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Reasons for Installing Disinfectants in Public Facilities and Shops during COVID-19 Pandemic

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ABSTRACT

Since the onset of the COVID-19 pandemic, many countries, including Japan, have increased the practice of hand disinfection at entrances when entering stores and indoor public facilities, including museums and libraries. The primary purpose of this should be to suppress infectious diseases; however, other purposes may also be considered. Disinfection is conventionally performed based on its use in medicine. In this study, after describing the types of infectants, we discuss the purpose of the disinfectants currently placed at the entrances of buildings in Japan.

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INTRODUCTION

Since then, disinfection methods have been widely used to prevent infectious diseases caused by microorganisms. People often rinse their mouths with water or mouthwash and wash their hands with soap when returning home. It is generally believed that this prevents or minimizes the intrusion of pathogenic microorganisms into the body, thereby preventing influenza and colds. At clinical facilities, such as hospitals, various pharmaceuticals are used to disinfect floors, furniture, and medical instruments, in addition to direct application by people[1)].

In recent years, the new coronavirus disease (COVID-19) has spread worldwide, and due to this, movement restrictions and avoidance of the 3Cs (Closed spaces, Crowded places, Close-contact settings) have been implemented in Japan as well[2)]. As a supplementary means of such preventive measures, the disinfection of each person's hands, handrails, desks, and chairs that are likely to be touched by an unspecified number of people is being enforced at shops and public facilities. Local governments, such as national and prefectural governments, lag behind this trend. For example, the conditions for the continuous operation of a store include sufficient ventilation and the ability to maintain distance between customers. When multiple groups of customers use the same table at a restaurant, it is necessary to install partitions between customers and limit the number of customers entering department stores. In addition, disinfectants are often installed at the entrances. Masks are often required to be worn, except when eating or drinking, and are only allowed to be removed for short periods to place food in one's mouth[3)]. Such regulations have gradually relaxed globally in recent years because of the emergence of p to treat COVID-19 and contain the spread of the infection. In Japan, in principle, since March 2023, it is no longer required to wear a mask in public. However, the practice of hand disinfection has been ongoing when entering shops and public facilities.

Among these, we have focused on the use of disinfectants. Disinfectants are placed at the entrances of buildings and can be used upon entering or exiting the building. However, users do not necessarily understand the purpose of the installed facility. There is a possibility of a gap between the intended meaning of installing disinfectants when permitting the operation of stores, as considered by the national and local governments, and the actual purpose considered by the stores.

Types and effects of disinfectants

Tables 1 and 2 show the types of disinfectants[1),4),5)]. Table 1 shows how different disinfectants are used depending on the disinfection site, and Table 2 enlists the usage of different disinfectants based on the type of microorganism. Disinfectants must kill or eliminate the pathogenic target microorganisms, and the types of microorganisms that are affected vary greatly depending on the type of chemical substance[1)]. This does not mean that the higher the concentration, the more potent the effect or that there is an optimum concentration range. For example, approximately 80% ethanol exhibited the highest disinfection effect. However, the disinfectant used (e.g, on the skin, instruments, and furniture) depends on whether the chemical damages the surface of the area where it is used, such as through discoloration or denaturation[1)]. Disinfectants are generally classified into high-, medium-, and low-strength according to their effects (Table 2). High-strength disinfectants can disinfect all types of microorganisms, including spores, but they are also highly toxic to the human body; therefore, they are mainly used for disinfecting medical equipment at hospitals. Medium-strength disinfectants are ineffective against spore-forming bacteria but are effective against most other microorganisms. If the concentration used in the human body is low, it is considered that the harm is unlikely to appear; therefore, it is used in many applications. Low-strength disinfectants are characterized by low toxicity and ease of use; however, their disinfection effects are also considered to be low. Toxicity is unlikely to occur; however, no effect was observed in some cases[5)]. If there is even a small reduction in microorganisms and a sterilizing effect, it means that there is a disinfection effect; therefore, it is necessary to separately consider whether the effect is sufficient.[6)].

For example, to prevent COVID-19, bottles placed at the entrances of stores often contain ethanol as a disinfectant[7)]. Ethanol is a disinfectant with moderate efficacy. The reason for this selection is that it is thought that a disinfectant effect can be obtained by applying it to the hand and rubbing it; even when not applied as desired, ethanol will volatilize such that its concentration will decrease (because it is often difficult to rinse off the disinfectant with water), and even if it enters the mouth, it is unlikely to be toxic. The disinfection effect of ethanol is high at 80%; alcohol evaporates at room temperature, and the concentration after application gradually decreases. To maintain the disinfection effect, it is necessary to check the concentration many times and replace the contents. We do not know if the employees of a store

without specialized knowledge do as required or if administrative guidance is thorough. In the past, soapy water, in which detergents were diluted with water, was sometimes used[7]. In Japan, ethanol shortages have occurred and ethanol has been replaced with highly diluted detergents to wash dishes and windows[8]. Dilution with high magnification is intended to prevent damage such as hand roughening. At present, it is not used because immediate removal by washing with water is not possible, and the trouble of wiping it off and skin damage are disadvantageous. Even if used, it is used only in a limited number of places. Additionally, given its dilution with water to avoid toxicity, its efficacy may be lost. Frequent disinfection with ethanol can also cause a decrease in moisture and lipids in the skin, causing pain due to penetration through wounds, therefore, it is not without disadvantages.

