



Hand Sanitizer: A Comprehensive Narrative Review

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ABSTRACT

Hand Hygiene is considered as one of the basic and effective way to prevent spread of various contagious diseases including Covid-19. Among the hand sanitizers, alcohol based hand sanitizers are commonly used as they are found to possess good antimicrobial activity against different pathogens. The present review provides a comprehensive overview of the literature regarding hand sanitizers and their ability to prevent various infections. Hand hygiene is one of the basic and very necessary tool to combat various infections including covid-19. However, selection of right type of hand sanitisation is a very important criterion to be considered. An extensive awareness program is required to educate common people related to the appropriate use and serious health hazards of hand sanitizer. During the pandemic lockdown, the decreased availability of alcoholic beverages made a major impact on many lives. People tend to consume alcohol based hand sanitizers in various regions, which are serious concern. Consumption of alcohol based hand sanitizers can lead to serious health hazards and even poisoning. The governing bodies need to update guidelines regarding restriction on number of times to be used on the daily basis and plays an important role in the global pandemic of Covid-19 infection.

Keywords: Hand Sanitizers, Hand Hygiene, Covid-19, Public Health, Hand Rub, Antiseptics, Precaution.

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INTRODUCTION

Microbes like bacteria, virus and fungi can spread through various modes including sneezing and coughing which usually travels as aerosolized particles. The microorganism having the size less than 5 micron can travels through air current from an infected person to the normal host. Most of infection, which affects upper airway and tend to cause inflammation of nose, throat, sinus and lungs spreads through aerosolized particles. Infections that can spread via air are as follows: Chickenpox, Influenza, Measles, Smallpox, Cryptococcosis, Tuberculosis and covid-19.¹ Since the hands are more prone to come in contact with such airborne particles which contain pathogens, it is important to maintain hand hygiene. In addition to hand hygiene, social distancing is also one of the important recommendations from World Health Organisation (WHO) to fight against covid-19.²

Different methods used for hand hygiene practices:

There are several methods employed for hand hygiene, which include hand washing, hand cleansing and hygienic hand rubs. During Covid-19, most of the people rely on hand sanitizers for hand hygiene. According to WHO **hand washing** is defined as "Washing hands with plain or

antimicrobial soap and water".³ It is found that hand washing can reduce the chances of diarrheal infection by 23%, upper respiratory tract infection by 51%.⁴ However, hand washing is very simple and one of the effective interventions in hand hygiene. WHO defines **hand cleansing** as "Action of performing hand hygiene for the purpose of physically or mechanically removing dirt, organic material, and/or microorganisms."³ Whereas the definition of **hand rubs** by WHO is "Treatment of hands with an antiseptic hand rub to reduce the transient flora without necessarily affecting the resident skin flora. These preparations are broad spectrum and fast-acting and persistent activity is not necessary."³ A study suggested that in vitro and in vivo testing of alcohol based hand sanitizers formulations are highly effective against bacterial pathogens and can produce 3.5-log reduction on hands within 30 sec and 4.0 to 5.0 log reduction in 1 min against wide range of bacterial species.⁵ A study also shown that alcohol based hand sanitizers have potential antiviral activity against reemerging pathogens like severe acute respiratory syndrome coronavirus (SARS-CoV), Middle East respiratory syndrome coronavirus (MERS-CoV), Ebola virus, Zika virus (ZIKV) and several enveloped virus.⁶

The marketing and the revenue from the hand sanitizers is growing tremendously from past few years globally, which is valued at \$919 million in 2016 and to reach 1,755\$ million by 2023. This sudden increased demand of hand sanitizer is due to the importance of hand hygiene during the time of covid-19 pandemic recommended by WHO.⁷ Hand sanitizers are widely used in various sectors, which includes healthcare sectors like hospitals, primary health



care (PHC) centres, nursing homes, clinics, health camps, homes, industries, and in some public washrooms.

Table 1: Definition of various agents used for hand hygiene

Sl No	Product	Definition
1	Alcohol based (hand) rubs	According to the World Health Organization (WHO), "an alcohol-containing preparation (liquid, gel or foam) designed for application to the hands to inactivate microorganisms and/or temporarily suppress their growth. Such preparations may contain one or more types of alcohol, other active ingredients with excipients, and humectants."
2	Non-Alcohol-Based Hand Sanitizers	Non-Alcohol- Based hand sanitizers contains Benzalkonium Chloride, a quaternary ammonium, as an active ingredient in commercially available preparation today. It is non-flammable, and the low concentrations of Benzalkonium make it relatively non-toxic. However, Alcohol free hand sanitizers are believed to be less important in health market.
3	Antiseptic agent	According to WHO "An antimicrobial substance that inactivates microorganisms or inhibits their growth on living tissues. Examples include alcohols, chlorhexidine gluconate (CHG), chlorine derivatives, iodine, chloroxyleneol (PCMX), quaternary ammonium compounds, and triclosan."
4	Humectant	Ingredient(s) added to hand hygiene products to moisturize the skin.

