IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 2, June 2025
Impact Factor: 7.67

Formulation and Evalution of Hand Sanitizer

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Abstract: *Hand hygiene plays a critical role in preventing the spread of infectious diseases. Hand sanitizers have become a popular choice for convenient and effective hand hygiene practices. This study aims to formulate and evaluate a hand sanitizer using readily available ingredients.*

The formulation includes alcohol as the active ingredient, along with moisturizers and emollients to counteract potential drying effects on the skin. Various concentrations of alcohol are tested to determine the optimal balance between antimicrobial efficacy and skin tolerance. Additionally, different thickening agents are explored to achieve the desired consistency and texture.

The evaluation process involves testing the formulated hand sanitizer for its antimicrobial activity against common pathogens, such as bacteria and viruses. The efficacy is assessed using standard microbiological methods, including agar diffusion assays and time-kill kinetics studies. Moreover, sensory evaluations are conducted to assess factors such as odor, texture, and skin feel.

The results of this study provide valuable insights into the formulation and performance of hand sanitizers, contributing to the development of products that effectively promote hand hygiene while ensuring user comfort and satisfaction..

Keywords: Hand Hygiene, Antimicrobial, Microorganisms

I. INTRODUCTION

AIM AND OBJECTIVES

Aim:- The aim of this study is to comprehensively explore the role and effectiveness of hand sanitizers in promoting hand hygiene and preventing the transmission of infectious diseases, with a focus on alcohol-based formulations. This investigation encompasses an analysis of the formulation aspects, efficacy, market dynamics, and broader implications for public health, particularly in the context of pandemic outbreaks like COVID-19

Objectives:-

1. To Review the Formulation Aspects of Hand Sanitizers: This objective involves examining the composition and formulation strategies of hand sanitizers, with a specific focus on alcohol- based formulations. It seeks to understand the key ingredients, their concentrations, and their roles in ensuring the efficacy and safety of hand sanitizers.
2. To Evaluate the Efficacy of Hand Sanitizers: This objective aims to assess the effectiveness of hand sanitizers in reducing microbial contamination on the hands, including bacteria, viruses, and fungi. It involves reviewing scientific evidence and empirical data to ascertain the ability of hand sanitizers to disrupt the transmission chain of infectious pathogens.
3. To Investigate Market Dynamics and Industry Initiatives: This objective focuses on analyzing the market dynamics of hand sanitizers, particularly in response to the COVID-19 pandemic. It involves examining industry initiatives, production capacities, and supply chain mechanisms aimed at meeting the surging global demand for hand sanitizers.
4. To Explore the Benefits and Limitations of Hand Sanitizers: This objective entails identifying and delineating the benefits of hand sanitizers in promoting hand hygiene and reducing the risk of disease transmission. It also aims to highlight any potential limitations or challenges associated with the use of hand sanitizers, including skin irritation, efficacy against certain pathogens, and environmental considerations.
5. To Provide Recommendations for Optimal Hand Hygiene Practices: This objective seeks to offer evidence-based recommendations for optimal hand hygiene practices, including the use of hand sanitizers in various settings and

DOI: 10.48175/IJARSCT-27458

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scenarios. It aims to inform healthcare professionals, policymakers, and the general public about best practices for hand hygiene to mitigate the spread of infectious diseases.

INTRODUCTION

In the ongoing battle against infectious diseases, particularly in the wake of global health crises such as the COVID-19 pandemic, the significance of hand hygiene cannot be overstated. Hand sanitizers, specifically formulated to combat the proliferation of harmful microorganisms, have emerged as indispensable tools in maintaining public health and preventing the transmission of infectious agents.

This systematic review delves into the multifaceted realm of hand sanitizers, exploring their formulation, efficacy, and broader implications for infection control. With a primary focus on alcohol-based formulations, which have garnered widespread adoption in both healthcare settings and the general public, this review scrutinizes the various types and forms of hand sanitizers available, emphasizing their effectiveness in disrupting the transmission chain of infectious pathogens.

Through an analysis of historical perspectives and scientific advancements, the evolution of hand sanitizers unfolds, tracing their roots from ancient antiseptic practices to modern-day formulations. By elucidating the pivotal role of alcohol as the cornerstone ingredient in hand sanitizers, this review underscores the longstanding efficacy of alcohol-based solutions in eradicating a diverse array of microorganisms.

