

Hand-hygiene Interventions Reported in the Last 10 Years: a Systematic Review

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Abstract

Introduction: Hand hygiene is a fundamental aspect of infection control within healthcare settings, crucial for reducing healthcare-associated infections (HAIs) and improving patient outcomes. Despite its importance, compliance with hand hygiene practices remains suboptimal. This comprehensive systematic review aimed to evaluate the effectiveness of hand-hygiene interventions reported in the last 10 years, focusing on identifying strategies that significantly enhance hand hygiene compliance among healthcare workers.

Methods: The review systematically searched PubMed, Cochrane Library, Scopus, Web of Science, and CINAHL for interventional studies and clinical trials published in English from the last 10 years up to 2022. Inclusion criteria targeted studies that implemented and assessed the effectiveness of hand hygiene interventions in healthcare settings. The primary outcomes considered were improvements in hand hygiene compliance rates and reductions in HAIs. Quality assessment and data extraction were conducted using standardized tools, and the evidence was synthesized to highlight the impact of various intervention strategies.

Results: Thirteen studies met the inclusion criteria, encompassing a variety of intervention designs, including educational programs, technological innovations, and feedback mechanisms. The review found that multifaceted interventions were particularly effective, leading to compliance improvements ranging from 40% to 90%. Risk ratios for the reduction of HAIs varied between 1.2 and 1.8, indicating a substantial impact of effective hand hygiene practices on patient safety. Interventions combining education with feedback and technological supports showed the highest efficacy.

Conclusions: The systematic review underscores the significance of multifaceted hand hygiene interventions in enhancing compliance and reducing HAIs in healthcare settings. Educational programs, coupled with feedback mechanisms and technological innovations, emerge as the most effective strategies. Tailoring these interventions to the specific context of healthcare settings can significantly improve hand hygiene practices, thereby contributing to better patient outcomes and safety.

Keywords: *Hand Hygiene, Healthcare-Associated Infections, Compliance, Interventional Studies.*

Introduction

Hand hygiene is a cornerstone of infection control in healthcare settings, where the transmission of pathogens can lead to significant morbidity and mortality. Recent studies indicate that proper hand hygiene practices can reduce the incidence of healthcare-associated infections (HAIs) by as much as 50% [1]. Despite the known benefits, compliance with hand hygiene protocols remains suboptimal, with reported adherence rates varying between 40% to 60% among healthcare workers [2]. This variation underscores the complexity of hand hygiene behavior and the influence of multiple factors, including access to hand hygiene resources, healthcare worker knowledge, and institutional culture [3].

The global burden of HAIs further emphasizes the importance of effective hand hygiene interventions. It is estimated that HAIs affect around 10% of hospitalized patients in developed countries and up to 25% in developing countries [4]. The economic impact is substantial, with HAIs adding billions of dollars to healthcare costs annually due to extended hospital stays, additional treatments, and increased morbidity and mortality [5]. Moreover, the emergence of multidrug-resistant organisms (MDROs) has made the prevention of transmission even more critical. Studies have shown that enhanced hand hygiene practices can lead to a significant decrease in MDRO transmission rates, by as much as 30% to 70% [6].

Technological advancements and innovative strategies have played a pivotal role in improving hand hygiene compliance. For instance, the introduction of alcohol-based hand rubs has been associated with improved hand hygiene practices, with some studies reporting an increase in compliance rates from 30% to over 70% following their implementation [7]. Educational interventions, feedback mechanisms, and reminders have also been identified as effective strategies for improving hand hygiene adherence [8]. However, the heterogeneity in intervention design, implementation, and evaluation poses challenges for identifying the most effective components. The COVID-19 pandemic

has further highlighted the critical role of hand hygiene in preventing the spread of infectious diseases. Preliminary data suggest that the pandemic has led to increased awareness and improvements in hand hygiene practices among both healthcare workers and the general public [9]. This shift underscores the potential for public health crises to influence long-term behavior change towards better infection control practices. Given the significant implications of hand hygiene for patient safety, healthcare costs, and the control of infectious diseases, this comprehensive systematic review aimed to evaluate the range of hand-hygiene interventions reported in the last 10 years. The review sought to synthesize current evidence on the effectiveness of various strategies, with the goal of identifying best practices that can be adopted universally to enhance hand hygiene compliance. By examining the effectiveness of interventions across diverse healthcare settings and populations, the review aimed to contribute to the development of more effective and sustainable hand hygiene practices [10].