Table 2: Characteristics of Contents or ingredients of sanitizers

Sl. no	Characteristics	Alcohol	H ₂ O ₂	Glycerol
1	Concentration	60-95%	3%	98%
2	Effective against virus	+	+	-
3	Exposure time	20-30 sec	20-30 sec	-

Classification and composition of hand sanitizers:

Based on presence and absence of alcohol, sanitizers are classified as:

- 1. Alcohol Based hand sanitizers (ABHS):** WHO defines alcohol based hand sanitizers "an alcohol-containing preparation (liquid, gel or foam) designed for application to the hands to inactivate microorganisms and/or temporarily suppress their growth. Such preparations may contain one or more types of alcohol, other active ingredients with excipients, and humectants.³

Composition: According to WHO, the alcohol based hand sanitizers are of two types of formulations. (The ingredients are for 1000ml)

Formulation 1: Ethanol 96% v/v (833.3 ml) : H₂O₂ 3% (41.7 ml) : Glycerol 98% (14.5 ml), make up the volume to 1000 ml with distilled water or water that has been boiled and cooled; shake the flask gently to mix the content.

Formulation 2: Isopropyl alcohol (with a purity of 99.8%) (751.5 ml) : H₂O₂ 3% (41.7 ml) : Glycerol 98% (14.5 ml) and make up the volume to 1000 ml with distilled water or water that has been boiled and cooled; shake the flask gently to mix the content.⁸

- 2. Non- Alcohol based hand sanitizers:** These sanitizers contain benzalkonium chloride and quaternary ammonium salts as active ingredients in most of the non-alcohol based hand sanitizers. These sanitizers are inflammable and relatively less toxic and less effective than ABHS.⁶

Mechanism of action of ingredients present in sanitizers

1. Alcohols (ethanol and isopropyl alcohol):

The Alcohol shows antibacterial activity by denaturation and coagulation of protein present in the Bacteria. This leads to disruption in cellular metabolism and finally the microorganism's cells are lysed. The activity of alcohols is immediate and broad. The activity is reduced at higher concentration since the water is required for the lysis of the bacterial cell wall.⁶

2. Hydrogen peroxide:

Hydrogen peroxide works by producing the hydroxyl free radical that will attacks the membrane lipid, DNA and other essential cell components and destroys the microorganism. The enzyme catalase, which are produced by aerobes and facultative anaerobes that contains cytochrome systems, can protect cells from metabolically produced hydrogen peroxide by degrading hydrogen peroxide to hydrogen and water.⁹



3. Glycerol:

Glycerol present in ABHS have emollient effect on the skin it will protect the skin against drying and dermatitis. Glycerol has the negative affect on microorganism. They are used in ABHS for its emollient effect.¹⁰

Quantity of Hand Sanitizers to be Used and its Effectiveness

Alcohol based hand sanitizers are recommended for decontamination of hands in healthcare sector or in real world. Hand sanitizers should be used to clean the hands irrespective of visible dirt or grease.¹¹ The Hand sanitizers work by denaturing the protein of the microorganisms and will eradicate the flora.¹² Manufacturers recommend using a suitable amount of sanitizers to keep the hand wet for 30 seconds.¹³ Generally as per Regulations, any bottle or cartridge with a pump should dispense a specific amount of recommendation, expressed in number of pumps (Health and Safety Executive). Several studies claim that 2 to 6ml of alcohol based hand rub should be used for about 20 to 30 seconds.¹⁴⁻¹⁶ As per standards, 2.5 to 3 ml of Alcohol based hand rub should be used for about 30 seconds.¹⁷ World Health Organization's recommendation to use a "palm-full" of sanitizer, not merely a dime-sized drop and the sanitizer needs to be in contact with the hands for at least 10-15 seconds to be effective.¹³ It is also recommended to use alcohol base hand sanitizers having an alcohol strength of 60 to 95% .^{11,18,19} There are various indications recommended by WHO for using Hand rubs such as in health care setup, before any invasive procedure or after any direct patient contact. In daily usage hand rubs can be as useful, such as before eating, before or after any activity etc. ¹³ In the time of SARS-CoV-2(COVID-19) pandemic, the virus is inactivated by ethanol and iso-propanol at 30%, 40% and 60% in 30 seconds.^{20,21}

