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Reducing COVID-19 Transmission Through Cleaning and Disinfecting Household Surfaces

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Background

The primary mode of human-to-human transmission for SARS-CoV-2, the virus responsible for coronavirus disease (COVID-19), is via direct contact with an infected person and their respiratory droplets, expelled during coughing, sneezing, speaking, or breathing.^{1,2} These droplets can be inhaled or become deposited on surfaces such as door handles, light switches, chairs, faucets, and other frequently touched surfaces.³

Contact with contaminated surfaces (fomites) followed by touching of the eyes, mouth, or nose is another important mode of SARS-CoV-2 transmission. The relative importance of other transmission pathways are still being investigated.^{4,5,6} SARS-CoV-2 has been found to remain viable for several hours on surfaces such as copper (four hours) and cardboard (24 hours) and for several days on plastics and stainless steel under experimental conditions.^{7,8} Other studies of coronaviruses have found that viruses can remain viable for up to nine days on non-porous surfaces such as metal, glass, or plastic.⁹ Interventions to reduce the transmission of SARS-CoV-2 via contact routes must include frequent cleaning and disinfecting to reduce viability of the virus on potentially contaminated surfaces.¹⁰

Current guidance on the safe and appropriate use of cleaners and disinfectants in homes varies widely across Canada, and accidental exposure to dangerous disinfection by-products or improper use of bleach have been reported.^a This document provides information to public health professionals who may be consulted on the appropriate use of cleaning and disinfection products as well as frequency of cleaning and disinfecting in homes to protect the health of the public.

^a Personal communication with colleagues at the Drug and Poison Information Centre, British Columbia Centre for Disease Control (Tina Chen, Knowledge Translation Scientist, National Collaborating Centre for Environmental Health, March 28, 2020, e-mail communication; unreferenced).

Types of Household Surfaces

Household surfaces can be categorized into food contact surfaces and environmental surfaces. Food contact surfaces are defined as surfaces that touch food or are in contact with other surfaces that touch food. Everything else is considered to be environmental surfaces, which can be further divided into high-touch and low-touch surfaces.¹¹ Table 1 lists some common household surfaces in each of these categories. This list is not exhaustive.

Table 1: Examples of common household surfaces

Food contact surfaces	Environmental surfaces	
	High-touch	Low-touch
<ul style="list-style-type: none"> Countertops Utensils Pots and pans Cutting boards Appliances such as stoves, refrigerators, toaster ovens, microwaves 	<ul style="list-style-type: none"> Door handles Light switches Faucets Stair banisters Toilet seats and flush levers Mobile devices and electronics Kitchen cabinet handles Toys and play mats 	<ul style="list-style-type: none"> Walls Floors Windows Windowsills Thermostats Blinds

Products used to reduce and inactivate microorganisms on food contact surfaces are different from those used on environmental surfaces that do not come into contact with food. This is due to the potential toxicological hazards of these products if residues contaminate foods. For food contact surfaces, the products must be approved for such use. Some products require rinsing with potable water. Manufacturer’s instructions for specific uses must be followed.

Appropriate use of cleaners, sanitizers, and disinfectants against SARS-CoV-2

SARS-CoV-2 genetic materials are enveloped by a fatty layer that is susceptible to soaps and detergents that can deactivate the virus by tearing apart its outer layer.¹² It is also susceptible to other lipid solvents including hydrogen peroxide, alcohol (ethanol or isopropyl alcohol), sodium hypochlorite (bleach), benzalkonium chloride (found in most Lysol products) and peroxyacetic acid (found in surface cleaners and sanitizers) among others.^{9,13-18} The type of cleaner and disinfectant depends on the intent, frequency of contact, and type of surface on which they are being used. Whenever possible, use pre-mixed disinfecting cleaner products instead of mixing separate products, to avoid accidental exposure to

harmful chemicals. Never mix bleach with ammonia or acid products as toxic chlorine gas and other dangerous by-products can be formed.¹⁹ Never use hot water as chlorine gas can be released when bleach is mixed with hot water.

What are cleaners, sanitizers, and disinfectants?

