Interventions to improve hand hygiene compliance in patient care (Review)

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[Intervention Review]

Interventions to improve hand hygiene compliance in patient care

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ABSTRACT

Background

Health care-associated infection is a major cause of morbidity and mortality. Hand hygiene is regarded as an effective preventive measure.

Objectives

To assess the short and longer-term success of strategies to improve hand hygiene compliance and to determine whether a sustained increase in hand hygiene compliance can reduce rates of health care-associated infection.

Search strategy

We conducted electronic searches of: the Cochrane Central Register of Controlled Trials; the Cochrane Effective Practice and Organisation of Care Group specialised register of trials; MEDLINE; PubMed; EMBASE; CINAHL; and the BNI. All databases were searched to July 2006; MEDLINE was searched from 1980, CINAHL from its inception, and the remainder from 1990 until July 2006.

Selection criteria

Randomised controlled trials; controlled clinical trials; controlled before and after studies; and interrupted time series analyses meeting explicit entry and quality criteria used by the Cochrane Effective Practice and Organisation of Care Group. Studies reporting proxy indicators of hand hygiene compliance were considered. Studies to promote compliance with universal precautions were included providing data relating specifically to hand hygiene were presented separately.

Data collection and analysis

Two reviewers independently extracted data and assessed data quality.

Main results

Two studies met the criteria for review. One was a randomised controlled trial. The other was a controlled before and after study. Both were poorly controlled. Statistically significant post-intervention increase in hand washing was reported in one study up to four months after the intervention. In the other there was no post-intervention increase in hand hygiene compliance.

Authors' conclusions

There is little robust evidence to inform the choice of interventions to improve hand hygiene. It appears that single interventions based on short, 'one off' teaching sessions are unlikely to be successful, even short-term. There is a need to undertake methodologically robust research to explore the effectiveness of soundly designed interventions to increase hand hygiene compliance.

PLAIN LANGUAGE SUMMARY

Patients in hospital are at high risk of developing infections that they did not have before admission. Most health care-associated infection is spread by direct contact, especially via the hands of health workers. Traditionally hand hygiene, such as washing hands before and after seeing patients, has been considered the single most important way of reducing such infections. But compliance with hand hygiene protocols in health workers is poor.

This review sought to establish whether there are effective strategies to improve hand hygiene compliance, whether such strategies are effective over short or longer term, and whether increased compliance reduces health care-associated infections.

There were two studies that assessed the success of campaigns to improve hand hygiene compliance. Both were of low quality and looked at the effects of strategies over very short periods of time (less than six months).

There is not enough evidence to be certain about what strategies improve hand hygiene compliance. "One off" teaching sessions about hand hygiene may not improve hand hygiene, but again there is not enough evidence to be certain. More research is needed.

BACKGROUND

Ten per cent of inpatients in the United Kingdom (UK) develop health care-associated infection (HCAI). HCAI causes 5,000 deaths and costs £930 million annually (Ntl. Audit Off. 1998). In the United States (US), an estimated 5% of patients develop HCAI, at a cost of 4.5 billion USD per year. In Canada, an estimated 220,000 HCAIs occur each year, with 8,000 related deaths (Zoutman 2003). Infection control experts everywhere are working to identify and correct factors that contribute to these rates. Although hand hygiene has long been regarded as the most effective preventive measure (Teare 1999), numerous studies over the past few decades have demonstrated that compliance with hand hygiene recommendations is poor and interventions are not effective long term.

In 2001, Naikoba 2001 systematically reviewed 21 studies published before the year 2000. They classified 17 as uncontrolled trials, and of these, 15 took place in intensive care units (ICUs). Numerous different interventions and combinations of interventions to improve hand hygiene were examined. The reviewers concluded that multifaceted approaches promoted hand hygiene compliance more effectively than approaches involving a single type of intervention and that education with written information, reminders and continuous feedback on performance were more useful than the other interventions assessed, such as automated sinks or provision of moisturised soaps. These findings do not support the results of more recently published work which indicate that multifaceted interventions are not likely to be more successful than single interventions in changing practice (Grimshaw 2004) and that audit with feedback has only a modest effect on improving practice (Jamtvedt 2006). The authors noted multiple limitations of the studies, including small sample sizes, short duration of follow-up, lack of or inappropriate control groups, lack of generalisability from the ICU to other settings, and emphasis on frequency of hand hygiene as an outcome measure rather than microbiological data. One key limitation of the review was that it included studies that had weak designs for making causal inferences about the effects of interventions (mainly uncontrolled before and after studies). Another disadvantage is the failure of authors to consider variables that might influence rates of HCAI. Seasonal variations are particularly likely to influence outcome measures in studies that examine hand hygiene. For example, bacterial counts are affected by seasonal factors such as humidity. Hand hygiene compliance is likely to be influenced by factors such as staffing levels and replacement of the usual staff by agency nurses at times such as national holidays or in the event of staff sickness.

