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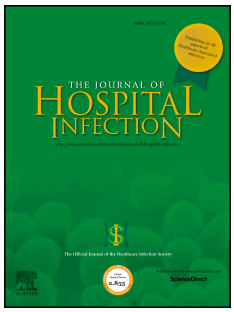

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Strategies to improve hand hygiene compliance among health care workers in adult intensive care units: a mini systematic review

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SUMMARY

Background: Hand hygiene (HH) compliance among health care workers (HCWs) in intensive care units (ICUs) is disconcertingly low.

***Aim*:** This mini systematic review aims to identify the effective intervention(s) for increasing HH compliance among HCWs in adult ICUs.

***Methods*:** Two major electronic databases, OVID Medline and CINAHL, were searched by using a combination of MeSH terms and text words (e.g. hand hygiene, hand washing, compliance, adher*, improve*, develop* and intensive care unit) for relevant articles. This was supplemented by Google Scholar and hand searching of included bibliographies. Data from identified articles were then abstracted, quality assessed and combined into a summary effect.

***Results*:** Of 89 titles and abstracts that were identified, 14 articles were finally included. Overall study quality was good. However, variations in design, setting, sample size and intervention(s) tested precluded a meta-analysis; hence a narrative synthesis was conducted. The interventions included education, observation, provision of supplies, improving access and directive support; tested singly or in combination; resulted in positive outcomes in all but one study. A combination of administrative support, 'supplies', education and training, reminders, surveillance, and performance feedback raised the compliance from a baseline of 51.5% to a record 80.1%; but no set of intervention(s) could improve the compliance to a desired near 100% level.

***Conclusion*:** Available data suggest that multimodal interventions are effective in raising the compliance to a 'plateau' level but not up to the mark. Methodologically appropriate trials of combined interventions could enhance the evidence about interventions to improve HH compliance among ICU staff.

Keywords: Effectiveness, hand hygiene compliance, health care worker, intensive care unit, intervention.

Introduction

The hands of healthcare workers (HCWs) are potential vectors for transmitting pathogens between patients. Hand hygiene (HH) programmes have been shown to achieve a high standard of care for the patients and reduce healthcare-associated infections (HAIs) by about one infection per 1000 patient days [1,2]. The pooled prevalence of HAI in Southeast Asia is about 9%, in Africa it ranges between 2.5% and 14.8% [3,4], whilst the prevalence in mixed patient populations in high-income countries is 7.6% [5]. The incidence of HAI is particularly high amongst patients admitted in intensive care units (ICUs). However, the frequency of patient contact in these settings may be too high to achieve full HH compliance among HCWs [6,7]. The invasive devices frequently used for ICU patients act as portals of entry for virulent microbes leading to an increased rate of HAIs [8]. Studies indicate that in developed countries, approximately 30% patients admitted to ICU will have at least one episode of HAI [5], whilst in developing countries the rate is 3 to 5 fold higher [9].

Numerous studies have demonstrated that proper compliance with HH can reduce the transmission of HAIs, associated morbidity and mortality, length of hospitalisation, healthcare cost, and promotes the health and safety of patients [10-12]. In response, international public health agencies, including the World Health Organization (WHO), have recommended enforced HH practice for HCWs [13,14]. Nevertheless, compliance currently remains low, and at times very low, even in ICU settings [11].

A number of systematic reviews have addressed HH compliance among HCWs [15-17]. However, a recent review focused on interventions to improve HH compliance amongst ICU staff is lacking . To this end, we have conducted a mini-systematic review to identify effective interventions to improve HH compliance among HCWs in adult ICUs.

Method

Search Strategy

OVID Medline and CINAHL were searched from the time of database inception to April 2017. This was supplemented using Google Scholar and manual search of the bibliographies from identified articles.

A preliminary search was undertaken to identify key terms to frame the advanced search of the aforementioned databases. The key terms were: hand hygiene, hand washing, hand rub, hand clean, hand disinfectant, compliance, adhere, improve, develop, enhance, critical care and intensive care unit. MeSH terms, synonyms from the database thesaurus and free text terms representing HH and ICU using Boolean operators were then incorporated.

