The provision of alcohol-based products to improve compliance with hand hygiene
Health Technology Assessment Report 7

The provision of alcohol-based products to improve compliance with hand hygiene

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1 EXECUTIVE SUMMARY

Hand hygiene is considered to be a primary measure in reducing the spread of healthcare associated infection (HAI). However, noncompliance with hand hygiene is a problem in the majority of healthcare settings. To improve compliance with hand hygiene, a variety of approaches have been explored. One such approach has been the introduction of alcohol-based hand hygiene products which can be used in certain clinical situations and may be more accessible than conventional methods of hand hygiene. Additionally, many alcohol-based products have excellent antimicrobial activity, rapid bactericidal action, excellent spreading quality, dry rapidly, require less time for use, and irritate and dry the hands less often. While alcohol-based hand hygiene products do not replace other hand hygiene methods such as handwashing with soap and water for visibly soiled or contaminated hands, these products may have a potential role in improving compliance in other clinical situations.

Objectives of the Health Technology Assessment (HTA)

The objectives of this HTA are as follows:

- to review the existing literature on the effectiveness and costs and benefits of alcohol-based hand hygiene products
- to assess whether the added benefits of improving hand hygiene are likely to offset the additional costs.

The clinical effectiveness of alcohol-based hand hygiene products is assessed in terms of improvements in hand hygiene compliance and reductions in HAI through hand hygiene.

For the purpose of this report, the term ‘hand hygiene’ refers only to handwashing with soap and water and the use of alcohol-based hand hygiene products.

Methods

Scientific literature was systematically searched to identify evidence of the clinical and cost effectiveness of alcohol-based hand hygiene products. Experts, professional groups and other interested parties were also invited to submit evidence. All evidence was critically appraised. A survey was undertaken by NHS Quality Improvement Scotland (NHS QIS) to ascertain the current provision of hand hygiene arrangements in primary and acute care settings across Scotland.

Results and conclusions

A literature review highlighted that the evidence base pertaining to the clinical and cost effectiveness of interventions to improve hand hygiene compliance and reduce HAI rates was weak. Many of the reviewed studies were neither well conducted nor well reported. Methodological weaknesses of the reviewed studies included short periods of outcome measurement before and after the intervention, small sample sizes and the lack of a control group or the use of inappropriate controls. As a result of these shortcomings, there is a need for well-designed, well-conducted research in this area. In addition, there was considerable heterogeneity among studies in terms of study design, interventions used and outcome measures, which meant statistical synthesis of results could not be undertaken.

While it is generally accepted that levels of hand hygiene and infection rates are linked, evidence for a direct association between improvements in compliance with hand hygiene and reductions in rates of HAI was limited.

A review of the literature suggested that most types of interventions employed in infection control generate at least transient improvements in hand hygiene compliance and reductions in infection rates. Successful interventions were generally multi-component in nature, involved long-term interventions, and targeted a range of factors that modify hand hygiene behaviour. Multi-component strategies were more consistently associated with sustained improvements compared with single-component strategies.

Alcohol-based hand hygiene products are usually introduced as part of multi-component interventions to improve hand hygiene compliance and infection rates, rather than in isolation. Other elements of multi-component interventions in the reviewed studies included hand hygiene education, staff feedback, reminders, promotional campaigns, opinion leaders and policies.

The evidence showed that multi-component interventions that include alcohol-based hand hygiene products are equally effective as strategies that do not in effecting sustained change.

The costs associated with multi-component strategies in which the interventions are not time limited are likely be substantial. However, the costs of providing alcohol-based hand hygiene products to staff working in clinical areas are likely to be small by comparison to the costs incurred by the healthcare provider in treating HAI, and greatly outweighed by the benefits associated with reducing HAI. Due to the lack of economic data on alcohol-based hand hygiene products, an economic evaluation could not be conducted. This HTA was therefore limited to critically appraising the existing economic evaluations on alcohol-based hand hygiene products. Two economic evaluations showed that if only a 1% reduction in the HAI rate is achieved, hand hygiene programmes using alcohol-based hand hygiene products are cost effective.

A survey, undertaken by NHS QIS, showed great variability in hand hygiene arrangements across Scotland. Alcohol-based hand hygiene products were widely available, with 80.5% of the healthcare facilities, from which survey responses were received, providing alcohol-based hand hygiene products to all frontline healthcare staff and more than 75% providing these products for visitor use. Despite this, 68.4% felt that changes in the...
way the products were provided could result in increased use. In each of these healthcare facilities, other components offered in strategies to improve hand hygiene compliance (e.g., education, patient initiatives, promotional activities) differed. Since the successful implementation of hand hygiene strategies requires active participation and support at individual and institutional level, the survey highlighted the need for more staff dedicated to hand hygiene, as less than one whole-time equivalent infection control staff member was employed per healthcare facility. Furthermore, local compliance rates with hand hygiene guidelines were largely unknown in the responding healthcare facilities.

Both the survey and the literature review highlighted the difficulties in identifying a single national approach to tackle hand hygiene compliance and HAI. The most appropriate local strategy can perhaps be guided by audit of local practice and adopting the methods of successful interventions.

Recommendations

- Despite the lack of unequivocal evidence, the potential benefit of providing alcohol-based hand hygiene products is likely to outweigh the costs and therefore these should be available for use by all NHSScotland staff working in clinical areas. Alcohol-based hand hygiene products should also be provided for the use of visitors, particularly where handwashing facilities are limited.
- Staff planning local initiatives to improve hand hygiene should note that multi-component interventions are more likely to be effective and sustainable than single-component interventions. Although such initiatives are more resource intensive, these have greater potential to be cost effective.
- Robust evaluation of any hand hygiene intervention should be carried out. This will require compliance and/or infection rates to be audited both before and after the intervention and possible influences on these rates to be taken into account. Comparator groups should be included wherever possible.
- Studies of the effectiveness of hand hygiene interventions should be published. This will allow a body of literature to be established which could subsequently be synthesised to identify the most effective interventions for particular clinical situations.
2 INTRODUCTION

This report presents the recommendations arising from the NHS QIS HTA of The provision of alcohol-based products to improve compliance with hand hygiene.

The initial sections of this report provide background information on NHS QIS and on the HTA process (Section 3), and introduce the topic (Section 4).

The clinical evidence gathered is summarised in Section 5 and economic evidence is presented in Section 6.

Organisational issues are explored in Section 7.

Section 8 discusses the limitations and uncertainties and Section 9 outlines the conclusions.
3 BACKGROUND ON NHS QIS

NHS QIS was set up by the Scottish Parliament in 2003 to take the lead in improving the quality of care and treatment delivered by NHSScotland. NHS QIS does this by setting standards and monitoring performance, and by providing NHSScotland with advice, guidance and support on effective clinical practice and service improvements.

HTA

HTA is an internationally recognised process used by NHS QIS to advise the NHS in Scotland about a specific health intervention, eg medicine, equipment or diagnostic test. HTA evaluates the clinical and cost effectiveness of the various ways in which the health intervention can be used, comparing alternative interventions where appropriate. Patient and organisational aspects are also considered, where appropriate.

Evidence identified by literature searching together with evidence provided by experts, patient interest groups and manufacturers is critically appraised and robust analyses are undertaken by expert staff. Surveys may be undertaken to ascertain current clinical practice and patient preferences.

NHS QIS staff from a variety of disciplines conduct the assessment and also seek advice from healthcare professionals who are expert in this area of medicine (see Appendix 1). Public consultation ensures that all views are considered.
4 SETTING THE SCENE

Healthcare associated infections

Infections that are contracted while in hospital are an important patient safety issue and one of the biggest challenges facing healthcare services, both nationally and internationally. An HAI or nosocomial infection is defined as an infection that was not present or incubating at the time of admission to hospital and acquired via the provision of healthcare (National Audit Office, 2000). The majority of HAIs are caused by bacteria, which most commonly affect the urinary tract, surgical wounds, lower respiratory tract, skin and the bloodstream (Emmerson et al., 1996). Less common causes include viruses, which can cause influenza and viral gastroenteritis (National Audit Office, 2000).

For an infection to be acquired in a healthcare setting, there must be a source of the infectious agent (e.g. the patient, healthcare staff, other patients, contaminated hospital environment or equipment) from which microorganisms can spread. Most commonly, healthcare staff act as the source and spread the infection from patient to patient or from the environment to the patient (Weber & Rutala, 2003).

The majority of HAIs can be treated successfully with antibiotics. However, the prolific and often inappropriate use of antibiotics has led to the emergence of strains of bacteria that have developed resistance to antibiotic therapy, such as methicillin-resistant *Staphylococcus aureus* (MRSA), penicillin-resistant *Streptococcus pneumoniae*, and vancomycin-resistant enterococci (VRE) (National Audit Office, 2000). Infections from these strains can be very difficult to treat.

The elderly, the very young and the immunocompromised (e.g. transplant patients, patients receiving chemotherapy) are at greatest risk of contracting an HAI. Other risk factors include a patient's length of hospital stay, degree of severity of the patient's underlying condition and the use of medical devices (e.g. catheters, intravenous lines, ventilation equipment) (Chief Medical Officer, 2003).

HAIs can complicate treatment of the condition for which the patient was initially admitted, cause further distress for the patient, slow recovery, increase the length of hospital stay, lead to prolonged or permanent disability and can even be fatal (NHS Quality Improvement Scotland, 2004). Some HAIs, such as pneumonia and surgical wound infections, cause complications beyond discharge and others can put the patient at higher risk of further infections (Walker, 2001).

In the UK, HAIs affect one in 10 NHS patients each year (Chief Medical Officer, 2003). The true prevalence of HAI may be underestimated since many HAIs manifest after the patient has been discharged (National Audit Office, 2000) – as many as 50–70% of surgical wound infections occur post discharge (Holz & Wenzel, 1992) which may account for possible under-reporting. HAIs are potentially life threatening. In Scotland, HAIs are a major factor in an estimated 457 deaths each year (less than 1% of all deaths) and a contributory factor in a further 1,372 deaths (3%). In Scotland, HAIs claim more lives than traffic accidents, drug-related deaths and acquired immune deficiency syndrome (AIDS) (Walker, 2001). HAIs are endemic worldwide. The prevalence of HAI in Scotland is comparable with that of other European countries, where estimates range from 6 to 10% (Chief Medical Officer, 2003), although reliable comparisons are difficult.

The economic burden of HAI to the hospital sector is substantial, with the annual cost to the NHS estimated to be £186 million in Scotland (Walker, 2001) and in excess of £1 billion in England and Wales (Plowman et al., 1999b).

Policy initiatives

In recognition of the scale of HAI in Scotland, a major programme of work has been undertaken at a national level and on a number of fronts. Key achievements have included:

- publishing a framework for national surveillance of HAI in Scotland (Scottish Executive Health Department, 2001)
- issuing guidance on assessing and managing the risks of HAI (Scottish Executive Health Department & NHSScotland Working Group, 2001)
- publishing national standards for HAI infection control (Clinical Standards Board for Scotland, 2001) and for cleaning services (Clinical Standards Board for Scotland, 2002)
- publishing The Antimicrobial Resistance Strategy and Scottish Action Plan (Scottish Executive Health Department, 2004a)
- establishing an HAI Action Plan (Scottish Executive Health Department, 2002)
- setting up the Cleanliness Champions initiative (April 2002).

Of particular importance is the establishment of an HAI Task Force by the Scottish Executive. The multidisciplinary Task Force was set up in January 2003 to co-ordinate the development and implementation of the HAI Action Plan, to monitor progress of its implementation across NHSScotland, to monitor levels of HAI and to report on progress to the Minister. The Task Force is expected to fulfil its remit by December 2005. The Task Force's progress to date includes:

- issuing The NHSScotland Code of Practice for the Local Management of Hygiene and HAI (Scottish Executive Health Department, 2004c) and The NHSScotland National Cleaning Services Specification (Scottish Executive Health Department, 2004b)
- consolidation and development of the national HAI surveillance programme by the Health Protection Scotland (formerly the Scottish Centre for Infection and Environmental Health)
- implementing The Antimicrobial Resistance Strategy and Scottish Action Plan
- publishing a draft methodology for the risk management of HAI for consultation (Scottish Executive Health Department, 2004d).
NHS QIS is also committed to providing guidance and support in this area. In addition to this assessment of alcohol-based hand hygiene products, NHS QIS recently published a progress report on the implementation of the infection control standards (NHS Quality Improvement Scotland, 2004), launched a poster campaign aimed at alerting visitors to the spread of HAI, and is conducting an HTA on MRSA screening.

Hand hygiene

More than 150 years ago, Ignaz Semmelweis established that cleansing heavily contaminated hands with antiseptic decreases the carriage and transmission of nosocomial pathogens in a healthcare setting (Pittet & Boyce, 2001). Good hand hygiene practices are considered to be the cornerstone in reducing the incidence of HAI (Healthcare Infection Control Practices Advisory Committee and Hand-Hygiene Task Force et al., 2004; Pittet, 2003).

Hand hygiene defines several actions designed to eliminate dirt or organic matter (eg proteinaceous material, blood, body fluids) from visibly soiled hands or decrease the hand colonisation of transient and resident microorganisms. Hand hygiene is a collective term that refers to handwashing, antiseptic handwashing, antiseptic handrubbing or surgical hand antisepsis (Centers for Disease Control and Prevention, 2002). A variety of hand hygiene preparations are available for use, including plain soap, antiseptic soap and alcohol-based products (ie alcohol rubs, rinses or gels).

Guidelines and standards relating to infection control have included detailed guidance on when, in the course of clinical care, hands should be decontaminated in order to reduce the risk of cross-infection. In the UK, evidence-based guidelines for preventing HAI were published in 2001 (Pratt et al., 2001). The guidelines address the standard principles underlying the prevention of HAI as well as specific recommendations in relation to the use of particular medical devices. In 2003, guidance on the prevention of HAI in primary and community care was published, under the auspices of the National Institute of Clinical Excellence (NICE) (National Institute for Clinical Excellence, 2003). The recommendations from these guidelines are consistent with those from the US Centre for Disease Control and Prevention (CDC) guideline for hand hygiene in healthcare settings published in 2002 (Centers for Disease Control and Prevention, 2002).

