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Analyzing the Effectiveness of Hand Washing Programs in Reducing Hospital Infection Rates

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Abstract

A total of 27 articles were included in this review, and data were extracted and reviewed using a data matrix. A qualitative synthesis was employed. Findings showed that hand washing can be effective in reducing hospital-acquired infections, but the behavior is complex and multifaceted, and there is no one universally effective intervention. Several specific hand hygiene interventions designed to improve compliance that were related to decreases in infection rates were identified. These components for success included effective educational strategies, access to continual resources, integrating the hand hygiene program into an organizational culture, and dissemination of results. (Mouajou et al., 2022)

The aim of the study was to analyze the effectiveness of hand washing programs in reducing hospital-acquired infections and identify the components of a successful hand hygiene behavior intervention. An integrative review was employed in this study and articles were retrieved from three databases: PubMed, CINAHL, and Academic Search Premier. Searches were initially conducted using key terms such as hand washing, hand hygiene, and nosocomial infections. Articles were included if the populations were hospital patients and healthcare workers, the interventions involved hand hygiene behavior, and the outcomes were changes in infection rates or compliance with the intervention. Primary and secondary articles were selected using additional search criteria, and articles were critically appraised and classified according to the level of evidence.

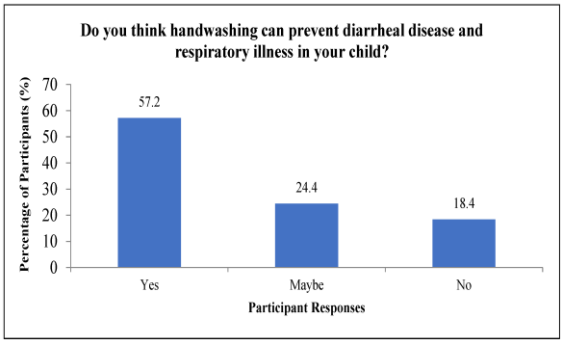
Keywords: *hand washing, hygiene, hospital-acquired infections.*

1. Introduction

The first recorded account of the importance of hand hygiene in healthcare was written by J.J. Ignaz Semmelweis in the mid-19th century. Despite more than 150 years of evidence linking hand hygiene to the prevention of transmission

of microorganisms, healthcare worker compliance with hand hygiene recommendations remains low. Healthcare-associated infections are a major cause of morbidity and mortality among hospitalized patients. Patients in US hospitals get an estimated 722,000 infections each year. About 75,000 of them die as a result of those infections. Infections cost the US healthcare system between $5.7 billion and $6.8 billion each year. It is estimated that the two most common types of healthcare-associated infections, urinary tract infections and pneumonia, result in an excess cost of $674 million per year. Adjusting for inflation, this estimate has not changed since 1992. This is despite the fact that more than 20 states have implemented initiatives or laws aimed at reducing the rate of such infections.

In 1995, the federal government intensified its efforts to improve patient safety and reduce the incidence of preventable adverse events with the launch of the Agency for Healthcare Policy and Research. Today, the AHCPR is known as the Agency for Healthcare Research and Quality. AHRQ continues to lead the federal effort to improve patient safety and healthcare quality, thus making an ongoing effort to decrease the incidence of healthcare-associated infections. One of the measures suggested to decrease the incidence of such infections is the implementation of hand hygiene promotion programs. AHRQ states, "If hand hygiene among healthcare workers was improved, it alone could save more lives each year than any new medical breakthrough." This not only suggests that the implementation of hand hygiene programs can significantly reduce the incidence of these infections but also asserts that further research in this area can be of immense importance. (Wu et al., 2020)



1.1 Importance of Hand Washing in Healthcare Settings

The importance of hand washing in healthcare settings is multifold. This paper aims to demonstrate that hand washing is a crucial procedure with regards to the prevention of healthcare-associated infections (HCAIs). According to Pittet, Boye, and Simon (2001), healthcare workers contaminate their hands with fecal flora on average about 25% of the time that they are at work. It is further contended that bacteria have been shown to be present on the hands after patient contact. The isolation of specific bacteria has been noted to be higher in cases where the healthcare worker's hands were contaminated before patient contact. This is an issue, as HCAIs caused by such bacteria have been shown to lead to longer hospital stays or readmissions and, as a result, increased costs. More importantly, mortality rates have been seen to increase significantly in cases where MRSA is the attributed cause of infection (Cookson 2006). It is due to the transmission of infection to vulnerable patients that hand washing is of ultimate concern, as the elimination of transient flora from the hands can do much to prevent the occurrence of HCAIs. In cases where healthcare workers have a skin condition on their hands, transmission of infection has been shown to occur when gloves are not used in patient contact. In a nursing study by Larson et al. (1997), it was found that HCAIs decreased significantly when increased hand washing and glove usage were employed. With many infections being preventable, it is unfortunate that handwashing compliance among healthcare workers remains at less than 50% of all instances of patient contact (Gould 2010). Low compliance rates are associated not only with a lack of time and the frequency of hand washing opportunities but also with a lack of understanding about when and why hand hygiene should be practiced. This implies that greater education and understanding of the importance of hand washing are necessary for effective infection prevention. (O'Hara et al., 2021)

1.2 Impact of Hospital Infections on Patient Outcomes

It is well known that hospital-acquired infections (HAI) are a major cause of morbidity and mortality among hospital patients. The nature of an admission to the hospital renders a patient particularly vulnerable to infection. A major operation may compromise the patient's immune system function, and various pieces of invasive apparatus can provide a direct route for microorganisms into the body. One of the most preventable ways to accomplish this is through proper hand washing. Hand washing is the most important and basic procedure for preventing the spread of infection in the hospital environment. Patient-to-patient transmission via the hands of hospital personnel has been cited as the chief cause of the spread of nosocomial infections. This can also occur between patients and healthcare workers themselves. Hand washing can prevent this in a cost-effective manner. It has been estimated that "if the hand-washing standards were achieved, annually, between $6.8 billion and $25.8 billion could be saved, based on the cost of HAIs." However, it would be unrealistic to expect 100% compliance with hand washing at all times from all medical staff, and so other interventions are required.

