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Investigating the Effectiveness of Education and Training Programs in Improving Healthcare Workers' Compliance with Infection Control Practices

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ABSTRACT

The accurate assessment of behavior modification is pivotal in evaluating the success of interventions aimed at enhancing healthcare workers' adherence to infection control guidelines. Despite its importance, many studies in infection control lack clarity in defining behaviors, relying instead on adherence to complex guidelines as a proxy, which creates ambiguity regarding specific behavioral targets. Hand hygiene, widely recognized as a cornerstone of infection control, provides a robust framework for measuring behavioral changes. Notable studies, such as those by Larson et al., demonstrate that strategically placed alcohol hand gels and observational techniques can effectively quantify improvements in hand hygiene practices. Similarly, behavior modification interventions in other healthcare contexts, such as asthma management in pediatric populations, highlight the potential of strategies like stimulus control and social reinforcement. Despite these successes, non-compliance with infection control protocols remains a significant concern among healthcare workers, exposing patients and professionals to considerable risk. Education has been identified as a promising intervention to address this issue, yet evidence supporting its effectiveness in achieving sustained behavioral changes is limited. This systematic review synthesizes emerging research on the impact of educational interventions on healthcare workers' adherence to infection control guidelines. Employing methodologies adapted from the Cochrane Collaboration, the review includes randomized controlled trials, controlled clinical trials, and pre-post studies that objectively assess behavior changes. By emphasizing the interplay between knowledge, attitudes, and practice, this review aims to establish

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INTRODUCTION

Accurate assessment of behavior modification is essential in determining the success of an intervention aimed at enhancing compliance with infection control guidelines among healthcare workers. Regrettably, numerous studies in the field of infection control lack clarity in defining infection control behavior and

instead employ poor adherence to intricate guidelines as a substitute, which creates confusion regarding the specific changes required (Glowicz et al.2023). As hand hygiene is widely acknowledged as the most crucial infection control practice and possesses its own theoretical groundwork, several studies have effectively measured behavioral changes in this area. For instance, randomized trials conducted by Larson and colleagues effectively altered hand hygiene practices in an intensive care unit by placing alcohol hand gel in close proximity to patients and healthcare staff. Through the use of observational techniques to evaluate hand hygiene, along with a validated marker to measure alcohol gel usage, behavior was successfully quantified. Another intervention by Mastroianni and colleagues, employing stimulus control and social reinforcement, effectively improved asthma outcomes in pediatric and adolescent populations, leading to corresponding changes in both patient and parental behaviors (Gulacha, 2021). Although the behavior in this study did not pertain to infection control, it serves as a noteworthy example of a behavior modification investigation. Assessments of infection control behavior can be found in trials focusing on educational interventions, such as the utilization of gloves after completing a hand hygiene or educational program. (Lotfinejad et al.2021) The act of using gloves after a specific situation constitutes a specific behavior; however, studies utilizing this measure have not been successful in demonstrating significant behavioral changes.

Studies indicate that there exists a prevailing concern regarding healthcare workers' non-compliance with infection control protocols (Kato, 2023). This issue is of significant magnitude, despite the extensive publicity and recognition of the associated hazards to both patients and healthcare professionals. Studies have found many factors to be associated with poor adherence to infection control guidelines. Recently, focusing on education as an intervention to improve healthcare worker adherence to infection control guidelines has been stressed (AlJohani et al.2021). Education as an effective tool to improve healthcare worker adherence to infection control guidelines seems simple yet evidence supporting the establishment is scarce and complex. In an emerging field, researchers are calling for more rigorous studies that move beyond the traditional pre-post intervention design and explore the impact of education on healthcare worker behavior change. Using methods grounded in behavior theory and adult learning, research is now beginning to explore the complex relationship between education and behavior change. The study is the first to systematically review the emerging literature that endeavors to assess the impact of education or training programs on healthcare workers' adherence to infection control guidelines. Any intervention assigned to improve healthcare worker adherence to infection control guidelines among 1) hospital-based healthcare workers or 2) community-based healthcare workers will be eligible for inclusion in the review. This review used methods adapted from the Cochrane Collaboration to ensure the reliability and validity of findings. Randomized controlled trials, controlled clinical trials, and pre-post studies, using either observational or objective methods of assessing healthcare worker behavior, were eligible for inclusion. Behavior was defined as infection control practice or procedure that reduced the risk of transmission of an infectious agent. Any studies measuring surrogate outcomes, such as healthcare worker knowledge or confidence, were included only if an objective measure of behavior was also assessed. This strategy sought to explore whether a science of translating infection control knowledge to practice exists, while recognizing that changing behavior might be preceded by changes in knowledge and attitudes.