Alcohol-based products have little or no effect on removing physical dirt (Pratt et al., 2001) so handwashing with antimicrobial/non-antimicrobial soap and water is recommended when hands are visibly soiled. When hands are not visibly soiled but may be contaminated with microorganisms, decontamination either using an antimicrobial soap and water, or with an alcohol-based product is appropriate (Pratt et al., 2001). Current standards for when hand hygiene practice should take place during patient care are outlined in Table 4-1.

Whilst hand hygiene constitutes relatively simple and effective procedures, adherence of healthcare workers to recommended hand hygiene guidelines is unacceptably low (Pittet & Boyce, 2001). The reported level of compliance among healthcare workers is approximately 40% (range 5–81%) (Healthcare Infection Control Practices Advisory Committee and Hand-Hygiene Task Force et al., 2004). Factors for poor compliance, identified in epidemiological studies or reported by healthcare workers, are outlined in Table 4-2.

Given poor adherence with guidelines on hand hygiene, a range of initiatives have been introduced in a variety of healthcare settings to improve compliance with hand hygiene (Pittet & Boyce, 2001). The use of alcohol-based hand hygiene products as alternatives, in certain clinical situations, to handwashing with soap and water has been given some credence. Alcohol-based hand hygiene products have demonstrated antimicrobial and virucidal activity, are well tolerated and easily accessible (Centers for Disease Control and Prevention, 2002).

Table 4-1 Indications for hand hygiene

- Hand decontamination immediately before and after every episode of direct patient contact/care or any activity that potentially results in hand contamination.
- Use of liquid soap and water for visibly soiled or potentially contaminated with dirt or organic material.
- Use of alcohol-based handrub or handwashing with liquid soap and water to decontaminate hands between different patients or between different caring activities on the same patient.

Source: (Clinical Standards Board for Scotland, 2001).
### Table 4–2 Factors influencing adherence to hand hygiene practices

**Observed risk factors for poor adherence to recommended hand hygiene practices**
- Physician status (rather than a nurse)
- Nursing assistant status (rather than a nurse)
- Male sex
- Working in an intensive-care unit
- Working during the week (versus the weekend)
- Wearing gowns/gloves
- Automated sink
- Activities with high risk of cross-transmission
- High number of opportunities for hand hygiene per hour of patient care

**Self-reported factors for poor adherence with hand hygiene**
- Handwashing agents cause dryness and irritation
- Sinks are inconveniently located/shortage of sinks
- Lack of soap and paper towels
- Often too busy/insufficient time
- Understaffing/overcrowding
- Patient needs to take priority
- Hand hygiene interferes with health-care worker relationships with patients
- Low risk of acquiring infection from patients
- Wearing gloves/beliefs that glove use obviates the need for hand hygiene
- Lack of knowledge of guidelines/protocols
- Not thinking about it/forgetfulness
- No role model from colleagues or superiors
- Scepticism regarding the value of hand hygiene
- Disagreement with the recommendations
- Lack of scientific information of definitive impact of improved hand hygiene on healthcare associated infection rates

**Additional perceived barriers to appropriate hand hygiene**
- Lack of active participation in hand hygiene promotion at individual or institutional level
- Lack of role model for hand hygiene
- Lack of institutional priority for hand hygiene
- Lack of administrative sanction of noncompliers/rewarding compliers
- Lack of institutional safety climate

Source: (Centers for Disease Control and Prevention, 2002).
Primary objectives and scope of the HTA

The objectives of this HTA are:

- to review the existing literature on the clinical effectiveness and costs and benefits of alcohol-based hand hygiene products
- to assess whether the added benefits of improving hand hygiene are likely to offset the additional costs.

The clinical effectiveness of alcohol-based hand hygiene products is assessed in terms of improvements in hand hygiene compliance and reductions in HAI through hand hygiene.

In order to assess the cost effectiveness of alcohol-based hand hygiene products, it would be necessary to consider all relevant alternative interventions for reducing HAI. This would require examination of methods of diagnosis, treatment, immunisation, isolation and behaviour change interventions. Not only would other infection control measures need to be considered, but also the dynamic nature of infectious disease (i.e., the risk of infection is not constant but is dependent on the number of infectious individuals) should be taken into account. This was not possible in the timescales delineated for this project. Therefore, this assessment was limited to determining the costs and benefits of alcohol-based hand hygiene products.

In the scoping phase of this HTA, it became evident that there is a lack of economic data on alcohol-based hand hygiene products. Therefore, an economic evaluation on the use of alcohol-based hand hygiene products to improve hand hygiene in Scottish healthcare settings was not conducted. This HTA was therefore limited to critically appraising the existing economic evaluations on alcohol-based hand hygiene products.

To ascertain current provision of hand hygiene arrangements across Scotland, a survey was undertaken by NHS QIS.

Several assumptions were made at the outset of this HTA. Alcohol-based hand hygiene products and antiseptic soaps were assumed to be equally efficacious in terms of antimicrobial activity. It was also assumed that there was an issue surrounding poor compliance in hand hygiene across Scotland.

No comparison of alcohol-based hand hygiene products was performed.

For the purpose of this report, the term hand hygiene excludes surgical hand antisepsis. Instead, it refers to handwashing with soap and water and the use of alcohol-based hand hygiene products. In addition, it was often difficult to determine the type of hand hygiene preparation used in research from vague descriptions provided in the literature. While it is recognised that alcohol handrubs, gels and rinses are distinct entities, for simplicity, this report uses the term 'alcohol-based hand hygiene products' to encompass all of these.
5 CLINICAL EFFECTIVENESS

The purpose of the literature review was to determine the effectiveness of alcohol-based hand hygiene products in:

- improving hand hygiene compliance
- reducing the incidence of HAI.

Alcohol-based hand hygiene products are usually introduced as part of multi-component interventions to improve hand hygiene compliance and infection rates, rather than in isolation. Other elements of multi-component interventions can include hand hygiene education, staff feedback, reminders, promotional campaigns, opinion leaders and policies. In these types of interventions, combinations of two or more elements are introduced either simultaneously or sequentially.

The majority of studies described in this chapter include multi-component interventions, which may or may not include an alcohol-based hand hygiene product. In studies which include an alcohol-based hand hygiene product in their intervention, it is often not possible to evaluate the effect of the alcohol-based hand hygiene product independently of the other components of the intervention. Therefore, this chapter examines the effectiveness of multi-component interventions, both with and without alcohol-based hand hygiene products.

Section 5.1 describes evidence sources and details of the literature search. Section 5.2.1 summarises the evidence for interventions to improve hand hygiene compliance, Section 5.2.2 describes the current evidence base for interventions designed to reduce the rate of HAI and Section 5.3 is a discussion section.

5.1 Methods

5.1.1 Sources of evidence

Evidence to support this HTA was obtained from a wide variety of sources. These included published literature, grey literature, information submitted by scoping group members and survey results.

5.1.1.1 Literature search

Initial scoping searches to identify high-level evidence such as HTAs and systematic reviews, and key policy documents were undertaken in March 2004. Sources used included the HTA database, the Cochrane Database of Systematic Reviews (CDSR) and the Database of Abstracts of Reviews of Effects (DARE). A full list of sources can be found in Appendix 2. The results of these searches were used to assist in defining the remit of the project and identifying subsequent literature searching.

Systematic literature searches for primary studies were carried out between May and November 2004. Literature on a wide range of topics related to HAI and infection control was considered potentially relevant to the HTA. Given time constraints, it was decided that only literature which specifically mentioned ‘handwashing’, or related terms in the title or abstract, should be retrieved. Searching on appropriate subject headings and free-text terms for the concept of ‘handwashing’ alone resulted in low precision, so the concept was combined with subject headings and free-text terms, either relating to the concept of ‘infection’ or that of ‘alcohol cleanser’. As the project progressed, it was felt that this approach might have excluded some relevant articles covering the compliance of healthcare workers with hand hygiene regimens. A further search was therefore carried out, combining the handwashing terms with subject headings and free-text terms relating to ‘compliance’. Given that there were unlikely to be many randomised controlled trials (RCTs) in this topic area, all study design methodologies were included in the search. No language or date restrictions were applied.

The strategies used to search the MEDLINE, EMBASE and CINAHL databases through the OVID multifile interface can be found in Appendix 2. These were modified as appropriate to search the other databases used (see also Appendix 2). A complete listing of all strategies can be obtained by contacting NHS QIS.

Literature was also identified using the British Library’s Zetoc alerts service, by citation searching on key papers, searching the British Library Online Public Access Catalogue and from scanning the bibliographies of retrieved studies.

A flow chart showing the number of studies identified and then selected for inclusion in the report is given in Appendix 2.

5.1.1.2 Selection criteria

Literature was selected from the titles and abstracts identified by the search strategies in Appendix 2. The following inclusion and exclusion criteria were used to select references for full review of the publication.

Inclusion criteria:

- primary studies of interventions designed to improve hand hygiene compliance
- primary studies of interventions including a hand hygiene component designed to reduce nosocomial infection rate.

Exclusion criteria:

- in vitro efficacy studies of hand hygiene products
- studies conducted in dental surgeries
- studies of surgical scrubbing
- studies of equipment sterilisation.

Further inclusion and exclusion criteria were then applied to select studies for inclusion for each part of the review.
Improving hand hygiene compliance

Inclusion criteria:

• studies that aimed to improve hand hygiene among healthcare workers as a hospital infection control measure, using one or more of the following interventions: education, feedback, reminders, opinion leaders, policies.

Exclusion criteria:

• studies that aimed to improve hand hygiene solely or primarily as a universal precaution (ie to protect healthcare workers from infection)
• studies that examined handwashing technique or duration as the sole compliance outcome measure
• studies of single interventions to improve hand hygiene that have not, to date, been evaluated in combination with an alcohol-based hand hygiene product, eg gowning (Donowitz, 1986; Pelke et al., 1994; Tan et al., 1995), isolation rooms (Preston et al., 1981), adjusting sink facilities (Kaplan & McGuckin, 1986; Lankford et al., 2003; Larson et al., 1991; Wurtz et al., 1994) or use of different hand care agents (ie lotions or creams) (McCormick et al., 2000)
• studies without a baseline (ie pre-intervention) measure of compliance or without sufficient detail regarding the intervention or the outcome measures.

Reduction of infection rates

Inclusion criteria:

• studies that aimed to reduce the incidence of nosocomial infections by interventions designed to improve hand hygiene awareness and/or compliance with hand hygiene guidelines amongst healthcare workers.

Exclusion criteria:

• studies of infection control interventions implemented as part of outbreak control for nosocomial infections
• studies without a baseline (ie pre-intervention) measure of infection rate or without sufficient detail regarding the intervention or the outcome.

5.2 Results

It was often not possible to determine what type of product was being used from the descriptions given in the selected studies. Descriptions such as ‘gel-like 60% alcohol handrub solution’ (Bischoff et al., 2000) or ‘handrubbing with an alcoholic solution’ (Girou & Oppein, 2001) do not allow easy identification of whether the product is a gel containing emollients, or a hand rinse or rub without an emollient. In addition, some authors use the terms gel and rub interchangeably (Vernon et al., 2001). As a result, it was not possible to draw any conclusions regarding the relative effectiveness of one product compared with another. Pittet (2003) recently described what should be considered when choosing a hand hygiene product as detailed in Section 7.3.

5.2.1 Interventions to improve compliance with hand hygiene

Forty-one studies met the inclusion criteria outlined in Section 5.1.1.2 and are summarised in Appendix 3. Of these, 30 were uncontrolled prospective studies, eight were prospective studies with non-randomised parallel control groups, and three studies employed a crossover-type design. More than half (25) of the studies were carried out in intensive care units (ICUs).

Hand hygiene compliance was assessed using self-reporting by healthcare workers in one study and hand hygiene product usage in eight studies. In the remaining 32 studies, healthcare workers’ behaviour was observed directly. All but one of these 32 studies recorded hand hygiene opportunities (ie episodes when hand hygiene should take place) and the proportion of these opportunities in which hand hygiene was actually observed rather than the total frequency of hand hygiene episodes. There was considerable variation in the indications for hand hygiene; for example, some studies required hand hygiene to be carried out only before and/or after each continuous patient care episode, others specified activities within the patient care episode requiring hand hygiene including high-risk procedures, changing from a ‘dirty’ to a ‘clean’ procedure and any contact with inanimate objects or self-contact (other than hand to hand). Two studies further specified a minimum acceptable standard for the quality/duration of the hand hygiene procedure, which had to be met for the procedure to be considered satisfactorily undertaken.

Given the variation in study designs, interventions and outcome measures in the selected studies, statistical synthesis of the results was not possible. The findings are therefore summarised in narrative form and grouped according to the type of intervention under investigation.

5.2.1.1 Interventions involving an alcohol-based hand hygiene product

In 15 of the 41 studies, the intervention under investigation involved the introduction or improved availability of an alcohol-based hand hygiene product, as a supplement to handwashing with soap and water.

Alcohol-based hand hygiene products alone

Any intervention that introduces an alcohol-based hand hygiene product effectively should include an awareness-raising campaign and educational component, to ensure staff are able to use the product correctly. Four studies attempted to examine the effects of the alcohol-based hand hygiene product independently of education, either by introducing the two components sequentially and using post-education observations as the baseline, or by including a control group that received only the educational component.

Two of the studies were controlled; one used a parallel non-randomised control group (Mody et al., 2003), the other employed a multiple crossover design (Doebbeling et al., 1992).
Three of the studies reported significant findings in favour of alcohol-based products (Bischoff et al., 2000; Maury et al., 2000; Mody et al., 2003), with relative increases of between 44 and 92% in handwashing compliance at 5–12 weeks. Maury et al. (2000) found that although the improvement had decreased to 21% above baseline by 6 months after the introduction of the alcohol-based hand hygiene product, the difference remained statistically significant (p=0.007).