Selection criteria

The inclusion criteria for this review were based on the PICO (participant, intervention, comparator and outcome) model [18]. Participants were any HCW working in adult ICUs, interventions were any action(s) implemented for the purposes of promoting HH compliance, comparators were data collected at baseline prior to interventions, and outcomes were any increase, decrease, or 'no change' in compliance with HH practised (in accordance with the WHO guidelines called 'the five moments for hand hygiene') [19]. Only primary research studies published in English were included.

The search result is summarised in the preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram (Figure 1).

Quality appraisal

Randomised controlled trials (RCTs) and prospective controlled cross-over trials were assessed using the critical appraisal skills program (CASP, available from http://www.casp-uk.net/casp-tools-checklists). Descriptive studies (seven of which were designed as before-and-after and four as observational) were evaluated using tools provided by the National Institution of Health (NIH), available from https://www.nhlbi.nih.gov/health-pro/guidelines/in-develop/cardiovascular-risk-reduction/tools/before-after and https://www.nhlbi.nih.gov/health-pro/guidelines/in-develop/cardiovascular-risk-reduction/tools/cohort).

Results

From the 89 titles and abstracts that were identified, 33 full texts were reviewed for eligibility, of which 14 were finally included (Figure 1). The included studies were published between 2000 and 2015, ten of which were published in 2010 or later (Table I). The study duration ranged from as short as eight weeks, in a before and after study [8], to as long as 2 years in a RCT [20]. Six studies were conducted in developed world settings: three in the USA [20-22], and one each in France [23], Germany [24] and the Netherlands [25]. Eight studies were conducted in developing countries: three in Saudi Arabia [8,26,27], two in India [28,29], two in Argentina [30,31] and one in China [32].

The study designs were disparate (Table I), ranging from 'before and after' designs, prospective controlled cross-over trials, slight variations to the 'before and after' design (whereby the phases were continuous or only had an 'after' phase without a baseline phase) to a cluster-RCT (Table I). Within each study, the implemented approach or duration also varied. For instance Maury *et al*. conducted their study for two consecutive five week periods [23], whereas Mazi *et al.*

conducted their study over four phases, each lasting two weeks [8]; and Su *et al*. conducted their study in two phases, each lasting three months [32].

Overall five studies claimed that the interventions were based upon the standardised WHO strategy 'five moments for hand hygiene'[8,24,26,27,31]; the remaining studies used approached that resembled the 'five moments' strategy, but did not explicitly refer to the WHO strategy.

All the studies focused on adult ICUs, three with minor deviations: two included adult and paediatric/neonatal ICUs [27,29], and one was conducted in two different departments- ICU and surgical ward [25]; only the results from the adult ICUs were extrapolated and synthesised.

Eleven studies were conducted in tertiary hospitals, one in a general hospital, and the remaining two did not specify their settings (Table I).

With the exception of two studies which focused solely on nurses [21,25], the studies addressed all HCWs active in the ICUs. Three studies indicated the number of participants involved [23,25,31], whereas the remaining studies did not, opting to compute the opportunities of hand hygiene activity instead. Collectively, the number of observed opportunities ranged between a minimum of 141 in one hospital [25], to a maximum of 10429 conducted in 11 hospitals [32].

Because of these clinical heterogeneities a meta-analysis was considered to be inappropriate and a narrative synthesis was done.

Effect of interventions

With the exception of Biswal et al. [29], the included studies implemented more than one intervention, with education and observation being the commonest interventions (Table II).

Educational interventions: Education was a commonly used element; only one study [21] did not include this intervention. Education was delivered largely through lectures, reminders, and face to face teaching. One study used all three approaches [20], seven employed two [23,26-

28,30-32] and the other five used only one approach [8,22,24,25,29]. Four studies indicated that expert infection control teams provided the lectures and training [27-30], whereas the others did not specify. Seven studies utilised reminders in the form of wall posters, hand-outs, HH technique instructions, and signs [20,23,26,29-32]. Three studies used face to face education, frequently in the form of interviews [20,23,25]. All studies that used education as an intervention reported improvement in staff HH compliance. However, in one study the improvement was marginal.

