Interventions to Improve Patient Hand Hygiene: A Systematic Review

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Summary

Background: Nosocomial pathogens may be acquired by patients via their own unclean hands, but there has been relatively little emphasis on patient hand hygiene as a tool for preventing healthcare-associated infections (HAIs).

Aim: To determine the efficacy of patient hand hygiene interventions in reducing HAIs and improving patient hand hygiene rates compared to usual care.

Methods: We conducted a systematic review. Electronic databases and grey literature were searched to August 2014. Experimental and quasi-experimental studies were included if they evaluated a patient hand hygiene intervention conducted in an acute or chronic healthcare facility and included HAI incidence and/or patient hand hygiene rates as an outcome. All steps were performed independently by two investigators.

Findings: Ten studies were included, most of which were uncontrolled before-after studies (n=8). The majority of interventions (n=7) were multimodal, with components similar to healthcare worker hand hygiene programs, including education, reminders, audit and feedback, and provision of hand hygiene products. Six studies reported HAI outcomes and 4 studies assessed patient hand hygiene rates; all demonstrated improvements but were at moderate to high risk of bias.

Conclusion: Interventions to improve patient hand hygiene may reduce the incidence of HAIs and improve hand hygiene rates, but the quality of evidence is low. Future studies should use stronger designs and be more selective in their choice of outcomes.

Introduction

Healthcare worker (HCW) hand hygiene at appropriate times during patient care is believed to be an effective means of reducing the risk of healthcare-associated infections (HAIs), as antibiotic-resistant organisms (AROs) and other causative organisms are often spread via the hands of HCWs.[1] However, transmission to patients also may occur because of their own unclean hands.[2] Organisms transmitted through the fecal-oral or contact routes may contaminate patients' hands, leading to colonization or infection.

Despite a strong theoretical basis to suggest that it may prevent HAIs, there has been comparatively little emphasis on patient hand hygiene and it is not clear if improving patient hand hygiene is an effective strategy. Although there have been some studies of interventions to improve patient hand hygiene, to date there has been no systematic review of the evidence. As healthcare organizations strive to reduce HAI rates, guidance is needed on whether these interventions may be worth implementing and, if so, which specific techniques are most effective at increasing patient hand hygiene and reducing transmission of pathogens.

The primary objective of this systematic review was to determine the efficacy of patient hand hygiene interventions in reducing HAIs (e.g., *Clostridium difficile* infection) or AROs. (e.g., methicillin-resistant *Staphylococcus aureus* [MRSA]) compared to usual care. The secondary objective was to determine the efficacy of these interventions in improving patient hand hygiene rates.

Methods

A systematic review protocol was prepared in advance and is available on request. Our review is in accordance with PRISMA guidelines.[3]

Search Strategy

We searched MEDLINE, EMBASE, CINAHL, Web of Knowledge, and the Cochrane Central Register of Controlled Trials (CENTRAL) from database inception until August 2014. The search strategy, designed by an experienced librarian, is shown in Appendix A. Key word searching was performed in Web of Science. We searched for unpublished studies and grey literature in the websites of major infection prevention and control organizations and public health agencies, and Google. Finally, we searched reference lists and forward citations of included studies and relevant review articles for additional relevant studies.

Eligibility Criteria

Randomized controlled trials, non-randomised controlled trials, controlled before-after studies, interrupted time series, and quasi-experimental studies were considered for inclusion if they evaluated a patient hand hygiene intervention conducted among inpatients in an acute or chronic healthcare facility. Studies had to include HAI/ARO incidence and/or patient hand hygiene rates as an outcome. Studies were excluded if they did not provide primary data.

The eligibility criteria were pilot tested on a selection of studies and refined. Subsequently, all retrieved titles and abstracts were independently assessed by two reviewers (JAS, CDF). If the inclusion/exclusion criteria could not be adequately assessed from review of the title and abstract, the full article was obtained and reviewed. Disagreements were resolved by a third reviewer (MG).

Data Extraction and Quality Assessment

A data extraction form was developed and piloted. The risk of bias of each included study was assessed using the Cochrane EPOC risk of bias tool for controlled studies and interrupted time series.[4] For uncontrolled before-after studies and other quasi-experimental designs, we used a design hierarchy and a risk of bias assessment developed specifically for infection prevention and control studies.[5,6] All steps were performed independently by two investigators (JAS, CDF), with disagreements resolved by a third reviewer (MG).

Data Synthesis

Summary tables of included studies were developed. We described the outcomes of each study as related to our objectives, explored factors that might explain differences across studies, and assessed the strength of the evidence. We assessed risk of bias across studies by searching trial registries for any missing studies. Although we intended to assess for outcome reporting bias, we were unable to find protocols to which to compare published studies.