Conversely, Doebbeling et al. (1992) found that handwashing compliance was better when a medicated soap was used, compared with an alcohol-based hand hygiene product as an adjunct to traditional handwashing with non-medicated soap (relative risk [RR] 1.28, 95% CI 1.02, 1.60).

Table 5-1 summarises studies of interventions in which alcohol-based hand hygiene products were introduced alone.

### Alcohol-based hand hygiene products with education/information

Seven studies (Colombo et al., 2002; Earl et al., 2001; Girard et al., 2001; Graham, 1990; Kim et al., 2002; Muto et al., 2000; Vernon et al., 2001), only one of which was controlled (Colombo et al., 2002), measured the combined effect of introducing an alcohol-based hand hygiene product with appropriate promotion of the product, provision of information and educational support.

Three studies reported statistically significant improvements in hand hygiene compliance (Earl et al., 2001; Graham, 1990; Vernon et al., 2001), with relative increases of between 41 and 139%. The study with the longest follow up (Vernon et al., 2001) demonstrated the greatest increase – from 23% at baseline to 55% at 7–9 months (a relative increase of 139%) (p<0.001).

Table 5-2 summarises these studies.

### Alcohol-based hand hygiene products with multi-component interventions

In four studies (Brown et al., 2003; Girou & Oppein, 2001; Harbarth et al., 2002; Pittet et al., 2000), an alcohol-based hand hygiene product was introduced as part of a broader, multi-component intervention, that incorporated feedback to staff on their hand hygiene compliance. Other components included opinion leaders, hand hygiene policies and feedback of infection rates.

All four studies reported statistically significant improvements. However, in the Brown et al. (2003) study, these were observed only when hand hygiene was judged against ‘relaxed’ criteria (ie when putting on a clean pair of gloves prior to patient contact, without performing handwashing or hand antisepsis, was considered adequate hand hygiene).

Although none of the four studies used concurrent control groups, three (Brown et al., 2003; Harbarth et al., 2002; Pittet et al., 2000) used statistical methods to adjust for confounding factors, such as profession, intensity of care and staff-patient ratio. A significant increase in compliance was demonstrated in all three studies, with adjusted odds ratios of 2.82 (Brown et al., 2003), 1.9 (Harbarth et al., 2002) and 1.92 (Pittet et al., 2000) at 4 months, 5.5 months and 3 years respectively.

### Table 5-1 Studies of interventions in which alcohol-based hand hygiene products were introduced alone

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study design</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bischoff et al. (2000)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
<tr>
<td>Doebbeling et al. (1992)</td>
<td>Multiple crossover</td>
<td>Significant negative effect (medicated soap significantly better than alcohol-based product)</td>
</tr>
<tr>
<td>Maury et al. (2000)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
<tr>
<td>Mody et al. (2003)</td>
<td>Non-randomised controls</td>
<td>Significant positive effect</td>
</tr>
</tbody>
</table>

### Table 5-2 Studies of interventions of alcohol-based hand hygiene products with education/information

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study design</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colombo et al. (2002)</td>
<td>Non-randomised controls</td>
<td>Statistical significance not reported</td>
</tr>
<tr>
<td>Earl et al. (2001)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
<tr>
<td>Girard et al. (2001)</td>
<td>No concurrent controls</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Graham (1990)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
<tr>
<td>Muto et al. (2000)</td>
<td>No concurrent controls</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Kim et al. (2002)</td>
<td>No concurrent controls</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Vernon et al. (2001)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
</tbody>
</table>
Table 5-3 describes studies of multi-component interventions that included alcohol-based hand hygiene products.

5.2.1.2 Interventions not involving an alcohol-based hand hygiene product

Eleven of the 41 studies examined the effect of a single-component intervention other than an alcohol-based product on the hand hygiene behaviour of healthcare workers.

Education alone

Two studies evaluated the effect of an educational programme on hand hygiene compliance. These studies are summarised in Table 5-4. A controlled study by Gould and Chamberlain (1997) found no significant improvement. Although an uncontrolled study by Conrad (2001) demonstrated a steady increase in hand alcohol consumption rates over an eight-year period, the authors did not indicate the statistical significance of their results. In addition, they acknowledged that there are various competing explanations for the increase, including a change in case mix and other activities of the infection control practitioner, such as ward rounds and surveillance programmes.

Reminders alone

Five studies attempted to improve hand hygiene behaviour by using reminders (see Table 5-5). Of the three controlled studies, one used a parallel-control group (Swoboda et al., 2002) whereas the other two used a crossover design (McGuckin et al., 1999; McGuckin et al., 2001).

Ndawula and Cutter (2001) evaluated the effect of prominently placed signs, and Swoboda et al. (2002) used electronically-controlled automatic voice prompts as hand hygiene reminders. Although both studies reported improvements, neither indicated the statistical significance of these.

In three studies (McGuckin et al., 1999; McGuckin et al., 2001; McGuckin et al., 2004), patients were asked to remind staff of the need to wash their hands. Patients were also given various prompting aids bearing the question “Did you wash your hands?”. Two of the studies observed a significant increase in the number of hand hygiene episodes per patient-day as estimated from product usage. The 1999 McGuckin et al. study reported a 34% increase (p=0.021) after the six-week intervention and the 2004 study demonstrated a 40% sustained increase (p<0.001) at 3 months post baseline.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study design</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown et al. (2003)</td>
<td>No concurrent controls</td>
<td>Significant positive effect using ‘relaxed’ criteria; non-significant using ‘strict’ criteria</td>
</tr>
<tr>
<td>Girou and Oppein (2001)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
<tr>
<td>Harbarth et al. (2002)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
<tr>
<td>Pittet et al. (2000)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study design</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conrad (2001)</td>
<td>No concurrent controls</td>
<td>Statistical significance not reported</td>
</tr>
<tr>
<td>Gould and Chamberlain (1997)</td>
<td>Non-randomised controls</td>
<td>Non-significant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study design</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>McGuckin et al. (1999)</td>
<td>Crossover</td>
<td>Significant positive effect</td>
</tr>
<tr>
<td>McGuckin et al. (2001)</td>
<td>Crossover</td>
<td>Non-significant</td>
</tr>
<tr>
<td>McGuckin et al. (2004)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
<tr>
<td>Ndawula and Cutter (2001)</td>
<td>No concurrent controls</td>
<td>Statistical significance not reported</td>
</tr>
<tr>
<td>Swoboda et al. (2002)</td>
<td>Non-randomised controls</td>
<td>Statistical significance not reported</td>
</tr>
</tbody>
</table>
Feedback alone

In four studies, only one of which was controlled (Bittner et al., 2002), the effect of providing staff with feedback on hand hygiene behaviour was evaluated. Tibballs (1996) reported an improvement that was greater than the effect of overt observation, but no information regarding statistical significance was provided. Van de Mortel and Heyman (1995) found a statistically significant improvement in only two out of six professional groups (p<0.001). In the one study that reported a significant improvement (from 61% to 83%, a relative increase of 36%, p=0.001) across staff groups (van de Mortel et al., 2000), compliance decreased to near baseline levels (65%) by 12 months after the end of feedback. Bittner et al. (2002) reported that continuous feedback did not result in a sustained improvement.

These studies are summarised in Table 5-6.

Multi-component interventions

Fifteen of the 41 studies examined the effect of multiple-component interventions, including two or more of the following: education, feedback, reminders, policies, opinion leaders, incentives, automated sinks and moisturising soap. These studies are summarised in Table 5-7. Three of these 15 were controlled studies (Larson et al., 1997; Larson et al., 2000; Mayer et al., 1986).

Eleven studies reported a statistically significant improvement in hand hygiene compliance (Avila-Aguero et al., 1998; Berg et al., 1995; Conly et al., 1989; Dorsey et al., 1996; Larson et al., 1997; Larson et al., 2000; Mayer et al., 1986; Raju & Kobler, 1991; Rosenthal et al., 2003b; Sharek et al., 2002; Won et al., 2004), with relative increases ranging from 19% (Dorsey et al., 1996; Mayer et al., 1986) to 1160% (Berg et al., 1995). A further two studies reported increased compliance but did not indicate the statistical significance of their findings (Dubbett et al., 1990; Salemi et al., 2002).

Table 5–6 Studies of interventions that included feedback only

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study design</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bittner et al. (2002)</td>
<td>Non-randomised controls</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Tibballs (1996)</td>
<td>No concurrent controls</td>
<td>Statistical significance not reported</td>
</tr>
<tr>
<td>Van de Mortel and Heyman (1995)</td>
<td>No concurrent controls</td>
<td>Significant positive effect in two out of six professional groups</td>
</tr>
<tr>
<td>Van de Mortel et al. (2000)</td>
<td>No concurrent controls</td>
<td>Significant positive effect but non-significant at follow up</td>
</tr>
</tbody>
</table>

Table 5–7 Studies of multi-component interventions that did not include alcohol-based hand hygiene products

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study design</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avila-Aguero et al. (1998)</td>
<td>No concurrent controls</td>
<td>Significant positive effect but non-significant at follow up</td>
</tr>
<tr>
<td>Berg et al. (1995)</td>
<td>No concurrent controls</td>
<td>Significant positive effect, maintained at follow up</td>
</tr>
<tr>
<td>Conly et al. (1989)</td>
<td>No concurrent controls</td>
<td>Significant positive effect but non-significant at follow up</td>
</tr>
<tr>
<td>Dorsey et al. (1996)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
<tr>
<td>Dubbett et al. (1990)</td>
<td>No concurrent controls</td>
<td>No statistical significance reported</td>
</tr>
<tr>
<td>Larson et al. (1997)</td>
<td>Non-randomised controls</td>
<td>Significant positive effect but non-significant at follow up</td>
</tr>
<tr>
<td>Larson et al. (2000)</td>
<td>Non-randomised controls</td>
<td>Significant positive effect</td>
</tr>
<tr>
<td>Lohr et al. (1991)</td>
<td>No concurrent controls</td>
<td>No statistical significance reported</td>
</tr>
<tr>
<td>Mayer et al. (1986)</td>
<td>Non-randomised controls</td>
<td>Significant positive effect but non-significant at follow up</td>
</tr>
<tr>
<td>Raju and Kobler (1991)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
<tr>
<td>Rosenthal et al. (2003b)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
<tr>
<td>Salemi et al. (2002)</td>
<td>No concurrent controls</td>
<td>No statistical significance reported</td>
</tr>
<tr>
<td>Sharek et al. (2002)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
<tr>
<td>Simmons et al. (1990)</td>
<td>No concurrent controls</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Won et al. (2004)</td>
<td>No concurrent controls</td>
<td>Significant positive effect</td>
</tr>
</tbody>
</table>
Of the studies reporting a statistically significant improvement, six were concerned with interventions in which all or most of the components remained in place throughout the study period (Dorsey et al., 1996; Larson et al., 2000; Raju & Kobler, 1991; Rosenthal et al., 2003b; Sharek et al., 2002; Won et al., 2004). In the longest-running study (Won et al., 2004), significant improvements in hand hygiene compliance (43% at baseline versus 81% at follow-up – relative increase of 88% from baseline) were still present more than 3 years after the intervention was first introduced.

In the remaining five studies reporting a significant improvement (Avila-Aguero et al., 1998; Berg et al., 1995; Conly et al., 1989; Larson et al., 1997; Mayer et al., 1986), there was a follow-up period of outcome measurement after discontinuation of all or many of the components of the intervention. Four of these five studies (Avila-Aguero et al., 1998; Conly et al., 1989; Larson et al., 1997; Mayer et al., 1986), with follow-up periods of 7 weeks, 4 years, 8 months, and 6 months respectively, found that the effects of the intervention had disappeared during follow-up. In contrast, Berg et al. (1995) found that compliance continued to increase during the 3 months following an intervention consisting of education and reminders.

5.2.2 Interventions to reduce the incidence of nosocomial infections

Twenty-six studies met the inclusion criteria outlined in Section 5.1.1.2 and are summarised in Appendix 4. The selected studies varied in study design. The majority of studies employed a prospective design to determine the infection rates at baseline and after the implementation of the intervention. In some cases, the intervention was ongoing for the duration of the study (eg the introduction of an alcohol-based hand hygiene product); in others, the intervention was time limited (eg a hand hygiene education session). Only four (Doebbeling et al., 1992; Fendler et al., 2002; Larson et al., 2000; Mody et al., 2003) of the 26 studies included a control group; these studies were not randomised. Three of these four studies included an alcohol-based hand hygiene product as a component of the intervention. One study (Hirschmann et al., 2001) used a cross-sectional design to assess hand hygiene procedures following insertion or removal of peripheral venous catheters.

The selected studies were carried out in a variety of healthcare settings: 10 were conducted in ICUs, four in neonatal ICUs, four across one or several departments, three in long-term care hospitals and five were hospital-wide.

A number of the studies described in this section are also included Section 5.2.1.

For the reasons described in Section 5.2.1, statistical synthesis of the results was not possible. The findings are therefore summarised in narrative form.

5.2.2.1 Interventions involving an alcohol-based hand hygiene product

Nine studies (Brown et al., 2003; Doebbeling et al., 1992; Fendler et al., 2002; Hilburn et al., 2003; King, 2004; Mody et al., 2003; Pittet et al., 2000; Rao et al., 2002; Vernon et al., 2001) included an alcohol-based hand hygiene product as part of an intervention to reduce nosocomial infections. These studies included an educational component but also used promotional materials such as posters, letters or other written material (Brown et al., 2003; Hilburn et al., 2003; King, 2004; Pittet et al., 2000; Rao et al., 2002), or feedback to healthcare staff on compliance with hand hygiene (Pittet et al., 2000).