In the years since the systematic review by Naikoba 2001, the topic of hand hygiene has received increasing attention in the UK, Europe and North America. The public is alarmed by the high incidence of HCAI and health providers must now demonstrate the effectiveness of infection control policies. A Swiss initiative used an uncontrolled before and after design to demonstrate that a hospital-wide poster campaign combined with performance feedback and alcohol hand rub placed at every bedside led to sustained improvement in hand hygiene for nursing but not medical staff, as well as reduction in HCAI and methicillin-resistant Staphylococcus aureus (MRSA) transmission (Pittet 2000). Follow-up data

published independently revealed continuing success (Hugonnet 2002).

Given the renewed interest in improving hand hygiene as a preventive strategy, and the availability of more studies not previously included in a systematic review, a reappraisal of available evidence is warranted. The purpose of our review was to identify all studies investigating the effectiveness of interventions intended to increase hand hygiene compliance short and longer-term, and to determine the success of these interventions in terms of hand hygiene compliance and subsequent effect on rates of HCAI.

OBJECTIVES

1. To assess the short and long term success of strategies to improve hand hygiene compliance in patient care.

2. To determine whether a sustained increase in hand hygiene compliance can reduce rates of health care-associated infection.

METHODS

Criteria for considering studies for this review

Types of studies

We considered randomised controlled trials (RCTs), controlled clinical trials (CCTs), controlled before and after studies (CBAs) and interrupted time series analyses (ITSs) meeting explicit entry and quality criteria used by the Cochrane Effective Practice and Organisation of Care Group (EPOC). Studies reporting proxy indicators of hand hygiene compliance (for example increased use of soap or alcohol hand rub) were considered. To be eligible for review ITS studies had to include three data collection points before and after the intervention to take into account the influence of secular trends and the auto-correlation among measurements repeatedly taken over time (Ramsay 2003). CBA studies were only included if they had more than two sites (i.e., they were excluded if they only had one intervention and one control site).

Types of participants

We considered studies where the participants or target groups were nurses, doctors and other allied health professionals (except operating theatre staff) in any hospital or community setting, in any country. Studies concentrating on operating theatre staff were excluded because specific hand hygiene techniques are used in this setting.

Types of interventions

We considered any intervention intended to improve compliance with hand hygiene using aqueous solutions and/or alcohol based products, for example, education, audit with feedback, health promotion, and variations in availability and type of products used for hand hygiene. Studies to promote compliance with universal precautions were considered providing data relating specifically to hand hygiene were presented separately.

Types of outcome measures

Our primary outcome of interest was:

- Rates of hand hygiene compliance and/or a proxy indicator of hand washing compliance (e.g. increased use of hand washing products).

Studies were also considered if they provided data on our secondary outcomes of interest:

- Reduction in healthcare-associated infection.
- Reduction in colonisation rates by clinically significant nosocomial pathogens.

Search methods for identification of studies

The following electronic databases were searched up to July 2006:
a) The EPOC Register (and the database of studies awaiting assessment) (see SPECIALISED REGISTER under GROUP DETAILS);
b) The Cochrane Central Register of Controlled Trials (CENTRAL);
c) Bibliographic databases, including MEDLINE (1980-2006), EMBASE (1990-2006), CINAHL (1982-2006), and the British Nursing Index (1985-2006).
Other sources included:
d) Hand searching of those high-yield journals and conference proceedings which have not already been hand searched on behalf of the Cochrane Collaboration.
e) Reference lists of all papers and relevant reviews identified.
f) Authors of relevant papers were contacted regarding any further published or unpublished work.
g) Authors of other reviews in the field of effective professional practice were contacted regarding relevant studies of which they might be aware.
h) ISI Web of Science for papers which cite studies included in the review.
i) The Database of Abstracts of Reviews of Effectiveness (DARE) was searched for related reviews
Electronic databases were searched using a strategy developed incorporating the methodological component of the EPOC search strategy combined with selected MeSH terms and free text terms relating to hand hygiene. This search strategy was translated into the other databases using the appropriate controlled vocabulary as applicable. We did not use language restrictions.

