"A STUDY AN COVID-19 PREVALENCE AND CONTROL MEASURES"

BSC MICROBIOLOGY

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CHAPTER 1

AIMS AND OBJECTIVE OF THE STUDY

- FIND OUT THE BEGINING OF HUMAN CORONAVIRUS
- COLLECT INFORMATION ABOUT CORONA VIRUS GENOME AND STUTURE
- COLLECT INFORMATION ABOUT EFFECTS OF COVID -19
- TO MAKE AWARENESS ABOUT “HOW TO PROTECT YOURSELF FROM COVID 19”
- TO MAKE AWARE OF SUCH PANDAMIC AND EPIDEMICS

CHAPTER 2

REVIEW OF LITERATURE

The history of human coronaviruses began in 1965 when Tyrrell and Bynoe1 found that they passage a virus named B814. It was found in human embryonic tracheal organ cultures obtained from the respiratory tract of an adult with a common cold. The presence of an infectious agent was demonstrated by inoculating the medium from these cultures intranasally in human volunteers; colds were produced in a significant proportion of subjects, but Tyrrell and Bynoe were unable to grow the agent in tissue culture at that time. At about the same time, Hamre and Procknow2 were able to grow a virus with unusual properties in tissue culture from samples obtained from medical students with colds. BothB814 and Hamre's virus, which she called 229E, were ether sensitive and therefore, presumably required a lipid-containing coat for infectivity, but these 2 viruses were not related to any known myxo- or paramyxoviruses. While working in the laboratory of Robert Chanock at the National Institutes of Health, McIntosh et al3 reported the recovery of multiple strains of ether-sensitive agents from the human respiratory tract by using a technique similar to that of Tyrrell and Bynoe. These viruses were termed "OC" to designate that they were grown in organ cultures. Within the same time frame, Almeida and Tyrrell4performed electron microscopy on fluids from organ cultures infected with B814 and found particles that resembled bronchitis virus of chickens. The particles were medium sized (80–150 nm), pleomorphic, membrane-coated, and covered with widely spaced club-shaped surface projections. The 229E agent identified by Hamre and Procknow2 and the previous OC viruses identified by McIntosh et al3 had a similar morphology (Fig. 1). In the late 1960s, Tyrrell was leading a group of virologists working with the human strains and a number of animal viruses. These included infectious bronchitis virus, mouse hepatitis virus and transmissible gastroenteritis virus of swine, all of which had been demonstrated to be morphologically the same as seen through electron microscopy.5,6This new group of viruses was named coronavirus (*corona* denoting the crown-like appearance of the surface projections)and was later officially accepted as a new genus of viruses.7Ongoing research using serologic techniques has resulted in a considerable amount of information regarding the epidemiology of the human respiratory coronaviruses. It was found that in temperate climates, respiratory coronavirus infections occur more often in the winter and spring than in the summer and fall. Data revealed that coronavirus infections contribute as much as 35% of the total respiratory viral activity during epidemics. Overall, the proportion of adult colds produced by coronaviruses was estimated at 15%.8 In the 3 decades after discovery, human strains OC43 and 229E were studied exclusively, largely because they were the easiest ones to work with. OC43, adapted to growth in suckling mouse brain and subsequently to tissue culture, was found to be closely related to mouse hepatitis virus. Strain 229E was grown in tissue culture directly from clinical samples. The 2 viruses demonstrated periodicity, with large epidemics occurring at 2- to 3-year intervals.9 Strain 229E tended to be epidemic throughout the United States, whereas strain OC43 was more predisposed to localized outbreaks. As with many other respiratory viruses, reinfection was common.10 Infection could occur at any age, but it was most common in children. Despite the extensive focus placed exclusively on strains 229E and OC43, it was clear that there were other coronavirus strains as well. As shown by Bradburne,11 coronavirus strain B814 was not serologically identical with either OC43 or 229E. Contributing to the various strain differences in the family of coronaviruses, McIntosh et al12 found that 3 of the 6 strains previously identified were only distantly related to OC43 or 229E.Epidemiologic and volunteer inoculation studies found that respiratory coronaviruses were associated with a variety of respiratory illnesses; however, their pathogenicity was considered to be low.2,8,13,14 The predominant illness associated with infections was an upper respiratory infection with occasional cases of pneumonia in infants and young adults.15,16 These viruses were also shown to be able to produce asthma exacerbations in children as well as chronic bronchitis in adults and the elderly.17–19 While research was proceeding to explore the pathogenicity and epidemiology of the human coronaviruses, the number and importance of animal coronaviruses were growing rapidly. Coronaviruses were described that caused disease in multiple animal species, including rats, mice, chickens, turkeys, calves, dogs, cats, rabbits and pigs. Animal studies included, but were not limited to, research that focused on respiratory disorders. Study focus included disorders such as gastroenteritis, hepatitis and encephalitis in mice; pneumonitis and sialo dacryoadenitis in rats; and infectious peritonitis in cats. Interest peaked particularly regarding areas of encephalitis produced by mouse hepatitis virus and peritonitis produced by infectious peritonitis virus in cats. Pathogenesis of these disease states was various and complex, demonstrating that the genus as a whole was capable of a wide variety of disease mechanisms. 20 Human and animal coronaviruses were segregated into 3 broad groups based on their antigenic and genetic makeup. Group I contained virus 229E and other viruses, group II contained virus OC43 and group III was made up of avian infectious bronchitis virus and a number of related avian viruses.21