Results

Overview of Included Studies

Ten studies met eligibility criteria (Figure 1). Meta-analysis could not be conducted due to significant heterogeneity in the types of intervention implemented and types and definitions of outcomes, which precluded the calculation of summary measures.

Most studies (n=8) were uncontrolled before-after studies (Table I). Three studies involved interventions that were implemented institution-wide, while the remaining seven studies involved one or more units within an institution. Six studies addressed the primary

objective of this review by reporting HAI outcomes, but each used different infections. Four studies assessed patient hand hygiene rates as the outcome, addressing the secondary objective of this review.

Studies Reporting HAI/ARO Outcomes

Pokrywka *et al*.[7] conducted a before-after study of an intervention to reduce CDI in a 520-bed tertiary care hospital that already had an evidence-based CDI bundle in place. Patients were provided with educational brochures, reminder signs, and alcohol wipes on meal trays. Staff and volunteers were recruited to help clean patients' hands at mealtimes. The CDI rate dropped from 10.45/10,000 patient days in the year before the intervention to 6.95/10,000 patient days during the one year intervention ($p = 0.0009$).

Gagne *et al*.[8] implemented a hospital-wide intervention in a before-after study design. Attendants met with all patients and visitors over a 346-day period to teach them about the benefits of hand hygiene and provided a brochure about HAIs. The attendants also cleaned the hands of all patients with hand sanitizer twice daily on weekdays. Nosocomial MRSA infections decreased from 10.6 per 1000 admissions in the 385-day period before the intervention to 5.2 per 1000 admissions during the intervention period. Statistical significance was not reported. Reductions were seen in all sites of infections, including septicemia, respiratory, surgical sites, bone and soft tissue, and urinary tract. HCW hand hygiene compliance also increased by approximately 30% even though there was no change in the hand hygiene program for HCWs. A cost-benefit analysis demonstrated that the intervention resulted in a net savings of $688,843 (CAD).

Cheng *et al*.[9] conducted a before-after study involving 595 patients admitted to a psychiatric unit. For approximately one year, staff dispensed alcohol-based hand rub (ABHR) to all patients every 4 hours during daytime hours and supervised hand rubbing. In the year prior to the intervention, there were 6 outbreaks affecting 66 patients (18.2% of the population at risk). The outbreaks during this period were caused by confirmed or suspected respiratory viruses in 4 cases, group A *Streptococcus*, and scabies. During the intervention period, there were 4 outbreaks affecting 23 patients (4.4% of the population at risk; p=0.005). Only one outbreak was due to a respiratory virus and the others were confirmed or suspected to be norovirus. The authors noted that there was a large community outbreak of norovirus at the time, and furthermore norovirus may be less susceptible to ABHR.

Thu *et al*.[10] conducted a controlled before-after study on two neurosurgical units in Vietnam. Surgical site infection (SSI) rates were assessed over a one-month baseline period in all admitted patients who had undergone a procedure. During the subsequent 12-month period on the intervention unit, educational brochures about hand hygiene were given to patients and bedside hand sanitizer dispensers were installed for use by patients, visitors, and HCWs. A co-intervention also occurred in which HCWs were given brochures, education sessions, portable hand sanitizer dispensers, and reminder posters at the nursing station. SSI rates were measured again for a one-month period following the intervention period.

At baseline, SSI rates were 8.3% on the intervention unit and 7.2% on the control unit (p=0.7). Following the intervention, SSI rates were 3.8% on the intervention unit and 9.2% on the control unit (p=0.04). The overall 54% decrease in SSIs on the intervention unit was not statistically significant (p=0.09), but there was a 100% decrease in superficial SSIs (p=0.007) and no significant change in organ/space infections (predominantly meningitis).

Hilburn *et al*.[11] implemented a multifaceted intervention targeted at both patient and HCW hand hygiene in a before-after study design on an orthopedic surgical unit. Patients received an educational brochure on the importance of hand hygiene and teachable patients were provided with bedside ABHR. A co-intervention with HCWs included educational sessions, portable ABHR, posters, and monthly feedback on infection rates provided to HCWs and the nurse manager.

The average nosocomial infection rate in the six months prior to the intervention was 8.2%, and this decreased to 5.3% during the 10-month intervention period. Statistical significance was not reported. Most of the decrease (>80%) was accounted for by urinary tract infections, but reductions in *C. difficile* infection, respiratory infection, and bacteremia were also seen. The average cost savings during the intervention was estimated to be $91,258 (USD).