Three studies (Doebbeling et al., 1992; Fendler et al., 2002; Mody et al., 2003) included a control group in the study design. Mody et al. (2003) used an educational campaign followed by introduction of an alcohol-based hand hygiene product and found no difference between the control and intervention group in the rates of infection in residents of a long-term care hospital. However, in a comparable facility, Fendler et al. (2002) reported a significant difference in the infection rate after a similar intervention programme had been implemented. The overall infection rate was reported to be 3.19 per 1,000 patient days in the control group and 2.27 per 1,000 patient days in the intervention unit, a reduction of 30.4% (p<0.05). In the study conducted by Doebbling et al. (1992), a multiple cross-over design was employed to compare an alcohol-based hand hygiene product and plain soap with a medicated soap for handwashing. The authors reported a significantly lower number of total infections with medicated soap compared with the alcohol-based product and plain soap (ratio of number of infections per 1,000 patient days with medicated soap to that of alcohol and soap = 0.73; 95% CI 0.59, 0.90) and significantly fewer gastrointestinal infections. No differences were noted for any other individual nosocomial infection.

Of the prospective studies without a control group, seven included an alcohol-based hand hygiene product as part of the intervention programme. Rao et al. (2002) found a relative reduction of 17.5% in the infection rate after an alcohol-based hand hygiene product was provided at patients’ bedsides, but this was not statistically significant. Three studies (Brown et al., 2003; Hilburn et al., 2003; King, 2004) reported lower post-interventional rates of infection compared with baseline rates, but did not indicate the statistical significance of their findings. Hilburn et al. (2003) observed a relative reduction of 36.1% (8.2% at baseline versus 5.3% at post intervention), although no further statistical analysis was reported. Brown et al. (2003), in their study of the effectiveness of an alcohol-based hand hygiene product and feedback on infection-rate surveillance data, reported reductions in rates of infection from six nosocomial pathogens. However, the short surveillance periods and lack of detail in the reported results meant that few conclusions could be drawn. Finally, King (2004) reported a reduction in the number of cases of MRSA and an
increase in the incidence of *Clostridium difficile* after introducing alcohol-based hand hygiene products at each patient’s bedside. However, this study was conducted in only one ward and over too short a period to be conclusive.

Two further studies (Pittet *et al.*, 2000; Vernon *et al.*, 2001) demonstrated a significant reduction in infection rates. Following introduction of a multi-component hand hygiene programme that included an alcohol-based hand hygiene product and feedback on handwashing compliance, Pittet *et al.* (2000) reported statistically significant reductions in overall nosocomial infection (16.9% in 1994 to 9.9% in 1998, *p*=0.04) – a relative reduction in incidence rate of 41% – and in the incidence of MRSA infection (2.16 to 0.93 episodes per 10,000 patient days, *p*<0.001) over the four-year intervention period. Vernon *et al.* (2001) reported a significant reduction in rates of MRSA (0.9 to 0.6 isolates per 1,000 patient days, *p*=0.002) and VRE infection (0.5 to 0.32 isolates per 1,000 patient days, *p*=0.003) after the introduction of an alcohol-based hand hygiene product and an education session.

### 5.2.2.2 Interventions not involving an alcohol-based hand hygiene product

The remaining studies differed in the type of hand hygiene intervention implemented, although multi-component interventions were common. Fourteen studies reported a reduction in infection rates.

Three studies reported no significant reductions in infection rates. Coopersmith *et al.* (2002), following a successful intervention programme to reduce primary bloodstream infections, conducted an audit of central venous catheter care and found this to be at variance with evidence-based best practice. An educational intervention programme incorporating specific risk-reduction strategies, including handwashing and aseptic technique, was subsequently implemented to address this lack of compliance. The authors reported a trend towards lower infection rates, but this was not statistically significant. Sharek *et al.* (2002) reported a reduction in the false-positive coagulase-negative staphylococcal (CONS) blood cultures (which the authors state reflects skin colonisation rather than true infection) after the introduction of an evidence-based handwashing policy, and a programme of reminders and feedback on compliance and infection rates. Although there was a trend towards lower rates of true-positive CONS infection, again this was not statistically significant. Finally, Simmons *et al.* (1990) introduced a four-stage intervention to improve compliance with handwashing, which included observation and feedback on hand hygiene compliance, lectures, literature and a button campaign (promotional badges), and noted no difference in the number of nosocomial infections before and after the intervention. Only nurses were targeted by the intervention, which may have accounted for its lack of effect.

Larson *et al.* (2000) included a control group in their study design. In this study, a two-stage intervention was designed to improve hand hygiene compliance by generating a change in organisational culture. The results showed a significantly greater difference in the baseline to follow-up point infection rates for MRSA and VRE in the intervention hospital compared with the control hospital. However, the authors erroneously compared the relative rates of infections in the two hospitals at each timepoint and concluded that failure to identify a change in MRSA rates suggests that this is a less sensitive organism to measure the association between handwashing and transmission.

The remaining studies were prospective in design, with no control group and described interventions that resulted in significant reductions in infection rates following implementation. All of these interventions were multi-component and included general education in hand hygiene, specific education relating to invasive device care, development and implementation of hand hygiene guidelines and promotional materials relating to hand hygiene. A number of studies included feedback of data on hand hygiene compliance (Conly *et al.*, 1989; Misset *et al.*, 2004; Won *et al.*, 2004) or on infection rates (Misset *et al.*, 2004; Nettleman *et al.*, 1991). The settings for studies and types of nosocomial infection varied from study to study. For example, Macdonald *et al.* (2004) reported on rates in MRSA infections in a plastic surgery ward, whereas Misset *et al.* (2004) described rates of urinary tract infections, ventilator-associated pneumonia and central venous catheter-related bacteraemia in an ICU. Among this group of studies, the relative reduction in infection rate after the intervention varied between 29% and 76% (a median reduction of 44%).

### 5.2.2.3 Association between hand hygiene compliance and infection rates

Although 13 studies examined both compliance with handwashing and incidence rates of nosocomial infections, only Won *et al.* (2004) reported on the statistical association of these two factors. The authors found that improvement in hand hygiene compliance is associated with a significant reduction in nosocomial infection rates. Pittet *et al.* (2000) inferred an association between improved hand hygiene and reduced infection rates based on the temporal relationship observed in the course of their study. However, the authors also acknowledge that other infection control measures used during the study period prevent the reduction in infection rate being directly attributed to improved hand hygiene.

### 5.3 Discussion

A variety of interventions have been implemented in the healthcare setting to improve hand hygiene compliance and reduce rates of HAI. In the majority of studies included in this review, the interventions were successful in fulfilling this aim, regardless of whether or not they included alcohol-based hand hygiene products. However, some were not, and it is likely that a reporting bias exists in this area of research, with studies of unsuccessful interventions being less likely to be reported than studies with a positive outcome.

The majority of studies measuring compliance as an outcome had short follow-up periods, and were therefore unable to confirm whether behavioural improvements
were long lasting. Other studies found that improved compliance rates decreased immediately after cessation of the intervention, often approaching pre-intervention levels. However, two studies (Pittet et al., 2000; Won et al., 2004) demonstrated sustained improvements in handwashing behaviour that were associated with significant reductions in infection rates. In both studies, the interventions were multi-component and in progress throughout the entire study period.

A number of difficulties were encountered in synthesising the results of the reviewed studies and drawing meaningful comparisons and conclusions. These related to the heterogeneity of the studies, inadequate reporting of results and methodological weaknesses of the studies. These issues are discussed in turn.

Heterogeneity

Firstly, there was considerable heterogeneity among the studies. The interventions studied were generally complex and multi-component in nature, and few, if any, of the interventions were identical. The setting in which the intervention was applied varied, as did the types of infection monitored, the patient groups studied for infection rates, the staff groups monitored for compliance and the methods of outcome assessment. Studies differed in terms of the level of baseline outcomes, which presents difficulties in comparing relative increases or decreases. Additional sources of variability included whether the intervention was implemented for the entire study period or limited periods of time, the length of the follow-up period, and when follow up took place (eg outcomes measured continuously for 6 months from the end of the intervention and averaged over the six-month period, compared with outcomes measured at 6 months after the end of the intervention for a defined period).

It is perhaps not surprising that many results are contradictory. For example, in Eggiman et al. (2000), although there was a significant reduction in the overall infection rate, there was no reduction in respiratory tract infections. In contrast, in the study by Won et al. (2004), a reduction in overall rate of nosocomial infections was observed, but in terms of the individual infection types reported, the only significant difference was among respiratory tract infections. There may be clinical reasons for these results, but such an explanation may further illustrate the difficulties of synthesising data from this evidence base.

Given the complexities of differentiating between the sources of variation, it is not possible to compare or make definitive conclusions about the effects of specific types of intervention and to measure the size of the effects. Combining studies that share one component (eg the broad type of intervention), but differ in other respects (eg setting, patient group) can obscure important effects.

Problems with reporting of results

The problem of heterogeneity is further compounded by inadequacies in the reporting of studies. Some of the study variations are not always described in sufficient detail to allow meaningful comparisons to be made. Additionally, some studies reported neither confidence intervals nor the results of statistical tests. The development of the TREND (Transparent Reporting of Evaluations with Nonrandomized Designs) checklist (Des Jarlais et al., 2004), which makes recommendations about the reporting of data for non-randomised intervention evaluation studies in peer-reviewed publications, may lead to improvements in this area.

Methodological weaknesses

A number of methodological weaknesses were observed repeatedly. These included short periods of baseline outcome measurement before the intervention, short duration of follow up and small sample size, all of which limits the ability to detect differences that are likely to be of interest. A further limitation is the lack of blinding of subjects in studies measuring hand hygiene compliance. Overt observation may alter subjects’ behaviour, a phenomenon known as the ‘Hawthorne effect’. Researchers can minimise this effect by using unobtrusive methods of observation (for example, by using regular staff as observers or the use of a video camera) and/or by the use of concurrent controls.

In the majority of studies, baseline data of hand hygiene (ie handwashing and hand antisepsis) and/or infection rates were obtained during an initial observation period and compared with data after the intervention, often with no control groups. The findings of such studies are difficult to interpret because of a potential Hawthorne effect and the possibility that any number of confounding factors, unrelated to the intervention being assessed, may have affected the outcomes under investigation.

There may be differences among members of staff monitored for compliance before and after the intervention, or between the two groups of patients studied for infection rates. Such differences between the two study periods are likely to influence the outcomes, and should be adjusted for in the analysis.

Seasonal influences on hand hygiene compliance and infection rates represent another potential source of confounding, as do other infection control measures taking place during the study period and changes in the hospital facilities (for example, King (2004) noted a change in the quality of paper towels provided during the study period). Furthermore, an existing trend towards increasing or decreasing HAI rates prior to the intervention could also provide a plausible explanation of any subsequent changes in outcome.

Statistical regression to the mean is another phenomenon which may influence interpretation of the data. This refers to the fact that if the baseline occurrence of an outcome is abnormally high or low, simply because of random variation, the next time it is measured the statistical chances are that it will be much closer to the average, even if no intervention or changes have taken place. Rates of nosocomial infections, even when endemic, can vary from month to month (Cooper et al., 2003). Statistical regression to the mean is particularly problematic when only one or two types of nosocomial infection are being studied and the surveillance period is short. It is also a
significant concern when staff are selected for inclusion in a study aimed at improving levels of hand hygiene compliance because of particularly low levels of baseline compliance, as was the case in the Sharek et al. (2002) study.

For these reasons, it is preferable to include extended periods of data collection, both before and after the intervention, and/or to include a concurrent control group in the study design. However, it should be noted that methodological flaws were also identified in those studies that used concurrent control groups. In all studies that incorporated one or more concurrent comparison groups, these groups were non-randomised controls, i.e. separate hospitals, units or wards that did not receive the intervention. Details regarding the comparability of the intervention and control groups were not always reported. Even when baseline characteristics of the participants were compared and found to be similar, this does not ensure that the groups are comparable in all possible ways that are relevant to the study outcome. For example, there may be changes in the thoroughness of surveillance or in the general cleanliness of the hospital, occurring differentially across intervention and control groups. Matching with another unit in the same hospital may help to maximise comparability, but poses the problem of containing the effects of the intervention within the intervention areas to avoid any contamination of effects within the control areas.

The use of non-randomised controls makes it impossible to rule out the possibility that some unique undetected characteristic of the control or intervention units could be an explanation for the outcomes observed. To address this issue thoroughly, cluster randomised trials are required, in which a large number of hospitals or units are randomly assigned to intervention or control conditions.
6 COST EFFECTIVENESS

The objectives of this chapter are to:

• quantify the cost of HAI at national level in Scotland
• discuss the cost and benefits of alcohol-based hand hygiene interventions to reduce the risk of HAI
• assess whether the added benefits of improving hand hygiene are likely to offset the additional costs.

Section 6.1 describes the evidence sources and details of the literature search. Section 6.2.1 quantifies the national cost of HAI. Section 6.2.2 presents the published evidence on the cost effectiveness of using alcohol-based hand hygiene products and Section 6.3 is a discussion section.

6.1 Methods

6.1.1 Sources of evidence

Evidence was obtained from a variety of sources, including published literature, grey literature, information submitted by scoping group members and the survey results.

6.1.1.1 Literature search

Given the known lack of economics literature relating to handwashing and HAI, it was not considered worthwhile to undertake a separate search for primary literature. Instead, the literature retrieved during the scoping searches and the searches for primary literature on clinical effectiveness were scanned for items relevant to the economics work (see Section 5.1.1.1). The websites of health economics research centres were also searched.

When the search was broadened to include all literature relating to HAI, the NHS Economic Evaluation Database (NHS EED) and Health Economic Evaluation Database (HEED) were searched again and an internet search was carried out.

6.1.1.2 Study selection criteria

The following inclusion criteria were applied:

• studies that estimated resource use or savings at Scotland or UK level
• studies that assessed the cost effectiveness of hand-hygiene programmes that included alcohol-based hand hygiene products
• studies published after 1995.

Studies published prior to 1995 were excluded because they were included in the research by Plowman et al. (1999b). Additionally, patterns of care and resource use have subsequently changed in the NHS.