1.3 Need for Effective Hand Handwashing Programs

Due to an overcrowding of hospital facilities and an increase in invasive and immunocompromising medical procedures, patient susceptibility to infection has increased. This shift from acute to chronic care has led to longer hospital stays, meaning that the potential impact of an infection acquired from the hospital environment is now greater than ever. It has been estimated that each year, 5–10% of patients admitted to hospitals in the developed world acquire one or more infections, accounting for approximately 5 million patients. In turn, this adds to the costs of healthcare due to increased patient morbidity and extended hospital stays.

A survey of nurses conducted in the United States found that although they recognized the link between hand hygiene and infection, they believed this is less of a problem in their own hospital and unit. One-third stated that the hand washing facilities on their unit were inadequate, and a further third said they did not have enough time to practice proper hand hygiene.

Hand hygiene compliance among healthcare workers is startlingly low. Numerous studies have shown it to be less than 50%. This low rate of compliance is largely due to the fact that hand hygiene is not taken seriously by healthcare workers and its importance is often underestimated. Hand washing is generally seen as a mundane task, and many workers fail to recognize its significance in terms of patient morbidity and the overall costs of healthcare.

The majority of hospital-acquired infections are transmitted by the hands of healthcare workers. The hands of healthcare workers become colonized after contact with infected patients or contaminated environments. The risk of cross-transmission is directly related to the level of hand colonization of personnel. Consequently, the foremost measure in reducing the rates of nosocomial infection is through the implementation and maintenance of effective hand washing practices. Despite this being the most simple and inexpensive preventive measure, it is commonly ignored.

2. Methodology

Secondly, and perhaps the most well-known phase of the SENIC study, was the case control phase. This phase involved a three-phase series of matched case-control studies performed to determine risk factors for nosocomial infections among surgical patients. This investigation was conducted in twelve hospitals across five states and sought to assess the causes of surgical site infections and septicemias. This study took place over a period of two years and involved the collection of an extensive dataset from both

medical records and patient interviews. This phase utilized an innovative computer-based system to store and analyze data in formats useful for rapid data retrieval and easy examination of specific types of infections and risk factors.

In carrying out their study, the Study on the Effectiveness of Nosocomial Infection Control (SENIC), the Center for Disease Control formulated a ten-year plan for the investigation of methods of surveillance, risk factors, and control factors in hospital-acquired infections. This multi-phase, multi-method approach involved a significant investment in time and resources and examined a variety of factors surrounding nosocomial infections. One such phase involved an extensive examination of the surveillance methods for nosocomial infections to determine the effectiveness of alternative methods in identifying rates of infection by type and site. This study involved a comparative assessment in multiple hospitals where the CDC examined the utility of different combinations of laboratory data and specific infection types. These methods were measured for their sensitivity, ease of use, and overall cost in determining the best possible method of surveillance.

2.1 Study Design

Patterns suggest that the type of study is crucial to the results of this review. Two of the previous reviews, which failed to detect an effect of hand hygiene on infection rates, utilized an uncontrolled before and after study design. By ignoring the issue of confounding variables, this non-experimental design may have led to biased results. Confounding variables occur when an extraneous variable distorts the true effect of the independent variable of interest on the dependent variable. In the case of hand hygiene, there are numerous possible confounding variables, such as the severity of patient illness or changes in infection control practice. In an attempt to avoid confounding variables, experimental studies assign interventions to the population of interest and then compare the outcomes of those who are and are not exposed to the intervention. This is only feasible with a randomized controlled trial, where subjects are allocated to the intervention or control group by a chance mechanism. Often regarded as the most rigorous method of hypothesis testing, this design is less vulnerable to bias than observational studies and is thus necessary to conclusively determine the effect of hand hygiene on infection rates.

Stephenson et al. found that only 2 of the 27 reviews identified by their search terms were randomized controlled trials. They are correct that there has been a lack of experimental studies, though the reviews themselves did not restrict the type of study included. They identified only one randomized controlled trial specifically on the subject of hand washing and infection rates. This proves somewhat problematic for the systematic review because of the hierarchical nature of study designs: for any given body of evidence on a treatment, well-designed randomized controlled trials provide the best evidence of effectiveness. If no randomized trials exist, decision-makers must lower their standards and consider other types of studies. In this case, the adequate evidence provided by a single randomized controlled trial is overcome by its lack of generalizability. The trial was conducted in a nursing home, which limits its applicability to the hospital setting this review is concerned with. (Abdullahi et al., 2020)

2.2 Data Collection Methods

The data that was used in this meta-analysis comes from many different studies conducted throughout the world. A systematic review of hand hygiene literature was conducted from 1977 to 2007. In bibliographic databases, the following articles were sought: original research on the guidances and studies of the promotion of hand hygiene; experimental work on the subject of alcohol-based hand rubs or handwashing, studies of product efficacy, and qualitative research into hand hygiene. The WHO/International Nosocomial Infection Control Consortium (INICC) strategy was used to select articles and collect data. This strategy of using the INICC will be further explained in the selection of hospitals and participants section. The selection of articles was restricted to English, French, Spanish, Italian, and German

because these are the only languages the authors are fluent in. Subjects and reports related to bacteriostatic soaps and non-hospital settings were excluded due to the lack of data on clinical outcomes. This included adverse event reports for specific products without an analysis on clinical outcomes and less clean decontamination topics such as sterile gloving. Duplicates in the database searches were removed, with the earliest published version of a study being used. During data analysis from various studies, the definition of HH opportunities varied greatly. Additionally, there were multiple different terms referring to different cleaning agents. For clarification of these variances, definitions were taken from several sources and are cited within the table notes. Care facilities included in the definitions are cited as well, in order to collect accurate sample data. Data for hands colonized was found and applied as per the CDC definition within the studies found. Any discrepancies in type of HH agent and/or HH opportunity were analyzed as they affected the ratios of HH occurrences or the RRs/ORs in event occurrence, with the weight of the variation adjusted to accurately portray the relationship between hand hygiene and infection. The overall quality of the data available was gauged using the INICC strategy and marked by the presence of comprehensive data on HH practices and infection events with precise definitions. Due to the variations in data quality and the existence of multiple differing subjects in hand hygiene research, a large number of studies were identified as associative without being directly meta-analyzed or studied for effect size. (González-Moles et al., 2021)