Cleaners

Cleaning involves the physical removal of dirt, debris, dust, body fluids, and other organic materials from a surface using surfactants such as detergents (soaps) or abrasive cleaners and water.²⁰ Soil debris encompasses several categories of debris that require different types of cleaners, for example: fats, oils and grease; proteins; carbohydrates; minerals and salts; corrosions (rust); adhesives, rubbers; and algae and fungi. Surfactants are used to disrupt fats and grease layers while caustic sodas and acid-based cleaners are used to disrupt proteins and carbohydrate layers. As debris such as dirt or organic materials may reduce the effectiveness of disinfectants, cleaners are used to pre-clean surfaces prior to sanitizers and disinfectants.^{16,20,21} Cleaning agents are also important to dislodge biofilm layers of microorganisms from surfaces.²² Cleaning products may kill or inactivate certain microorganisms but do not fully eliminate all of them from surfaces.²¹ Common cleaning products include detergents, caustic sodas and acid-based cleaners, soaps, pre-mixed detergent products, and mops, cloths, and paper towels. Ensure cleaning products are rinsed off thoroughly with potable water before applying sanitizers/disinfectants, unless otherwise indicated. Always follow manufacturer's instructions.

Sanitizers

Sanitizers are defined as substances or a mixture of substances that reduce but do not necessarily eliminate microorganisms on environmental surfaces and inanimate objects. Effective sanitizers reduce microorganisms by a minimum of 99.9% or 3 \log_{10} within 5 minutes at room temperature.^{23,24} On food contact surfaces, approved food grade sanitizers can be used. Food grade sanitizers must achieve 99.999% or 5- \log_{10} reduction of *Escherichia coli* and *Salmonella aureus* bacteria within 30 seconds at room temperature.²³

Box 1: What is log reduction?

This example demonstrates log reduction of microorganisms. Starting with one million (1,000,000) bacteria, a 90% or 1- \log_{10} reduction eliminates 90% of the bacteria, leaving 100,000 bacteria. A 2- \log_{10} reduction eliminates another 90%, leaving 10,000 bacteria. A 3- \log_{10} reduction eliminates another 90%, leaving 1,000 bacteria. A 5- \log_{10} reduction leaves only 10 bacteria out of the original 1,000,000 bacteria, demonstrating an acceptable food contact surface sanitizer.

As mentioned above, surfaces must be cleaned first before sanitizing; soiled surfaces reduce the effectiveness of sanitizers. Some sanitizer products may need to be rinsed off with potable water; manufacturer's instructions must be followed and verified for the product to be safe on food contact surfaces. There is currently no evidence to demonstrate that viral transmission can occur through consuming contaminated food. As any surface may be contaminated, it is important to practise proper hand hygiene after handling groceries and deliveries as well as before eating.^{1,25,26} Common sanitizer products include bleach (sodium hypochlorite), iodine, and quaternary ammonium compounds (quats).

Box 2: Sanitizer concentrations

- Diluted bleach solution: 100 to 200 ppm²⁷ (use the [online bleach calculator](#) to determine the amount of bleach and water required to achieve desired concentrations).
 - Contact time should be a minimum of 45 seconds to 2 minutes; allow to air dry after sanitizing.²⁷⁻²⁹
- Iodine: 25 ppm or follow manufacturer's instructions for concentration and contact time.²⁹
- Quats: 200 ppm or follow manufacturer's instructions for concentration and contact time. At 200 ppm or less, rinsing is not required. Allow to air dry after sanitizing.²⁹
- Hot water at 77°C or above (for items that can be immersed for at least 45 seconds).^{29,30}

Disinfectants

Disinfectant products include bactericides, fungicides, virucides, mycobactericides, tuberculocides, sporicides, and sterilants. These products have a greater ability than sanitizers to eliminate microorganisms and are categorized into low, intermediate, and high levels depending on their intended use and efficacy against different types of microorganisms.³¹ To inactivate coronaviruses, including SARS-CoV-2, intermediate to intermediate-high level disinfectants are required.^{9,15,18} The strength levels of some common disinfectants are dependent upon concentration and contact time. For example, bleach solution at 100–200 ppm is a food contact sanitizer, but is considered a disinfectant at 500 ppm or more.²⁷ To disinfect environmental surfaces potentially contaminated with SARS-CoV-2, the disinfectant product must be approved for such use.¹³ The manufacturer's instructions, including concentrations and contact time, must also be followed to ensure the product's effectiveness.