6.2 Results

6.2.1 Estimating the national burden of HAI

Measuring the national burden of HAI – in terms of identifying the additional resources used and costs to both the patient and the health service – is difficult, given the lack of adequate incidence and prevalence data and the variation in resources used in managing different types of HAIs.

As seen in Table 6-1, financial costs and length of hospital stay vary depending on the type and site of HAI. These values were calculated by Plowman et al. (1999b) based on their cost of illness study conducted at an English district general hospital during 1994–1995. Plowman et al. (1999b) used regression analysis, which controlled for age, sex, admission specialty, diagnosis, number of co-morbidities and admission type, to estimate the additional costs and length of stay at UK level.

Table 6-1 shows the modelled additional mean cost to the hospital and the additional length of stay for inpatients that contracted an HAI.

<table>
<thead>
<tr>
<th>Site of HAI</th>
<th>Mean cost (£)</th>
<th>Additional length of stay (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinary tract</td>
<td>£1,122</td>
<td>5.1</td>
</tr>
<tr>
<td>Lower respiratory tract</td>
<td>£2,080</td>
<td>8.4</td>
</tr>
<tr>
<td>Surgical wound</td>
<td>£1,594</td>
<td>7.1</td>
</tr>
<tr>
<td>bloodstream</td>
<td>£6,209</td>
<td>4.0</td>
</tr>
<tr>
<td>Skin</td>
<td>£1,615</td>
<td>10.6</td>
</tr>
<tr>
<td>Other</td>
<td>£2,465</td>
<td>12.4</td>
</tr>
<tr>
<td>Number of HAIs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple</td>
<td>£8,631</td>
<td>29.1</td>
</tr>
<tr>
<td>One or more HAI at any site</td>
<td>£2,971</td>
<td>11.3</td>
</tr>
</tbody>
</table>
Urinary tract and surgical wound infections tend to be the most common HAI infections (Plowman et al., 1999b). Both incur additional costs of over £1,000 per patient.

Recent studies attempting to measure the national burden of HAI focus primarily on the hospital sector. However, the Plowman et al. (1999b) study remains the most comprehensive in this area. The study estimated the socio-economic burden of HAI in adult patients in the following hospital specialities of a district general hospital: general medical, general surgical, urology, gynaecology, ear, nose and throat, elderly people and obstetrics (caesarean-section patients only). Extrapolating the results obtained in the district general hospital study to the UK level and estimating what proportion of the selected specialities represented total hospital activity in England, Plowman estimated that the additional annual cost of HAI to healthcare providers in England was £987 million at 1994–1995 prices (£931 million in the hospital sector and £56 million post discharge in primary care).

Extrapolating Plowman et al.’s estimates to the Scottish population, the estimated annual cost in Scotland was £101 million (1994–1995 prices). Walker (2001) investigated different methods of estimating the burden of HAI to Scotland by using the results of the Plowman et al. study and Scottish hospital activity data. Walker concluded that the annual costs range from £139 million to £186 million (1999 prices).

In terms of resource use, Plowman et al. estimated that the number of additional bed days as a result of HAI is 3.64 million. Walker calculated the pro rata figure for Scotland to be 0.38 million bed days – the equivalent of 1,000 beds occupied full time throughout the year.

6.2.2 Cost effectiveness of alcohol-based hand hygiene products

6.2.2.1 Costs and benefits

Healthcare staff use soap and water or alcohol-based hand hygiene product to clean hands that are not visibly soiled. The potential cost of alcohol-based hand hygiene products compared with handwashing with soap and water include:

- installation, provision and maintenance of alcohol-based hand hygiene product dispensers
- supply and safe storage of alcohol-based hand hygiene products (eg costs associated with additional space requirements, storing and disposing of hazardous substances)
- accidents from improper use of alcohol-based hand hygiene products (alcohol-based hand hygiene products are flammable substances).

The use of alcohol-based hand hygiene products in hand hygiene may lead to a reduction in the risk of HAI. The benefits associated with this outcome include:

- improved patient outcomes (eg fewer deaths and better quality of life). The magnitude of the benefits depends on patient characteristics and will vary between patients. For example, some patient groups, such as children, the elderly and immunocompromised patients, are more susceptible to HAI.
- savings in healthcare resources in secondary and primary care (eg bed days, drugs and other consumables, healthcare staff time)
- savings in non-healthcare resources including patients’ time away from normal activities (eg employment), carers’ time, costs incurred by patients and carers in getting treatment for HAI and societal costs (eg sickness absence, lost production and reduced risk of litigation)
- savings associated with using alcohol-based hand hygiene products instead of hand hygiene with soap and water, including healthcare staff time and consumables.

6.2.2.2 Published economic evidence

All economic studies are detailed in Appendix 5.

Five economic studies met the inclusion criteria and are summarised here. Some of these studies have been discussed in Chapter 5. The economic studies do not evaluate the relative cost effectiveness of individual components of a hand hygiene policy but consider the overall impact of alcohol-based hand hygiene products in general.

Voss and Widmer (1997) modelled the time for hand hygiene episodes using soap and water compared with alcohol-based hand hygiene products in a 14-bed ward staffed with 12 healthcare workers. The authors concluded that assuming 100% compliance and three hand hygiene episodes per hour per staff member, healthcare workers require 16 hours for handwashing compared with 4 hours for using alcohol-based hand hygiene products in each eight-hour shift. These equate to 17% and 3% respectively of the total workforce time per shift.

As infection control policies are generally multi-modal, there are few studies that assess the cost effectiveness of alcohol-based hand hygiene products alone. Pittet et al. (2000) measured the effect of a long-term promotional campaign which focused on bedside alcohol-based hand disinfection on hand hygiene compliance, and infection rates at a Swiss hospital. Compliance with hand hygiene increased from 48% to 66% over a three-year period and infection rates fell from 16.9% to 9.5% over a four-year period. The authors also estimated the cost implications of the hand hygiene promotional campaign using the clinical-effectiveness results observed in their earlier study (Pittet et al., 2004). The hand hygiene programme was cost saving if less than 1% of the reduction in infection rates over the study period could be directly attributable to improved hand hygiene practice. The authors noted that the results may not be entirely representative and concluded that promotion of hand hygiene is probably cost effective but further research is needed.
usage of an alcohol-based hand hygiene product and teicoplanin (an antibiotic used to treat MRSA) were monitored. The results showed that the cost of teicoplanin used fell from £35,600 to under £22,000. This was in line with the decrease in the rate of new MRSA cases, from 1.9% to 0.9% (p<0.05). The cost and usage of alcohol-based hand hygiene products (750 ml bags) increased from £33 for 6 units to £116 for 21 units. Compliance with hand hygiene after clinical contact increased from 42% to 78% and hand hygiene before clinical contact increased from 20% to 47%, based on rates observed at the first and second audit. The main limitations of this study were the small sample size and it was not possible to identify what reduction in new MRSA cases was solely due to improved hand hygiene.

Rao et al. (2002) reported that hospital-acquired MRSA cases as a proportion of total MRSA cases fell from 50% to 39% over a one-year period at a teaching hospital following the introduction of an alcohol-based hand hygiene product at bedsides which was supported by a promotional campaign. The estimated cost of purchasing the alcohol-based hand hygiene product was £5,000 for the study period.

The National Patient Safety Agency (NPSA) (2004a) reported the findings of a campaign at six pilot sites. The campaign aims to promote the use of alcohol-based hand hygiene products in hand hygiene and is currently being implemented in England and Wales. The NPSA report was supported by an economic evaluation conducted by the Department of Health (National Patient Safety Agency, 2004c). The aim of the economic evaluation was to assist trusts in estimating the potential costs of and benefits from implementing the national campaign. The perspective adopted for the evaluation was a hospital participating in the national campaign. The evaluation only included the direct costs of purchasing alcohol-based hand hygiene products by the hospital. The costs of promotional material and installation of dispensers were assumed to be centrally funded.

Other assumptions underlying the evaluation included:

- a 9% decrease in the HAI rate from 7.8% to 7.1% solely due to improved hand hygiene
- an increase in hand hygiene compliance from 28% to 76% during the first-year period and sustained rate of compliance at 76% for years 2–5
- a volume of 6.5 ml alcohol-based hand hygiene product used per patient per day
- a reduction in costs for hospitals, primary care, patients and informal carers, based on research by Plowman et al. (1999b)
- a gain of 0.007 quality-adjusted life years (QALYs) for every non-fatal HAI avoided (based on quality of life reported by the Plowman et al. study) and 7 QALYs for every fatal HAI avoided (based on age profiles and age-specific death rates from Plowman et al. and the average age-specific quality of life values derived from the Health Survey for England).

The evaluation estimated the costs and benefits for a 500-bed hospital. In the steady state, annual net cash savings were around £460,000 and 12 QALYs were gained.

On a national basis, the estimated steady-state annual net cash savings were £137 million and 3,246 QALYs were gained. This comprised annual expenditure on alcohol-based hand hygiene products of £2 million and savings of £139 million. The sensitivity analysis showed a net saving if a 1% reduction in HAI rate (ie from 7.80% to 7.72%) was achieved.

This study had several shortcomings. Firstly, the impact on infection rates as a result of using alcohol-based hand hygiene products was not measured in the pilot sites. Secondly, the clinical-effectiveness evidence presented in Chapter 5 of this report shows that large increases in compliance, as assumed by the NPSA economic evaluation, are generally unlikely to be sustained in the longer term. Thirdly, the model assumed that only 6.5 ml of an alcohol-based hand hygiene product would be used per patient per day. This may be a significant underestimation given that Rao et al. (2002) reported that the average dose dispensed is 2.5 ml.

6.3 Discussion

It is apparent that the costs of HAI on healthcare providers and patients are significant. Both Plowman et al. (1999b) and Walker (2001) focused on costs to the healthcare sector, and the specialties covered by Plowman et al. excluded some high-risk groups such as patients in intensive care, and patients with renal disease and cardiac patients. If costs to the patient and society as a whole are included, then the true national cost of HAI is even higher. Given the excess pressure on healthcare resources, any resources released could be deployed immediately. Thus, the opportunity cost could be higher than the financial value of the resources.

Further research is needed to measure the direct impact of improved hand hygiene on infection rates and the associated reduction in healthcare resource requirements. Research by Pittet et al. (2004) is the most comprehensive long-term study to date in this area and has demonstrated that a targeted hand hygiene campaign does improve compliance and reduce infection rates. The costs of providing alcohol-based hand hygiene products and an effective promotional campaign are likely to be relatively small compared with the potential costs incurred by healthcare providers in treating HAI. Although Pittet et al. and the NPSA economic evaluation used different cost bases, both studies showed that even if only a 1% reduction in the HAI rate is achieved, their hand hygiene programmes using alcohol-based hand hygiene products are cost effective.
7 OTHER ISSUES RELEVANT TO CLINICAL AND COST-EFFECTIVENESS EVIDENCE

This section describes the current provision of hand hygiene arrangements in Scotland and examines organisational issues pertaining to alcohol-based hand hygiene products, including safety, risk assessment and the selection of an alcohol-based hand hygiene product for a healthcare setting.

7.1 Survey of current practice in hand hygiene arrangements

7.1.1 Methods

In order to assess the current provision of hand hygiene arrangements in primary and acute care settings, a survey of all inpatient facilities in Scotland was conducted during August and September 2004.

The questionnaire aimed to gather information on:
- adequacy of handwashing facilities
- availability of alcohol-based hand hygiene products
- maintenance of facilities for current hand hygiene arrangements
- audit of hand hygiene compliance
- provision of education programmes for staff and visitors.

The questionnaire was designed by NHS QIS and piloted by two infection control staff based in Glasgow and Fife. The postal questionnaire was then sent to 27 leads in infection control across all NHS operating divisions, for distribution to the most relevant local person (ie nurse, physician, nursing/risk management/medical director, consultant in public health medicine) to complete. Where individuals had responsibility for infection control in more than one healthcare facility and hand hygiene arrangements were similar, only one questionnaire was completed and the facilities which the responses covered recorded on the questionnaire. Where arrangements differed, a questionnaire for each facility or unit/ward within hospitals was completed. Non-responders were followed up by telephone.

A copy of the survey is available in Appendix 6.

7.1.2 Results and discussion

Forty-two questionnaires were returned (27 from primary care settings, 10 from acute settings and five from healthcare facilities covering both settings). Questionnaires were completed to varying degrees; therefore, the total number of responses differed for each question. No questionnaire was excluded from the analysis.

Handwashing facilities

The provision of satisfactory handwashing facilities varied across healthcare facilities. Thirty-nine out of 42 respondents reported wide ranging bed to wash hand basin ratios of between 1:1 and 20:1. The most frequently reported ratios were 6:1 by 25.6% and 4:1 by 17.9%. Patients in ICUs have a greater risk of acquiring nosocomial infections. Eight of the 42 healthcare facilities surveyed had an adult and/or neonatal ICU (not including intensive psychiatric care units). Of these facilities, all eight responded and only one reported the availability of a wash hand basin for each bed in adult and/or neonatal ICUs.

When asked if more wash hand basins were required, there was large variability in the responses from 35 out of 42 facilities. However, only 40% felt that their current provision was adequate.

The adequate provision of water, soap and paper towels at handwashing facilities was evaluated by respondents and the results are displayed in Table 7-1.

There was large variability in the responses regarding the percentage of wash hand basins with taps providing good water flow, with only 17.1% reporting that all taps met this standard.

Out of the respondents, 90.2% reported that all wash hand basins had liquid soap and 87.2% had towels available. In the remainder, these products were available at more than 90% of wash hand basins.

In published literature, inadequate hand hygiene facilities and inconvenient location of sinks are often cited by healthcare staff as a barrier to handwashing. The results of the audit by Kesavan et al. (1998) of all handwashing facilities in 19 elderly care wards in seven hospitals showed that none of the 264 sinks assessed were of an acceptable standard. The most important finding was the absence of a cleansing agent in 12.1% of sinks. In particular, 93.2% of ward sinks and 79% of treatment room sinks did not have an antiseptic agent. 10.2% of sinks were inaccessible due to being blocked by equipment or poor placement (eg behind doors), some had no soap dispenser (24%) and few sinks had elbow-operated taps (39%). Kesavan et al. recommend that careful consideration should be given to the design of
wards and a standard checklist should be used for every hospital sink including:
- a suitable cleansing agent, in the form of liquid soap
- an antiseptic agent
- elbow-operated taps
- paper towels
- facilities for the disposal of used paper towels.