Furthermore, in light of the unprecedented demand for hand sanitizers amidst the COVID-19 pandemic, this review examines the dynamic landscape of the hand sanitizer market, highlighting industry initiatives aimed at ramping up production and meeting the surging global demand. From chemical manufacturers to cosmetic giants, key players have mobilized resources to bolstersupply chains and address public health needs on a monumental scale.

As the world grapples with evolving health threats, the role of hand sanitizers in promoting hygiene, curbing disease transmission, and safeguarding public health remains unequivocal. Through comprehensive analysis and critical insights, this systematic review endeavors to illuminate the pivotal role of hand sanitizers in shaping the future of global health and infection control strategies.

Hand Sanitizer and COVID-19:-

Hand sanitizer has been an essential part of many people's personal hygiene routines since years. Yet, the market of hand sanitizer has experienced a great boost during the coronavirus virus outbreak. When the COVID-19 pandemic broke out all of the worlds, hand sanitizer was one of the first things to go missing from supermarket shelves.Currently, to strengthen the footprint in the global market, the leading players of hand sanitizer market have started working on the development and production of hand sanitization products.

For instance, in March 2020, DOW, a notable leader in chemicals manufacturer, has launched a project of manufacturing hand sanitizer for hospitals and pharmacies to support the society during the pandemic. The company is planning to produce 300 tons of hand sanitizer per month. In addition to this, in March 2020, Coty, a significant beauty company in cosmetic manufacturers, has started manufacturing hydro-alcoholic gel hand sanitizer amid the COVID-19 outbreak.

Production and donations are expected to reach tens of thousands of units per week. The company is planning to produce 10 thousand units of hand sanitizer per week.

Hand sanitizers were first introduced in 1966 in medical settings such as hospitals and healthcare facilities. The product was popularized in the early 1990s.

Alcohol-based hand sanitizer is more convenient compared to hand washing with soap and water in most situations in the healthcare setting. Among healthcare workers, it is generally more effective for hand antisepsis, and better tolerated than soap and water. Hand washing should still be carried out if contamination can be seen or following the use of the toilet. Hand sanitizer that contains at least 60% alcohol or contains a "persistent antiseptic" should be used. Alcohol rubs kill many different kinds of bacteria, including antibiotic resistant bacteria and TB bacteria. They also kill many kinds of viruses, including the flu virus, the common cold virus, coronaviruses, and HIV. 90% alcohol rubs are more effective against viruses than most other forms of hand washing. Isopropyl alcohol will kill 99.99% or more of all non-spore forming bacteria in less than 30 seconds, both in the laboratory and on human skin. In too low quantities (0.3 ml)

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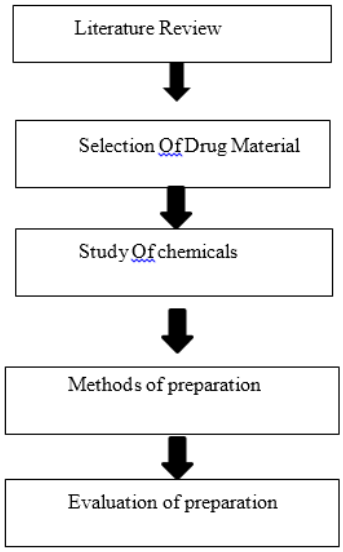
or concentrations (below 60%), the alcohol in hand sanitizers may not have the 10–15 seconds exposure time required to denature proteins and lyse cells. In environments with high lipids or protein waste (such as food processing), the use of alcohol hand rubs alone may not be sufficient to ensure proper hand hygiene. For health care settings, like hospitals and clinics, optimum alcohol concentration to kill bacteria is 70% to 95%. Products with alcohol concentrations as low as 40% are available in American stores, according to researchers at East Tennessee State University. Alcohol rub sanitizers kill most bacteria, and fungi, and stop some viruses. Alcohol rub sanitizers containing at least 70% alcohol (mainly ethyl alcohol) kill 99.9% of the bacteria on hands 30 seconds after application and 99.99% to 99.999% in one minute.