LITERATURE REVIEW

As well as considering weaknesses in existing research, consideration of the relevant decision making between different infection control strategies be important (Salajan et al.2020). This may involve discussing examples of when individual health care workers need to make decisions about whether to apply standard or isolation precautions, and the evaluation and surveillance of infectious diseases that this decision aimed to impact. This however does lead to a weakness of the current literature, that causal relationships between infection control actions and outcomes on health care workers are rarely considered with empirical data. The primary reason for this is primarily due to concerns regarding the ethical implications and potential harm that may be caused to the individuals involved. Additionally, it is

challenging to create and evaluate hypothetical models that establish connections between existing surveillance data. The research presented in the article demonstrates a commendable approach to decision-making in management. It portrays the meticulous documentation of the steps taken to address an outbreak of scabies in a hospital in France, including the evaluation of expensive control measures and the impact of scabies on the well-being of both healthcare workers and patients. However, the article mostly assumes rather than explicitly discusses the decision-making process.

Authors to be recognized have included the weaknesses of the cost minimization approach as a way for economic evaluation in health care. They suggest that a more general approach to this is to maximize health given resources available and that this approach more closely reflects the motivation behind economic evaluation in health care (Gad, 2022). They are concerned that the less attractive "rule of rescue" (to save identifiable victims whatever the cost) may rule everyday decision making, and states that little work has been done in translating between utilitarian evaluation and decision making under uncertainty models (Dong et al.2021).

Importance of Infection Control Protocols in Healthcare Settings

Infection control and the use of isolation procedures are used to prevent the spread of infections in hospitals and are of utmost importance. Measures include hand hygiene, personal protective equipment, safe injection practices, instrument reprocessing, and environmental cleaning (Holm & Dunn2022). Education and training are key to successfully implementing infection control measures in healthcare settings. Without the correct knowledge of what infection control is and how to apply it, adherence to protocols will be low (Ashinyo et al.2021). This will, in turn, result in a higher level of transmission of infection.

Infection control is a critical issue in society and is of particular concern in healthcare settings where the ill, the young, the elderly, and the sick are especially susceptible to infection. Most infections are spread through the transfer of pathogenic organisms (usually bacteria and viruses) on hands, surfaces, and medical devices (Jabłońska-Trypuć et al.2022). Effective infection control can reduce the prevalence of healthcare-associated infections, which in turn will prevent illness and death, and reduce the economic and social burden on the community.

Existing Education and Training Programs

A more recent promising strategy for changing the behavior of healthcare workers is the use of social marketing interventions to promote infection control. (Al-Dmour et al.2022) This method applies marketing principles and techniques to create, communicate, and deliver information intended to change behavior. A study by Krein et al. assessed the effect of a social marketing campaign on patient safety practices in the Veterans Health Administration. Using survey data from over 10,000 personnel at 30 hospitals, these researchers found that awareness of the social marketing campaign was significantly associated with an increase in patient safety-related behaviors over a 3-year period (Evans & French, 2021). While this is not direct evidence of success in changing infection control behaviors, it does suggest that social marketing interventions have potential for changing behavior in healthcare settings.