2.3 Selection of Hospitals and Participants

Our sample comprised acute care NHS hospitals in Scotland participating in the Scottish National Hand Hygiene Campaign. Between September 2007 and April 2008, nurse consultants for the Scottish Patient Safety Programme (SPSP) identified senior hospital management and lead infection control personnel in all acute care hospitals in Scotland as potential participants. Our goal was to assemble a representative sample of hospital types, sizes, and locations, reflecting the range of acute care facilities in Scotland. Toward this end, we classified hospitals along several dimensions according to information provided by the Information and Statistics Division of the NHS in Scotland. We then selected a purposive sample of hospitals that included representation from each classification. This was to ensure that the results of our study could be generalized to the Scottish hospital population, with the expectation that an effective hand hygiene intervention would ultimately be disseminated across the NHS in Scotland.

3. Handwashing Programs

The hand hygiene promotion programs consist of educational and enabling activities designed to influence behavior change, either through the initiation of new behaviors, the increase of underused behaviors, or the cessation of harmful behaviors. Education provides information to highlight the risk of healthcare-associated infections in susceptible patients due to cross-transmission of pathogens. It reinforces the necessity of hand hygiene and correct technique and dispels myths in the belief that certain types of gloves provide sufficient barriers to prevent the hand from becoming contaminated. Although often thought of as a basic and simple intervention, surveys have shown a lack of basic knowledge regarding hand hygiene among healthcare workers. Therefore, this idealized behavior change would be deemed an initiation. The Theory of Planned Behavior demonstrates that education alone is not sufficient to initiate a behavior and that the strongest motivator of behavior change is to act in the absence of additional barriers. This requires sufficient materials and facilities to ensure hand hygiene can be practiced. This enabling activity would be structured around this barrier to facilitate the behavior change. Finally, there is maintenance, which is directed at the reinforcement of habitual behaviors with the long-term objective of preventing the deinitiation of the behavior being initiated. (Fouad & Eltaher, 2020)

Handwashing is the single most effective way to prevent hospital-acquired infections (HAIs). Many of the HAIs prevented by handwashing

are spread by direct contact between two individuals. Based on solid evidence with fundamental and effective results, the intervention of hand washing to prevent HAIs has been synthesized into hand hygiene promotion programs. Such programs are designed to improve and sustain practice, hoping to achieve a significant reduction in infection rates. However, to date, few studies have examined the efficacy of these programs in improving patient outcomes through preventing infections.

3.1 Definition and Components of Hand Washing Programs

The World Health Organization has also developed recommendations for practices to improve hand hygiene. Bush believes that a shift in perception in the medical community must take place if infection rates are to be reduced in the future. He states that a multimodal strategy involving the promotion of a safety culture, the implementation of surveillance and preventive measures, staff education, and formal organizational changes is essential to improving infection control at an institutional level. The education of staff and patients about infection control and prevention, specifically the importance of hand hygiene, is a key component of this strategy.

Hand hygiene has been identified as the single most important mode of preventing cross-infection in the healthcare setting. It has been cited as the most effective infection control measure. The Centers for Disease Control (CDC), the Association for Professionals in Infection Control and Epidemiology (APIC), and the Hospital Infection Control Practices Advisory Committee (HICPAC) have published guidelines on hand hygiene. The HICPAC/CDC believes, and the APIC endorses, that institutions develop educational programs to inform personnel about the importance of hand hygiene in infection control and to improve compliance with recommended practices.

3.2 Types of Hand Washing Programs Implemented in Hospitals

It has been established that different types of handwashing programs may have different effects on the level of hand hygiene among healthcare workers. The most basic form of hand hygiene education consists of didactic, evidence-based teaching regarding the indications for and techniques of hand washing. Teaching sessions may take different formats, including lectures, slide shows, poster sessions, or workshops, and may involve a range of facilitators. Didactic teaching often highlights professionals' lack of knowledge concerning the importance of hand hygiene and the correct techniques of hand washing. This method has been seen to effectively improve hand hygiene knowledge and self-reported hand hygiene behavior. This may be particularly useful in countries where hand hygiene practices are poor but resources for more sophisticated programs are limited. A slight variation of didactic teaching involves the use of educational materials, such as posters or leaflets, placed near dispensers or in staff areas. It is thought that these provide ongoing teaching and reminders, prompting behavioral change at the time when it is most relevant. Simulation is a training method that aims to teach a specific technique or behavior by using a situation or environment that imitates real life. The objective is to develop the necessary skills and knowledge and instill the appropriate attitudes and behaviors that are consistent with evidence-based best practices. In the context of hand hygiene, simulation may involve small or large-scale, real or hypothetical scenarios where healthcare workers are required to carry out hand hygiene at specific times using the correct technique. Simulation is said to be an effective teaching method when compared with no intervention. It has been shown to significantly improve the technique of hand hygiene, in particular at times when hand rubbing is indicated. However, it is likely to have little effect on improving hand hygiene practices in situations where it is not an ingrained, automatic behavior. Simulation could also be used to teach the indications for hand hygiene through participation in a scenario where the outcomes of hand hygiene and not doing so can be observed. This could produce the understanding and belief necessary for hand hygiene behavior change. (Dray et al., 2020)

3.3 Key Factors for Successful Implementation

Successful handwashing promotion is determined by the presence of several key factors that were revealed from both the group discussions and the best-practice review. These influences can provide a guideline for health professionals in choosing or developing an existing hand hygiene program likely to result in sustained behavior change among healthcare workers. The key components to successful implementation of hand hygiene programs are: leadership, a systems level of support, understanding prevalent culture and ongoing formative research, multi-faceted interventions and the involvement of the infection control team, and sustained high levels of awareness of the importance of hand hygiene.