For health care, optimal disinfection requires attention to all exposed surfaces such as around the fingernails, between the fingers, on the back of the thumb, and around the wrist. Hand alcohol should be thoroughly rubbed into the hands and on the lower forearm for a duration ofat least 30 seconds and then allowed to air dry. Use of alcohol-based hand gels dries skin less, leaving more moisture in the epidermis, than hand washing with antiseptic/antimicrobial soap and water. There are certain situations during which hand washing with soap and water are preferred over hand sanitizer, these include: eliminating bacterial spores of Chloridoids difficile, parasites such as Cryptosporidium, and certain viruses like norovirus depending on the concentration of alcohol in the sanitizer (95% alcohol was seen to be most effective in eliminating most viruses). In addition, if hands are contaminated with fluids or other visible contaminates, hand washing is preferred as well as after using the toilet and if discomfort develops from the residue of alcohol sanitizer use. Furthermore, CDC states hand sanitizers are not effective in removing chemicals such as pesticides.

Plan of work:-



Literature Review:-

Hand hygiene, particularly through the use of hand sanitizers, plays a pivotal role in preventing the transmission of infectious diseases, especially during outbreaks such as the COVID-19 pandemic. This literature review aims to provide a comprehensive overview of the importance of hand hygiene, the efficacy of hand sanitizers, their formulations, and the historical context behind their development. Drawing from various scholarly sources and empirical studies, this review synthesizes information on the antimicrobial properties of alcohol-based hand sanitizers, their effectiveness against a wide range of microorganisms, and the recommended concentrations for optimal efficacy. Furthermore, it examines the role of key ingredients such asisopropyl alcohol, triethylamine, and Carbopol in hand sanitizer formulations, elucidating their chemical structures and properties. The review also discusses the benefits of hand sanitizers, including their portability, ability to reduce disease transmission, and impact on skin health. Additionally, it

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explores the surge in hand sanitizer production by leading companies during the COVID-19 pandemic and provides insights into the formulation process. Overall, this literature review serves as a comprehensive resource for understanding the science behind hand hygiene and hand sanitizer formulations, offering valuable insights for healthcare professionals, researchers, and individuals alike.

DRUG PROFILE

Selection Of Drug Material:-

Hand sanitizers play a crucial role in maintaining hand hygiene and preventing the transmission of infectious diseases. The selection of chemical components in hand sanitizer formulations significantly impacts their efficacy, safety, and practicality. This study aims to conduct a comparative analysis of various chemical components commonly used in hand sanitizer formulations, including alcohol-based and non-alcohol-based options. The selected chemicals for analysis include isopropyl alcohol (IPA), hydrogen peroxide, glycerin, distilled water.

Study of Drug Material:-

ISOPROPYL ALCOHOL

Chemical Name :- propan-2-ol

Molecular formula :- C3H8O or CH3CHOHCH3 or (CH3)2CHOH

Structure :-

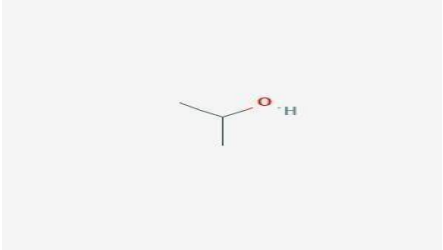

Fig.1 Isopropyl alcohol

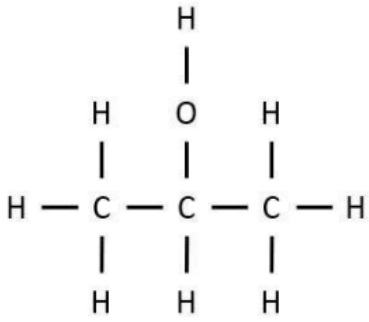

Fig.2 Isopropyl Alcohol

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Isopropyl Alcohol is an isomer of propyl alcohol with antibacterial properties. Although the exact mechanism of isopropanol's disinfecting action is not known, it might kill cells by denaturing cell proteins and DNA, interfering with cellular metabolism, and dissolving cell lipo-protein membranes. Isopropanol is used in soaps and lotions as an antiseptic. Volatile, colorless liquid with a sharp musty dour like rubbing alcohol. Flash point of 53°F. Vapors are heavier than air and mildly irritating to the eyes, nose, and throat. Density approximately 6.5 lb / gal. Used in making cosmetics, skin and hair preparations, pharmaceuticals, perfumes, lacquer formulations, dye solutions, antifreezes, soaps, window cleaners. Sold in 70% aqueous solution as rubbing alcohol. Propan-2-ol is a secondary alcohol that is propane in which one of the hydrogens attached to the central carbon is substituted by a hydroxy group. It has a role as a protic solvent.