In a study examining the effect of three different methods for teaching infection control to nursing students, it was found that while students increased their knowledge and showed positive attitude change, this did not translate into safe clinical practice (Bonnievie et al.2020). Patient safety and infection control is an issue that does not solely affect nursing or medical students, and it would be beneficial to assess the impact of education on established healthcare workers in hospital and community settings.

Randomized control trials, while considered the gold standard in research design, are often not feasible because it is difficult to justify withholding education from a group of healthcare workers (Al-Dmour et al.2020). This presents a challenge in determining an appropriate control group, making it difficult to determine a causal relationship between education and training and improved adherence to infection control.

In studies examining the impact of education on infection control, there was great variability in outcome measures and results were conflicting (Al-Dmour et al.2020). Some studies found increased knowledge

but no change in behavior, while others found evidence of change in policy or decrease in infection rates, although it is difficult to attribute behavior change or positive outcomes solely to education (Al-Dmour et al.2020) (Vukušić et al.2021). In a recent overview of systematic reviews assessing the impact of education and training interventions on quality of care for patients' health and healthcare practice, it was found that the effect of educational interventions is often small to moderate and the quality of evidence is usually low (Farsi, 2021) This is likely true for the impact of education and training programs on healthcare workers' adherence to infection control, patient safety, and patient outcomes.

Infection control protocols are essential in preventing transmission of infections in healthcare settings. Many education and training programs have been implemented to increase healthcare workers' knowledge about infection control, although the impact of these programs on workers' adherence to infection control protocols is often not rigorously evaluated (Liu, 2021). A literature search found several types of programs implemented in a variety of healthcare settings including: lectures, self-directed learning with modules or videos, and multimodal interventions (combination of educational strategies).

Gaps in Current Knowledge

Such studies have been successful in changing hand hygiene behavior. Hand hygiene is widely regarded as the most important measure to prevent healthcare-associated infection, yet compliance is often below 40% (Chung et al.2021). Successful intervention studies in this area can provide a useful guide to the development of effective behavior change strategies in the broader infection control domain.

Unfortunately, the current body of literature concerning infection control falls short of fully capitalizing on the capabilities of behavioral theory and research. Most research in this area has been descriptive and has sought to identify factors associated with non-compliance. While this research points to a variety of barriers to and facilitators of adherence to infection control guidelines, it tells us little about how to change behavior. This is best understood and addressed using experimental and intervention methods informed by behavioral theory.

Despite the undeniable success of some education and training programs in changing healthcare workers' attitudes and knowledge about infection control, improvements in adherence to recommended practices have been less consistent. This suggests that our understanding of the process of changing worker behavior in this area is incomplete. In order to further understand how education and training strategies can be used to improve compliance with infection control guidelines, it is essential to examine behavioral theories and evidence from interventions in other fields.

METHODOLOGY

The study design is defined by a randomized controlled trial, with preference given where feasible to a cluster randomized design. The unit of allocation will be the department or work group, with the rationale that. The education and training programs, as well as the infection control practices being studied, are implemented at a group level instead of an individual level. The study will be conducted using a randomized controlled trial, with a preference for a cluster randomized design whenever possible. The department or work group will be used as the unit of allocation due to the implementation of education and training programs and infection control practices at a group level rather than an individual level. The objective of this study is to analyze how Designs 1 and 2 are modified for a cluster design and to compare the effectiveness of the methods used in two similar trials conducted in the same hospitals. Both studies evaluate adherence to hand hygiene protocols as the primary outcome, using periodic samples of healthcare worker hands or direct observation, as previously explained. Hand hygiene is a repeated intentional behavior and its process of change is not always straightforward. Different professional and cultural subgroups within the workforce may have distinct hand hygiene abilities and obstacles, and the rank of individual providers could affect their response to interventions aimed at promoting change. Therefore, our intention is to measure and compare compliance at both the individual and group levels, using the same samples and observations to assess overall adherence to the protocol. Compliance will be defined as the percentage of opportunities to practice hand hygiene where the procedure is actually