Observational interventions: Various observation techniques were used in 11 of 14 studies, all of which showed a significant improvement in HH compliance. Technology via monitoring systems was used in two studies [22,24] and direct observation in the remaining nine; trained infection control staff were specified as the observers in only 1 of these 9 studies [8].
In two studies the observations were conducted during both day and night shifts [23,32], in another two during day time only [8,25], and in the remaining studies the time of observation was not reported. In four studies, it was reported that the HCWs were made aware that observations were being undertaken [8,20,23,28]. Two studies used a surveillance format of observation [31,32]: one was based on the US National Healthcare Safety Network methodology [32], and the other on measuring the materials implemented for HH [31]. Koff and colleagues' observations incorporated technology in the form of alcohol based hand rub (ABHR) dispensers worn by the HCWs, which concurrently recorded a time stamp [22] while Scheithauer and colleagues' observations included standalone signal coloured devices [24].Eight studies used direct performance feedback (Table I), with one also incorporating e-mail feedback [26]. Only one study [21] reported that observational interventions were ineffective.

Improving access and 'Supplies': The provision of hand wash basins, ABHRs and/or soaps, and towels was utilised in seven studies [20,23,27,28,30-32] (Table II). One study [32] ensured the accessibility of all three types of 'supplies' whilst in the other six, only one type of supply was used [20,23,27,28,30,31].

Among 3678 HH opportunities, Rupp *et al*. found that the compliance rate improved from about 37% to 69% ($P<0.01$) [20]. Similar findings were found in another study involving 1526 opportunities, compliance rate reported to increase from 42.4% to 60.9% ($P<0.01$) following the introduction of ABHRs [23]. Using a different approach, Bittner *et al*. focused solely on soap and paper towel consumption with continuous feedback [21]. Their study showed that post-intervention, hand washing frequency declined in medical intensive care units (MICUs) from a baseline of 2.58 (mean) to 1.74 (mean).

Management support: Management support included involving executive staff in the promotion of HH compliance among HCWs. This was explored in four studies, all of which reported significant improvement in HH compliance (Table II) [26,27,31,32].

Data from a RCT: By conducting a cluster-stepped RCT, Rodriguez *et al*. demonstrated that by using a set of interventions containing elements of leadership commitment, surveillance of material consumption, reminders, posters, a storyboard of the project and feedback, HH compliance among 705 participants could be raised from 63.8% to 75.2% ($P<0.01$) [31].

Quality appraisal

Although most of the included studies were observational, their quality was generally good. Two out of the three controlled studies were rated good [20,31], and one rated fair [21]. Seven of the

descriptive studies were rated good [22,24,25,27,29,30,32], while the other four rated fair [8,23,26,28]. No study was rated 'poor' signifying very low risk of bias in included studies.

Discussion

This review suggests that the use of a multi-pronged strategy is effective in increasing HH compliance among HCWs in ICUs. A combination of management support, ensuring access to 'supplies', education, observation and training, workplace reminders, surveillance, and performance feedback could potentially raise the compliance by about 30% (from 51.5% to 80.1%) [32]. In one study that did not include management support an even higher absolute increase in compliance (41%) was achieved, but only to a maximum compliance rate of 65% [30]. Despite the success of interventions no set of intervention(s) could improve compliance to a desired near 100% level, suggesting the possibility of existence of a 'plateauing' effect. Overall, the studies that incorporated education as an intervention demonstrated significant improvement, however, the magnitude of HH compliance achieved varied widely ranging from 25% to 86% [25,27]. This variation may stem from factors such as existing practice and policies in the trial settings, HCWs' background knowledge and understanding of the importance of HH compliance, and HCWs' willingness to learn and accept change, local customs and culture. Of course the educational approaches used may also have been important. Adopting a proper education campaign through customised lectures, posters, face-to-face learning or a combination of these can increase the effectiveness of the intervention [33]. Moreover, optimum use of learning strategies, such as the adult learning model, was essential to deliver the message effectively [34]. Delivery of these materials through experts in the field, such as infection control staff or "champions" [29,35], group discussion, by encouraging active participation and addressing current and emerging issues, was also deemed an advantageous approach [36].

Despite this, educational effects were often reported as transient and should thus be continued through regular refresher courses, preferably six-monthly, to maximise sustained benefits [37]. Studies in this review have shown that judiciously employed observational methods could enhance HCWs' HH compliance but effective only when incorporated in a multimodal program [8]. Direct observation was the most commonly used method [38], but the provision of immediate feedback was also effective. The use of technology also enhanced HH compliance and has the advantage of providing continuous monitoring and direct feedback, reducing gaps in routine audits, and accessing locations where direct observation is unfeasible such as in operation theatres or behind curtains [37]. Limitations of these systems may include malfunction, failure of the devices to observe all the 'five moments of HH' or monitor proper technique, their inability to distinguish the type of HCW (nurse or physician), and ability to distract the staff, potentially compromising the quality of HH due to the noise [37]. Finally, the issues around cost and the need to train infection control personnel for performing observation can be prohibitive for many hospitals.