Hydrogen peroxide:-
Chemical Name :- Hydrogen
Molecular Formula :- H2O2
Structure :-

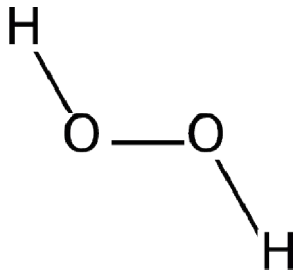

Fig.3 Hydrogen peroxide

Hydrogen peroxide is a chemical compound with the formula H2O2. In its pure form, it is a very pale blue liquid that is slightly more viscous than water. It is used as an oxidizer, bleaching agent, and antiseptic, usually as a dilute solution (3%–6% by weight) in water for consumer use and in higher concentrations for industrial use. Concentrated hydrogen peroxide, or "high-test peroxide", decomposes explosively when heated and has been used as both a monopropellant and an oxidizer in rocketry.
Hydrogen peroxide is a reactive oxygen species and the simplest peroxide, a compound having an oxygen–oxygen single bond. It decomposes slowly into water and elemental oxygen when exposed to light, and rapidly in the presence of organic or reactive compounds. It is typically stored with a stabilizer in a weakly acidic solution in an opaque bottle. Hydrogen peroxide is found in biological systems including the human body. Enzymes that use or decompose hydrogen peroxide are classified as peroxidases.

Glycerin:-
Chemical Name :- Glycerol or Propanetriol, propane-1,2,triol
Molecular formula :- C3H8O3

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Structure :-

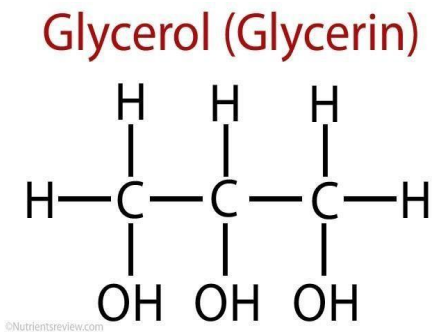


Fig.4 Glycerin

Glycerin, also known as glycerol, is commonly used in hand sanitizers for several reasons: Moisturizing: Glycerin is a humectant, meaning it attracts moisture to the skin. Hand sanitizers often contain alcohol, which can be drying to the skin. Adding glycerin helps counteract this drying effect by retaining moisture, leaving the hands feeling softer and less irritated.

Thickening Agent: Glycerin can also act as a thickening agent in hand sanitizers, helping to give them a gel-like consistency. This makes the sanitizer easier to apply and helps it stay on the hands long enough to effectively kill germs.

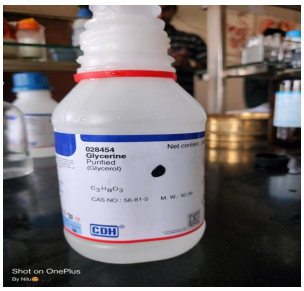
Stabilizer: Glycerin can help stabilize the formulation of hand sanitizers, ensuring that the ingredients remain well mixed and the product maintains its effectiveness over time.

Skin Barrier: Glycerin forms a protective layer on the skin, which can help prevent the loss of moisture and protect against irritants.

When used in combination with alcohol and other active ingredients, glycerine enhances the overall effectiveness and user experience of hand sanitizers. However, it's essential to use it in the right proportion to avoid making the sanitizer too sticky or reducing its germ-killing effectiveness.

Method Of Preparation:-

Formulation Table:-



SN.	Chemical	Amount	Uses
1	Isopropyl Alcohol	60ml	Antibacterial, antimicrobial
2	Hydrogen peroxide	3ml	Antibacterial,and antiseptic
3	glycerin	5ml	Moisturizing, Thickening Agent
4	water	32ml	qs.