Peters *et al*.[12] used a before-after design with repeated treatment on a maternity ward of an acute care teaching hospital in Germany. Following a 10-month baseline period, postpartum women were provided with hand disinfectant at the bedside for 10 months, after which the disinfectant was removed for 2 months and then reinstated for an additional 2 months. During the 12 months without bedside disinfectant, the incidence of mastitis was 2.9%, compared to 0.66% when bedside disinfectant was provided ($p<0.001$).

Studies Reporting Patient Hand Hygiene Rates

Ardizzone *et al*.[13] conducted a before-after study on 3 surgical units at an academic medical center in the United States. HCWs were provided with education and then audited to assess whether they assisted patients with hand hygiene at 6 moments, including before eating, after toileting, before visitor contact, and after contact with a contaminated object or their own

secretions. Based on observation of approximately 80 patients during the 6 weeks before and 6 weeks after implementation, the overall proportion of HCWs assisting with hand hygiene increased from 17.3% to 44.6% ($p = 0.0003$).

Hedin *et al*.[11] studied 109 patients at a rehabilitation clinic using a before-after design. Patients received education and ABHR was provided in their bathrooms; HCWs gave out alcohol wipes at mealtimes and were encouraged to remind and assist patients with hand hygiene. Hand hygiene rates were assessed by patient self-report and increased from "seldom" before the intervention to 85% before meals and 49% after toilet use. Statistical significance was not reported.

Lary *et al*.[14] implemented a cluster randomized controlled trial at a children's hospital in the United Kingdom. Six wards were randomized to one of two interventions or control. One intervention involved interactive educational activities using "Glo-Yo," a UV lotion that had to be cleaned off the hands. The other intervention was described as "mobile learning technology," but no further information was provided. Hand hygiene compliance was measured by direct observation based on the WHO 5 moments. Overall hand hygiene compliance increased by 31.7% in the intervention groups, compared to a 13.8% increase in the control wards ($p < 0.001$).

Whiller *et al*.[15] carried out a before-after study of 40 inpatient with mobility difficulties. Hand wipe containers and signs reminding nurses to assist patients with hand hygiene were attached to commodes. A survey of patients found that 100% were offered wipes at least some of the time after using the commode compared to 69% before the intervention, and the proportion of patients offered wipes all of the time increased from 50% to 85%. Statistical significance was not reported.

Risk of Bias

All included studies are at moderate to high risk of bias (Tables II, III). Eight studies were uncontrolled before-after designs and thus at high risk of bias. Only Peters *et al*.[12] used a repeated treatment design in an attempt to reduce the potential for bias. Although many studies took seasonal variation in infection rates into account by assessing a full year before and after the intervention, other factors potentially could have contributed to the reported decreases in infections. For example, the authors generally do not comment on whether there were any changes in surveillance, infection definitions, or other preventive measures occurring simultaneously. Regression to the mean may also be a factor as an outbreak or high HAI rates are often the trigger for implementing an intervention. Furthermore, no studies state whether the outcome assessors were blinded, which could be another source of bias due to the subjectivity in distinguishing infection from colonization in some cases.

The study by Thu *et al*.[10] is at moderate risk of bias as it used a control group that had similar baseline characteristics and outcome measurements. However it is not possible to separate the effect of the patient hand hygiene intervention from the co-intervention with HCWs. The study by Lary *et al*.[14] is also at moderate risk of bias. Although the cluster randomized design was strong, minimal information was provided with respect to allocation procedures, baseline characteristics of participants, and potential for contamination.

Discussion

The role of patient hand hygiene in preventing transmission of HAIs is often overlooked but may represent a promising target for improvement. This systematic review identified ten

studies of patient hand hygiene interventions; six resulted in decreases in HAIs/AROs, and four reported improvements in patient hand hygiene rates.

The components of the interventions were similar to the WHO multimodal approach for improving HCW hand hygiene compliance, including education, reminders, audit and feedback, and provision of hand hygiene products.[1] Most studies implemented interventions that included multiple components. Hand sanitizer was provided in eight of the studies, and this is likely to be a key element of patient hand hygiene interventions. Lack of access is known to be a significant barrier to hand hygiene among HCWs,[1] and the same likely applies to patients. Hospital inpatients are often immobile or otherwise unable to easily access sinks or wall-mounted ABHR dispensers. Providing hand sanitizer on bedside tables, with meal trays, or with commodes is likely to result in a significant increase in patient hand hygiene. Education was the second most commonly used component, in seven interventions. Although education is important to address gaps in knowledge around hand hygiene, education alone is rarely sufficient to bring about lasting behaviour change.[16] Only four studies used additional elements beyond product provision and education. Due to limitations in the study designs, it is impossible to determine the relative importance of each component.