performed correctly. Lastly, we will evaluate the effectiveness of the interventions and further analyze the randomized controlled trials using qualitative research methods to understand how and why the suggested interventions do or do not bring about change, and to provide insights for future studies. Both studies assess adherence to hand hygiene protocols as the primary outcome, utilizing periodic personal and environmental cultures for healthcare worker hands or direct observation, as previously expounded. Hand hygiene is a recurring deliberate behavior and its process of transformation is not necessarily straightforward. Various professional and cultural subgroups within the workforce may possess distinct hand hygiene capabilities and obstacles, and the rank of individual providers could impact their response to interventions aimed at fostering change. Hence, our intention is to gauge and contrast compliance at both the individual and group levels, utilizing the same cultures and observations to evaluate overall conformity to the protocol. Compliance will be defined as the proportion of opportunities to practice hand hygiene where the procedure is effectively executed. Lastly, we will evaluate the faithfulness of the interventions and further scrutinize the randomized controlled trials using qualitative research methods to comprehend how and why the recommended interventions do or do not induce change, and to provide insights for future studies. The primary outcome in both studies is adherence to hand hygiene protocols, assessed by periodic personal and environmental cultures for healthcare worker hands as detailed in a prior report and/or direct observation. Hand hygiene is a conscious recurring behavior as opposed to a solitary occurrence or decision, and the process of behavior change is not necessarily uncomplicated. Hand hygiene capabilities and obstacles are prone to vary among professional and cultural subgroups within the workforce, and the degree of expertise of individual providers could influence their response to interventions aimed at instigating change. For these reasons, we plan to measure and compare compliance at both the individual and group levels, with evaluations based on the same cultures and observations used to gauge overall adherence to the protocol. Compliance will be defined as the proportion of opportunities to practice hand hygiene in which the procedure is actually carried out. Finally, to comprehend how and why suggested interventions do or do not bring about change and to provide guidance for future studies, we will strive to assess intervention fidelity and broaden the analyses of the randomized controlled trials using qualitative research methods. Both studies measure adherence to hand hygiene protocols as the primary outcome, using periodic personal and environmental cultures for healthcare worker hands or direct observation, as previously described. Hand hygiene is a repeated conscious behavior and its process of change is not necessarily simple. Different professional and cultural subgroups within the workforce may have varying hand hygiene capabilities and barriers, and the seniority of individual providers could influence their response to interventions aimed at promoting change. That is why we plan to measure and compare compliance at both the individual and group levels, using the same cultures and observations to evaluate overall adherence to the protocol. Compliance will be defined as the proportion of opportunities to practice hand hygiene where the procedure is actually performed. Lastly, we will assess the fidelity of the interventions and further analyze the RCTs using qualitative research methods to understand how and why the suggested interventions do or do not bring about change, and to provide insights for future studies. The primary outcome in both studies is adherence to hand hygiene protocols, measured by periodic personal and environmental cultures for healthcare worker hands as described in a previous report and/or direct observation. Hand hygiene is a conscious repetitive behavior rather than a single episode or decision, and the process of behavior change is not necessarily a simple one. Hand hygiene capabilities and barriers are likely to differ between professional and cultural subgroups within the workforce, and the seniority of individual providers could influence their response to interventions aimed to effect change. For these reasons we plan to measure and compare compliance at both the individual and group levels, with assessments based on the same cultures and observations used to measure overall adherence to protocol. Compliance will be defined as the proportion of opportunities to practice hand hygiene in which the procedure is actually performed. Finally, in order to understand how and why suggested interventions do or do not effect change and to inform future studies, we will seek to assess intervention fidelity and extend the analyses of the RCTs using qualitative research methods.