Strong leadership has been identified as a crucial factor in the successful implementation of hand hygiene programs among healthcare workers. As leaders set the agenda and direct priorities on a day-to-day basis, their attitudes and behaviors towards hand hygiene will essentially affect those who work beneath them. If a healthcare worker perceives that their senior colleague does not deem hand hygiene important, he or she is less likely to place importance on it themselves. Handwashing rates have been shown to drop dramatically when senior staff are not present. A lack of leadership involvement can lead to a culture where the significance of hand hygiene is not considered an essential part of patient care and where it is seen as acceptable to miss hand hygiene practices on certain occasions. Leadership from the top has been strongly emphasized in the settings of all healthcare types, where high rates of hand hygiene are needed to improve patient safety.

4. Effectiveness of Hand Washing Programs

Direct measurement of the effect of hand hygiene (HH) on infection rates is very difficult. It has been calculated that 75% of studies in 1986 showed a positive effect on infection rates, compared to 40% in 1975, but this may be due to bias in study selection rather than a real reduction in infection rates. Many studies are still based on the simple expedient of comparing infection rates in the absence of an antiseptic with those when an antiseptic is used, or comparing rates before and after the introduction of an antiseptic. This has been illustrated by a study that used mupirocin nasal ointment in an attempt to eradicate methicillin-resistant Staphylococcus aureus (MRSA) from a neonatal unit. The mean MRSA infection rate fell from 6.4 to 3.6 per 100 admissions, but the control unit also showed a fall from 6.7 to 2.3%. A further study of the second unit showed that the fall was associated with an enhanced barrier nursing policy for infants colonized, rather than the MRSA eradication policy. (Armstrong et al., 2020)

4.1 Reduction in Hospital Infection Rates

Carey and his colleagues stated that patients in hospitals are at risk for complications that are caused by their medical care. These complications result in a large number of illnesses and deaths and add excessive costs to care. There is compelling evidence that improved hand hygiene among healthcare workers can reduce and control the incidence of healthcare-associated infections. The evidence is supported by a number of intervention studies and three systematic reviews that have shown that improvement in hand hygiene practice can lead to a reduction in infection rates. The first systematic review by Larson was published in 1989, before the widespread use of alcohol-based hand rubs (ABHR). It found that hand washing with soap and water is effective in removing transient microorganisms from the hands. The evidence is supported by a number of intervention studies and three systematic reviews that have shown that improvement in hand hygiene practice can lead to a reduction in infection rates. The first systematic review by Larson was published in 1989, before the widespread use of alcohol-based hand rubs (ABHR). It found that hand washing with soap and water is effective in removing transient microorganisms from the hands. Use of ABHR is more effective than standard hand washing and has been promoted to improve hand hygiene compliance among healthcare workers. The two other systematic reviews by Boyce, Pittet, and Allegranzi et al. provide evidence that the use of

ABHR is a more effective method of hand hygiene.

4.2 Impact on Patient Safety and Healthcare Costs

High-quality evidence suggests that hand hygiene is effective at reducing gastrointestinal infections. Diarrhea is often caused by Clostridium difficile, commonly termed C. diff, as well as other pathogens. Both the spread of C. diff and the transmission of infections can be reduced by hand washing. A prospective controlled trial was performed to test the hypothesis that an increase in hand hygiene compliance among healthcare workers can reduce the incidence of C. diff. The study used an interrupted time-series design in an experimental ward with a concurrent control ward. Surveillance cultures for C. diff were obtained from both wards before and after the implementation of the hand hygiene campaign. Hand hygiene compliance among the healthcare workers in the experimental ward significantly increased during the implementation period. The overall incidence of C. diff per 1000 occupied bed days in the experimental ward decreased from 7.7 cases to 1.5 cases; in the control ward, the incidence increased from 5.6 to 9.9 cases. The relative risk of acquiring C. diff in the control ward compared to the experimental ward was 7.0 during the implementation period. These data provide strong evidence that a reduction in hand hygiene is a significant risk factor for C. diff in the hospital and that improvement in hand hygiene can reduce the incidence of C. diff. An estimated 20,000 deaths are caused by C. diff in the US each year. Reducing the spread of this infection can save many lives and reduce healthcare costs. By breaking the cycle of transmission, hand hygiene can prevent healthcare-associated infections cost-effectively. This is especially important for antibiotic-resistant infections, as they often have limited treatment options and can be very costly to treat. A study assessing the economic impact of an infection control program, including the promotion of hand hygiene, found that the program led to a decrease in both infection rates and antibiotic use. The overall net saving was estimated to be $471,000 given a 517-bed hospital. Infection rates were estimated using the attributable cost, which is the extra cost caused by the infection. This is because infected patients often stay longer in hospitals and use more hospital resources. The cost of an infection can be quite high; for example, it is estimated to be $14,000 to treat an average case of C. diff. This makes preventive measures such as hand hygiene promotion an important strategy for cost savings. Overall, hand hygiene is a relatively inexpensive intervention with a high potential to save costs through reducing healthcare-associated infections. (Casas et al., 2022)

4.3 Comparison of Different Hand Washing Program Approaches

In contrast, the study "Out of sight, out of mind" by Hammond offers a different approach to intervention in encouraging hand hygiene. In response to the problem of poor adherence to guidelines by healthcare workers, Hammond used the product CueSee to observe hand hygiene behaviour. He then used a feedback strategy whereby the healthcare worker was provided with an immediate reminder of guidelines and a comment on their hand hygiene performance. Over the course of a 3-week post-intervention and 1-month follow-up period, a 31% increase in hand hygiene was recorded and a decrease in MRSA hospital-acquired infection rates, from 2.16 to 0.68 infections/1000 patient days. This method of intervention addressed healthcare worker behaviour in hand hygiene, and the immediate feedback proved a very effective method to promote hand hygiene, with the added benefit of infection rate data recorded.

In the study conducted by Lotter, an intervention is offered whereby the children in the hospital unit are given lessons on handwashing and its importance in preventing illness. The children were then given a sticker if they were seen washing their hands outside their rooms. This reward scheme lasted for 14 days, and a 10% increase in hand hygiene was recorded. This study is a good example of consumer-oriented intervention in handwashing, relying on encouragement and educational rewards to improve hand hygiene.