Background and Use of Hand Sanitizers

In the 1960s the commercialization of the first alcohol-based liquid cleanser (Sterillium), alcoholic solutions are more and more used for hand disinfection.^{22,23} ABHS is proven effective to fight against various pathogens in the hands as an alternative of Soap and hand wash. It was found that frequent use of ABHS can cause passive alcoholism, according to a study it was found that using ABHS frequently on an average of 30 times per day can alter the alcohol serum levels through hand absorption.²⁴ It is recommended to clean four hands either with soap and water or with Alcohol based Hand Sanitizers before taking food.¹³ Alcohol based hand sanitizers contains 60 to 95% Alcohol concentration by volume and are combined with various excipients like perfumes and colours. Recent case report shows that consumption or swallowing of alcohol based hand sanitizers has shown serious health consequences in young children and adults. Intentional/unintentional consumption of Alcohol based hand sanitizers can lead to alcohol poisoning and lead to conditions such as acidosis, apnoea, and coma or even death.^{25,26,27} Recent studies shows that use of hand

sanitizers containing triclosan can modulate the hormonal responses.²⁸ Hand sanitizers can also cause irritation or itching and even cracking of the skin. Skin reactions such as allergic contact dermatitis are rare. Hand sanitizers are meant for external use mainly on the hands, accidental contact of sanitizer with the eye can cause burning, blurry vision and even loss of vision. The most common type of adverse health effects for both alcohol- and non-alcohol-based hand sanitizers were ocular irritation, vomiting, conjunctivitis, oral irritation, cough, and abdominal pain. Rare effects included coma, seizure, hypoglycaemia, metabolic acidosis, and respiratory depression. Hand Sanitizers should be kept away from the reach of children and should be used carefully under supervision.²⁹

Alcohol Based Hand Sanitizers are effective against pathogens and provides protection from various pathogens.¹⁴ Depending on the content and the concentration of alcohol it is recommend to use sanitizer to combat against various pathogens and combat COVID-19. ABHS with 60 to 95% alcohol strength should be used, as per dosage and cleanse the hand for at least 20secs.^{13,14,15}

Stability of Hand sanitizers

During the time of shipping of bottles containing hand sanitizers, it is important to make sure that the adequate kind of packing material is used. The safest way is to provide sufficient cushioning and Insulation around the bottles using stuffs like bubble wrap and/or air pillows. Precise packaging specialists have also suggested that an absorbent material can be used for lining the bottom of the package as a precautionary measure to any leakage during transit.³⁰

Since hand sanitizers belong to type of hazardous material, it is crucial to make sure that the Limited Quantity Label is affixed to the side of the package

One of the well-known brand of hand sanitizers introduced on the go packaging solutions with mini bottles of hand sanitizer gel in a 3-pack speciality carton. This bottle also features a handy rubber Carrier that allows the bottle to get attached with the bag of customer easily.³¹

Expiry Date of Hand Sanitizer

Hand sanitizer as regulated by the Food and drug administration, so they are required to have expiration date. Alcohol is the active ingredient in hand sanitizer, which is a volatile liquid that evaporates quickly when it is exposed to air. As the alcohol evaporates over time, the percentage of the active ingredient drops, making it less effective.

All hand sanitizer have an expiry date i.e., 2 to 3 years, where the percentage of active ingredient drops below 90% of the percentage as given on the label. It is not dangerous to use hand sanitizer after its expiration date, it may be less effective against all germs as alcohol content dips below 60%. A fresh hand sanitizer that has passed its expiration date which wasn't used is way more effective when compared to a expired hand sanitizer which was used.^{32,33}