We searched MEDLINE from 1980 to July 2006 using the following search strategy:
1. Handwashing/
2. (hand astisepsis or handwash$ or hand wash$ or hand disinfection or hand hygiene or surgical scrub$).tw.
3. 1 or 2
4. exp Hand/
5. exp Sterilization/
6. 4 and 5
7. 3 or 6
8. randomized controlled trial.pt.
9. controlled clinical trial.pt.
10. intervention studies/
11. experiment$.tw.
12. (time adj series).tw.
13. (pre test or pretest or (posttest or post test)).tw.
14. random allocation/
15. impact.tw.
16. intervention?.tw.
17. chang$.tw.
18. evaluation studies/
19. evaluat$.tw.
20. effect?.tw.
21. comparative studies/
22. animal/
23. human/
24. 22 not 23
25. or/8-21
26. 25 not 24
27. 7 and 26

Additional search strategies included: hand searching key journals from 1985 onwards (British Medical Journal; Journal of Hospital Infection; American Journal of Infection Control, Infection Control and Hospital Epidemiology). Conference proceedings from the UK Hospital Infection Society and the Infection Control Nurses' Association were hand searched. Contact was established with the Hand Hygiene Liaison Group to discuss progress with their current study funded by the Department of Health. Conference proceedings from the Society of Hospital Epidemiologists of America, and the Community and Hospital Infection Control Association of Canada were hand searched if accessible. Colleagues from all these organisations were contacted to ask if they were aware of any unpublished work within the field. Pharmaceutical companies manufacturing hand hygiene products were also contacted to determine if they were aware of any unpublished material.

Data collection and analysis

DJG and JC screened the results of searches to identify potentially relevant papers. Two reviewers (DJG and JC or ND) independently selected the studies to be included in the review.

Data from each paper were abstracted independently by two authors (DJG and JC, ND or DM) using the standard EPOC checklist (see Effective Practice and Organisation of Care Group details). Data abstraction was checked and discrepancies were resolved through discussion by the relevant two authors. ND acted as arbitrator for any unresolved difficulties. DJG was included in the authorship of one paper, which was reviewed by JC and ND. Given the substantial heterogeneity of interventions and methods across studies, it was not sensible to use meta-analysis to pool results. Instead, we present the results of studies in tabular form and make a qualitative assessment of the effects of studies, based on quality. We report the following data (where available): pre-intervention study and control data and statistical significance across groups, absolute and percentage improvement.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies.

Once opinion pieces, general reviews and non-intervention studies were excluded, 49 papers and one thesis appeared potentially eligible for review and were read in detail. The studies evaluated a wide variety of interventions, with the description of the intervention(s) being cursory in a number of reports. Eleven of the studies involved a single intervention that featured education or training related to hand hygiene, usually combining formal teaching with practical demonstrations (Conly 1989, Baker 1998, Berg 1995, Diekema 1995, Dorsey 1996, Gould 1997, Huang 2002, Shaw 2003, Panhotra 2004, Prieto 2005, Moongtui 1999). Hand hygiene was often covered with other topics such as universal precautions or epidemiology. Dubbert 1990 combined education with audit and feedback, while six studies looked at audit and feedback alone (Bittner 2002, Raju 1991, Van de Mortel 1995, Tibbals 1996, Van de Mortel 2000, Salemi 2002). Seven studies involved single interventions related to introduction of a new hand hygiene product such as emollient soap (Mayer 1986) or alcohol hand rub (Graham 1990, Maury 2000, Muto 2000, Earl 2001, Colombo 2002, Brown 2003). Marena 2002 compared plain soap and an antimicrobial solution, in combination with education. Other single interventions studied were use of visual feedback of organisms from hand cultures (Moore 1980), gowns (Donowitz 1986), labeled teddy bear (Hughes 1986), labels on ventilators (Khatib 1999), reminders from patients (McGuckin 2004 , McGuckin 1999), posters (Thomas 2005), voice prompts (Swaboda 2004),automated sink (Larson 1991), and move to a new hospital (Whitby 2004). The remaining studies involved multidimensional campaigns featuring different combinations of an ed-

ucational program, a new product, audit and performance feedback, written information and written reminders such as posters or labels. Theoretical frameworks were only clearly articulated for two studies reported (Larson 2000, Creedon 2005)