Table 2: Disinfectant categories

Low-level disinfectants	Intermediate-level disinfectants	High-level disinfectants
Able to destroy vegetative bacteria, some fungi, and viruses, but not mycobacteria or spores. These products are used on non-critical surfaces that only come into contact with intact skin.	Able to destroy vegetative microorganisms, mycobacteria, all fungi, and inactivates most viruses, but not spores. These disinfectants can also be used on non-critical surfaces that only come into contact intact skin and for household disinfection.	Able to destroy vegetative microorganisms and inactivate viruses but not necessarily bacterial spores unless they are specifically designed for such purpose. ³²⁻³⁴ With longer contact time (6–10 hours), they are capable of sterilization. ³⁴ These products are typically used on medical devices or to clean up a blood or bodily fluid spill. ²¹

Disinfectant products in Canada are assessed and approved by Health Canada. All approved disinfectant products in Canada have a Drug Identification Number (DIN). Health Canada maintains a list of [authorized hard-surface disinfectants](#) that may be used against SARS-CoV-2.¹³ To find out whether the disinfectant product meets Health Canada’s requirements, locate the DIN on the product label, and look for the product in the list.

Health Canada also provided a list of disinfectants [approved under interim measures](#) in response to COVID-19.³⁵ These products may not be fully compliant with labelling requirements, or are not authorized for sale in Canada but are authorized or registered in other jurisdictions with similar regulatory frameworks and quality assurances as Canada. To find out whether the disinfectant product meets Health Canada’s requirements, locate the DIN on the product label, and look for the product in the list.

Apart from commercial products specifically approved for use in the lists maintained by Health Canada, household bleach (sodium hypochlorite) is an inexpensive and commonly used disinfectant for use against SARS-CoV-2. A study demonstrates that 0.05% (500 ppm) and 0.1% (1000 ppm) sodium hypochlorite solutions are both able to reduce the SARS virus by more than 3 log₁₀ within 5 minutes.¹⁴ Another study found that 500 ppm sodium hypochlorite solution was able to inhibit viral replication in cell culture after less than 2 minutes contact time; 1000 ppm sodium hypochlorite completely inhibits viral replication and damages viral genome in less than 2 minutes contact time.¹⁸ Higher concentration bleach solutions are not necessary to ensure effective inactivation of SARS-CoV-2, and may increase risk of irritation to mucosae such as eyes and throat.³⁶ Prolonged exposure to bleach disinfectants may increase risk of chronic obstructive pulmonary disease.³⁷ Common disinfectants include bleach, hydrogen peroxide 0.5%, alcohols with at least 60% concentration, and benzalkonium chloride (found in most Lysol products). Low-touch household surfaces such as blinds, floors, and walls only require intermediate level disinfection when soiled to avoid irritation to mucosae, while high-touch surfaces such as light switches, doorknobs, toilets, tables, and faucet handles require intermediate-high level disinfection.

Box 3: Preparing bleach disinfection solutions (using 5.25% household bleach)^{13,36,38-40}

- Intermediate level disinfection (1:100, approximately 500 ppm)
 - 1 teaspoon (5 mL) of household bleach in 2 cups (500 mL) room temperature water.
 - Recommended for use on low-touch environmental surfaces.
 - Surfaces should remain wet for at least 5 minutes to allow adequate contact time. Air dry after disinfecting.
- Intermediate-high level disinfection (1:50, approximately 1000 ppm)
 - 1 teaspoon (5 mL) of household bleach in 1 cup (250 mL) of water.
 - 4 teaspoons (20 mL) of household bleach in 1 L of water.
 - Recommended for use on high-touch surfaces and when there is visible bodily fluid contamination.
 - Allow surfaces to air dry after disinfecting.^{13,40}

Use a [bleach calculator](#) for other concentrations.

Frequency of cleaning, sanitizing, and disinfecting surfaces

High-touch surfaces should be cleaned and disinfected once every few days, and twice daily if someone in the household is symptomatic or has tested positive for COVID-19, or if there are elderly or immunocompromised individuals in the household.^{36,38,41,42} Low-touch surfaces should be cleaned and disinfected once a week, and daily if someone in the household is symptomatic or has tested positive for COVID-19, or if there are elderly or immunocompromised individuals in the household.^{36,38,41,42} However, if visibly soiled, surfaces should be cleaned immediately. Higher disinfection frequency is not necessary if everyone in the household is well, to reduce risk of accidental exposure to dangerous chemicals or by-products. Ensure robust hand hygiene practices are followed by all household members.

Under certain circumstances, a low-touch surface may be considered as high-touch. For example, where young children frequently play on the floor or climb on window sills, those surfaces should be considered high-touch surfaces and should be cleaned and disinfected frequently.

Special recommendations for other household surfaces

Apart from the household surfaces mentioned above, other frequently used and potentially contaminated items require special disinfection procedures that differ from recommendations mentioned above.