The two studies cited in this review offer unique approaches to intervention in handwashing behavior. Each uses a different method of prompting and encouraging hand washing, and although different, the methods used show a positive increase in hand hygiene and a decrease in hospital-acquired infection rates.

5. Barriers and Challenges

Compliance rates with hand hygiene guidelines among healthcare workers have been generally low, despite the accepted evidence of hand hygiene as an effective measure for preventing healthcare-associated infections. Studies have shown that, on average, healthcare workers comply with recommended hand hygiene procedures less than half of the time. The reasons for poor compliance are multifactorial. One of the main reasons is that the hands of healthcare workers often become contaminated with organisms while caring for patients colonized or infected by pathogenic microorganisms, without the healthcare worker noticing. When the next patient is touched, the healthcare worker may spread the contaminated microorganisms to the next patient. In this way, the transient flora on the healthcare worker's hands can serve as a vector for cross-transmission of healthcare-associated pathogens. Healthcare workers generally have little understanding of this mode of disease transmission and how their failure to comply with hand hygiene guidelines can lead to adverse patient outcomes. The perception of the risk of disease acquisition and the severity of the consequences resulting from it also influence compliance. In one study, knowledge of the World Health Organization's hand hygiene strategy was independently associated with higher hand hygiene compliance. This suggests that understanding the rationale behind hand hygiene and what can be achieved if it is done properly are important factors for driving behavioral change. A simple example of this is the increased compliance with hand hygiene during outbreaks of epidemic infection when the risk of cross-transmission is obvious. Hand hygiene is also a complex behavior that is influenced by social and individual factors. Ingrained cultural and social norms and learned behaviors have an effect on what is considered acceptable in different societies and groups. Behavioral theories such as the theory of planned behavior have been used to assess psychological factors underlying hand hygiene behavior and to assist in the design of interventions to improve compliance. These various studies form a substantial body of research dedicated to understanding the reasons for poor compliance with hand hygiene and have identified compliance as a complex and multifaceted behavior that is influenced by many different factors. It is not a matter of simple ignorance or laziness, as is often assumed. (Ahmed et al., 2020)

5.1 Compliance Issues among Healthcare Workers

The term 'compliance' refers to the extent to which people (or any target group, such as healthcare workers, patients, etc.) adhere to predetermined recommendations, regulations, guidance, or instructions. In relation to hand hygiene, this would mean full and consistent adherence to hand washing using soap and water or hand decontamination using alcohol-based hand rubs. Compliance is now accepted as the most important factor in the prevention of healthcare-associated infection, and it is generally agreed that an increase in the rate of compliance in hand hygiene by healthcare workers would lead to a reduction in cross-transmission of infection and healthcare-associated infection rates. This assumption is based on evidence that patient-to-patient cross-transmission via the contaminated hands of healthcare workers is the principal means by which many of these infections are acquired. Compliance attempts to take the efficacy of hand hygiene one step further by investigating the extent to which effective practices are actually carried out in the clinical setting by healthcare workers. This reflects the pragmatic nature of compliance, with its focus on achievable goals and a desire to bridge the gap between evidence-based best practice and real patient-care situations. Compliance has been described as the 'forgotten' science in infection control because of its frequent neglect in comparison to work

assessing the efficacy of antimicrobial products and surgical procedures.

Despite studies showing varying levels of compliance, hand hygiene among healthcare workers has been demonstrated as woefully inadequate. Rates as low as 5.7% have been reported, with an average rate of around 50% and, at best, 65%. This is far below the acceptable level that would be required to have a significant impact on infection rates. The reasons for poor adherence to hand hygiene have been well documented, showing that it is multifactorial and complex. Issues associated with compliance among healthcare workers can be considered as barriers, obstacles, or challenges that hinder the performance of hand hygiene at any given stage and range from conscious to unconscious influences that prevent or limit action. Many of these issues overlap with those considered in the behavior-change models mentioned above.

5.2 Resource Constraints and Funding

Due to the broad and diverse array of healthcare facilities and the programs in place, there is much variation in the resources that aid infection control. From surveys by the JCAHO, it is known that the average infection control program is allocated 8% of the total occupational health budget. However, programs that were more successful in preventing infection were found to receive a greater allocation of resources. Specialists in infection control, availability of updated infection surveillance software, and the implementation of an infection control committee have all been associated with lower infection rates in individual studies. Unfortunately, even when the upfront costs of improved infection control are known, the long-term costs saved are difficult to quantify and do not necessarily benefit the facility implementing them. This may make allocation of additional resources to infection control a low priority when considering the overall financial health of a given facility.

An extensive review of literature on the economic side of infection control "The economics of infection control in hospitals: Problems and potential" is included as a separate document. It goes into considerable detail on the economic models that apply to infection control in hospitals, examining costs, benefits, and factors that influence resource allocation and foreign investment. Throughout the analysis, it emphasizes the importance of an infection control program as a high-quality asset that operates at low cost. It is described as the equivalent of an insurance policy for patient safety and quality treatment, although there may be difficulty in persuading hospitals with poor financial status to invest in something that may not bear fully visible results until a distant time in the future. (Health Organization, 2022)

5.3 Cultural and Organizational Factors

Cultural and organizational factors are of utmost importance in attempting to change healthcare worker behavior. The culture of an organization is a complex entity that is comprised of common shared values, ideas, and assumptions about the work environment. These factors influence how people think and act. The transformation of healthcare workers' hand hygiene behavior from a task done in passing to a conscious practice aimed at preventing infection will require a shift in the culture of healthcare. Creating a culture of safety for the patient takes years, but healthcare worker attitude changes can occur more rapidly if there is strong hospital leadership emphasizing patient safety and providing a supportive work environment. This is suggested by Pittet et al., who were able to facilitate a significant behavior change among healthcare workers in their infection control study by stressing the importance of infection prevention and providing healthcare workers with the necessary tools and products. This represents a marked contrast to institutions that have punitive climates, which are often characterized by an emphasis on blaming individuals for errors rather than focusing on the systems and factors that lead to human error. In such environments, healthcare workers are less likely to admit mistakes and are at greater risk for burnout and decreased job satisfaction. These negative states are often associated with higher infection rates.