The thesis (Moongtui 1999) and the paper subsequently written from it (Moongtui 2000) were discounted because the data related to universal precautions with information pertaining to hand hygiene were not presented separately. A further paper was excluded because it did not contain any data (Moore 1980). Of the remaining 46 studies, three were excluded because no baseline data were collected or were collected on only a few of the participating wards. A further 21 were excluded because they reported uncontrolled before and after study designs. Three ITS studies were reported, each with less than three pre and post-intervention data collection points.

Of the remaining 20 studies, an additional twelve studies reported complicated before and after designs in which two or more sequential interventions had taken place, but with only one or two episodes of data collection after each new intervention. This group included one study which is very widely quoted as evidence of the ability of hand hygiene campaigns to increase compliance and decrease rates of HCAI (Pittet 2000) and a longer follow-up study building on the original work (Hugonnet 2002). In this group of studies, a single episode of baseline data collection took place with further data collection over extended periods. These long periods of data collection became interventional, because feedback performance was provided to health workers during each as part of a deliberately engineered Hawthorne (productivity) Effect (Roethlisberger 1939).

Six CBA studies were identified each employing one intervention and one control unit (Mayer 1986, Larson 1991, Larson 1997, Larson 2000, Bittner 2002, Colombo 2002). Key weaknesses of these studies were the dissimilarities of the control and experimental sites and in some studies imbalances in baseline hand hygiene. In addition, because of the limited control group, the intervention was completely confounded by the study site making it difficult to attribute any observed changes to the intervention rather than to other site-specific variables.

In the CBA study by Mayer 1986, the experimental and test wards were dissimilar. One was a medical ICU while the other was a surgical ICU. Surgical ICU patients are more likely to undergo invasive procedures and are more likely to have open wounds, placing them at greater risk of HCAI than medical patients. The need to manipulate invasive devices and undertake wound care place greater demands on health workers to perform hand hygiene. Other differences between the wards likely to have influenced the outcome measures included a higher admission rate on one ward than the other and a different proportion of nursing assistants (who are less well qualified than registered nurses). In this study percentage number of hand hygiene episodes was the same (63%) on experimental and control wards, but on the experimental (surgical) unit demand for hand hygiene was more than double the demand on the control ward.

The CBA study reported by Larson 1991 took place in two completely dissimilar clinical settings (neonatal intensive care and postanaesthesia recovery). Baseline measures of hand hygiene were not quoted separately for these settings.

In the CBA study reported by Larson 1997, a seven-bed neurosurgical ICU served as the experimental unit against a reasonably similar control (a seven bed surgical ICU). However, provision for hand hygiene was not the same on the two units. In the experimental unit five patients were nursed in a bay area served by only one sink. Two more beds were in single rooms, each with its own sink. The control unit was better equipped, with individual rooms for all patients, each with its own sink. Baseline observation of hand hygiene (not use of alcohol) was 151 episodes in the experimental unit compared to 310 episodes in the better equipped control, although this difference was not shown to be significant.

The CBA study published by Larson 2000 took place in two different hospitals. The authors state that the experimental and control hospitals were 'similar' in terms of nurse-patient ratios, staffing patterns and patient populations, but without supporting evidence. However, frequency of hand hygiene was documented in only two dissimilar sites in these hospitals, adult medical intensive care and neonatal intensive care, with no data provided to describe the characteristics of the two units. Baseline frequency of hand hygiene was greater in the experimental hospital (42.6%, CI 1.3) than the control (30.3, CI 1.52).

The CBA study by Bittner 2002 was excluded because the experimental unit was a surgical ICU and the control was a medical ICU. The baseline rates of hand hygiene were similar in these units.

The CBA study reported by Colombo 2002 was excluded because of lack of matching between control and intervention sites. The intervention was conducted on surgical, medical and intensive care units, while the control specifically excluded intensive care. This was not considered a valid comparison because of the differences between critical care and general ward patients.

Two studies were included in the review. The 44 excluded studies are reasons for their exclusion are presented in Table 1.

