before and after using the toilet, and before eating. During the COVID-19 pandemic, sanitation workers should also wash their hands after interacting with clients or the public, when entering or leaving buildings, and after contacting high-touch surfaces. See the infographic above which illustrates these important moments for hand hygiene and the description in the related report.
3. Workers should avoid touching their face, eyes, nose, mouth, and any open sores while handling waste. If waste contacts eyes, clean water should be used to flush eyes thoroughly. Keep wounds clean and covered. Headsets could be used to facilitate communication while limiting touching of the face.
4. Workers should never eat, drink, chew gum, tobacco, or any other substance, or smoke while handling human waste.
5. Contaminated work clothing and PPE should always be removed prior to eating, and eating should be done in areas away from waste handling procedures.

Other Health and safety considerations

1. Workers should be provided health checks, health care, and setting-appropriate vaccinations.

2. During the COVID-19 pandemic, workers should stay home from work if ill, have COVID-19 symptoms, or have a family member in the same household who has COVID-19 symptoms. If certain workers are considered 'high-risk' (60+ years old or have comorbidities), consider adjusting their duties or schedule to limit their exposure to colleagues and clients. Flexible sick leave policies will protect clients, workers, employers, and their families, limiting the risk of a localised outbreak and ensuring most sanitation workers remain available to continue their essential work.
3. Care should always be taken to avoid splashing, spraying, or aerosolizing waste during emptying, transport, treatment, and disposal. Only properly trained sanitation workers wearing appropriate PPE should be allowed in the area during waste handling procedures. In case of spills, immediately clean and disinfect the area. In the case of spillage of high-strength waste, the spill can be covered with lime prior to cleaning and disinfection.
4. Vehicles and equipment used for wastewater collection and transport should be cleaned and disinfected daily. During the COVID-19 pandemic, PAHO recommends cleaning the vehicle cabin with soap and water followed by 0.1% chlorine solution (1 part household bleach to 50 parts water) between uses. High touch surfaces (steering wheel, door handle, control panels, handles of push carts or other equipment) should be frequently cleaned and disinfected. Greywater used for cleaning and disinfection should be disposed of in drains connected to sewers, soakaway pits, or septic tanks.
5. Comprehensive worker protection includes more than a list of recommendations and extends beyond the COVID-19 pandemic. To read more about health, safety, and legal protection for sanitation workers, please see this WHO report.

Editor's note

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