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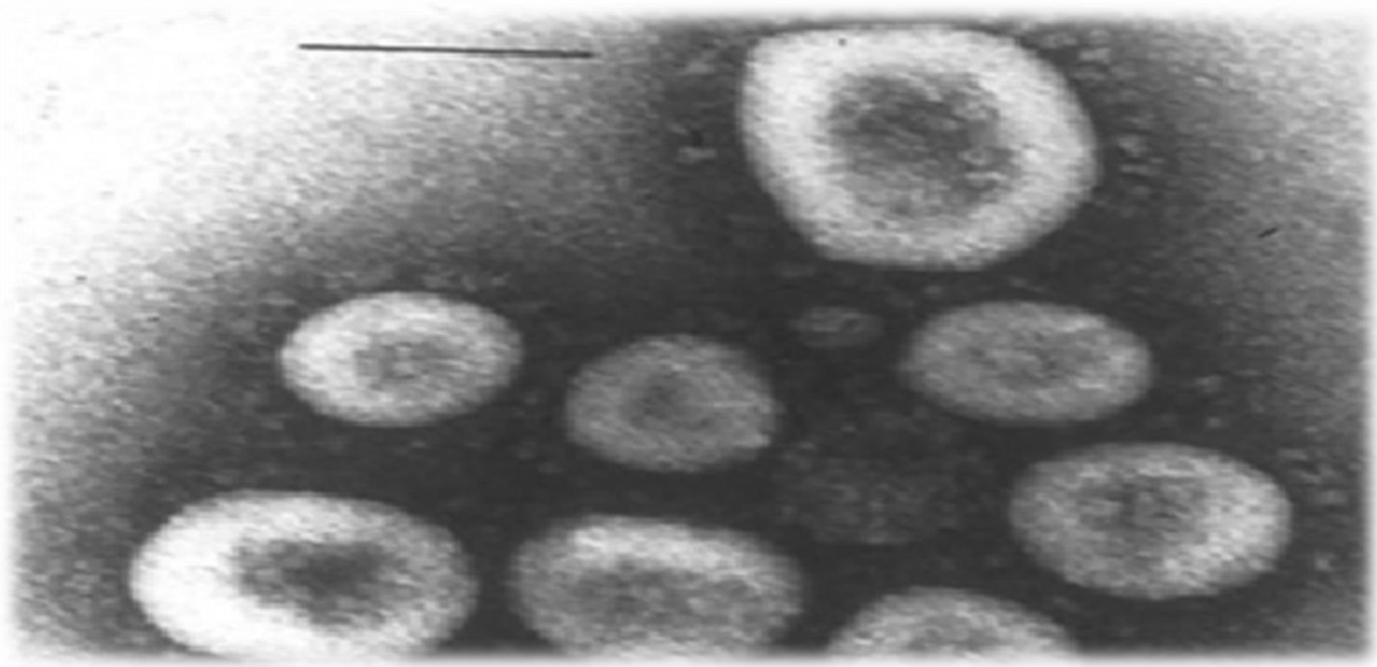