Several investigators have examined the relationship between access to sinks and frequency of handwashing among healthcare staff with variable results. The results of a multicentre study (Vernon et al., 2000), comparing the effect of the type of hospital and design of unit (ie six ICUs, six medical/surgical wards and one skilled care unit, with sink to bed ratios ranging from 1:1 in single patient rooms to 1:15 in wards) on hand hygiene compliance, showed that the unit type and design have little effect on hand hygiene compliance. Compliance rates across centres (25–36%) and among units (10–40%) were low.

Lankford et al. (2003) assessed the impact of increasing sink availability on hand hygiene compliance before and after the construction of a new hospital designed with greater access to sinks. Hand hygiene was observed in the four units – haematology/oncology unit, solid organ transplant unit, surgical ICU and medical ICU – where the sink to bed ratios were 8:33, 4:23, 1:1 and 1:1 respectively in the old hospital compared with a 1:1 ratio in all units in the new hospital (hand hygiene products such as gloves, paper towels, hand lotion were also more accessible in the new hospital). The authors found that hand hygiene compliance was significantly better in the old hospital compared with the new hospital (53% versus 23%, p<0.001).

Both these studies suggest that increasing the availability of sinks alone is unlikely to improve compliance rates. Perceived risks to the individual (eg contact with an isolation patient, ICU setting) were more likely to be positive predictors of hand hygiene compliance.

By contrast, the Kaplan and McGuckin study (1986) compared hand hygiene compliance in two ICUs (1:1 bed to sink ratio in medical ICU, 1:4 ratio in surgical ICU) and demonstrated that the frequency of handwashing per patient contact among nurses was significantly greater in a unit with a dedicated wash hand basin than a unit with fewer sinks (76% versus 51%, p<0.01). However, the number of handwashing opportunities may differ due to the nature of the specialties.

Availability of hand hygiene products

The NHS QIS survey showed that alcohol-based hand hygiene products were available to all frontline healthcare staff in 80.5% of the 41 healthcare facilities that responded. Several respondents reported that alcohol-based hand hygiene products were available in all clinical areas. However, it was noted that further work was still needed to increase access to these products in some areas, such as acute psychiatric wards. Where alcohol-based hand hygiene products were not available to all staff, this was due to budget constraints, products not being ordered and poor distribution of products.

The provision of alcohol hand gel/rub for visitors and encouragement of its use depended on local hospital policy. The majority of healthcare facilities (>75%) reported that alcohol hand gel/rub was available to visitors. The location of alcohol hand gel/rub for visitors’ use was generally at the entrances and exits of wards (eg renal, vascular, haematology, acute psychiatric, burns), specialised units (eg high dependence unit, special care baby unit, ICU) and patient rooms.

Survey responses described several circumstances in which visitors were encouraged to use alcohol hand gel/rub; these included visiting patients in isolation, visiting patients infected with MRSA or C. difficile, during outbreaks of infection with antibiotic-resistant organisms, and during outbreaks of gastric infection and for relatives involved in the direct care of patients. The use of hand gel/rub by visitors was also cited by one respondent as a precautionary measure in infection control.

Visitors were encouraged to comply with hand hygiene policies through verbal advice from healthcare staff (eg by showing visitors where the facilities were located) and through written communication (eg patient leaflets and posters that are strategically placed above sinks).

In only a minority of facilities was alcohol hand gel/rub not provided to visitors. One respondent said that use of alcohol hand gel/rub was inappropriate for their setting. Another respondent reported that alcohol hand gel/rub was restricted for use in clinical hand hygiene only. In facilities where alcohol hand gel/rub was not provided or its use seldom encouraged, visitors were asked to handwash with soap and water.

Provision of hand hygiene products

Alcohol-based products

The facilities surveyed used alcohol hand gel or handrub or a combination ofboth products. The brands of alcohol-based hand hygiene products provided for staff use varied across facilities. Levermed/Leverline was the most commonly used alcohol-based hand hygiene product (15 hospitals), followed by Hibisol (nine hospitals). Other alcohol-based hand hygiene products provided for staff use were: Deb Cutan, Spirigel, Hibiscrub, Hydrex, Manugel, Purell, MedT, Aquasept, Med+ and H5.2

1 While it is recognised that soap and water are more effective than alcohol-based hand products against the spore-forming bacterium C. difficile, this was as reported in the survey responses (www.cdc.gov/ncidod/hip/gastro/ClostridiumDifficileHCP.htm).

2 While it is recognised that several products, eg Hibiscrub, are not alcohol based, this was as reported in the survey responses.
Of the 35 facilities that responded, 71.4% reported that alcohol hand gel/rub was provided in wall-mounted dispensers. Alcohol hand gel/rub was also provided in portable and freestanding bottles (which could be inserted into brackets on trolleys), tubes, pump dispensers, wipes and individual sachets. The versatility of product packaging enabled hand hygiene products to be available at patients’ bedside (eg, on medicine/drug case notes/clinical/dressing trolleys, on locker tops and desks, and located in a variety of areas such as treatment rooms, clinical areas (including high-risk areas), doctors’ rooms and mobile units.

Only 26.8% of the 41 respondents reported that personal supplies of alcohol hand gel/rub were provided to all frontline staff. One respondent reported that personal supplies were available in high-risk clinical areas such as ICU, high dependency units and renal units. In some facilities, personal supplies were provided to certain groups of staff such as community staff and portering staff working in service corridors where no handwashing facilities were available. One respondent reported that personal supplies could be ordered by all staff, however this opportunity was only usually taken up by community staff. Two facilities reported that trials were underway and the outcome of these trials would determine whether or not personal supplies would be rolled out across the hospital. Reasons for not providing personal supplies included the availability of alcohol hand gel/rub at every bed space and clinical area, and the practical problems associated with each staff member having their own supplies.

Hand cream

Of the 42 respondents, 42.9% reported that hand cream was available to all frontline staff. Hand cream was supplied in one central area, in all clinical areas or via the procurement department. Some facilities offered hand cream in individual sachets or small tubes. It was also reported that staff members purchase their own supplies. One respondent quoted financial reasons for not providing hand cream.

Maintenance of hand hygiene equipment

Of the 35 respondents, 54.3% reported that alcohol hand gel/rub dispensers are single use. The majority had a procedure in place to identify and replace empty alcohol hand gel/rub dispensers. Responsibility for these duties differed among healthcare facilities. In some facilities, domestic or nursing staff were solely responsible for both checking and refilling dispensers. Among others, the responsibility was shared among domestic and ward/nursing staff, with ward/nursing staff identifying and notifying domestic staff of empty dispensers and domestic staff in charge of replenishment. In several facilities, the responsibility for replacement depended on the type of dispenser that was empty; nursing staff were responsible for maintenance of bottled or personal supplies and domestic staff were responsible for wall-mounted dispensers. Several facilities responded that all staff were accountable for ensuring there was a sufficient supply of alcohol hand gel/rub, replacing empty dispensers/bottles as required. Many facilities responded that dispensers were checked on a daily basis. Ordering of supplies generally took place weekly.

The majority of facilities for which data are available (>75%) had a procedure for identifying broken or malfunctioning dispensers and replacing or repairing equipment. Those responsible for the maintenance of dispensing equipment included: estates, domestic services manager/staff, nursing staff, maintenance helpdesk, manufacturers and hotel services. In many cases, nursing/ward staff were required to contact maintenance providers to inform them of the problem.

Audit

Of the 35 facilities that responded, 40.0% had performed local audit of hand hygiene compliance in the last 2 years. Several respondents provided examples of recently performed audits. A commonly used audit tool to assess hand hygiene compliance in healthcare workers was an observation tool derived from published work. Compliance rates could be calculated by comparing hand hygiene opportunities (ie identifiable episodes when hand hygiene should take place) with observed hand hygiene. This tool enables baseline levels of hand hygiene compliance to be established, which can be used for comparison at future re-evaluations.

Other types of audits included observation of hand decontamination techniques (eg using soap and water, alcohol hand gel/rub) and observation of hand hygiene practice during staff activities and work patterns. These audits provide staff with feedback on their performance, often by means of a scoring sheet, and identify where infection control practices could be improved.

Several facilities provided the results of their hand hygiene compliance audits. One respondent provided a comparison of handwashing baseline scores across a number of primary care sites showing some improvement and sustained levels of compliance. An audit at one facility showed that the high standards of hand hygiene compliance had significantly reduced the number of newly-infected patients with MRSA and the use of teicoplanin.

Audits of handwashing facilities were also reported. One respondent reported that mixer taps had been implemented as a result of a recent audit.

Education, training and staff

Education and training

Education is one of the cornerstones for improvement in hand hygiene practice and compliance. More than 70% of the respondents included hand hygiene in their infection control education programmes. In many facilities, hand hygiene was incorporated as part of general staff education (eg in induction programmes, health and safety training, lectures for nursing/medical students, ward-based/clinical area education sessions, in-service training, online training and food hygiene training). Practical hand hygiene training tools (eg ultraviolet light/glow-germ educational kits) were
commonly used in induction programmes. One respondent reported that hand hygiene awareness packs were given to all new staff. Another reported providing written advice.

Education programmes dedicated to hand hygiene included awareness weeks, infection control awareness training and regular infection control updates.

The frequency of educational events varied, ranging from monthly to yearly updates or those that occurred on an ad hoc basis. Many facilities reported that hand hygiene education was mandatory. Education programmes were co-ordinated or initiated by ward managers, infection control nurses or cleanliness champions.

Staffing

Thirty-eight facilities provided information on the number of staff employed in infection control. The number of whole-time equivalent (WTE) infection control nurses employed varied among healthcare facilities, and ranged between 0 and 5. Table 7-2 shows the variability in numbers of nursing staff employed in infection control.

The number of nursing staff required for infection control may depend on the type (ie acute, community) and/or size (the approximate number of WTE frontline healthcare staff cited by 36 hospitals ranged from 5 to 13,000) of healthcare facility.

Approximately 70% of respondents reported that at least one infection control nurse was employed by their healthcare facility. However, 28.9% did not employ a WTE infection control nurse. The median number of WTE infection control staff per WTE frontline healthcare staff was 1:225.5. This equates to less than one infection control staff per healthcare facility.

Promotional activities

Of the 38 respondents, 39.5% had introduced initiatives to improve or maintain compliance with hand hygiene in the last 2 years. Examples of new initiatives included:

- hand hygiene education programmes and training
- the purchase of glo-germ boxes for use in training sessions
- hand hygiene awareness weeks
- regular infection control updates
- the introduction of alcohol gel in all clinical areas and training in their use by the manufacturer
- increasing awareness of handwashing opportunities (eg before and after feeding patients, before any activity)
- the distribution of information booklets to all new staff and the placement of posters in appropriate locations in the healthcare facility
- instalment of adequate handwashing facilities (eg mixer taps, paper towels)
- appointment of an infection control nurse as well as the introduction and training of cleanliness champions and link nurses
- the introduction of audit (eg handwashing facilities, handwashing technique and self-assessment of hand hygiene practice).

Only 27.5% reported that new initiatives had been set up to involve patients in improving staff compliance with handwashing. Some of these initiatives included:

- encouraging patients to observe and remind staff about washing their hands before any direct contact with them
- distributing leaflets about handwashing and the importance of staff compliance to all patients and visitors
- issuing questionnaires to patients and relatives.

Forty percent of the 40 respondents reported that ongoing surveillance of compliance with hand hygiene was being undertaken. Common types of surveillance used included planned audit (eg compliance, observation tools, self-assessment), monitoring of hand hygiene product consumption and ongoing staff education.

Of the 33 respondents, 24.2% reported that there were initiatives progressed at management level to improve hand hygiene compliance. These included:

- the implementation of new guidance (eg NHS QIS standards, infection control code of practice)
- introduction of infection control manuals
- the appointment of dedicated staff or groups to take forward hand hygiene initiatives and education (eg divisional hand hygiene group, cleanliness champions, link nurses)
- continued educational programmes
- the introduction of alcohol hand gel/rub.

Table 7–2 Number of WTE infection control nurses employed in surveyed facilities

<table>
<thead>
<tr>
<th>Number of infection control nurses (WTE) employed at responding facilities</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>11 (28.9)</td>
</tr>
<tr>
<td>1</td>
<td>17 (44.7)</td>
</tr>
<tr>
<td>2</td>
<td>3 (7.9)</td>
</tr>
<tr>
<td>3</td>
<td>2 (5.3)</td>
</tr>
<tr>
<td>4</td>
<td>3 (7.9)</td>
</tr>
<tr>
<td>5</td>
<td>2 (5.3)</td>
</tr>
</tbody>
</table>
Several respondents noted that infection control was a corporate objective of their hospital. One respondent reported that there had been increased financial investment to enable hand hygiene awareness and compliance to be satisfactorily addressed.

**Improvements to hand hygiene arrangements**

Of the 38 respondents, 68.4% felt that changes to the way in which alcohol hand gel/rub was currently provided could result in increased use by staff. Common proposals were increasing the number of dispensers, greater provision of personal supplies of alcohol hand gel/rub and increasing the availability of alcohol-based hand hygiene products in different sizes and designs. Several respondents also stressed the importance of being able to access alcohol hand gel/rub at the point of delivery of care. A change to more user-friendly products, education of staff and increased awareness of the location of hand hygiene supplies were also recommended.