Studies also varied in terms of whether the interventions were implemented directly with patients, with HCWs who would then facilitate patient hand hygiene, or with both patients and HCWs. The relative efficacy of each approach is likely to depend on the patient population and the healthcare setting. Targeting patients directly may enhance buy-in and lead to more sustainable behaviour change, but this may not be possible if patients have cognitive or physical barriers to performing hand hygiene. If HCWs are involved in facilitating patient hand hygiene, there may be an added benefit of improved HCW hand hygiene compliance. HCWs who

emphasize the importance of hand hygiene to patients but are not compliant themselves would experience cognitive dissonance and thus may change their behaviour to reduce that discomfort.[17]

Although interventions to improve patient hand hygiene may reduce HAIs and improve compliance, the overall quality of evidence is low. Almost all of the included studies used uncontrolled before-after designs. The choice of primary outcome was also suboptimal in many cases. For example, Hilburn *et al*. used a composite HAI outcome and found that the vast majority of the decrease in HAI rate following the intervention was attributable to urinary tract infections.[18] Hand hygiene would not be expected to have such a significant impact on urinary tract infections as they are typically caused by endogenous bacteria in the setting of catheter use, so factors other than the patient hand hygiene intervention may have been responsible for the overall decrease in HAIs. Additionally, the outcomes in studies reporting on hand hygiene rates were not ideal. Hedin *et al*.[11] and Whiller *et al.*[15] used self-reported hand hygiene as the primary outcome, and self-report has been shown to correlate only weakly with observed hand hygiene.[19]

Future studies of patient hand hygiene interventions should use stronger study designs, preferably randomized controlled trials or interrupted time series. When this is not possible, before-after studies should at least include methods to reduce the risk of bias, such as the use of a control group or a repeated measures design. HAI outcomes should be included where possible, but the infections chosen should be those with a strong theoretical basis for prevention through hand hygiene, such as those transmitted by the fecal-oral and contact routes. If hand hygiene compliance is included as an outcome, it should be measured by direct observation as this is the current "gold standard" and will allow for comparison across studies. Hand hygiene monitoring

technology may be an alternative approach but there are issues of validity and comparability between different systems.[20]

To our knowledge, this is the first systematic review of patient hand hygiene interventions. The inclusion criteria allowed for a range of study designs, conference abstracts, and grey literature in order to review the broadest possible selection of patient hand hygiene interventions. However there are several limitations. First, although studies published in languages other than English were included if they had an abstract in English, the databases searched were primarily English language and may have missed studies. Second, abstracts presented at conferences other than those of the major infection prevention and control organizations may have been missed. Finally, there is potential for publication bias in this area as no negative studies were reported. Although we did not find any missing studies in trial registries, quasi-experimental studies would not necessarily be registered in advance.

In conclusion, interventions to improve patient hand hygiene may reduce the incidence of HAIs and improve compliance, but the quality of evidence is low. Future studies should use stronger designs and be more selective in their choice of outcomes. Patient hand hygiene may be as important as HCW hand hygiene in preventing transmission of microorganisms and is an area worthy of further study as healthcare organizations continue to struggle to reduce HAI incidence.

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Table I: Characteristics of Included Studies

Author (Year)	Study Design	Study Setting	Participating Patients	Recipients of Intervention	Elements of Intervention	Results: Healthcare Associated Infections	Results: Hand Hygiene Rates
Pokrywka (2014)	Before-after	520-bed tertiary care and teaching hospital	All inpatients	Both	Education, reminders, provision of product	CDI rate 10.45/ 10,000 patient days before to 6.95/ 10,000 patient days after; p=0.0009	N/A
Gagne (2010)	Before-after	250-bed community hospital	All inpatients	Patients	Education, provision of product	MRSA 10.6/ 1,000 admissions before to 5.2/1,000 admissions after	N/A
Cheng (2007)	Before-after	Inpatient psychiatric department	Long-stay psychiatric patients	HCWs	Provision of product	6 outbreaks affecting 66 patients (18.2%) before; 4 outbreaks affecting 23 patients (4.4%) after; p=0.005 for total patients involved	N/A
Thu (2007)	Controlled before-after	2 neurosurgical wards	Inpatients who had undergone a neurosurgical procedure	Patients	Education, provision of product	SSI decreased from 8.3% to 3.8% on intervention unit and increased	N/A