As anticipated, observing HCWs can naturally introduce the Hawthorne effect. This phenomenon has been commonly cited as a potential and actual confounder, and is particularly relevant when participants are acutely aware of being monitored [21,22,30]. Therefore, whilst observation may elicit some promising results, in practice once observation ceases, the effects dissipate somewhat [39]. Incidentally, over half of the improvements in HH have been attributed to the Hawthorne effect [39]. Furthermore, not all staff may be open to being monitored and assessed whilst practicing difficult and life-threatening medical procedures that require urgent attention, at times without scrupulous HH.

Compliance with HH also requires ensuring adequate supplies and access to proper facilities and products but supplies alone cannot improve compliance [40]. Easy access to proper water, soap

and towel is crucial in improving compliance with HH [23]. Products, particularly ABHRs that are of poor quality, increase the risk of skin irritation, allergy and peeling on prolonged use [41]. Thus, essential 'supplies' of standard quality should be ensured to maintain an optimum compliance.

In 2009 the WHO recommended involving executive leaders to promote HH compliance as a critical component of daily practice [5]. Among the selected studies, only three used this method as an intervention [26,27,42]. Whilst the outcome of these studies are promising, the level of improvement was inconsistent, which may be more an indication of a variable level of administrative support than the intervention itself.

The complex nature of HH practices often failed to distinguish a universally applicable formulation of interventions to improve it. Lack of time to practice proper HH, especially during busier periods and heavier workloads, inversely correlated with undertaking HH [16,24,26,43]. Further reasons may include issues of understaffing and perceived, or actual, under-funding [16,21,44]. Studies also denoted poor compliance to "gaps in knowledge", however even with appropriate education, lack of time appeared to be the most crucial barrier [29,44,45]. This can be explained by the theory of planned behaviour, whereby because of circumstantial limitations, behavioural intention does not necessarily translate into action [46-49]. Interestingly, female staff were generally characterised as complying more readily than males, and nurses more than other HCWs [8,20,27,30,32]. Only one study contradicted these findings, stating that the frequencies of hand washing were similar for all HCWs [23].

Encouragingly, the majority of these studies were published between 2010 and 2015, indicating renewed interest in this area potentially stemming from a raised awareness among the healthcare industry regarding the significance of HH compliance.

There are several important limitations to this review that are mainly down to the heterogeneity of the studies reviewed. It is also unclear, even from the longer duration studies, whether any interventions are more likely to deliver sustainable improvement. In theory at least new technologies, such as electronic devices, that monitor room entry and exit and soap use by HCWs [50] might have more potential to deliver sustained improvement, but this has not been demonstrated. Sample sizes were also inconsistent across the studies. The majority did not provide any information on sample size, whilst one study included only 17 participants [25]. The majority of studies were conducted in tertiary hospitals, and the findings may not be generalizable to other health care settings. Any review of HH performance is constrained by the fact that, whilst 100% should be the ideal target [51], we do not know at what level of compliance benefits are seen. This is especially important in critical care settings where both the incidence of, and risks from, HAIs are high [5-9], and the reality of attaining 100% HH compliance remains elusive. Finally, most studies focus on the frequency of HH; further work is required to address the quality of HH [51].

Conclusion

In conclusion, the available data are inadequate to support or refute a single or a set of interventions in improving the compliance to near 100%. A multimodal approach, composed of education, observation, and improved access and supplies, proved to be more effective than any single intervention alone. Further controlled studies are necessary to investigate the true effects and sustainability of multimodal interventions. Exploring alternative modes of action, such as the role of hospital policy and engaging patients in the interventions would also be beneficial.