Table 1. Table of Results

Study	Results	Additional Notes
Huang et al 2002	% of 49 nurses who used appropriate HH -before pt contact -Expt pre 51% Expt post 85.7% Control pre 53.1% Control post 53.1% -after pt contact Expt pre 75.5% Expt post 91.8% Control pre 75.5% Control post 71.4%	- significant increase in expt group at post test for both before pt contact (p<.001) and after contact (p<.05) compared to control and baseline - no confidence material reported
Gould and Chamberlain	% of essential hand decontamination Expt pre 54.5% Expt post 58.6% Control pre 54.4% Control post 64.1%	- no significant difference between expt and control - no confidence intervals reported

Characteristics of the Included Studies

Study designs

Two studies met the criteria for review. They were published in 1997 and 2002. One study was a randomised controlled trial (Huang 2002); the other was a controlled before and after study (Gould 1997).

Characteristics of participants

One study was based in the People's Republic of China (Huang 2002). It included nurses from all the departments of a single hospital. The other study was based in the UK and included nurses recruited from four similar surgical wards in the same hospital (Gould 1997).

Characteristics of the intervention

Both studies featured a single intervention involving education relating to universal precautions as well as hand hygiene. The intervention employed by Huang 2002 involved two hours of formal teaching about blood borne pathogens and universal precautions delivered by specially trained nurses, an hour of practical demonstration, thirty minutes of discussion, and written information. In the study by Gould 1997, teaching was provided by a nurse teacher with special infection control expertise. The educational package was designed to consist of five different sessions each thirty minutes long, covering a comprehensive range of topics relating to infection control generally and specifically to universal precautions and hand hygiene. Practical demonstrations were included. Huang 2002 did not mention evaluation of the educational intervention or the number of nurses able to attend. Gould 1997 were obliged to cancel half their teaching sessions because the wards were too busy so that some nurses failed to receive all of the intended input. However, the teaching was well-evaluated. Neither study employed a theoretical framework to inform the intervention, but Gould 1997 discussed the rationale for delivering teaching in the workplace with reference to the nursing education literature.

Risk of bias in included studies

Table 2 summarizes the characteristics of the included studies. (see ASSESSMENT OF METHODOLOGICAL QUALITY IN GROUP DETAILS)

In their RCT Huang 2002 recruited a hundred nurses who were then randomised into experimental and control groups. Data collection from 98 nurses was by direct observation undertaken by three observers for 30 minutes each before the intervention and four months afterwards. Data were presented on the proportion of nurses who washed hands, but there was no information to explain how the proportion was calculated. The unit of analysis was the individual nurse. Four months post-intervention hand hygiene compliance was significantly improved (p<0.001) for the nurses in the experimental group compared to the control.

Gould 1997 reported a CBA conducted in four matched surgi-

cal wards from the same hospital. Two wards were randomly selected to serve as experimental units, then two matched wards were selected as controls. Nurses were recruited from the wards, with complete data obtained from 16 nurses on the experimental group and 15 nurses from the control groups. Each nurse was observed continuously for two hours by the same observer, who was blinded to group allocation. The outcome measure was number of hand washes performed after activities judged likely to offer a risk of cross-infection ('essential' hand hygiene episodes). The unit of analysis was the individual nurse. Baseline data were similar in control and experimental wards. Three months post-intervention the number of essential hand hygiene episodes performed was similar in the intervention and control groups.

In both studies the outcome measure was the number of times hand hygiene was performed before and after specific types of patient contact collected by direct observation during day shifts. Microbiologically-defined outcome measures were not used. The criteria used to determine when hand hygiene should be performed were explicitly stated, with reference to official guidelines from the US (Larson 1995) or derived from them. Details of the training received by observers were disclosed in the study by Huang 2002 but details of inter-rater reliability testing for the three data collectors were not supplied. The possibility of a Hawthorne Effect (increased productivity i.e. more hand hygiene episodes resulting from the presence of observers) was considered by the authors as unlikely in the study by Gould 1997. The possibility of a Hawthorne Effect was not discussed by Huang 2002.

Effects of interventions

Table 3 summarizes the key results from the included studies.