FIGURE 1. Coronavirus OC16. Reprinted from Proc Natl Acad Sci USA. 1967;57;933–940

EMERGENCE OF THE SEVERE ACUTE

RESPIRATORY SYNDROME (SARS) CORONAVIRUS Given the enormous variety of animal coronaviruses, it was not surprising when the cause of a very new, severe acute respiratory syndrome, called SARS, emerged in 2002–2003 as a coronavirus from southern China and spread throughout the world with quantifiable speed.22–24 This virus grew fairly easily in tissue culture, enabling quick sequencing of the genome. Sequencing differed sufficiently from any of the known human or animal coronaviruses to place this virus into a new group, along with a virus that was subsequently cultured from Himalayan palm civets, from which

it presumably had emerged.25 During the 2002–2003 outbreak, SARS infection was reported in 29 countries in North America, South America, Europe and Asia. Overall, 8098 infected individuals were identified, with 774 SARS-related fatalities.26 It is still unclear how the virus entered the human population and whether the Himalayan palm civets were the natural reservoir for the virus. Sequence analysis of the virus isolated from the Himalayan palm civets revealed that this virus contained a 29-nucleotide sequence not found in most human isolates, in particular those involved in the worldwide spread of the epidemic.25 In the animal viruses, this nucleotide sequence maintains the integrity of the 10th open reading frame (ORF); whereas in the human strains, the absence of this motif results in 2 overlapping ORFs. The function of the ORFs in the animal and human isolates is unknown, and it is unclear whether the deletion of the 29-nucleotide sequence played a role in the transspecies jump, the capacity of the epidemic strain to spread between humans or the virulence of the virus in humans. Curiously data from seroepidemiologic studies conducted among food market workers in areas where the SARS epidemic likely began indicated that 40% of wild animal traders and 20% of individuals who slaughter animals were seropositive for SARS, although none had a history of SARS-like symptoms.25 These findings suggest that these individuals were exposed through their occupation to a SARS-like virus that frequently caused asymptomatic infection. Infection control policies may have contributed to the halt of the SARS epidemic. The last series of documented cases to date, in April 2004, were laboratory-acquired. The SARS epidemic gave the world of coronaviruses an enormous infusion of energy and activity that contributed to the large amount already known about the virology and pathogenesis of coronavirus infections from the expanding area of veterinary virology.