Possible reasons for placing disinfectants

It was only after the spread of COVID-19 that disinfectants were placed at the entrances of public institutions and stores, whereby the novel coronavirus was targeted as the pathogen. The reasons can be classified as follows: **A**) to maintain the health of customers, users, and employees; **B**) to appeal to customers and the administration; and **C**) to suppress the attachment and transmission of viruses by an unspecified number of people touching products such as exhibits and sales items inside.

Supplementary information (for **A**). Reason **A)** is the most common reason and is the purpose of administrative guidance. When entering a building, the contamination can progress through the contact with handrails and objects. Therefore, disinfecting hands in advance deters the establishment of an infectious disease, even if the virus adheres to the hands. Depending on the facility, body-temperature sensors may also be placed simultaneously. This seems to be to call attention to people with fever not to enter; however, in the case of using disinfectants, there is no reason to refuse entry.

Supplementary Information (for **B**). Even in large buildings such as department stores and small shops, disinfectants are often installed only near the entrance. However, hospitals normally have disinfectants in each room. If stores and public facilities want to do the same thing, it would be better to install disinfectants for each store in the department store or on each floor; however, they are not usually placed to that extent. From these observations, installation of disinfectants is

often unavoidable because it is merely obligatory, and its effect is often overlooked. To avoid suspension of business by administrative agencies, application of disinfectants was mandatorily performed, and we have considered to minimize this application.

Supplement Information (for **C**). To prevent the viral contamination of products at stores, examining the products with disinfected hands is desirable. Although propagation through the air is not effective, propagation through contact can be effective. In particular, depending on the type of product, it may be difficult to disinfect the product itself; therefore, the store cannot prevent customers from touching the products, but hand disinfection is considered useful in such scenarios. In this case, this does not mean that customers and visitors are considered, but rather that the facility's employees and administrators act so as not to cause any disadvantage to the displayed products. As a special directive, buffet-style restaurants may encourage the wearing of disposable gloves in addition to using a disinfectant. It may be considered a means to prevent contamination of food through hands and the other types of food in the buffet.

In our opinion, the reasons for **A**)–**C**) are complex, and we believe that the installation of the disinfectant was decided upon. However, we also believe that the biggest reason for this is likely **C**). If so, it may be an unintended event for a customer to use disinfectants at the store exit. Store employees feel that such actions are unnecessary, and they are possibly more concerned regarding the increase in drug consumption and purchase costs. People such as employees involved in the customer service industry may not be able to object to this.

Disinfectants suitable for COVID-19

As already mentioned, alcohol (ethanol) is often used to cope with COVID-19. Table 3 shows the disinfection methods indicated by the Ministry of Health, Labor, and Welfare. Water, soapy water, and alcohol are considered suitable for hand disinfection. The water has the effect of washing off some of the attached virus by its flow. To further enhance this effect, soap, which is a surfactant with low toxicity to the human body, is recommended. Alcohols (including ethanol) can be considered more effective because it can disrupt and viruses can be detoxified by breaking the surface membrane[7]. Because soapy water must be washed away, the places where it can be used are limited. Viruses that adhere to objects can also be removed to some extent using detergents, and hot water and chlorine-based substances can kill and detoxify viruses.

Although this is slightly off-topic, we have described a disinfectant that uses chlorine dioxide. Currently, the number of air purifiers sold in Japan has increased significantly owing to the impact of COVID-19, and some of them have had an ambiguous scientific impact. One is an air purifier and portable sterilization medical device based on the disinfection effect of chlorine dioxide[9),10)]. Chlorine dioxide, such as in hypochlorous acid and chlorine gas, has a proteolytic action by chlorination and oxidation, and it has a preventive effect against infectious diseases by attacking the cell membranes of microorganisms[11)]. Additionally, it has a nucleic acid-cleaving action and can suppress the growth of microorganisms; therefore, it is expected to be highly effective in disinfecting instruments and vomited areas (Table 1). However, it cannot be used in the human body at high concentrations because it causes skin damage. A medical product that evaporates chlorine dioxide was released as a product that can be worn around the neck like a necklace or placed in a room like a deodorant[10)]. However, it has been reported that these products do not sufficiently increase chlorine dioxide levels in the air[6)]. Recently, as an air purifier, a product that cleans rooms by generating chlorine dioxide using common salt (sodium chloride) as a material has been introduced; however, a sufficient scientific basis has not yet been established for this[6),9),12)]. Chlorine dioxide has a bactericidal effect at high concentrations; however, at low concentrations, it does not damage the skin, and the disinfection effect is considered as low[12)]. If it is effective in the air and human living spaces, it may indirectly affect the virus by an undetermined mechanism[9)].