Procedure :-

This procedure using isopropyl alcohol, hydrogen peroxide, glycerin, and water. Here's a breakdown of the steps:

1. Wash Your Hands: Always start by washing your hands thoroughly to prevent introducing any germs into the hand sanitizer mixture.

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2. Clean Containers: Ensure that the container used for mixing the hand sanitizer and any bottles used for storage are clean. If they are heat-resistant, you can sterilize them by boiling or using a dishwasher on high heat.
3. Pour Isopropyl Alcohol: Pour the 60ml of isopropyl alcohol into the clean container. Isopropyl alcohol should make up at least 60% of the final volume of the hand sanitizer to effectively kill germs.
4. Mix in Hydrogen Peroxide: Add the 3ml of hydrogen peroxide to the container with isopropyl alcohol. Hydrogen peroxide helps kill bacteria that may contaminate the bottles or the sanitizer during preparation. Take care during this step, as hydrogen peroxide may irritate the skin.
5. Add Glycerin: Measure and add 5ml teaspoons of glycerin to the mixture. Glycerin helps protect the skin from drying out, especially since alcohol-based hand sanitizers can be drying.
6. Add Water: Measure and add 32ml of sterile water to the mixture. This helps dilute the solution and adjust the consistency. Ensure the water used is sterile to prevent introducingcontaminants into the hand sanitizer.
7. Mix Thoroughly: Mix all the ingredients together thoroughly to ensure they are well combined. After following these steps, your homemade hand sanitizer should be ready for use. It's essential to store it in clean, properly labeled containers and use it as needed for hand hygiene. Remember to follow proper hygiene practices and precautions when making and using hand sanitizer.

Evolution Test:-
1) Alcohol Content Test: Ensures the sanitizer contains the correct percentage of alcohol (usually 60-95% for effectiveness).
2) pH Test: Measures the pH level to ensure it is within a safe range for skin contact. Microbial
3) Contamination Test: Checks for the presence of harmful bacteria and fungi. Viscosity Test: Ensures the sanitizer has the right consistency for application
4) Stability Test: Determines the shelf life and stability of the product under various conditions. Packaging Integrity Test: Ensures that the packaging is secure and does not
5) leak Sensory Evaluation: Assesses the smell, feel, and appearance of the sanitizer to ensure it is acceptable to consumers.

Benefits of hand sanitizers:-
1. Efficient Germ Elimination: Hand sanitizers are designed to kill a broad spectrum of microorganisms, including bacteria, viruses, and fungi, on the hands. With proper use, they can effectively reduce the microbial load, helping to prevent the spread of infectious diseases.
2. Convenience and Portability: Hand sanitizers come in small, portable containers, making them convenient for use on the go. Whether you're traveling, commuting, or in public spaces where access to soap and water is limited, hand sanitizers offer a quick and easy solution for hand hygiene.
3. Reduced Risk of Disease Transmission: Regular use of hand sanitizers can significantly decrease the risk of contracting infectious diseases, especially during times of heightened vulnerability such as flu season or pandemic outbreaks. By disinfecting the hands, hand sanitizers help to break the chain of transmission and protect both individuals and communities.
4. Improved Skin Health: Some hand sanitizers contain moisturizing ingredients such as glycerine or aloe vera, which help to counteract the drying effects of alcohol. These moisturizers can leave the skin feeling softer and more hydrated, promoting overall skin health with regular use.
5. Enhanced Compliance with Hand Hygiene Practices: In situations where access to soap and water is limited or impractical, hand sanitizers serve as a convenient alternative for maintaining hand hygiene. Their ease of use and portability encourage greater compliance with hand hygiene practices, ultimately contributing to better public health outcomes.
6. Additional Benefits in Specific Situations: In certain scenarios, such as healthcare settings or food processing environments, hand sanitizers offer specific advantages over hand washing with soap and water. For healthcare workers, they are generally more effective for hand antisepsis and better tolerated than frequent hand washing.

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Additionally, in environments with high lipid or protein waste, where traditional hand washing may be insufficient, alcohol-based hand sanitizers provide a valuable alternative for maintaining hand hygiene.

7. Cleanliness: Hand sanitizers are designed to kill germs and keep hands sanitized. With proper use, hand sanitizers are capable of eliminating 99.9% of germs on the hands. It can be used as an occasional replacement of soap and water.