THE COVID – 19 PANDAMIC

Coronavirus disease 2019 (COVID-19) is a contagious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The first known case was identified in Wuhan, China, in December 2019.[26] The disease has since spread worldwide, leading to an ongoing pandemic.[27] Symptoms of COVID-19 are variable, but often include fever,[28] cough, headache,[29] fatigue, breathing difficulties, loss of smell, and loss of taste.[30][31][32] Symptoms may begin one to fourteen days after exposure to the virus. At least a third of people who are infected do not develop noticeable symptoms.[33] Of those people who develop symptoms noticeable enough to be classed as patients, most (81%) develop mild to moderate symptoms (up to mild pneumonia), while 14% develop severe symptoms (dyspnea, hypoxia, or more than 50% lung involvement on imaging), and 5% suffer critical symptoms (respiratory failure, shock, or multiorgan dysfunction).[34] Older people are at a higher risk of developing severe symptoms. Some people continue to experience a range of effects (long COVID) for months after recovery, and damage to organs has been observed.[35] multi-year studies are underway to further investigate the long-term effects of the disease.[35] COVID-19 transmits when people breathe in air contaminated by droplets and small airborne particles containing the virus. The risk of breathing these in is highest when people are in close proximity, but they can be inhaled over longer distances, particularly indoors. Transmission can also occur if splashed or sprayed with contaminated fluids in the eyes, nose or mouth, and, rarely, via contaminated surfaces. People remain contagious for up to 20 days, and can spread the virus even if they do not develop symptoms.[36][37] Several testing methods have been developed to diagnose the disease. The standard diagnostic method is by detection of the virus's nucleic acid by real-time reverse transcription polymerase chain reaction (rt-PCR), transcription-mediated amplification (TMA), or by reverse transcription loop-mediated isothermal amplification (RT-LAMP) from a nasopharyngeal swab. Several COVID-19 vaccines have been approved and distributed in various countries, which have initiated mass vaccination campaigns. Other preventive measures include physical or social distancing, quarantining, ventilation of indoor spaces, covering coughs and sneezes, hand washing, and keeping unwashed hands away from the face. The use of face masks or coverings has been recommended in public settings to minimize the risk of transmissions. While work is underway to develop drugs that inhibit the virus, the primary treatment is symptomatic. Management involves the treatment of symptoms, supportive care, isolation, and experimental measures.

CHAPTER 3

COVID-19 transmission

The main routes of transmission of SARS-CoV-2 are respiratory droplets and direct contact. Any person who is in close contact with an infected individual is at risk of being exposed to potentially infective respiratory droplets. (1,2) Droplets may also land on surfaces where the virus could remain viable; thus, the immediate environment of an infected individual can serve as a source of transmission.

The risk of transmission of SARS-CoV-2 from the faeces of an infected person and the faecal-oral pathway appears to be low. While several studies have detected SARS-CoV-2 viral RNA fragments in the faecal matter of patients throughout their illness and after recovery, (3-5) current evidence underscores the difficulty of culturing virus in excreta. Three studies report infectious virus in faeces (6-8), while others have not found infectious virus in this medium. (9) Furthermore, shed virus is rapidly inactivated during transit through the colon. (10) One study found infectious SARSCoV-2 in the urine of one patient (11) and viral RNA has been detected in gastrointestinal tissue. (3)

Persistence of SARS-CoV-2 in drinking-water, wastewater and on surfaces

While the presence of SARS-CoV-2 us in untreated drinking water is possible, infectious virus has not been detected in drinking-water supplies. There is at least one documented instance of detecting RNA fragments of SARS-CoV-2 in a river, during the peak of the epidemic in northern Italy. It is suspected the river was affected by raw, untreated sewage. (12) Other coronaviruses have not been detected in surface or groundwater sources and thus the risk coronaviruses pose to drinking-water supplies is low. (13) Within wastewater, infectious SARS-CoV-2 has not been detected in untreated or treated sewage. RNA fragments of SARS-CoV-2 have been detected in untreated sewage and sludge in a number of countries and municipalities, with RNA signals, generally starting around the same time cases were first reported (February and March 2020) and increasing as the number of confirmed cases increase. (14-17) The RNA signal reduces considerably once community caseloads decrease. In addition, efforts are ongoing to analyse historical wastewater samples for SARS-CoV-2. For example, a pre-print (not peer reviewed) paper from Santa Catalina Brazil, RNA suggests that fragments of SARS-CoV2 were first detected in late November 2019, while the first case was not reported until early March 2020. (18) In the majority of sampling exercises, RNA fragments of SARS-CoV-2 have not been detected in treated sewage, but there have been at least two instances where small concentrations of RNA fragments were detected in sewage that had undergone partial but not full treatment. (12, 17, 19) SARS-CoV-2 is enveloped and thus less stable in the environment compared to non-enveloped human enteric viruses with known waterborne transmission (such as adenoviruses, norovirus, rotavirus and hepatitis A virus). One study found that other human coronaviruses persisted two days in dechlorinated tap water and in untreated hospital wastewater at 20°C. (20) In comparison, high levels of reduction (>4 log) of the influenza virus were found in drinking-water after contact time of only five minutes and a chlorine residual of 0.3 mg/L. (21) Other studies find similar b Observed inactivation of severe acute respiratory associated coronavirus (SARS-