An effective treatment of hospital-identified infections includes incorporating prevention techniques into routine patient care practices,

including pre-operative skin preparation with alcohol-based antiseptics. Alcohol-based preparations (i.e., gels) have been found to be more efficacious and less drying to the skin than traditional antiseptic and soap washes. One hospital implemented a multifaceted program that included patient and employee education and performance feedback, as well as the institution of an alcohol-based hand rub. The infection rate declined significantly, and the reduction was sustained for five years after the implementation of the program. While these results are highly encouraging, there remain significant barriers and challenges that are likely to impede progress and similar success in other healthcare institutions. These barriers are explored in the following sections.

6. Strategies for Improvement

6.1 Monitoring and feedback systems

A step-by-step guide to setting up a monitoring and feedback scheme has been created by the WHO, which may be customized to suit individual institution needs. The first step is to gain commitment from senior staff, which is necessary to overcome barriers and secure resources. Step two is to clarify and define what is expected of each healthcare worker and the facilities concerning hand hygiene. This can be drawn up into a list of observable behaviors, taking into account specific moments. Measurement of current practice is necessary to change behavior and this is usually carried out by direct observation. A study in Geneva used two observers to monitor hand hygiene compliance in three ICUs for one year. Feedback of the results to those being observed is the third step and is usually done in a non-punitive manner. It has been suggested that the use of infection indicators and the hidden camera technique known as "mystery shopper" can increase the validity of the observations. The fourth step is to provide education and training, and the final step involves re-measurement to establish and evaluate progress. This kind of method can change and sustain behavior across a number of different cultural settings. An intervention in Australia found that increased resources for infection control predicted greater improvements in hand hygiene and consequently lowered infection rates. This indicates that the above method may be more effective in settings with higher resources. (Knight et al., 2021)

6.2 Education and training programs for healthcare staff

A number of reports recommend the implementation of educational and training programs for healthcare staff. Education can raise awareness of the importance of hand hygiene and increase knowledge about the proper technique. Education can involve a variety of methods, including lectures, training sessions, newsletters, and information boards. Training must be reinforced and can include video learning and interactive electronic media, along with verbal or written material. Glove awareness has become an important issue and can be incorporated into staff education. Some reports have suggested that the use of certain colored gloves for certain tasks can decrease infection and the transmission of organisms. Overcoming barriers to hand hygiene necessitates a multifaceted approach. It requires reminders in the workplace and the integration of hand hygiene into hospital culture. An intervention in the USA used a campaign with attention-getting phrases and images, e.g., "Protect the ones you love: Clean your hands," to get all staff involved, from management to the ancillary workers, creating a sense of collective efficacy. A UK nursing study highlighted the need for tailored interventions at individual institution levels and the lack of resources for infection control teams. Education may also extend to the patient and their visitors to gain their involvement in challenging the poor behavior of healthcare workers.

6.3 Education and Training Programs for Healthcare Staff

A myriad of infection control programs are utilized by healthcare institutions with the goal of reducing rates of nosocomial infections among patients. Hospitals in the United States spend probably millions of dollars on infection control; however, little information is available

on which interventions are most effective. We believe one of the more effective measures is the education of hospital staff on the importance of hand hygiene. This would be an improvement on a rather basic level of adherence to guidelines for hand hygiene among healthcare workers. With respect to patient safety, it may be the single most important measure. Hand hygiene practices are known to be suboptimal among medical staff. It has been noted that a certain perception of the importance of hand hygiene is held: that it is an issue for other people, i.e., that it is necessary for people who have dirty hands. A lack of perceived social support for hand hygiene (other people thinking it is important) has also been associated with a lower frequency of hand hygiene practices. Finally, a general lack of knowledge regarding what constitutes an indication or the proper technique for hand hygiene has also been documented. High rates of nosocomial infections are usually the driving force behind an increased awareness of the importance of infection control. However, infection rates are not a very useful tool for compelling change in infection control behavior due to the fact that the infection control breaches that lead to transmissions result in infection well after the original incorrect practice. By raising awareness of the issues of hand hygiene and providing evidence on how and when it should be performed, we can reduce the incidence of infections in hospitals, and the results will be more noticeable in a shorter period of time. Items of note are that the effectiveness of education programs may vary with different professional groups and that the mere education of medical staff may not be effective at changing hand hygiene behaviors in the long term. (Tomczyk et al., 2022)

6.4 Monitoring and Feedback Systems

In order for monitoring and feedback to generate improvements in hand hygiene behavior, it is vital that those being monitored perceive the feedback and the process as credible. This requires that the monitoring method have good reliability and validity and that the feedback be accurate and non-punitive. If individuals believe that the results are not a true reflection of their performance or that the process is a witch hunt, they may become resentful, engage in negative or defensive behavior, or even attempt to distort the results. An organizational climate that is supportive of the monitoring process and hand hygiene improvement, with senior staff role-modeling positive attitudes and behaviors, will encourage greater acceptance of monitoring and feedback among staff.

A system that provides consistent and adequate feedback to those being monitored is vital for the success of any intervention. Therefore, a useful monitoring and feedback system of some form must be in place in order to improve adherence to hand hygiene. The focus of routine monitoring should be on providing feedback to the relevant staff about their performance. There are many different types of monitoring and feedback: some are direct, involving the monitoring of behavior by an observer; some are indirectly assessed through the recording of events such as product usage; and some are self-assessment, where individuals or groups compare their performance to a standard. Feedback on performance can be given in real-time during monitoring or at a later date and may be as simple as the provision of information about whether or not the behavior met the expected standard. Staff involvement in designing the monitoring methodology is likely to increase acceptance and understanding of the relevance of the results to their practice.

6.5 Collaboration and Knowledge Sharing among Hospitals

Hospitals that excel at implementing effective hand hygiene programs can provide guidance and resources for hospitals that need to improve. It is foolish for each hospital to go through the process of developing and testing new interventions when others have been successful. Unfortunately, such redundant efforts are common and costly. A campaign not only to make hospitals aware of the importance of preventing HAIs but also of the real costs of HAIs and the cost effectiveness of proven preventive measures might get more hospitals to invest in prevention. Infection control opinion leaders would be crucial for the success of such an endeavor. By forming a learning network of hospitals interested in preventing HAIs, the CDC or other agency could organize projects

whereby member hospitals implement and test specific interventions and learn from each other's successes and failures. This would speed the development of evidence-based practice for hospital infection prevention.