Groceries, food deliveries, and food take-outs

There is currently no evidence to show that viral transmission is possible by eating contaminated food. If ingested, SARS-CoV-2 is unlikely to survive stomach acid.⁴³ Viral load and infectivity decrease over time on inanimate surfaces.⁴⁴ Unlike bacteria, viruses cannot proliferate in food.⁴³ However, as any fomite (such as food packaging) may potentially become contaminated, it is prudent to practise proper hand hygiene after handling groceries and food delivery items, as well as before preparing food and eating.^{25,26} Safe food handling practices should continue to be followed.⁴⁵

Mobile phones and electronics

Follow manufacturer's recommendations for disinfecting mobile devices and electronics.⁴⁶ If no recommendations are available, consider disinfecting touch screens using alcohol-based or disinfecting wipes, or sprays with 60–70% alcohol. However, alcohol should be limited to use on small surface areas as it is flammable.⁴⁷ Hydrogen peroxide or bleach is not recommended as it may damage the coating on mobile phone screens.^{46,48}

Toys and playrooms

Toys, toy bins, play mats, and other high-touch play surfaces may be contaminated with saliva, pathogens, visible dirt or dust, and bodily fluids. Therefore, it is important to clean and disinfect them regularly^{21,49}:

- Clean toys in hot soapy water prior to disinfecting with a brush for hard-to-reach areas; rinse thoroughly.
- Disinfect toys with an approved disinfectant that is safe for use for children, for the required amount of time. Follow manufacturer's instructions. If using bleach, use a 500-ppm bleach solution. Allow the surface to remain wet for a minimum of 2 minutes, then rinse with potable water. Use the [bleach calculator](#) to determine the appropriate amount of bleach and water. Air dry after rinsing.
- Dishwasher-safe, hard plastic toys can be cleaned and sanitized in a dishwasher with a sanitizer or a hot rinse cycle.
- Toy bins, play mats, and high-touch play surfaces should also be pre-cleaned with a cleaning product before being disinfected with an approved product that is safe for children.
- Plush toys should be laundered in a washing machine with hot water and dried in the dryer on a hot cycle.

Box 4: Important precautions when using sanitizers and disinfectants^{11,29,47,50,51}

- Wear protective clothing and eye covering when disinfecting with bleach solutions.
- Make sure the area is well ventilated.
- Always add concentrated bleach to water; to avoid accidental exposure from splashes, never add water to concentrated chlorine.
- Always follow manufacturer's instructions on the product label for the intended use.
- Make sure the cleaner and disinfectant are compatible with the finish and material of the surface.
- Check the expiration date of the product before use.
- To prevent cross-contaminating cleaner areas with dirtier surfaces, always clean from low-touch to high-touch surfaces, cleaner area to dirtier area, and from top to bottom.
- Consider using squirt bottles for the cleaner, sanitizer, or disinfectant; avoid double-dipping cloths into the solutions.
- Do not refill cleaning and disinfectant solutions.
- Consider using single-use cleaning products such as paper towels or wipes. Mops and cloths should be cleaned with laundry soap and hot water and disinfected with diluted bleach solution (1000 ppm) after use.
- Bleach disinfectant solutions should be prepared fresh each time. Dispose of leftover bleach in the toilet or down the drain with a large amount of water. Follow manufacturer's instructions for safe disposal of all sanitizer and disinfectant products.^{11,50}

Common hazards

Cleaning products and bleach contain chemical ingredients that could react and create dangerous by-products that could cause adverse reactions.^{19,51} Sodium hypochlorite is the active ingredient in bleach, and reacts with ammonia, drain cleaners, and other acids. If two separate products to clean and to disinfect must be used, ensure that the ingredients do not react with each other, to prevent formation of dangerous by-products. Specifically, thoroughly rinse the residues of the first product from the surface before using the second product. Safety Data Sheets about cleaners and disinfectants can be found online, containing information such as ingredients, handling and storage instructions, hazard warnings, and first-aid measures.^{19,51}

Ammonia

Ammonia may be found in cleaning products, some glass and window cleaners, urine (potentially in diaper pails, cat litter boxes), and some interior and exterior paints. Mixing bleach and ammonia produces chloramine gases. Chloramines can cause the following symptoms^{19,51}:

- Coughing
- Shortness of breath

- Chest pain
- Wheezing
- Nausea
- Watery eyes
- Irritation to the throat, nose, and eyes
- Pneumonia and fluid in the lungs

Acids

Acids may be found in vinegar, some glass and window cleaners, some automatic dishwasher detergents and rinses, some toilet bowl cleaners, some lime, calcium, and rust removal products, and some brick and concrete cleaners. Combining bleach and an acid produces chlorine gas. Mixing bleach with hot water also releases chlorine gas.²⁹ Chlorine gas exposure can cause symptoms even at low levels, and death can occur at very high levels of exposure^{19,51}:

- Coughing
- Shortness of breath
- Burning and watery eyes
- Runny nose

If chlorine gas is combined with water, hydrochloric or hypochlorous acids are formed, which can cause burns to the skin, eyes, nose, throat, mouth, and lungs.