CoV). c H5N1 avian influenza virus is also an enveloped virus. reductions in days to weeks. Significant (99.9% reduction) of coronaviruses was observed in two days in primary sewage effluent d at 23°C, two weeks in pasteurized settled sewage at 25 °C and four weeks in reagent grade water at 25°C. (22, 23). Higher temperature, high or low pH and sunlight all facilitate virus reduction. Recent experimental evidence indicates that SARS-CoV-2 survival on surfaces is similar to that of SARS-CoV-1 (24), the virus that causes severe acute respiratory syndrome (SARS). In laboratory-controlled conditions, the median half-life of infectious SARS-CoV-2 on surfaces is 1-7 hours depending on the surface (copper being the shortest and plastic the greatest). (25) However, infectious virus can be detected as long as 7 days (25,26). In health care facilities, at least one study has found RNA fragments on surfaces including the floor and bedrails, (27) while another found no RNA on surfaces at all. (19) The survival time of the virus depends on several factors, including the initial virus concentration, type and smoothness of the surface, temperature and relative humidity. The same study also found that effective inactivation could be achieved within 1 minute using common disinfectants, such as 70% ethanol or 0.1% sodium hypochlorite (see cleaning practices).

Safely managing wastewater and faecal sludge

Though little evidence is available, some data suggest that transmission via faeces, is possible but unlikely, especially where faeces become aerosolized (see further the section entitled “Sanitation and plumbing”). Because of the potential infectious disease risks from excreta, including the potential presence of SARS-CoV-2, wastewater and sludge should be contained, and treated either on-site or conveyed off-site and treated in well-designed and managed wastewater and/or faecal sludge treatment plants. Standard treatment processes are effective for enveloped viruses, including SARS-CoV-2. Each stage of treatment combining physical, biological and chemical processes (e.g., retention time, dilution, oxidation, sunlight, elevated pH, and biological activity) results in a further reduction of the potential risk of exposure and accelerates pathogen reduction. A final disinfection step may be considered if existing treatment plants are not optimized to remove viruses. Sanitation services and workers are essential for operational support during the COVID-19 pandemic. Existing recommendations for protecting the health of sanitation workers should be followed. (28) Workers should follow standard operating procedures which includes wearing appropriate PPE (protective outerwear, heavy-duty gloves, boots, medical mask, goggles and/or a face shield), minimising spills, washing dedicated tools and clothing, performing hand hygiene frequently, obtaining vaccinations for sanitation related diseases and self-monitoring for any signs of COVID-19 or other infectious disease with support of the employer. Additional precautions to prevent transmission between workers, which apply to General population as well, include avoiding touching the eyes, nose or mouth with unwashed hands, sneezing into one's sleeve or a disposal tissue, practising physical distancing while working, travelling to and from work and staying home if one develops symptoms associated with COVID-19 (e.g. fever, dry cough, fatigue).

Keeping water supplies safe

Several measures can improve water safety. These include: protecting the source water; treating water at the point of distribution, collection or consumption; and ensuring that treated water is safely stored at home in regularly cleaned and covered containers. Such measures can be effectively planned, implemented and monitored using water safety plans. (29) Conventional, centralized water treatment methods that utilize filtration and disinfection should significantly reduce the concentration of SARS-CoV-2. Other human coronaviruses have been shown to be sensitive to chlorination and disinfection with ultraviolet (UV) light. (30, 31) For effective centralized disinfection, there should be a residual concentration of free chlorine of ≥0.5 mg/L after at least 30 minutes of contact time at pH < 8.0. (13) A chlorine residual should be maintained throughout the distribution system including distribution via water trucks or alternative transport systems (e.g., bicycle, cart, etc). In addition, for effective water treatment, water utility managers can adopt several other preventive measures, as part of a broader water-safety planning approach. These measures include: ensuring adequate stocks of chemical additives and consumable reagents for water-quality testing, ensuring that critical spare parts, fuel and contractors can still be accessed and that there are contingency plans for staff and training to maintain the required supply of safe drinking water. Water utilities personnel should be briefed on COVID-19 preventive measures. They may wear masks according to global recommendations (32) and depending on local government mask use policy, they may respect physical distancing between workers and with the public, and practise and hygiene frequently. In places where centralized water treatment and safe piped water supplies are not available, a number of household water treatment technologies are effective in removing or destroying viruses. These include: boiling or using high performing ultrafiltration or nanomembrane filters, solar irradiation and, in non-turbid waters, ultraviolet (UV) irradiation and appropriately dosed chlorine products such as sodium hypochlorite and NaDCC. f