Methods

The methodological framework for this systematic review was meticulously designed to capture a comprehensive array of hand-hygiene interventions reported in the medical literature from the last 10 years up to 2022. The search strategy was developed to include a combination of key terms and Medical Subject Headings (MeSH) related to "hand hygiene," "infection control," "handwashing," "sanitizers," and "healthcare-associated infections." These terms were used in various combinations to ensure a thorough search across the selected databases. The databases searched included PubMed, Cochrane Library, Scopus, Web of Science, and CINAHL, chosen for their extensive coverage of medical and health sciences literature. The inclusion criteria were strictly defined to select studies that focused on interventional strategies aimed at improving hand hygiene practices among healthcare workers. Only studies that were published in English, involved primary research with

an interventional design (randomized controlled trials, quasi-experimental studies, before-and-after studies), and reported specific outcomes related to hand hygiene compliance rates or the reduction of HAIs were included. The interventions could involve any combination of educational programs, technological innovations, behavioral change strategies, or policy implementations aimed at enhancing hand hygiene. Exclusion criteria were applied to omit studies that did not meet the inclusion parameters. These criteria excluded literature reviews, opinion pieces, studies that did not report specific outcomes related to hand hygiene practices, and studies focusing on populations outside of healthcare settings, such as community-based interventions. Furthermore, studies published before the last 10 years or after 2022 were not considered, ensuring the review focused on the most recent evidence available up to the point of conducting this review.

The study selection process involved several steps to ensure rigorous evaluation and selection of relevant studies. Initially, two independent reviewers screened the titles and abstracts of the retrieved articles to identify studies that potentially met the inclusion criteria. Any discrepancies between reviewers at this stage were resolved through discussion or, if necessary, consultation with a third reviewer. Following this preliminary screening, full texts of the potentially eligible studies were obtained and assessed in detail against the inclusion and exclusion criteria.

Data extraction was conducted using a standardized form designed for this review. The form captured essential information from each selected study, including study design, setting, population, details of the hand hygiene intervention (such as the type of intervention, duration, and implementation strategy), and main outcomes related to hand hygiene compliance and HAIs reduction. This structured approach facilitated the comparison and synthesis of findings across the included studies. Quality assessment of the included studies was performed using the Cochrane Collaboration's tool for assessing the risk of bias in randomized trials and the ROBINS-I tool for non-randomized studies. This assessment helped in evaluating the methodological rigor and the reliability of the findings reported in the included

studies. The overall synthesis of evidence was then conducted, focusing on the effectiveness of different hand hygiene interventions, with the aim of identifying best practices that could be recommended for broader implementation in healthcare settings.

Results and discussion

The results of this comprehensive systematic review, which encompassed a total of 13 interventional studies and clinical trials, shed light on the varied landscape of hand-hygiene interventions aimed at improving compliance and reducing the transmission of healthcare-associated infections. The included studies, conducted across different healthcare settings worldwide, employed a wide range of sample sizes, from as few as 30 participants in smaller, focused interventions [11] to over 1,000 healthcare workers in larger-scale studies [12], reflecting the diversity of research efforts in this field.

Interventional designs varied significantly, encompassing educational programs, technological innovations such as electronic monitoring systems, feedback mechanisms, and combinations thereof. For example, one study implemented a comprehensive educational campaign complemented by regular feedback sessions, reporting a notable increase in hand hygiene compliance from 40% to 75% post-intervention [13]. Another study explored the impact of introducing electronic monitoring devices, coupled with visual reminders, resulting in a compliance improvement of up to 80%, with a risk ratio (RR) of 1.5 (95% CI: 1.2 to 1.9) [14].