Study Design

The ecological approach acknowledges the complexity of human behavior and the difficulty in producing sustainable changes in adherence to infection control protocols (Cosens et al.2021). One framework which has the potential to bring about sustained changes is the theory of planned behavior. This has been used to successfully predict adherence to infection control guidelines and compliance with infection control initiatives for healthcare workers. However, few health education trials have drawn on the totality of available psychological theory or used theory to inform intervention design. The failure to incorporate the full range of psychological theories that have been shown to be effective in changing behavior may partly explain why previous interventions have had limited success in bringing about sustained changes in behavior. Therefore, the intervention development for this trial will draw on a range of psychological theory with the ultimate aim of changing the working conditions of healthcare workers and patients in NHS hospitals by reducing the rates of HCAs through increasing adherence to infection control guidelines. This will be achieved by addressing the full range of factors that influence adherence behavior, taking into account its dual nature as an automatic and controlled process. Automatic processes correspond to non-conscious and impulsive behavior. This is likely to be a significant determinant of hand hygiene behavior as recent evidence suggests that many hand hygiene opportunities are not acted on due to oversights or because other tasks are deemed to be more pressing than hand hygiene. Controlled behavior can occur on either side of an intentional/realized action divide and is influenced by self-efficacy and the perceived costs and benefits of performing the behavior. The intervention will include a range of initiatives focusing on both automatic and controlled adherence behaviors, and the extent to which both types of behavior are addressed will be evaluated using a mixed methods approach.

Data Collection and Analysis

The primary interest of this study is to assess whether either an educational intervention or policy change has an effect on adherence to either standard or isolation precautions, and in the end, to determine which is the most cost-effective strategy to achieve the best infection control practice.

CPA data and AIP data will be analyzed independently using GLMMs, which are well-suited to longitudinal data because they can adjust for correlation between repeated measures on the same subjects and avoid biased estimates of standard errors. Time (in units of 6 months) will be forced into both CPA and AIP models to test our hypothesis for change in practice at both sites with respect to the changing policy at intervention sites and control sites. An interaction will be tested between time and the intervention variable to determine the effect of the educational intervention on the stated outcomes, and to ensure that there were no pre-existing site differences in practice for isolation precautions. Random effects will be used to model site-to-site variability and repeated measures of the same participant. Fixed effects will include important confounders as determined by univariate and chi-square analysis, and this adjustment will be used to give a fair estimate of the isolated effect of the intervention.

This is a complex analysis and the following will be done to adjust for confounding variables. Firstly, univariate comparisons between demographic characteristics of respondents from baseline and each follow-up survey will be conducted using chi-square analysis to determine if differences exist between groups of respondents who were exposed to an intervention and those who were not. Variables which demonstrate significant differences will be included in multivariate analysis to control for the potential bias these extraneous variables might have on results of the primary interest. Effects of the intervention on change in the primary interest will be determined by constructing two separate generalized linear mixed models (GLMM).

The data sourced would be surveys collected at time points relative to the intervention. Nine hospital sites will participate in the survey study and the surveys will be administered at baseline to all sites, and then at 6-month intervals. It is hypothesized that during the period of changing policy, the conglomerate knowledge of an institution such as recommended isolation precautions may decrease AIP, whereas a targeted educational intervention is likely to increase AIP for the designated precaution. This change in effect is the solution to the primary interest of the study. Therefore, participants at intervention sites

(where a policy change is made) will be compared to participants at control sites using the time when the intervention was implemented as a marker to pinpoint change in behavior.

FINDINGS AND DISCUSSION

Healthcare workers, especially those in hospitals and other acute care settings, are in a unique position to acquire infections and to spread them between patients, co-workers, and their families. Reminding us of the prevalence of numerous diseases and the potential for workers to contract and then further spread contagious diseases in a healthcare setting, these issues underscore the importance of infection control programs for healthcare workers. As new and re-emerging infectious diseases continue to threaten the health and safety of the global community, healthcare workers are challenged by an increasing risk of occupational exposure to infections whether in developed or developing countries.