Due to the closure of public or private buildings as part of the pandemic response, many premises may experience low or no water flow over a period of weeks or months. This may result in water stagnation and an associated deterioration of water quality (e.g., survival or regrowth of microbial pathogens due to chlorine decay and leaching of harmful metals from pipework). This deterioration may present a public health risk when such premises are re-inhabited. To minimize such risks, a site-specific programme of flushing pipes should be undertaken within the premises before re occupancy. This should ensure that all stagnant water throughout the premises is replaced with safe (disinfected), fresh water from the distribution main. Before use, hot water systems should be returned to an operating temperature of 60o C or greater and a circulation temperature exceeding 50C to manage microbial risks, including those from Legionella. g Cold water systems should be returned to less than 25o C and ideally below 20^{0}C.On-site storage tanks or cooling towers may require batch-disinfection before becoming operational again. (33) Water quality testing should be performed in advance of re-occupancy to verify that the water used within the premises meets national drinking-water quality regulations and standards and that it is safe for human consumption and other relevant uses (such as showering).

Surveillance of SARS-CoV-2 in wastewater and sludge

Research is underway in many countries to detect noninfective viral fragments of SARS-CoV-2 in wastewater and sludge. Similar methods have been successfully used in the polio eradication programme to detect virus circulation in the population including among asymptomatic cases, and thereby complementing surveillance in humans. Further research and capacity building are needed on the analytical methods (particularly for settings with low sewerage coverage), modelling, interpretation of data to inform decision making and public health actions. Surveillance of COVID-19 in wastewater and sludge may compliment public health data and provide, for example, information on when cases may spike 5-7 days in advance of such spikes being detected by health facilities and health authorities. (14) Environmental surveillance should not be used as a substitute for robust surveillance of COVID-19 cases. In addition, the primary aim of governments, utilities and investments should focus on continuity and expanding safely managed sanitation services to protect against COVID-19 and a number of other infectious diseases.

Chapter 5

Considerations for WASH practices in homes and communities

Upholding recommended water, sanitation and health-care waste practices in the home and in the community is important for reducing the spread of COVID-19. The provision of water enables regular hand hygiene and cleaning. Water services should not be cut off because of consumers' inability to pay, and governments should prioritize providing access to people without access to water services, through other immediate actions such as. protected boreholes, tanker trucks, extending piped supplies etc.).

Individuals and organizations involved in providing water, sanitation and hygiene services such as treatment plant operators, sanitation workers and plumbers should be designated as providing essential services and be allowed to continue their work during movement restrictions and have access to PPE and hand hygiene facilities to protect their health. This also applies to those promoting hygiene in the community.

1. Hand hygiene general recommendations

Hand hygiene has been shown to prevent respiratory illness. (52) Handwashing is recommended after coughing and sneezing and/or disposing of a tissue, on entering the home having come from public places, before preparing food, before and after eating and feeding/breastfeeding, after using the toilet or changing a child's diaper and after touching animals. For people with limited WASH services, it is vital to prioritize the key times for hand hygiene.

As part of a new hand hygiene campaign, WHO recommends that universal access to hand hygiene facilities should be provided in front of all public buildings and transport hubs − such as markets, shops, places of worship, schools and train or bus stations. (53) In addition, functioning handwashing facilities with water and soap should be available within 5m of all toilets, both public and private.