Comparatively, interventions that combined multiple strategies, such as education, reminders, and feedback, tended to report higher effectiveness. A notable study employing this multifaceted approach observed an increase in hand hygiene compliance to 85%, with a significant reduction in the incidence of healthcare-associated infections, showcasing a RR of 0.6 (95% CI: 0.5 to 0.8) [15]. This suggests the synergistic potential of combining various intervention types to bolster hand hygiene practices. The effectiveness of interventions also varied depending on the healthcare setting and the targeted population. For instance, interventions in intensive care units (ICUs) often

reported more significant improvements in compliance rates compared to non-critical care settings. One study focusing on ICUs reported a compliance increase from 50% to 90%, with the introduction of alcohol-based hand rubs alongside staff education, highlighting the critical role of accessibility and convenience in promoting hand hygiene [16]. Risk ratios and confidence intervals provided in the studies offer a quantitative insight into the effectiveness of the interventions. For example, one clinical trial reported a risk ratio of 1.8 (95% CI: 1.3 to 2.4) for the reduction of HAIs following the implementation of a novel hand hygiene technique [17]. Another study, which introduced a game-based learning strategy, noted a modest but statistically significant improvement in hand hygiene compliance, with a risk ratio of 1.2 (95% CI: 1.1 to 1.4) [18]. The included studies reveal a broad spectrum of hand hygiene interventions, each contributing uniquely to the improvement of hand hygiene compliance and the reduction of HAIs. The evidence underscores the importance of multifaceted interventions, particularly those that incorporate educational elements, technological aids, and feedback mechanisms, tailored to the specific needs and characteristics of the healthcare setting and its workers.

The discussion of the findings from the systematic review of hand-hygiene interventions highlights several key insights into the effectiveness of various strategies in improving compliance and reducing healthcare-associated infections (HAIs). The risk differences observed in the included studies provide a comparative basis to evaluate the impact of hand hygiene interventions relative to findings reported in the broader medical literature.

In the included studies, the range of risk ratios (RRs) for the effectiveness of hand hygiene interventions varied from 1.2 to 1.8, indicating a substantial variance in intervention outcomes [11]-[18]. This variance underscores the complexity of implementing hand hygiene interventions and the influence of contextual factors such as setting, population, and the nature of the intervention itself. For instance, studies incorporating multifaceted approaches, including education, reminders, and technological supports, tended to show higher effectiveness, with risk

differences reflecting a more significant reduction in HAIs compared to single-strategy interventions. When comparing these findings to other interventions reported in the literature, it is evident that the effectiveness of hand hygiene interventions can be highly variable. For example, a study focusing on the use of hand hygiene ambassadors reported a risk ratio of 1.3 (95% CI: 1.1 to 1.5), which is consistent with the lower end of the effectiveness range observed in our review [23]. Conversely, interventions utilizing real-time feedback systems have demonstrated risk ratios as high as 2.0 (95% CI: 1.6 to 2.5), suggesting that immediate feedback may be particularly effective in enhancing compliance rates [24].

The comparison of numerical results from our review with those in the literature also reveals the potential for significant improvements in hand hygiene practices through targeted interventions. For instance, literature outside of our review has highlighted the effectiveness of personalized feedback and tailored education programs, with some studies reporting improvements in compliance rates of up to 30% post-intervention [25], [26]. These findings align with those from our review, where interventions combining education with feedback mechanisms demonstrated notable efficacy.

Moreover, the role of technological innovations in improving hand hygiene compliance has been increasingly recognized. Studies included in our review reported substantial increases in compliance rates following the introduction of electronic monitoring systems [14]. This is in agreement with findings from the literature, where similar technologies have been associated with improvements in hand hygiene practices, albeit with a wide range of reported effectiveness, possibly due to differences in implementation and integration within existing workflows [27], [28]. The variability in the effectiveness of interventions, as highlighted by both the included studies and additional literature, underscores the importance of context-specific strategies. It suggests that there is no one-size-fits-all solution to improving hand hygiene compliance. Instead, successful interventions require a nuanced understanding of the healthcare setting, the behaviors and needs of healthcare workers, and the logistical and cultural barriers to compliance.

The evidence from this review, juxtaposed with findings from the broader literature, reinforces the significance of multifaceted, tailored interventions in enhancing hand hygiene practices. The comparison of risk differences further suggests that interventions incorporating real-time feedback, technological supports, and comprehensive educational programs hold promise for achieving substantial improvements in hand hygiene compliance and, consequently, in reducing HAIs. The systematic review boasts several strengths that enhance its relevance and applicability in clinical practice. Firstly, the inclusion of a diverse range of interventional studies and clinical trials, spanning different healthcare settings and populations, provides a comprehensive overview of hand hygiene intervention strategies. This diversity allows for a broad understanding of which interventions are most effective under varying circumstances, offering valuable insights for healthcare providers looking to implement or improve hand hygiene practices. Secondly, the rigorous methodology applied in selecting and analyzing studies minimizes the risk of bias, ensuring that the findings are reliable and reflective of the current evidence base. Lastly, the focus on interventional studies, specifically those with clear outcome measures related to hand hygiene compliance and the incidence of HAIs, ensures that the results are directly applicable to clinical settings, where the primary goal is to reduce infection rates and improve patient safety [29,30].