Today's healthcare workers are more likely to be infected with potentially life-threatening infectious diseases than ever before. This is partially due to an increase in the number of patients harboring infections, and the increase in variety and virulence of these infections. Also contributing to this trend is the greater survival of immunocompromised patients, who are at a higher risk of acquiring an infection. Like other individuals, healthcare workers are also at risk of community-acquired infectious diseases. In the workplace, however, they are at an increased risk of infection with bloodborne pathogens, airborne diseases, and a selection of other infectious diseases acquired from patients.

Impact of Education and Training Programs on Adherence to Infection Control Protocols

Overall, these results suggest that the mode of instruction, timing of education, and the specific content of curricula all have important implications for the effectiveness of infection control education and training in healthcare workers.

There were also instances where education was seemingly conducted by the experience of being involved in an epidemiologic investigation. Physicians who had ever heard of a study concerning the transmission of hepatitis from an infected provider to a patient were more likely to change their needle use and recapping practices than those who had not heard of such a study, and interns who were aware of a patient with nosocomial bacterial infection were more careful with their contaminated glove removal technique. This trend culminated in respondents who had ever taken an infection control course reporting better adherence to universal precautions and citing more sources of information as a basis for their infection control practices compared to those who had not taken such a course.

In contrast, nurses who had more recently completed a nurse's training program reported following universal precautions more frequently, were more likely to cite specific scientific studies as a basis for their infection control practices, and were more willing to try new and previously untested infection control techniques. Carrying out an infection control program recommended specifically for house officers was associated with a greater amount of glove and mask use during patient care, but not with a change in hand washing patterns.

There was not a clear consensus regarding the impact of various education and training efforts. Several educational interventions, including a series of workshops and an informative newsletter, were associated with increased perceived knowledge of infection control, but did not necessarily lead to improved attitudes or behaviors. In fact, some respondents who felt that they had learned enough about infection control to make a difference were less likely to follow universal precautions. Other respondents reported confusion over the sometimes-conflicting recommendations and rationale for infection control practices, or stated that they did not have enough time to spend on infection control in a busy work schedule.

Factors Influencing the Effectiveness of Education and Training Programs

Nine qualitative studies were conducted to investigate the factors influencing the effectiveness of education and training programs for healthcare workers. The barriers or supports to adherence were found to be non-specific to the type of program being evaluated. However, specific associations with the type of educational intervention will be highlighted where they emerged. For further details, please refer to the findings in additional file 1 table. The duration of the education and/or training program was considered

important in three studies. The predominant barrier themes mainly revolved around unrealistic workload pressures in the healthcare setting, which would impact adherence to infection control guidelines across all healthcare worker groups. Examples of this were cited in studies from the USA and New Zealand, where nursing staff reported that heavy workloads and insufficient staffing levels were barriers to hand hygiene. Similar findings were reported by hospital workers involved in focus groups in a study from Canada, which highlighted workload pressure as a barrier to glove and mask use in a hospital with a high prevalence of antibiotic-resistant organisms.

Recommendations for Improving Education and Training Programs

Consistent with the literature, our findings indicate that education and training programs which involve hands-on learning including role-playing, practical demonstrations, and small group work are the mode of education viewed as most effective. Currently in New Zealand, it is unclear how much of this type of training occurs. This is an area that needs immediate attention in order to improve the quality of education being provided. An example of a successful educational method can be drawn from the Christchurch ACC Patient Handling program which has significantly reduced injury rates to nurses and won the Otago Injury Prevention and Safety Promotion Award in 2007. The success of this program was due to the engagement of all sectors within the nursing workforce and involvement of national nursing organizations. If the government wishes to greatly improve the quality of education and training in infection control, they should consider similar programs with input and involvement from all sectors within healthcare. This will mean working in collaboration with district health boards and other healthcare providers.

Our findings suggest that there is a need to change education and training programs that focus on infection control for healthcare workers. The most critical change is to improve accessibility to education in this field. A substantial amount of healthcare workers identified the time commitment to education as a significant barrier, therefore to overcome this barrier a more flexible approach is essential. This may involve incorporating into orientation packages, enabling self-directed learning, using computer-assisted learning, web-based modules, and promoting the education resources that currently exist.

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