DISCUSSION

Despite the importance attached to hand hygiene to reduce HCAI and considerable increase in the number of intervention studies intended to encourage hand hygiene compliance, the evidence base remains poor. Since the last review (Naikoba 2001) there is still a dearth of methodologically robust studies to explore the effectiveness of interventions to improve hand hygiene compliance, with no tendency for the quality of study designs to improve over time. As reported in the last review, studies are still small scale, poorly controlled and abandon follow-up too soon to establish longer term impact. We were obliged to reject the majority of studies included in the older review because they were categorised as uncontrolled before and after designs. Of the remainder most were excluded because they were ITS studies lacking sufficient data collection points to take into account the influence of secular trends and the auto-correlation among measurements repeatedly taken over time (Ramsay 2003) or because they reported CBA designs each with poor controls and only one control and intervention site, making it impossible to attribute any observed changes to the intervention.

Although direct observation was used to assess compliance of hand hygiene in both studies, the length of time that nurses were watched varied and was limited to 30 minutes in one study. Observation periods took place exclusively during the daytime, although opportunities for hand hygiene arise over 24 hours for inpatients requiring regular pressure area care and/changes of position.

Many of the methodological shortcomings evident in the studies are inherent in the nature of behavioural research employing direct observation to collect data. The Hawthorne Effect is an obvious problem, but was discounted by Gould 1997 who argued that hand hygiene is such an ingrained activity that it would not be possible for health workers to maintain any changes in usual practice throughout the period of observation. Observation is a skilled activity which requires training and quality control procedures to ensure that the results are valid and reliable. This aspect was not adequately addressed and overlooked entirely by Huang 2002. Inter-rater reliability was not discussed adequately in this study although it was an issue.

Both studies reviewed reported single educational interventions that in both cases were described in considerable detail. Failure to increase hand hygiene compliance in the study by Gould 1997 appears to have been related to poor attendance at the ward-based teaching sessions at times of heavy workload. Lack of involvement between the resident infection control team and the researchers was also suggested by the authors as a reason for failure of the intervention to promote hand hygiene. The results of the study by Pittet 2000 which we were obliged to exclude and its longer follow-up (Hugonnet 2002) reported from the University Hospital Geneva, where the drive to change culture is ongoing, contrast with the methodologically better but less successful studies we included in our review. Other ingredients thought to contribute to the success in Geneva were: support for the campaign by participating health workers, support from senior managers and excellent communication between staff of all grades. These were key contextual features of the Geneva initiative, which would be difficult to replicate in other studies, especially in countries where resources for health care and facilities to perform infection control activities are less good.

Neither of the studies reviewed or those excluded considered economic outcomes. Apart from the study reported by Pittet 2000 there was no mention of the cost of the resources required in any of the attempts to increase hand hygiene compliance. Similarly there was no mention of health service utilisation outcomes such as: readmission rates, changes in levels of health care; length of patient stay; or the effects of any of the interventions on patients' health.

We were unable to determine whether sustained increase in hand hygiene compliance could reduce rates of HCAI because of the

lack of longer-term follow-up and the inability of the interventions to promote hand hygiene.

In summary, there is little robust evidence to inform the choice of interventions to improve hand hygiene. According to the most recent evidence, interventions previously thought to be ineffective such as education can have modest success (Grimshaw 2004). This is supported by the one of the studies we reviewed (Huang 2002), while in the other study (Gould 1997) failure to improve hand hygiene compliance can be attributed to inability to implement an otherwise well-designed, educationally sound teaching programme.

AUTHORS' CONCLUSIONS

Implications for practice

Implications for practice

Although this review has been not been able to provide evidence of the effect of interventions to promote hand hygiene on compliance even short term (less than six months), the findings should not be taken to suggest that attempts to increase compliance or reduce HCAI are not worth undertaking. Much HCAI is spread by direct contact, especially via health workers' hands and logically hand hygiene seems an important and cost-effective intervention. Hand hygiene at appropriate times is highly desirable on aesthetic grounds alone, forms an important indicator of the quality of health care and should continue to be promoted in all clinical settings.