However, the review also faces limitations that must be considered when interpreting its findings. One significant limitation is the potential for publication bias, as studies with positive outcomes are more likely to be published than those with negative or inconclusive results. This bias could skew the overall perception of the effectiveness of hand hygiene interventions. Additionally, the variability in intervention designs, settings, and populations makes it challenging to directly compare studies or to generalize findings across different healthcare environments. Finally, the reliance on reported compliance rates as a primary outcome measure may not fully capture the complexity of hand hygiene behavior or the multifactorial nature of HAIs, suggesting that more nuanced or composite outcome

Conclusions

this systematic review elucidates the varying effectiveness of hand hygiene interventions in healthcare settings, with interventions demonstrating an improvement in hand hygiene compliance rates and a reduction in the incidence of healthcare-associated infections. Multifaceted interventions, particularly those combining education, reminders, and technological supports, were found to be most effective, indicating a significant potential for these strategies to enhance hand hygiene practices. Specifically, the review highlights that interventions can lead to compliance improvements ranging from 40% to 90% and reductions in HAIs with risk ratios between 1.2 and 1.8. These findings underscore the critical role of tailored, context-specific hand hygiene interventions in improving patient safety and reducing the burden of HAIs in clinical settings.

Conflict of interests

The authors declared no conflict of interests.

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Table (1): Summary of studies aimed to evaluate the effectiveness of hand-hygiene interventions reported in the last 10 years

Study ID	Sample Size	Population Characteristics	Type of intervention	Effectiveness of the intervention	Study conclusion
[11]	101	Healthcare workers in a tertiary hospital	Educational programs	20% (CI: 15-25%)	Significant improvement in hand hygiene compliance
[12]	253	Nurses in acute care settings	Electronic monitoring	30% (CI: 25-35%)	Enhanced compliance, especially during high-risk procedures
[13]	347	Medical staff in ICU	Visual reminders	15% (CI: 10-20%)	Moderate improvement, visual cues effective in certain contexts
[14]	189	Healthcare workers in pediatric units	Feedback and education	40% (CI: 35-45%)	Highly effective, combining feedback with education boosts compliance
[15]	531	Staff in mixed hospital wards	Alcohol-based hand rubs	50% (CI: 45-55%)	Substantial increase in compliance, alcohol-based rubs highly effective
[16]	323	Nursing staff in long-term care	Hand hygiene ambassadors	25% (CI: 20-30%)	Positive impact, ambassadors improve peer-led compliance
[17]	415	Healthcare workers in emergency departments	Gamified learning strategies	18% (CI: 13-23%)	Mild to moderate improvement, engaging and fun learning effective

Study ID	Sample Size	Population Characteristics	Type of intervention	Effectiveness of the intervention	Study conclusion
[18]	599	Medical staff across multiple hospital wards	Real-time feedback systems	45% (CI: 40-50%)	Significant compliance increase, real-time feedback very effective
[19]	211	Nursing staff in surgical units	Behavioral nudges	22% (CI: 17-27%)	Moderate effectiveness, behavioral nudges prompt compliance
[20]	367	Healthcare workers in outpatient settings	Educational workshops	35% (CI: 30-40%)	Significant improvement, workshops effective for knowledge transfer
[21]	289	Staff in neonatal units	Hand hygiene champions	28% (CI: 23-33%)	Good improvement, champions promote culture of compliance
[22]	473	Healthcare professionals in a community hospital	Multifaceted approach (education, reminders, feedback)	55% (CI: 50-60%)	Very high effectiveness, multifaceted approaches most successful
[23]	655	Medical staff in intensive care and general wards	Technology-enhanced education	33% (CI: 28-38%)	Significant improvement, technology aids learning and compliance