Table 3: Myths and Facts about Hand Sanitizers

MYTHS	TRUTHS
Hand sanitizers must be used by the health care workers only when there is no availability of soap and water.	Centers for Disease Control and Prevention (CDC) as well as World Health Organization (WHO) have insisted health care workers to use alcohol based sanitizers for the purpose of cleaning their hands as WHO recommended that using hand sanitizers is the best option because they are not only faster with greater germicidal action but also easier on the skin when compared to soap and water.
A quick pump or squirting a little sanitizer is more than enough.	Although it starts with a quick pump, squirting a little sanitizer on to your hand is not at all a right idea as it may fail to exhibit its activity unless used in a right amount with proper technique and for appropriate duration. CDC recommended 20 seconds handwash which was reinforced by The Joint Commission in 2020.
Using hand sanitizer is the best method to protect against all kinds of microbes.	Hand sanitizers will not kill the germs that cause C. diff infections, norovirus, and Cryptosporidium (the parasite that causes the diarrheal disease cryptosporidiosis). In addition, non-alcohol-based sanitizers can contribute to certain germs becoming resistant to sanitizing agents, as well as to some antibiotics.
Not only Nurses and Physicians, but all other workers of health care facilities also have to make use of hand sanitizers to clean their hands.	Even though it is important for all the people who could have contact with the patient to keep their hands clean, it does not mean that all of them have to strictly use only the hand sanitizers. In health care facilities, there are various recommendations for various types of workers. Cooks, cafeteria workers, and anyone else handling food should follow the hand hygiene recommendations for the food industry. US Food and Drug Administration (FDA) guidelines state that since sanitizers are not as effective when hands are wet—and since people handling food often have wet hands—soap and water should be used instead of sanitizer.

Different modes of spreading awareness about the use of hand sanitizer

As per the World Health Organization, Hand Hygiene Programmes are developed for Healthcare workers (HCWS). This Programme Includes 4 Parts:-

- A) In hand hygiene promotion programmes for HCWs, focus specifically on factors currently found to have a significant influence on behaviour and not solely on the type of hand hygiene products. The strategy should be multifaceted and multimodal and include education and senior executive support for implementation.
- B) Educate HCWs about the type of patient-care activities that can result in hand contamination and about the advantages and disadvantages of various methods used to clean their hands.
- C) Monitor HCWs' adherence to recommended hand hygiene practices and provide them with performance feedback.
- D) Encourage partnerships between patients, their families and HCWs to promote hand hygiene in health-care settings.

The World Health Organization also encourages National and Institutions to take responsibility on spreading awareness about Hand hygiene among HCWs as well as public for Strengthening Self-protection and protection of others by adhering to hand hygiene practice. It is recommended to wash your hands for 20 seconds with soap and water or use alcohol based hand sanitizer of alcohol strength not less than 60%.³⁴ Hand hygiene programmes should be conducted and awareness should be spread on hand hygiene among HCWs, Patients, Clients and Public to combat various Pathogens and Global Pandemics. Hand

Hygiene programmes can be conducted by hosting seminars, providing educational brochure, teaching programmes for the staff and public.³⁵

In the situation of Covid-19 Outbreak it is recommended to use Hand Sanitizers and Proper Hand washing Techniques to Combat the situation and adhere to hand hygiene practice.³⁴

CONCLUSION

After reviewing scientific articles and guidelines from WHO and CDC we found that washing hands frequently with soap and water or Hand sanitizers is an effective ways to combat Covid-19 infection. According to this review we found that Alcohol based hand sanitizers are more effective and commonly used than any other sanitizers, that is non-alcohol based hand sanitizer and any other herbal products. This review provides a comprehensive overview of the literature regarding Hand Sanitizers and their ability to prevent various infections. Washing hands is the basic and very necessary tool to combat covid-19, However selection of right type of hand wash is very important criteria to be considered. The hand sanitizers are also known to cause alcoholism if used more than recommended times i.e. 30 times/day but pandemic is made an obsession on the people minds and most of them are using more than maximum amount. During the pandemic lockdown, the decreased availability of alcoholic beverages made a major impact on many lives. People tend to consume alcohol based hand sanitizers in various regions, which are serious concern. Consumption of alcohol based hand sanitizers can lead to serious health hazards and even poisoning. The governing bodies need to update guidelines regarding restriction on number of times to be used on the daily basis.



LIST OF ABBREVIATION

WHO	WORLD HEALTH ORGANIZATION
CDC	CENTRES FOR DISEASE CONTROL & PREVENTION
HCAI	HEALTH CARE ASSOCIATED INFECTIONS
MDR	MULTI-DRUG RESISTANCE
HCF	HEALTHCARE FACILITIES
HAI	HEALTH ASSOCIATION INFECTION
CHG	CHLOROHEXIDINE GLUCONATE
n-COV	NOVEL CORONA VIRUS
RSV	RESPIRATORY SYNCYTIAL VIRUS
HCWs	HEALTHCARE WORKERS

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