Implications for research

Study design

Soundly designed studies are urgently required to evaluate the effectiveness of interventions intended to improve hand hygiene compliance and reduce HCAI. Adequately powered cluster randomised trials would provide the optimal study design. In view of the difficulty obtaining well-matched controls, a well-designed ITS study meeting the criteria demanded by Ramsay 2003 would offer advantages over the poorly designed controlled and uncontrolled trials which have so far been published. This should include at least three pre-intervention data collection points. Post-intervention data collection should continue at repeated intervals for at least 12 months to determine longer-term impact and avoid secular and seasonal trends that have the potential to affect microbiological data. All health workers having direct contact with patients and/or the near patient environment (bedside equipment, hygiene equipment, invasive lines) should be included in data collection, not just nurses, because all have the potential to contribute to HCAI. Well-designed studies might also consider a range of variables that have the potential to affect hand hygiene compliance which have not received adequate emphasis in existing studies. These might include nurse/patient ratio or another measure of workload, accessibility of hand hygiene products, and health worker skill mix.

Future studies could also take into account the effects of interventions to increase hand hygiene compliance on health service utilisation outcomes such as: readmission rates, changes in levels of health care; length of patient stay; and the effects on patients' health, for example changes in the incidence of emergency surgery for sepsis arising through HCAI.

As the study by Pittet 2000 indicated that an increase in hand hygiene compliance has been successful for some groups of health workers, accompanied by decrease in rates of MRSA and overall rates of HCAI, it might be more profitable to make the purpose of the study known to staff at the outset, deliberately promoting a Hawthorne Effect as one of the components to increase effectiveness.

Choice of intervention

The nature of the intervention requires consideration in addition to its length. In the past the literature in relation to change management more generally suggested that multifaceted campaigns are more effective (NHS 1999), but this view has now been challenged by more recent work (Grimshaw 2004) and it has become apparent that strategies such as audit with performance feedback may be less successful than educational intervention (Jamtvedt 2006). These findings should be taken into consideration when designing future intervention studies. The quality of published studies could also be improved if more complete descriptions of the chosen interventions were provided. For educational interventions the following details are indicated: rationale for choice of educational approach and venue; who delivered the teaching and their training; teaching content; numbers of health workers attending; details of evaluation; and any changes necessary to the planned teaching. Studies involving audit with performance feedback should indicate the nature of the audit tool and how feedback was provided. Staff are more likely to respond positively to feedback that is given sensitively and takes into account factors such as heavy workload than if they feel 'policed'. Pittet 2004 has pointed out that as most HCAIs result from inappropriate patient care practices, the way towards improved compliance and better control lies in modifying health workers' behaviour, drawing on knowledge from the behavioural and social sciences, especially social cognitive models. These models have been used successfully in the past to achieve change in behavioural medicine and preventative medicine, but they have been under-used in the field of infection control, with a few exceptions (see for example Larson 2000). Much more work could be undertaken in this area, where there is enormous scope for collaboration between medical staff and behavioural scientists. The work that has so far been published may suffer because it has been written up mainly in medical and specialist infection control journals where the emphasis is placed on the microbiological detail

rather than extensive description and evaluation of behavioural interventions. Future studies might also benefit from underpinning theoretical frameworks.

Outcome measures and data collection processes

A range of outcome measures and approaches to data collection could be combined to corroborate findings. These could include direct observation by trained observers using a validated method of observation, with testing for inter-rater reliability where more than one data collector is employed. Indirect measures such as amount of soap used per bed per day could also be collected in addition to microbiological data to assess any reduction in HCAI rates. Health worker behaviour should be observed over 24 hours, seven days a week in studies taking place in inpatient settings to capture the full range of health worker activity at different times of day. Consistency of outcome measurement and units of analysis would facilitate comparison of results across studies.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Gould 1997

Methods	Design :CBA Baseline measurements: Done Appropriate choice of control: Done Objective measure of performance:Done Outcome measures: Reliable Protection against contamination:Not done Validated audit tool used Done Inter-rate reliability testedNot appropriate Possibility of Hawthorne Effect Discussed
Participants	UK Nurses on general surgical ward
Interventions	Single teaching session: hand hygiene, universal precautions
Outcomes	% frequency of hand washes after high risk activities
Notes	Intervention not successful at three months

Huang 2002

Methods	Design :CCT Baseline measurements: Done Appropriate choice of control: Done Objective measure of performance:Done Outcome measures: Not reliable Protection against contamination:Done Validated audit tool used not stated Inter-rate reliability tested Not done Possibility of Hawthorne Effect Not discussed
Participants	People's Republic of China Nurses throughout a hospital
Interventions	Education, mainly universal precautions
Outcomes	% of nurses washing hands before and after patient
Notes	Intervention successful after four months