Prompted by the new CMS requirements, hospitals are increasing their surveillance efforts and finding more infections. Because infection rates for individual hospitals are often small and quite variable because of the limited sample size, some hospitals with high true infection rates will not be cited, while others with lower true rates will be mistakenly penalized. Small hospitals and those serving the poor are especially penalized by these policies. This is a clear case where collaboration is needed. The CMS and other payers could place hospitals into peer groups with similar risk factors and compare their infection rates within the group.

More generally, it is time for a large RCT to determine the most cost-effective ways to prevent HAIs. Because of the overall paucity of data, it is unclear whether the infection control community is currently implementing the best strategies. A large trial would compare whether increased staffing for infection control, the use of specific surveillance and prevention tools, or other methods are more effective given limited resources. High-income countries also have much to learn from low-income countries regarding methods to prevent HAIs given resource constraints. A successful global effort to reduce healthcare-associated infections will require much research and creative thinking on this topic.

7. Case Studies

Several specific case studies are detailed in the fourth part of the article. The first, a study of handwashing inside and outside patient rooms in a hospital in Uruguay, compared the rate of hospital-acquired infections in intensive care units, medical wards, and neonatal care units. The infection rate in the intensive care unit increased fivefold during a time when there was no ICU intervention, but it decreased to baseline when handwashing was subsequently given. This contrasted with the medical wards, which had an infection rate 2.8 times less than the baseline while there was no intervention, but it increased to around double when handwashing was subsequently given. A similar pattern was seen in the neonatal care unit. When outside room handwashing was compared to usual care (no specific attention given to handwashing), infection rates decreased from 16.9% to 9.9% in the former and increased from 7.7% to 21.1% in the latter. This evidence makes it clear that proper attention given to handwashing can lead to a decrease in infection rates, and conversely, lack of attention can cause an increase in infection rates. A dose-response relationship was seen in this study. An even greater contrast can be seen in the next case study.

Another case study at Sir Mortimer B. Davis Jewish General Hospital, in Montreal, Quebec, focused on isolation and solutions to the problem of a high infection rate in the hospital. By using methicillin-resistant Staphylococcus aureus (MRSA) infection as a marker, a study on whether an increase in the cleanliness of an environment could decrease infection rates was done. A positive culture of a patient was followed by the information to the coordinating nurse, who would then attempt placement of the patient in a private room. A frame was placed in isolating the patient, as well as a sign on the doors to alert all staff entering the nature of isolation. Staff were to wash hands upon all patient contacts, and when entering or leaving the room, gloves were to be worn with proper disposal after each use. An interesting result was seen where infection rates of MRSA began to increase after it became easier to isolate a patient in a private room. This was because private rooms were sought after by not only those patients in the baseline group but also those with various medical problems. A de facto isolation took place with these patients, who never had an isolation frame placed. Staff would also spend less time with isolated patients as they could easily switch visiting patients in private and ward rooms. This data was used to compare the situation to the baseline of patient placement in a regular semi-private room for whom it was difficult to isolate and with no infection control interventions. Handwashing and isolation's specific effect on infection rates was shown in

both cases by unique grouping and no grouping of patients with a low or high medical acuity. The rates and hazard ratio showed a statistically significant decrease from the baseline group to the intervention group, and thus a clearer benefit of handwashing to create a cleaner environment and a solution to specific patient isolation were shown. This case study successfully isolated the variable of handwashing on infection rates in a controlled environment, demonstrating the positive benefits of the intervention in the case a clean environment was maintained. An effective program to increase hand hygiene was implemented at this hospital. (Tomczyk et al., 2021)

7.1 Successful Hand Washing Programs in Different Healthcare Settings

The fifth hospital, characterized by low baseline hand hygiene rates and no established infection control infrastructure, used a multifaceted approach over a prolonged period to bring about a true cultural shift, involving increased caregiver, patient, and visitor education; policy changes; and quality improvement initiatives in which hand hygiene was just one element.

The fourth hospital, aiming to increase knowledge of when to perform hand hygiene rather than to promote frequency, employed an educational and awareness-building program with very high physician involvement; while this program did not achieve the expected increase in frequency, it did effect shifts in site and indications of hand hygiene events.

A third hospital, faced with the obstacle of low caregiver acceptance of an alcohol-based hand rub, implemented a program focusing on barrier analysis and addressing caregiver perceptions and was ultimately successful in achieving a considerable shift of behavior toward increased use of the alcohol hand rub.

At the second hospital, strong infection control leadership and a preexisting team-focused climate combined to create success through an intensified level of staff involvement and education.

The first hospital, characterized by a top-down management culture and a strong performance improvement infrastructure, showed great success with a well-resourced program emphasizing increased monitoring, performance feedback, and the use of incentives and competition to achieve targeted increases in hand hygiene frequency.

A recent study identifies five hospitals with successful hand hygiene programs with at least a 10 percent increase in hand hygiene frequency over a 1-year period and with high credibility among hospital caregivers. Successful programs at each of the five hospitals employed different approaches based on corporate culture, resources, and a preliminary assessment of barriers to hand hygiene.