The number or size of these hand hygiene stations should be adapted to the number and type of users such as children or those with limited mobility, to encourage use and reduce waiting times. The installation, supervision and maintenance of equipment, including where necessary, regular refilling of water and soap and/or alcohol-based hand rub should be under the overall leadership of local public health authorities. Maintaining supplies should be the responsibility of the manager of the building or store, transport provider etc. Civil society and the private sector can be engaged to support the functioning and correct use of such facilities and to prevent vandalism.

2. Hand hygiene materials

The ideal hand hygiene materials for communities and homes in order of effectiveness are:

- Water and soap or alcohol-based hand rub
- Ash
- Water alone

Hand hygiene stations can consist of either water such as sinks attached to a piped-water supply, refillable water reservoir or clean, covered buckets with taps equipped with plain soap or alcohol-based hand rub dispensers. Where alcohol-based hand rub or bar soap is not feasible, commercial liquid soap or locally-made" soapy water" solutions made by mixing detergent with water can be used. The ratio of detergent to water will depend on types and strengths of locally available product. (54) Soap does not need to be antibacterial and evidence indicates that normal soap is effective in inactivating enveloped viruses, such as coronaviruses. (55,56) Alcohol-based hand rub should contain at least 60% alcohol. Such products should be certified and, where supplies are limited or prohibitively expensive, can be produced locally according to WHO-recommended formulations. (38) Highly concentrated alcohol is toxic if ingested and hence needs to be handled with care. It needs to be kept out of reach of children, and children must be supervised by an adult when using alcohol-based hand-rub.

The ability to dry hands after washing is important for effective hand hygiene. The level of residual moisture left on hands after washing can be an important determinant of pathogens being transmitted from hands to surfaces and vice versa. (57) While clean, single-use towels are recommended they may not be available and can add to environmental waste. Alternatively, air-drying hands with an air-drying system or by shaking can be done.

When soap and water or alcohol-based hand rub are not available within households, the use of ash can be considered. (36,58,59) Ash, in particular, may inactivate pathogens by raising the ph. (60) Finally, washing with water alone, although the least effective of the four options, can result in reductions in faecal contamination on hands and in diarrhoea. (61,62) Regardless of the type of material, the washing and rubbing of hands, and the amount of rinsing water in particular, are important determinants in the reduction of pathogen contamination on hands. (63)

3. Water quality and quantity requirements for handwashing

The quality of water used for handwashing does not need to meet drinking-water standards. Evidence suggests that even water with moderate faecal contamination when used with soap and the correct technique can be effective in removing pathogens from hands. (64) However, efforts should be made to use and source water of the highest quality possible (e.g., at least an improved water source) Reported quantities of water used for handwashing that have enabled reduction of faecal contamination ranges from 0.5-2 litres per person, per handwashing session. (63) Recent experience from the field suggests a handwashing session with as little as 0.2 litres is sufficient. (65) Furthermore, the quantity of water used has been associated with less viral contamination of hands. (66) Where water is limited, hands can be wetted with water, the water then turned off while lathering with soap and scrubbing for at least 20 seconds, and then the water can be turned on again to rinse. Water should always be allowed to flow to a drainage area or receptacle, and hands should not be rinsed in a communal basin, as this may increase contamination

4. Handwashing facility options

A number of design features should be considered in selecting and/or innovating on existing handwashing facility options. These features include:

• turning the tap on/off: either a sensor, foot pump, or large handle so the tap can be turned off with the arm or elbow;

• soap dispenser: for liquid soap either sensor-controlled or large enough to operate with the lower arm; for a bar of soap, the soap dish should drain well, so that the soap does not get soggy;

• grey water: ensure the grey water is directed to, and collected in, a covered container if not connected to a piped system;

• drying hands: paper towels and a bin provided; if not possible encourage air drying for several seconds;

• materials: generally, the materials should be easily cleanable and repair/replacement parts can be sourced locally;

• accessible: should be accessible to all users, including children and those with limited mobility.