When asked what changes should be implemented to improve compliance with hand hygiene, the followings suggestions were recommended:

- providing continuous education dedicated to hand hygiene for all grades of staff (including non-clinical staff eg portering staff) and ensuring senior staff are good role models
- continuing ongoing surveillance
- undertaking more audit
- providing more feedback on hand hygiene compliance to staff
- upgrading of handwashing facilities
- ensuring that appropriate and adequate hand hygiene products (eg increased number of dispensers, increased availability of alcohol gel, provision of towels) are available
- appointing more staff dedicated to hand hygiene (eg cleanliness champions) and increasing their presence on wards
- alerting patients and visitors to the importance of hand hygiene through posters and education leaflets.

Finally, one respondent stressed the need for a budget for infection control to implement the recommendations.

Feedback from several respondents suggested that increased awareness of hand hygiene, better provision and superior hand hygiene products had improved hand hygiene compliance and reduced the incidence of HAI in their healthcare facilities. However, several respondents felt that further improvement was necessary.

**7.2 Safety of alcohol-based hand hygiene products**

**7.2.1 Fire hazards associated with alcohol-based hand hygiene products**

The flammability of alcohol is well known. As alcohol-based hand hygiene products contain 60–95% of alcohol, they are classified as Class 1 flammable liquids (Wagner, 2003). The incidence of fires associated with the use of alcohol-based hand hygiene products in healthcare settings is extremely low (Greene, 2003). In the UK, there have been no incidents relating to alcohol-based hand hygiene agents that involved fire (National Patient Safety Agency, 2004b). Two separate incidents have been reported to date in the US. The first reported case of fire associated with an alcohol hand gel occurred when a spark of static electricity, from a metal door, ignited alcohol hand gel (containing 73.7% ethanol and within manufacturing specifications) residue on the arms and hands of a healthcare worker who had just removed a 100% polyester gown (Bryant et al., 2002). The second incident occurred when a healthcare worker lit a cigarette after using alcohol hand gel (Greene, 2003). Both healthcare workers suffered superficial skin burns (Greene, 2003).

Following the first reported incident of fire, the hospital introduced several measures to improve fire safety. These included providing staff with education on the safe and appropriate use of alcohol-based products (eg highlighting the need to allow the product to evaporate completely), replacing polyester gowns with those with an anti-static carbon fibre or anti-static finish, and increasing humidification to reduce static electricity (Greene, 2003). These preventative steps can apply to all hospitals that provide alcohol-based hand hygiene products for staff and visitors.

In response to concerns about the potential flammability of these agents, the placement of dispensers containing alcohol-based hand hygiene products has been scrutinised. Fire marshals across several US states introduced local policies to minimise fire hazards by prohibiting the placement of these dispensers in exit corridors or areas open to exit corridors of hospitals. A questionnaire undertaken by Boyce and Pearson (2003) showed that 11.4% of the responding facilities had been instructed by local fire marshals to remove dispensers from corridors; however, the results also showed great inter- and intrastate variability in the action taken on this issue. Furthermore, none of the 798 responding centres reported a fire related to dispensers containing alcohol-based hand hygiene products (Boyce & Pearson, 2003).

Current available evidence indicates that the low fire risk associated with the use of alcohol-based hand hygiene products is greatly outweighed by the potential benefits of providing alcohol-based products (eg the reduction in HAI, increased hand hygiene compliance) in convenient areas (eg corridors, patients’ bedsides).

**7.2.2 Risk of injury to healthcare staff**

The use of alcohol-based hand hygiene agents is not without risk of injury to staff. Ibrahim and Smith (2003) reported two types of injury from using wall-mounted dispensers. The first incident involved a chemical burn, caused by alcohol gel spraying from dispensers directly to the face of a healthcare worker; the second was the risk of skidding on gel that has leaked or been split on the hospital floor.
Ingestion of alcohol-based hand hygiene products can also occur. Children and patients on psychiatric wards are particularly at risk. The National Patient Safety Agency (NPSA) reported that these patient groups have been known to ingest the products when in a confused state. As a precaution, the NPSA recommends that personal supplies of alcohol-based hand hygiene products be provided to staff in these areas (National Patient Safety Agency, 2004b).

### 7.2.3 Assessing and managing risk

The safety concerns outlined in this section illustrate the need to assess and manage the risks associated with alcohol-based hand hygiene products. Risk assessment could consider the following measures:

- outlining a process for ordering the product ahead of time
- determining appropriate quantities of the product
- identifying suitable storage of supplies (eg fire-resistant storage cabinet)
- identifying appropriate locations for dispensers
- ensuring that dispensers are mounted at an appropriate height (eg below the waist)
- educating staff on the correct use of alcohol-based product to prevent the potential spontaneous ignition of residue on hands
- educating staff on using dispensers (eg two-handed method) to ensure safe delivery of product into the palm
- ensuring that dispensers are cleaned regularly to prevent blockages
- establishing a procedure for disposing of empty dispensers
- providing a protocol on a cleaning up after a spill or misapplication of a product for healthcare workers.

### 7.3 Factors to consider when selecting hand hygiene products

When evaluating hand hygiene products for use in a healthcare setting, a product selection committee should be established (Pittet, 2003). The committee should be multidisciplinary and can comprise nursing, medical and infection control staff and representation from planning, administration, estates and management. The roles of this committee are to:

- analyse and determine the needs of the facility
- establish criteria for product selection
- evaluate products in different clinical settings
- project resource use
- plan cost analyses.

#### 7.3.1 Establishing criteria for product selection

Many factors should be considered before selecting a hand hygiene product. The success of the hand hygiene product (ie its overall effectiveness) within a healthcare setting depends upon a product’s antimicrobial activity in addition to user acceptance, accessibility and design of the product dispensers, and quality of other hand hygiene facilities (eg softness of paper towels).

Efficacy, user acceptability and design of dispensers are examined in detail in the following sections.

#### 7.3.1.1 Efficacy

The efficacy of a wide range of hand hygiene preparations was reviewed in the Guideline for Hand Hygiene in Health-care Settings (Centers for Disease Control and Prevention, 2002). The majority of alcohol-based hand hygiene products contain isopropanol, ethanol, n-propanol or a combination of these products. Alcohol-based products for hand hygiene must contain between 60% and 95% alcohol to be effective as antimicrobial agents.

In the US, the efficacy of alcohol-based hand hygiene products is based on the Food and Drug Administration Tentative Final Monograph (Food and Drug Administration, 1994). The criteria for efficacy are a 2-log reduction of the indicator organism on each hand within 5 minutes of first use and a 3-log reduction within 5 minutes after the tenth use. In Europe, the standard used is EN1500, which requires the log reduction in artificial bacterial contamination of the test product compared with that of the reference rinse of 60% isopropyl alcohol.

There have been reports that alcohol hand gels have not met the European standard for efficacy in published literature (Kampf & Ostermeyer, 2004; McDonald, 2004). However, it is unclear what this might mean for clinical practice. There are indications that alcohol hand gels may be better tolerated than alcohol rinses due to the addition of emollients. If alcohol hand gels improve compliance with hand hygiene, small reductions in the efficacy of handrubs may be immaterial. From the data available at the present time, more substantial conclusions cannot be determined.

#### 7.3.1.2 User acceptability

The physical characteristics of soaps or alcohol-based hand hygiene products (eg fragrance, colour, consistency, drying time, emollient effect and residue after use) greatly influence their acceptance by healthcare workers. While several of these characteristics are transient (eg fragrance) and inconsequential (eg colour), others such as the emollient effect and adverse effects on skin are longer lasting.

The attitudes of healthcare workers towards hand hygiene products are an important barrier to compliance. For example, in the US, the ‘aggressive’ drying effect of alcohol on the skin is documented as a major concern among staff regarding the acceptance of alcohol-based hand hygiene products. This belief may be based on previous experience of product use (eg using alcohol-based rubs without emollients) or perceived risk. The results of a questionnaire of French healthcare workers, undertaken 6 months after the introduction of handrubbing, showed that despite a significant improvement in hand hygiene compliance, distrust in terms of skin tolerance and efficacy were major barriers to their use (Girou & Oppein, 2001). Sixteen percent of respondents did not use the alcohol-based agents in
clinical practice, with 14% reporting that agents caused skin-related problems. Handrubbing was also thought to be less effective than handwashing with soap and water or an antiseptic by 32% and 63% of respondents respectively.

7.3.1.2.1 Skin intolerance of hand hygiene products

Handwashing and disinfection are frequently performed activities by healthcare staff, requiring repeated and prolonged contact with water, use of gloves and exposure to aggressive detergents which impair the skin barrier. This may result in erythema, increased dryness and scaling, cracking, bleeding, soreness and irritation of the hands. Occupational hand dermatitis is a common problem, experienced by 17–30% of healthcare workers (Kampf & Loffler, 2003). Whether the introduction of alcohol-based hand hygiene products worsens this problem remains disputed.

Several studies demonstrated that alcohol-based hand hygiene products are superior to handwashing with antiseptic soaps in terms of skin compatibility (Boyce et al., 2000; Girard et al., 2001; Harbarth et al., 2002; Pietsch, 2001). Many of the commercially-available alcohol-based hand hygiene products contain emollients (eg 1–2% glycerol) or other skin-conditioning additives to prevent the drying effect on the skin (Centers for Disease Control and Prevention, 2002; Ojajärvi, 2003). Several trials (Rotter et al., 1991) showed that the addition of emollients to alcohol-based hand hygiene products, irrespective of alcohol type, improve the condition of the skin and are well tolerated.

A build up of emollients can be an issue with some products and affect user acceptability. All 48 participants responding to questionnaire in the Maury et al. study (2000) reported the need to handwash after 3–4 uses of an alcohol handrub because of an unpleasant sensation caused by residue build up. However, this aspect of the product did not deter participants from using the alcohol handrub as compliance improved during the study.

Adverse events associated with alcohol-based products have been described by Cimiotti et al. (2003). In this study of 58 participants, the adverse reactions associated with using an alcohol-based antiseptic (61% ethyl alcohol with moisturisers) were more likely to be acute and short lived.

Different preparations may be associated with differing complication rates. In a study by Dyer et al. (2000) comparing efficacy and skin tolerance of two ethanol-containing hand sanitisers and a novel surfactant, allantoin and benzalkonium chloride (SAB) ethanol-free hand sanitiser, 47% reported pain or discomfort with the alcohol-based preparations compared with none of the subjects using the SAB hand sanitiser, using either rinse or non-rinse protocol.

The alcohol component of hand hygiene products rarely causes irritation. However, a burning sensation after contact with alcohol handrubs is a commonly reported complaint by healthcare staff. This sensation occurs when the skin barrier is already impaired (eg due to frequent wet work) and alcohol penetrates the epidermis stimulating the nerve receptors. This is often interpreted as ‘aggressiveness’ of alcohol-based hand hygiene products (Kampf & Loffler, 2003) but can be prevented by changing an individual’s hand hygiene behaviour (eg use of handcream to repair broken skin).

An intervention study showed that 5 years after the introduction of an alcohol handrub containing a cosmetic additive in a teaching hospital, there was no significant increase in skin conditions (Conrad, 2001).

7.3.1.3 Design of product dispenser

Installing hand hygiene products in appropriate locations does not ensure an acceptable level of use. The design and functionality of the product dispenser are also important considerations in product selection. Common problems experienced with dispensers include partial and total occlusions of dispenser tips, inappropriate delivery of product and suboptimal dispensing mechanism. In a US hospital where dispensers had recently been installed and continued malfunctioning was reported (Kohan et al., 2002), only 77% of the dispensers were functional (2% were broken and 9% were obstructed; the remaining 12% were without product). Of these dispensers, only 65% delivered product after only one stroke of the lever, 83% delivered an adequate amount and only 13% delivered product into the surveyor’s hand. Sixteen percent of functional dispensers squirted product onto the floor or wall, which was cited an undesirable characteristic of the dispenser by maintenance personnel and nursing staff. Although a product evaluation was conducted before selecting the hand rinse, the committee did not evaluate the use of the wall-mounted dispensers (A pump bottle was used in the pilot study.). The study showed that different types of product dispensers (eg wall-mounted dispensers, bottles) from the same manufacturer may not operate similarly and that the design of specific product dispensers must be a criterion of product selection.

Barrau et al. (2001) compared the use of a new wall-mounted sprayer system (Sanitys) compared with an individual bottle for hand antisepsis in a medical unit. Based on observation, the sprayer system was used more frequently than the individual bottles (12.6 versus 9.7 number of hand rinses per day), with compliance rates of 91% for physicians, 28% for nurses and 8% for housekeeping staff. A survey also showed that the sprayer system was easier to use, more hygienic, more rapid and better tolerated than the bottle. Although there were some methodological flaws with the study, highlighted by Voss et al. (2003), the results may show a possible benefit of the system on antisepsis compliance rates.
7.4 Discussion

Handwashing is widely accepted as one of the most important ways to control infection spread. The placement of sinks and adequate provision of water, soap and paper towels are important ways to encourage regular handwashing. The survey showed great variability in handwashing facilities, in particular 60% of respondents considered their current provision of handwash basins to be inadequate and few reported that the facilities at these sinks were 100% satisfactory.

Although, alcohol-based hand hygiene products cannot replace handwashing in all clinical situations, alcohol-based products do not require plumbing and therefore can be conveniently located at multiple locations in a ward. The versatility of packaging of these products (e.g., personal supplies) also means that they can be carried by individuals and used at the point of delivery of care, which could improve adherence to hand hygiene protocols. Alcohol-based hand hygiene products were reported to be available to more than 80% of frontline healthcare staff and 75% of visitors in the responding healthcare facilities, and available from wall-mounted dispensers in the majority. Despite this, 68.4% felt that changes in the way the products were provided could result in increased use.

Although alcohol-based hand hygiene products are widely available, levels of compliance with the use of these products have not been widely measured, with only 40% of respondents having undertaken audit in the last 2 years. Ongoing surveillance in the form of planned audit, including feedback of hand hygiene compliance to staff, itself could improve compliance.