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Table I

Summary of interventions targeting HH compliance in ICU settings

Study year [ref]	Setting	Number of opportunities	Study design	Interventions tested
Assessment tool: By observation including the use of computerised devices				
2010-2011 [8]	MICU, NICU, Kidney centre and Burns Unit; Tertiary hospital, Taif, Saudi Arabia	Phase 1- 409 Phase 2- 406 Phase 3- 620 Phase 4- 540	Before and After	Educational lectures, observations
1998 [21]	MICU and SICU; Tertiary hospital, Omaha, USA	N/A	Prospective controlled cross-over trial	Feedback, supplies- hand washing
2006-2008 [22]	MICU and SICU; Tertiary hospital	NA	Before and After	Educational lectures, observations
2012 [24]	MICU; University Hospital, Aachen, Germany	40827	Before and After	Observations (plus educational lectures*)
2008 [25]	ICU and a Surgical Ward; Tertiary teaching hospital; University Hospital in	283 (141 in ICU, 142 in Surgical Ward)	Before and After	Educational interviews, observations

	Rotterdam, The Netherlands			
2011-2013 [27]	MICU, CCU, PICU and NICU, Tertiary hospital, Abha, Saudi Arabia	Before-1182 After-2212	Before and After	Educational lectures & reminders, feedback, directive support and supplies including hand washing and ABHRs
2011-2012 [29]	MICU, PICU, NICU, CCU, Transplant ICU, various SICUs, Tertiary hospital, Chandigarh, India	822	Observational	Educational intervention (via lectures, reminders, and workshops)
2000-2002 [30]	MICU, SICU and CCU; Tertiary hospital, Buenos Aires, Argentina	4347	Observational	Educational lectures & reminders, observations and directive support
Assessment tools: By observation and questionnaire/surveillance form				
1998 [23]	MICU; Tertiary hospital, Paris, France	Before- 621 After- 905	Before and After	Educational reminders, interviews, supplies- hand washing and ABHRs
2011-2012 [26]	MICU; Tertiary hospital, Riyadh, Saudi Arabia	836	Observational	Educational lectures & reminders, observations, directive support
2009-2010 [28]	MICU, Tertiary hospital, India	Before-1001 After-1026	Before and After	Educational lectures, reminders, observations, supplies-ABHRs
2009-2010 [32]	Five ICUs members of the INICC; Tertiary hospital,	2079	Before and After	Educational lectures & reminders, observations,

	Three hospitals in three cities in China			surveillance, feedback, supplies- hand washing & ABHRs, directive support
Assessment tools: By observation, questionnaire and meeting/interview				
2001-2003 [20]	MICU and SICU; Tertiary hospital. Omaha, USA	3678	Prospective controlled cross-over trial	Educational interviews, lectures, reminders, supplies- ABHRs
2011-2012 [31]	11 ICUs from 11 hospitals; Tertiary hospital, Buenos Aires	10429	A stepped wedge RCT	Educational lectures & reminders, observations, surveillance, feedback, supplies- ABHRs, directive support

ABHR, alcohol based hand rub; CCU, Cardiac Care Unit; HH, hand hygiene; INICC, International Nosocomial Infection Control Consortium; MICU, Medical Intensive Care Unit; NICU, Neonatal Intensive Care Unit; PICU, Paediatric Intensive Care Unit; SICU, Surgical Intensive Care Unit.

*Education to the HCW was provided independent to the intervention a few years prior to the study.

Table II

Description of intervention combinations and their effects

Number of interventions	**Intervention types**	**Number of studies**	**Reported effects[ref]**	***P*-value**
One	Education	1	23.1- 41.2% [29]	<0.01
Two	Education, Observation	3	39-81% [8] 9.3-25.4% [25] 6% ↑ [24]	<0.05 <0.01 NA
	Education, Supplies	1	37-68% [20]	<0.01
	Feedback, Supplies	1	MICU- M 2.58-1.74; 33%↓[21] SICU- M 2.68-1.96 28%↓[21]	NA
Three	Education, Observation, Supplies	2	42.4-60.9% [23] 26-57.36% [28]	<0.01 <0.01
	Education, Observation, Directive	2	23.1-64.5% [30] 64-80% [26]	<0.01 <0.01
	Education, Observation, Feedback	1	53-75% [22]	<0.05
>Three	Education, Observation, Supplies, Directive	3	51.5-80.1% [32] 63.8-75.2% [31] 60.8-86.4% [27]	<0.01 <0.01 <0.01

NA, not available.

Figure 1. PRISMA flow chart summarising the search results