						from 7.2% to 9.2% on control unit; p=0.04 for comparison between units	
Hilburn (2003)	Before-after	Orthopedic surgical unit	N/S	Patients	Education, reminders, provision of product	Nosocomial infection rate 8.2% before to 5.3% after	N/A
Peters (1992)	Before-after with repeated treatment	Maternity ward	Postpartum women	Patients	Provision of product	Puerperal mastitis 2.90% before to 0.66% after; p<0.001	N/A
Ardizzone (2013)	Before-after	3 surgical inpatient wards	Inpatients > 18 years old, dependent on nursing staff	HCWs	Education, audit/ feedback	N/A	14/81 (17.3%) before to 37/83 (44.6%) after; p=0.0003
Lary (2013)	Cluster RCT	6 wards at a pediatric hospital	Children	Patients	Education	N/A	Increased by 31.7% among intervention patients compared to 13.8% in control group; p<0.001
Hedin (2012)	Before-after	Rehabilitation centre with 3 units	Rehabilitation inpatients	Both	Education, provision of product	N/A	“Seldom” before to 85% before meals and 49% after toilet use
Whiller (2000)	Before-after	N/S	Inpatients with mobility difficulties	HCWs	Reminders, provision of product	N/A	69% of patients offered hand hygiene facilities some of the time before

							intervention to 100% after

CDI: *Clostridium difficile* infection; MRSA: methicillin resistant *Staphylococcus aureus*; N/A: not applicable; N/S: not specified; SSI: surgical site infection

Table II: Cochrane EPOC Risk of Bias Assessment Tool – Studies with a Separate Control Group

Criteria	Lary (2013)	Thu (2007)
Random sequence generation	Unclear	High
Allocation concealment	Unclear	High
Baseline outcome measurements	Low	Low
Baseline characteristics	High	High
Incomplete outcome data	Unclear	Unclear
Knowledge of allocated interventions	Unclear	Unclear
Contamination	Unclear	Unclear
Selective outcome reporting	High	Low
Other risk of bias	Low	Low

Table III: Risk of Bias – Quasi-experimental Studies

Criteria	**Ardizzone (2013)**	**Cheng (2007)**	**Pokrywka (2014)**	**Gagne (2010)**	**Hedin (2012)**	**Hilburn (2003)**	**Peters (1992)**	**Whiller (2000)**
Did the study attempt to avoid bias and control for confounding?	High	High	High	High	High	High	Low	High
Was the study successful at avoiding bias and controlling for confounding?	High	High	High	High	High	High	Low	High
Did the study include an appropriate control or comparison group?	High	High	High	High	High	High	High	High
Were the operational definitions or description of the interventions clear?	Low	Low	High	Low	Low	Low	Low	Low
Was the statistical analysis adequate?	Low	Low	Low	High	Low	High	Low	High
Was adherence to the intervention monitored?	High	High	High	High	High	High	High	Low
Justification of the use of a quasi-experimental design	High	High	High	High	High	High	High	High
Use of correct nomenclature to describe the quasi-	Low	High	High	High	High	High	High	High

experimental design								
Recognition of possible limitations of the quasi-experimental design	Low	Low	High	Low	High	High	High	High

Figure 1: Overview of Study Selection

Appendix A: MEDLINE Search Strategy

1	exp Patients/
2	Patient Compliance/
3	Patient Education as Topic/
4	Patient Participation/
5	Infectious Disease Transmission, Patient-to-Professional/
6	Patient-Centered Care/
7	Consumer Health Information/
8	1 or 2 or 3 or 4 or 5 or 6 or 7
9	Hand Hygiene/
10	Hand Disinfection/
11	Hand/ and Disinfection/
12	9 or 10 or 11
13	8 and 12
14	((patient$ or inpatient$ or outpatient$ or hospitali?ed$ or institutionali?ed or (hospital room$ adj2 (occupant$ or occupi$)) or consumer$) adj15 (handwash$ or hand-wash$ or (hand adj2 (disinfect$ or wash$ or sanitis$ or sanitiz$ or antiseptic$ or contaminat$ or decontaminat$)) or (alcohol$ adj2 hand saniti?er$) or (alcohol$ adj2 hand rub$))).mp.
15	13 or 14
16	exp Handwashing/
17	exp Patients/
18	Patient Education as Topic/
19	Patient Compliance/
20	17 or 18 or 19
21	16 and 20
22	((patient* or inpatient* or resident*) adj3 ("hand hygiene" or handwashing or "hand washing")).tw.
23	21 and 22
24	((patient or inpatient or resident) adj ("hand hygiene" or handwashing or "hand washing")).tw.
25	23 or 24
26	15 not 25