Other cleaning products^{19,51}

Ingredients in other cleaning products such as some oven cleaners, hydrogen peroxide, and some insecticides can also react with bleach to produce harmful by-products.¹⁹

Proper Storage of Cleaners, Sanitizers, and Disinfectants

For approved commercial disinfectant products, follow manufacturer's instructions for proper storage. Chlorine, which is found in household bleach, is relatively unstable. Bleach solutions gradually lose their effectiveness within 24 hours, even in covered containers. Therefore, fresh bleach solutions should be prepared daily.²⁹

Cleaning and disinfection products should be stored in a cool area away from the reach of children, elderly, and pets. Undiluted bleach can release a toxic gas if exposed to sunlight.⁴⁷ Products should remain in their original containers as much as possible. Use plastic storage containers instead of metal. Ensure bottles are clearly labelled with the type of product.²⁹

Summary

While aerosol transmission remains the primary transmission pathway for SARS-CoV-2, the role that fomites play in the chain of transmission cannot be discounted. The ability of SARS-CoV-2 to persist on a variety of surfaces warrants proper cleaning, sanitizing, and disinfection processes not only in homes but also in a variety of public settings. However, improper or excessive use of these products pose potential health risks to users. Therefore, consistent and evidence-based recommendations are crucial to protect the public from not only SARS-CoV-2 but also accidental exposures to dangerous chemicals. Table 4 summarizes the cleaners, sanitizers, and disinfectants for various household surfaces and the recommended concentrations and frequencies as presented in the document.

Table 4: Recommended products and concentrations

Surface Type	Cleaning Options	Sanitizing Options	Disinfecting Options	Frequency
High-touch surfaces (e.g., doorknobs, light switches, toilets, faucet handles, tables, chairs)	<ul style="list-style-type: none"> • Pre-mixed disinfecting cleaner products • Soap/detergent and hot water 	N/A	<ul style="list-style-type: none"> • Health Canada approved disinfectant • 1000 ppm (1:50) diluted bleach solution; air dry after application 	<p>Household with no symptomatic or COVID-19-positive individuals: Once every few days</p> <p>Household with symptomatic or COVID-19-positive individuals: Twice per day</p>
All other surfaces	<ul style="list-style-type: none"> • Pre-mixed disinfecting cleaner products • Soap/detergent and hot water 	N/A	<ul style="list-style-type: none"> • Health Canada approved disinfectant product • 500 ppm (1:100) diluted bleach solution; allow surface to remain wet for 5 minutes, then air dry 	<p>Household with no symptomatic or COVID-19-positive individuals: Once per week</p> <p>Household with symptomatic or COVID-19-positive individuals: Daily</p>
Food contact surfaces (e.g., cutting boards, countertops, utensils, pots/pans, appliances)	<ul style="list-style-type: none"> • Soap/detergent and hot water 	<ul style="list-style-type: none"> • 100–200 ppm diluted bleach solution • 25 ppm iodine or follow manufacturer’s instructions 	N/A	After each use

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		<ul style="list-style-type: none"> • 200 ppm quats or follow manufacturer’s instructions • Hot water at 77°C or above (dishwasher with a hot rinse cycle is adequate) 		
Mobile phones and electronics	<ul style="list-style-type: none"> • Wipe off visible dirt or grime 	N/A	<ul style="list-style-type: none"> • Follow manufacturer’s recommendations • Alcohol-based or disinfecting wipes • Sprays with 60–70% alcohol 	Once every few days or when visibly soiled
Toys, toy bins, playmats	<ul style="list-style-type: none"> • Soap/detergent and hot water with a brush 		<ul style="list-style-type: none"> • Health Canada-approved disinfectant that is safe for children • 500 ppm diluted bleach solution; rinse with potable water after 2 minutes contact time • Dishwasher or launder with a hot rinse cycle 	<p>High-touch surfaces and toys: Once every few days</p> <p>Toy bins and low-touch surfaces: Once a week or when visibly soiled</p>
Cleaning equipment	<ul style="list-style-type: none"> • Use single-use disposable products • Mops and cloths: Laundry detergent with hot water followed by 1000 ppm diluted bleach solution 			

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