CONCLUSION

There are many types of disinfectants, but only a limited number of them can be used on the human skin and have a disinfecting effect. Moreover, ethanol appears to be the only appropriate disinfectant for preventing COVID-19. There are various possible purposes for the installation of alcohol disinfectants, and some cannot directly prevent infectious diseases. For example, customers at a store may disinfect often to prevent their own infectious diseases or for compliance, but the store may not actually require such disinfections. The practice of disinfection when leaving may not be necessary for the store. Given the difficulty in complaining to customers, so there is a possibility that they will not say anything. Similarly, it seems that there is a possibility that public facilities may not be able to limit their use.

Disinfectant installation is often performed because it may be essential for the continuous operation of a facility, as stipulated by the country. However, few researchers are concerned about whether the chemical has a disinfecting effect or whether its effectiveness decreases. Although it cannot be ruled out that chemicals with no sterilizing effects are used because they are cheap, currently, there are no means to confirm this. Beyond this idea, there is a possibility that many unspecified people will touch bottles containing disinfectants that are not effective, and as a result, they may transmit infectious diseases[13]. In this case, pathogens contaminate the area where the bottle is pushed or touched to release the disinfecting substance. This has not yet been properly confirmed and may be an issue for future studies.

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Table 1 Types of common disinfectants and disinfection points

Type		Use								
Classification	Disinfectant	Hands and skin	Surgical site		Wound site		Excrement	Metal utensils	Non-metallic utensils	Environment
			Skin	Mucosa	Skin	Mucosa				
Alcohol	Ethanol	○	○					○	○	
	Isopropanol	○						○	○	
Aldehyde	Glutaral							○	○	
	Phthalal							○	○	
	Formalin							△	△	△
Chlorine compound	Sodium hypochlorite	△	△	△			○		○	○
Iodine compound	Povidone iodine	○	○	○	○	○				
	Iodo tincture	○			○	○				
Phenol	Phenol	△	△				○	△	△	△
	Cresol soap	△	△				○	△	△	△
Quaternary ammonium salt (inverted soap)	Benzalkonium chloride	○	○	○	○	○	△	○	○	○
	Benzethonium chloride	○	○	○	○	○	△	○	○	○
Oxidant	Peracetic acid							○	○	
	Oxidol				○	○				

○: usable, △: use with caution, others: unusable.

Based on references 1) and 4).

Table 2 Types of general disinfectants and target microorganisms

Type		Microbial species to be disinfected							
Division	Disinfectant	General bacteria	*Pseudomonas aeruginosa*	MRSA	*Mycobacterium tuberculosis*	Spore	Fungus	Virus (enveloped)	Virus (non-enveloped)
High-strength	Glutaral	○	○	○	○	○	○	○	○
	Peracetic acid	○	○	○	○	○	○	○	○
	Furthalal	○	○	○	○	○	○	○	○
Medium-strength	Formalin	○	○	○	○	△	○	○	○
	Sodium hypochlorite	○	○	○	○	△	○	○	○
	Povidone iodine	○	○	○	○		○	○	○
	Iodo tincture	○	○	○	○		○	○	○
	Ethanol	○	○	○	○		○	○	△
	Phenol	○	○	○	○		○	△	
	Cresol soap	○	○	○	○		○	△	
	Oxidol	○				△			
Low-strength	Benzalkonium chloride	○	○	○			△	△	
	Benzethonium chloride	○	○	○			△	△	

○: effective, △: difficult to obtain effect, but may become effective over time or if the concentration is high, others: ineffective or no information available.

Based on references 1) and 5).

Table 3 Disinfectants for preventing COVID-19

Type	Disinfecting target		Supplement
	Hand	Object	
Water and soap	○	○	Hand disinfection with soap requires rinsing (washing off the drug).
Hot water	×	○	Do not use on hands due to risk of burns.
Alcohol	○	○	Most commonly used for COVID-19 measures.
Sodium hypochlorite	×	○	Main component of chlorine bleach. There is a risk of protein denaturation of hands and rusting of metals.
Surfactant (detergent)	△	○	Unrated by hand. Rinsing required if used on hands.
Hypochlorous acid	△	○	Unrated by hand. If the concentration is high, it is a strong acid. It seems that there are also disadvantages similar to sodium hypochlorite.
Chlorous acid	△	○	Unrated by hand. If the concentration is high, it is a strong acid. It becomes a material for generating chlorine dioxide gas. It seems that there are also disadvantages similar to sodium hypochlorite.

○: usable, ×: unusable, △: unusable or unknown (used temporarily in emergencies).

Based on reference 7).