Characteristics of excluded studies *[ordered by study ID]*

Avila-Aguero 1998	mUncontrolled before and after study design with sequential addition of new intervention(s) but limited data collection after each addition.
Baker 1998	Uncontrolled before and after study design
Berg 1995	Uncontrolled before and after study design
Bischoff 2000	Uncontrolled before and after study design with sequential addition of new intervention(s) but limited data collection after each addition.
Bittner 2002	Controlled before and after study design with one nonequivalent control group.
Brown 2003	Uncontrolled before and after study design
Coignard 1998	Uncontrolled before and after study design
Colombo 2002	Controlled before and after study design with one nonequivalent control group.
Conly 1989	Interrupted time series design with less than three data entry points before/after each intervention.
Creedon 2005	Uncontrolled before and after study design
Diekema 1995	Uncontrolled before and after study design
Donowitz 1986	Interrupted time series design with less than three data entry points before/after each intervention.
Dorsey 1996	Uncontrolled before and after study design
Dubbert 1990	Uncontrolled before and after study design
Earl 2001	Uncontrolled before and after study design
Graham 1990	Uncontrolled before and after study design
Harbarth 2002	Uncontrolled before and after study design with sequential addition of new intervention(s) but limited data collection after each addition.
Hughes 1986	Uncontrolled before and after study design
Hugonnet 2002	Uncontrolled before and after study design with sequential addition of new intervention(s) but limited data collection after each addition.
Khatib 1999	Uncontrolled before and after study design with sequential addition of new intervention(s) but limited data collection after each addition.

(*Continued*)

Lam 2004	Uncontrolled before and after study design
Larson 1991	Controlled before and after study design with one nonequivalent control group.
Larson 1997	Controlled before and after study design with one nonequivalent control group.
Larson 2000	Controlled before and after study design with one nonequivalent control group.
Marena 2002	No control group for intervention of interest
Maury 2000	Limited or no baseline data
Mayer 1986	Controlled before and after study design with one nonequivalent control group.
McGuckin 1999	Uncontrolled before and after study design with sequential addition of new intervention(s) but limited data collection after each addition.
McGuckin 2004	Uncontrolled before and after study design
Muto 2000	Uncontrolled before and after study design
Panhotra 2004	Limited or no baseline data
Pittet 2000	Uncontrolled before and after study design with sequential addition of new intervention(s) but limited data collection after each addition.
Prieto 2005	Uncontrolled before and after study design
Raju 1991	Interrupted time series design with less than three data entry points before/after each intervention.
Rosenthal 2003	Uncontrolled before and after study design with sequential addition of new intervention(s) but limited data collection after each addition.
Salemi 2002	Uncontrolled before and after study design
Shaw 2003	Uncontrolled before and after study design
Simmons 1990	Uncontrolled before and after study design with sequential addition of new intervention(s) but limited data collection after each addition.
Swaboda 2004	Uncontrolled before and after study design with sequential addition of new intervention(s) but limited data collection after each addition.
Thomas 2005	Limited or no baseline data

(*Continued*)

Tibbals 1996	Uncontrolled before and after study design with sequential addition of new intervention(s) but limited data collection after each addition.
Van de Mortel 1995	Uncontrolled before and after study design
Van de Mortel 2000	Uncontrolled before and after study design
Whitby 2004	Uncontrolled before and after study design with sequential addition of new intervention(s) but limited data collection after each addition.
Won 2004	Uncontrolled before and after study design

DATA AND ANALYSES

This review has no analyses.

WHAT'S NEW

Last assessed as up-to-date: 6 February 2007.

24 June 2008	Amended	Converted to new review format.

HISTORY

Protocol first published: Issue 4, 2004

Review first published: Issue 2, 2007

7 February 2007	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

JC was responsible for the searches. Papers were reviewed by DJG, JC, DM and ND. ND acted as arbitrator in cases of disagreement. DJG and DM compiled the final report.

DECLARATIONS OF INTEREST

DJG co-authored one of the studies included in this review.

SOURCES OF SUPPORT

Internal sources

- City Hospital, London, UK.
- Memorial University School of Nursing, St John's, Canada.

External sources

- Department of Health Cochrane Review Incentive Scheme 2005, UK.

INDEX TERMS

Medical Subject Headings (MeSH)

Handwashing [*standards]; Infectious Disease Transmission, Professional-to-Patient [*prevention & control]

MeSH check words

Humans