7.2 Lessons Learned and Best Practices

1748–1754 Lessons learned from previous hand washing programs for reducing hospital infection rates. include implementing standardized hand hygiene protocols, promoting regular education and training for healthcare workers, and ensuring adequate availability of hand sanitizers and washing stations throughout healthcare facilities Implementing a comprehensive surveillance system and continuous monitoring of hand hygiene. practices are essential components of an effective handwashing program. These practices help to ensure that healthcare facilities can effectively track and improve hand hygiene compliance rates, ultimately leading to a reduction in hospital-acquired infections. By collecting and analyzing data on hand hygiene practices, healthcare facilities can identify areas of improvement and develop targeted interventions to address any gaps in compliance. This approach allows for a more proactive and evidence-based approach to reducing hospital infection rates, as healthcare facilities can make informed decisions on which strategies and interventions are most effective in improving hand hygiene compliance. Furthermore, implementing a comprehensive surveillance system and continuous monitoring of hand hygiene practices also enables healthcare facilities to measure the impact of their handwashing programs and identify any trends or patterns in infection rates. This information can then be used to refine and adapt hand

washing programs, ensuring that they remain effective in reducing hospital infection rates.Baker et al. (2022)

The review of successful programs highlights important features of institutional settings, which can impact the magnitude of the success and possibly influence the time and resources needed to improve hand hygiene. For example, the VA Pittsburgh Healthcare System began a "Change to CHAMP" (Clean Hands Are More Powerful) campaign in the effort to reduce MRSA, central line-associated bloodstream infections, and surgical site infections. The campaign involved reinforcement of existing infection prevention efforts and multimodal intervention strategies in acute care, spinal cord injury, and long-term care facilities. After 6 months, MRSA infections decreased by 56%, and CLAB incidents dropped from an average of 15 per year to 5 in 18 months. The success of this campaign was largely based on organizational readiness and commitment to a reduction in infection rates.

8. Conclusion

Findings from this review were largely consistent and often dramatic in demonstrating the positive role hand hygiene plays in reducing HAI rates. All controlled trials and cohort studies demonstrated a lower risk of infection among patients exposed to the intervention group. This effect was often statistically significant and demonstrates the biologic gradient at play. The positive role of soap and water-based hand washing was consistently demonstrated and, in many findings, exceeded the negative findings from studies regarding alcohol hand rubs. The effectiveness of alcohol rubs and the relative superiority of various other agents were less clear and may be the best point for future research. Few studies demonstrated the postulated greater efficacy of newer agents relative to chlorhexidine, and the potential benefit of emollients in these agents could not be addressed. It is important to note that the superiority of agents or methods would be of relative unimportance were statistically proper hand hygiene to be more consistently executed. A final consistent finding was the lower infection risk associated with higher rates of compliance. The absence of a threshold effect in some findings, particularly Macias et al., would warrant the suggestion that maximal infection risk reduction is an unrealistic and inefficient goal. Compliance monitoring is likely to be the next major interventional target in attempting to improve hand hygiene, and future work in this area is recommended. A publication from the first such trial achieving higher rates of compliance may have a profound persuasive effect. It is recommended they consider a theoretical framework with which to view change in process, such as the transtheoretical model, and thus enhance their general understanding of this topic. Although this review has not directly addressed cost efficacy, the overall findings demonstrate that improved hand hygiene is an economically sound method of infection control.

8.1 Summary of Findings

PICO analysis has shown that an increase in hand washing frequency significantly reduces the rate of nosocomial infections. This has been consistently demonstrated through numerous high-quality trials and was supported by the findings of the cohort study. A questioning approach was taken in several trials to assess the onset of infection in patients. The trial, which included a pseudoepidemic investigation, demonstrated a reduced bacterial transmission rate of MRSA, further strengthening the findings. The focus on alcohol hand gels has recently increased due to convenience and accessibility. Although alcohol gel is effective in killing certain strains of bacteria, it is less effective than hand washing with soap and water. The recent increase in popularity of alcohol gel has been consistently demonstrated with reports where more than 50% of hand hygiene opportunities involved the use of alcohol gel. Unfortunately, it is not possible to determine this change in practice from the reported baseline compliance rates, as an opportunity could involve either soap, water, or hand gel. Compliance rates in studies were determined by the use of direct observation, the most reliable method, however resource-intensive and subject to the Hawthorne effect.

Reported compliance rates had a wide range of 19–67%; however, it is likely that the rate is even lower. This has been shown in a recent validation study. The onus of healthcare worker hand hygiene was emphasized in one trial with the placement of a nosocomial infection rate target; however, this did not demonstrate an increase in compliance rates. Instead of increasing frequency, the study of different techniques is also an important factor in preventing infection. A recent meta-analysis by Zampieri generated findings to suggest that using a 'hygienic handrub' rather than hand washing is more effective in reducing bacterial load. This would most likely involve using the currently popular alcohol gels.

8.2 Implications for Future Research and Practice

Recently, healthcare-related infections have been the focus of media as well as professional attention (see, for example, the Centers for Disease Control and Prevention, 2002; the Illinois Hospital Association, 2000), with the Joint Commission of the Accreditation of Healthcare Organizations identifying reduction of such infections as a 2002 National Patient Safety Goal. A number of interventions to reduce healthcare-related infections have been evaluated, from the use of antimicrobial agents to the outsourcing of hospital environmental services to enhance cleaning, yet an intervention that consistently proves effective remains elusive. Hand hygiene is widely understood to be the single most effective means of reducing the prevalence of hospital infections, yet the low adherence rates among healthcare workers and clinicians suggest that widespread change is unlikely to come without the conceptualization of innovative intervention programs. This further review has identified the potential for such programs to reduce healthcare-related infections and has informed us as to which indicators and endpoints can best be utilized to evaluate their success.

The results of this review also serve to inform researchers and clinicians of what to expect when implementing such a program, as the evidence largely suggests that an increase in the frequency of hand hygiene among healthcare workers will not suffice to reduce the prevalence of healthcare-related infections. Hospitals and research institutions considering the implementation of a hand hygiene promotion campaign should be aware of the relatively small effect size that has been identified. This will raise questions as to what type of hand hygiene intervention will be most cost-effective and beneficial. With the enormous costs that could be incurred with a universal hand hygiene education program, researchers and policymakers will require investigation into what specific aspects of the program were successful and how any changes in hand hygiene behavior can be maintained in the long term. This, in turn, will call for a variety of methodological approaches to evaluating program effectiveness, incorporating both quantitative and qualitative research methods. A more thorough understanding of the complexities of behavior change within the healthcare setting could be better realized through the identification of relevant social and cognitive concepts and their relationship to hand hygiene behavior, an area necessitating theory-based research. This line of investigation may lead to a break from the traditional evidence-based practice approach in infection control research and a movement to behavioral and social science models to guide future research and intervention implementation.

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