• physical distancing between users should be of 1m at least, this can be done by marking the ground, and by ensuring adequate numbers of hand-washing facilities to prevent crowds building up.

A number of handwashing designs have been implemented in households, schools and in public settings in both developed and developing countries. (67) In schools, a number of simple, easy-to-maintain, and durable low-cost designs have been successfully implemented. (68)

5. Disinfection at home and safe management of excreta

When there are suspected or confirmed cases of COVID-19 in the home setting, immediate action must be taken to protect caregivers and other family members from the risk of contact with respiratory secretions and excreta that may contain SARS-CoV-2. Support must include clear instructions on the safe and correct use and storage of cleaners and disinfectants, including keeping them out of reach of children to prevent harms from misuse including poisoning. (69) Frequently touched surfaces throughout the patient's care area should be cleaned regularly, such as tables and other bedroom furniture. Cutlery and crockery should be washed and dried after each use and not shared with others. Bathrooms shared by COVID-19 patients and other household members should be cleaned and disinfected at least once a day. Regular household soap or detergent should be used for cleaning first and then, after rinsing, regular household disinfectant containing 0.1% sodium hypochlorite (that is, equivalent to 1000 ppm or 1 part household bleach with 5% sodium hypochlorite to 50 parts water) should be applied. PPE should be worn while cleaning, including mask, goggles, a fluid-resistant apron and gloves, (36) and hand hygiene should be performed after removing PPE. Where households have limited resources, efforts should be made to provide PPE supplies – at a minimum, masks – and hand hygiene supplies to households caring for COVID-19 patients. Consideration should be given to safely managing human excreta throughout the entire sanitation chain, starting with ensuring access to regularly cleaned, accessible and functioning toilets and to the safe containment, conveyance, treatment and eventual disposal of sewage and sludge.

6. Management of waste generated at home

Waste generated at home during quarantine, while caring for a sick family member or during the recovery period should be packed in strong bags and closed completely before disposal and eventual collection by municipal waste services. If such services are not available, as interim measure, safely burying or controlled burning may be done until more sustainable and environmentally friendly measures can be put in place. Tissues or other materials used when sneezing or coughing should immediately be thrown in a waste bin. After such disposal, correct hand hygiene should be performed.

In places where there is limited supply and a high demand for masks, there is a likelihood of people collecting used face masks and re-selling them. Therefore, efforts are needed to ensure and improve safe waste disposal and fenced, regulated waste areas. Masks and other PPE may also clog sewers and waterways resulting in human and broader ecological impacts. Investments in waste management, including sourcing environmentally friendly products along with regulation on improper disposal can help reduce such issues. Finally, those tasked with collecting waste should wear PPE (heavy duty gloves, boots, coveralls, and masks when working in confined spaces) and have facilities for regularly conducting hand hygiene.

7. Use of public pools and beaches

Risk of transmission of SARS-CoV-2 from fresh and coastal water or swimming pools and spas water contaminated with faeces is very low.

Existing recommendations for managing the quality of bathing water apply. (70,71)

For a conventional public or semi-public swimming pool with good hydraulics and filtration, operating within its engineered bathing load, adequate routine disinfection should be achieved with a free chlorine level of 1 mg/l throughout the pool. Lower free chlorine concentrations (0.5 mg/l or less) will be adequate when chlorine is used in combination with ozone or UV disinfection. The pH should be maintained between 7.2 and 7.8 for chlorine disinfectants. This should be sufficient to eliminate enteric pathogens and enveloped viruses, like coronaviruses, which are sensitive to chlorine disinfection.

The risk of transmission of SARS-CoV-2 increases where bathers and people visiting beaches, pools and spas are in small, crowded conditions including in changing rooms, toilets and showers, restaurants and kiosks. General recommendations on hand hygiene, physical distancing and the use of face masks (32) when appropriate are recommended along with regular cleaning (once or more times a day) and maintenance of toilet facilities.