8. Lessens risk of diseases: During the monsoon or a pandemic, frequent sanitization of hands decreases the chances of contracting the disease. Studies also show that the risk of spreading gastrointestinal (stomach) and respiratory infection is decreased by frequent use of hand sanitizer.

9. Softer Hands: Hand sanitizers without alcohol are beneficial for the skin. It improves the texture of the skin in your hands. Some hand sanitizers comprise emollients which moisturize and soften your hands. These are the main benefits of using hand sanitizer regularly. Using hand sanitizers on a daily basis guarantees more cleanliness and less diseases.

Overall, hand sanitizers play a crucial role in promoting hand hygiene, reducing the transmission of infectious diseases, and safeguarding public health in a variety of settings. Their convenience, effectiveness, and versatility make them indispensable tools in the ongoing pursuit of global health and well-being.

Side effects of hand sanitizer:-

1. Skin Irritation: The most common side effect of hand sanitizers is skin irritation, especially with frequent use. This can manifest as dryness, redness, itching, or even a burning sensation. Alcohol-based hand sanitizers, in particular, can be drying to the skin because of their high alcohol content.

2. Allergic Reactions: Some people may be allergic to certain ingredients in hand sanitizers, such as fragrances or other additives. Allergic reactions can range from mild to severe and may include symptoms like itching, swelling, or rash.

3. Eye Irritation: Hand sanitizers can cause irritation if they come into contact with the eyes. This can lead to redness, stinging, or discomfort. It's essential to avoid getting hand sanitizer in your eyes and to rinse them thoroughly with water if it does happen.

4. Ingestion Risks: Hand sanitizers are not meant to be ingested, and ingesting even small amounts can be harmful, especially to young children. Ingestion of hand sanitizer can cause alcohol poisoning, which can be life-threatening. Hand sanitizers with high alcohol contentshould be kept out of reach of children and used with caution around them.

5. Resistance: There is some concern that overuse of hand sanitizers containing antibacterial agents like triclosan could contribute to antibiotic resistance. However, most hand sanitizers use alcohol as the active ingredient, and resistance to alcohol-based sanitizers is unlikely.

6. Drying of Hands: Frequent use of hand sanitizer, especially those containing alcohol, can lead to dryness and cracking of the skin on the hands, particularly in individuals with sensitive or already dry skin.

To minimize the risk of side effects, it's essential to use hand sanitizers as directed, apply them only to intact skin, and avoid contact with the eyes or ingestion. If you experience any adverse reactions after using hand sanitizer, discontinue use and consult a healthcare professional.

REGULATORY BODYIES

Centers for Disease Control and Prevention (CDC): The CDC provides extensive guidance on hand hygiene practices, including the use of hand sanitizers, especially in the context of preventing the spread of infectious diseases. You can find information on their website: CDC Hand Hygiene in Healthcare Settings.

World Health Organization (WHO): The WHO offers guidelines and recommendations for hand hygiene practices, including the use of hand sanitizers, in various settings. Their website contains valuable resources: WHO Hand Hygiene.

Food and Drug Administration (FDA): The FDA regulates hand sanitizers in the United States and provides information on their website regarding the safety and efficacy of hand sanitizers, as well as regulations for their manufacturing and marketing: FDA Hand Sanitizers.

National Institutes of Health (NIH): The NIH may publish research articles and studies related to hand hygiene, including the effectiveness of hand sanitizers in reducing the transmission of pathogens. You can search their database, PubMed, for relevant articles: PubMed.

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Peer-Reviewed Journals: Journals such as the Journal of Hospital Infection, Infection Control and Hospital Epidemiology, and the American Journal of Infection Control often publish research articles on hand hygiene practices and the use of hand sanitizers.

II. CONCLUSION

With the current research in the literature, it is difficult to confidently suggest one mode of hand sanitizing delivery over the other. What we can state, however, is that soap and water is superior to sanitizer, and when hand washing is unavailable or inconvenient, a sufficient volume ofsanitizer is important to ensure complete hand coverage, and compliance is critical for appropriatehand hygiene. And finally, with extrapolating the virucidal data on viruses of similar structure to SARS- CoV-2, this virus can be effectively inactivated with current hand hygiene products,though future research should attempt to determine this directly

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