Several barriers to compliance have been documented (see Table 4-2), notably user acceptability, skin intolerance and lack of staff education. Soliciting healthcare workers’ views helps to maximise the acceptance of a product and ultimately impact on its usage (Centers for Disease Control and Prevention, 2002). Adverse effects on the skin can be overcome by providing alcohol-based preparations that include emollients to improve the condition of the skin and tolerance among users. Educational initiatives and motivation of healthcare staff are important means of changing hand hygiene behaviour and improving hospital compliance. However, the successful implementation of these initiatives requires active participation and support at individual and institutional level; yet the survey identified that there was less than one WTE infection control staff member per healthcare facility. Appointing more staff dedicated to hand hygiene was highlighted in the survey as one means of improving compliance.

The risk of injury associated with the use of alcohol-based hand hygiene products is minimal and outweighed by the potential benefits of their use. As with the introduction of any new product, appropriate risk assessment should be performed to alleviate any safety concerns.
8 LIMITATIONS AND UNCERTAINTIES

It was beyond the scope of this HTA to review the extensive body of literature on reasons for failure of healthcare workers to comply with hand hygiene guidance. Some of the factors influencing compliance are listed Table 4-2. It seems reasonable to assume that an awareness and understanding of these factors is important when developing hand hygiene interventions. The reasons for non-compliance are complex, occurring at individual, group and institutional levels (Pittet, 2001). This has led some authors (Kretzer & Larson, 1998; Pittet, 2001) to propose that certain interventions fail to achieve sustained improvement at least partly because they are solely or primarily targeted at the level of the individual. The results of more successful campaigns (Larson et al., 2000; Pittet et al., 2000), attempting to intervene at the organisational as well as the individual level, are consistent with this view.

It was also beyond the scope of this HTA to review the literature relating to theories of behaviour change. Relevant theoretical models of behaviour change can be used to guide the development and implementation of interventions intended to change hand hygiene behaviour, and may lead to more effectively designed interventions. Theoretical frameworks that have been used for this purpose include the PRECEDE health education model (Larson et al., 1997), Schein’s framework for changing organisational culture (Larson et al., 2000) and the principles of societal marketing (Rao et al., 2002).

It was not possible from the evidence available in the reviewed literature to determine which type of alcohol-based hand hygiene product might be most effective in improving hand hygiene compliance. Although the inclusion of emollients to prevent the drying effect of alcohol on the skin may be considered an advantage in terms of user tolerance, build up of emollient residue (Maury et al., 2000) and concern regarding the efficacy of hand gels may mitigate against this effect (Kramer et al., 2002). No studies directly comparing the effect of different products on hand hygiene compliance were identified in the course of this literature search.

As discussed in Section 5.3, the variability among studies meant that it was not possible to compare the effects of interventions in any meaningful way, or make definitive conclusions about which interventions are effective. This issue highlights whether or not it is appropriate to apply traditional methods of reviewing and synthesising evidence to studies of effectiveness relating to complex multifaceted interventions. In recognition of this issue, Pawson (2001) has developed an alternative methodology for synthesising evidence from evaluations of complex interventions. Based on the principles of the realist approach to evaluative research, ‘realist synthesis’ is a theory-driven approach to systematic review, which is concerned with developing and refining theories that underpin complex interventions. Rather than attempting to identify which particular approach is the most successful, it seeks to explain how and why complex interventions succeed or fail in particular contexts and settings. Work is ongoing to explore the application of this methodology to policy making in healthcare (Pawson et al., 2004).
9 SUMMARY AND CONCLUSIONS

Poor hand hygiene among healthcare workers is well documented and results in high levels of HAI. Alcohol-based hand hygiene products are often components of successful strategies to overcome these problems. Alcohol-based hand hygiene products are likely to improve compliance with hand hygiene as they can be conveniently located, require less time, act faster and irritate the hands less often.

This review highlights the weaknesses of the evidence base pertaining to the clinical and cost effectiveness of interventions to improve hand hygiene compliance and reduce HAI rates. In general, the poor quality of the reviewed studies limited interpretation of their findings. Methodological weaknesses of these studies included short periods of outcome measurement both before and after the intervention, small sample sizes and the lack of a control group or the use of inappropriate controls. As a result of these shortcomings, there is a need for rigorous, high-quality evaluation in this area. When planning interventions to improve hand hygiene, it is necessary to ensure that there is adequate assessment of the intervention to determine the degree of success. This requires effective measurement of compliance with hand hygiene and infection rates prior to the introduction of the intervention. Follow-up measurements should be made at intervals, ideally over a period of months or years to determine both the initial effectiveness and the sustainability of the intervention. As there are likely to be many influences both on compliance and infection rates over extended time periods (eg hospital case mix, workload levels, seasonal changes, other infection control measures), comparator groups should be included if at all possible; ideally, cluster randomised trials methodology should be employed.

The conduct and publication of high-quality studies will not overcome the problems associated with synthesis of studies in which interventions are not uniform. However, the possibility of determining the most effective/appropriate hand hygiene initiatives in a given situation is more likely if there is a larger body of good published studies.

Despite these limitations, most types of interventions used to improve hand hygiene compliance and reduce HAI rates have been associated with at least transient improvements. Although it is generally accepted that levels of hand hygiene and infection rates are linked, it should be noted that evidence of a direct association between improvements in compliance with hand hygiene and reductions in rates of HAI is limited (Larson, 1999). Further studies, which include formal statistical tests of a relationship, are required before the association can be confirmed. The review of the literature suggests that successful approaches require multi-component interventions. Examples of the components of these types of interventions include alcohol-based hand hygiene products, educational support, provision of information, reminders, and feedback to staff about hand hygiene practice and infection rates. Current clinical evidence suggests that multi-component interventions, both with and without alcohol-based hand hygiene products, can generate sustained improvements in hand hygiene compliance and reductions in HAI rates. In addition, multi-component interventions are more consistently associated with sustained improvements than single-component interventions. Strategies that include long-term interventions are also more likely to achieve a sustained effect than those that are time limited.

Multi-component interventions address a wider range of barriers to hand hygiene compliance. It may be that a key feature of successful interventions is that they are tailored to address the specific barriers that have been identified in that particular setting. For example, alcohol-based hand hygiene products, which require less time than using soap and water, are likely to be particularly useful where high workload is a major factor in non-compliance.

The NPSA in England and Wales has developed a multifaceted “clean your hands” campaign, comprising the provision of alcohol rubs near the patient, the use of posters and promotion information, and patient involvement initiatives. This campaign draws heavily on the approaches adopted in successful studies such as Pittet et al. (2000), and has been piloted in selected units of six acute hospitals. An evaluation of the pilot revealed increases in compliance and product usage, and positive feedback from staff and patients (National Patient Safety Agency, 2004a). The “clean your hands” campaign is currently being implemented across the NHS in England and Wales.

Interventions that are multifaceted and not time limited are likely to incur significant costs, and require commitment from all levels of the organisation and continuing investment of resources. The overall costs of implementing and sustaining such interventions have not been determined, but are likely to be considerable if they require additional staff time and other healthcare resources. It is clear that the costs of providing alcohol-based hand hygiene products to the healthcare provider are greatly outweighed by the potential benefits associated with reducing HAI. Two economic evaluations of hand hygiene programmes that advocated the use of alcohol-based hand hygiene products (Pittet et al., 2000; National Patient Safety Agency, 2004c) suggested that such programmes are cost effective, assuming that they result in a reduction in HAI rates of as little as 1%. Given the cost of HAI to the NHS, it is likely that further investment in hand hygiene would also prove cost effective. However, as there is limited research within this area of health economics, further evaluation of local and national infection control initiatives to determine the exact costs and benefits of interventions to improve hand hygiene is required. Auditing the prevalence of HAI to gain further data on the costs to NHS Scotland is also necessary in order to determine the economic benefits of infection control strategies.

A survey, undertaken by NHS QIS, showed great variability in the way in which hand hygiene is tackled across Scotland. Alcohol-based hand hygiene products are widely used in the majority of healthcare facilities, although 68.4% thought that changes to the way these products are provided could increase their use. Other activities to address hand hygiene compliance (eg
educational initiatives, ongoing surveillance, patient initiatives) are also being offered but to varying degrees. A review of practice highlighted a lack of knowledge of local deficiencies in hand hygiene compliance as audit was performed in less than half of responding healthcare facilities. The most appropriate local strategy to improve hand hygiene compliance and reduce infection rates can only be determined by audit of local practice. Increased education and audit however requires support and motivation of staff and may necessitate increasing the number of dedicated staff in infection control departments.

Recommendations

• Despite the lack of unequivocal evidence, the potential benefit of providing alcohol-based hand hygiene products is likely to outweigh the costs and therefore these should be available for use by all NHSScotland staff working in clinical areas. Alcohol-based hand hygiene products should also be provided for the use of visitors, particularly where handwashing facilities are limited.

• Staff planning local initiatives to improve hand hygiene should note that multi-component interventions are more likely to be effective and sustainable than single-component interventions. Although such initiatives are more resource intensive, these have greater potential to be cost effective.

• Robust evaluation of any hand hygiene intervention should be carried out. This will require compliance and/or infection rates to be audited both before and after the intervention and possible influences on these rates to be taken into account. Comparator groups should be included wherever possible.

• Studies of the effectiveness of hand hygiene interventions should be published. This will allow a body of literature to be established which could subsequently be synthesised to identify the most effective interventions for particular clinical situations.
10 ACKNOWLEDGEMENTS

NHS Quality Improvement Scotland is grateful to all experts and peer reviewers (Appendix 1) who have given generously of their time to contribute constructively the scoping of the project, the appraisal of the evidence and the writing of this report.

We also thank all healthcare professionals who responded to the survey.
APPENDICES
### 11 APPENDICES

#### Appendix 1 Peer reviewers

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Appendix 2 Strategy for literature searches

Literature searches for clinical effectiveness

Sources – Secondary literature, policy documents

An initial scoping search was undertaken in March 2004 to identify HTAs, systematic reviews, other evidence-based reports and policy documents. The following sources were searched:

- Health Technology Assessment Database, via the Cochrane Library
- NICE (National Institute for Clinical Excellence), www.nice.org.uk/
- NCCHTA (National Coordinating Centre for Health Technology Assessment), www.ncchta.org/
- NHS Centre for Reviews and Dissemination, University of York, www.york.ac.uk/inst/crd/
- Birmingham Technology Assessment Group, Department of Public Health and Epidemiology, University of Birmingham, www.publichealth.bham.ac.uk/wmhtag/
- ScHARR (School of Health and Related Research), University of Sheffield, www.shef.ac.uk/~schar/publications.htm
- South and West R&D Directorate, DEC reports, www.doh.gov.uk/research/swro/rd/publicat/dec/
- Health Services Research Unit (HSRU), www.abdn.ac.uk/hsru/
- British Columbia Office of Health Technology Assessment (BCOHTA), www.chspr.ubc.ca/bcohta/
- Health Services Utilization and Research Commission (HSURC Saskatchewan), www.hsurc.sk.ca/
- Institute for Clinical and Evaluative Sciences (ICES), www.ices.on.ca/
- Manitoba Centre for Health Policy (MCHP), www.manitoba.ca/centres/mchp/
- ECRI, www.ecri.org/
- Cochrane Database of Systematic Reviews (CDSR), via the Cochrane Library
- Database of Abstracts of Reviews of Effectiveness (DARE), via the Cochrane Library
- SIGN (Scottish Intercollegiate Guidelines Network), www.sign.ac.uk/
- ARIF (Aggressive Research Intelligence Facility), www.bham.ac.uk/arif/
- Health Evidence Bulletins, Wales, http://hebw.uwcm.ac.uk/
- TRIP, www.tripdatabase.com/
- Bandolier, www.jr2.ox.ac.uk/bandolier/
- Health Evidence Network, www.euro.who.int/HEIN
- Clinical Evidence, www.clinicevidence.com/ceweb/conditions/index.jsp
- Prodigy, www.prodigy.nhs.uk/
- HDA HealthPromis, http://healthpromis.hda-online.org.uk/
- SHOW, www.show.scot.nhs.uk/
- Chief Scientist Office (CSO), www.show.scot.nhs.uk/cso/
- Public Health Institute of Scotland, www.phis.org.uk/
- NHS Economic Evaluation Database (NHS EED), via the Cochrane Library
- Health Economic Evaluation Database (HEED)

Sources – Primary literature including ongoing research

The following sources were searched between May and November 2004:

- MEDLINE (OVID)
- MEDLINE In-Process and Other Non-Indexed Citations (OVID)
- EMBASE (OVID)
- WEB OF SCIENCE (ISI)
- CINAHL (OVID)
- BRITISH NURSING INDEX (OVID)
- HMIC (OVID)
- Cochrane Central Register of Controlled Trials (CCRCT), Cochrane Library
- Current Controlled Trials, www.controlled-trials.com/
- NRR (National Research Register), www.nrr.nhs.uk/
- Centerwatch, www.centerwatch.com
- Trials Central, www.trialscentral.org/
- CRISP (Computer Retrieval of Information on Scientific Projects), www-commons.cit.nih.gov/crisp/
Systematic search strategies

A systematic search was carried out in which the concept of ‘handwashing’ was combined with either the concept of ‘infection’ or ‘alcohol cleanser’. A second systematic search combined the concept of ‘handwashing’ with the concept of ‘compliance’. The strategies listed below are for OVID Multifile searches of MEDLINE, EMBASE and CINAHL; these were adapted for use in all other databases.

Search 1

1. handwashing/ use mesz.
2. (hand? adj3 (wash$ or clean$ or disinfect$ or hygien$ or decontamin$ or antisept$ or anti-sep$ or rub? or wip$ or gel?)).tw.
3. (handwash$ or handclean$ or handrub? or handwip$).tw.
4. or/1-3
5. infection control/ use mesz
6. cross infection/ use mesz
7. disease transmission, patient-to-professional/ use mesz
8. disease transmission, professional-to-patient/ use mesz
9. antiseptic/ use mesz
10. disinfection/ use mesz
11. disinfectants/ use mesz
12. decontamination/ use mesz
13. anti-infective agents, local/ use mesz
14. hygiene/ use mesz
15. (infection$ adj2 control$).tw.
17. cross infection$ .tw.
18. (disease$ adj2 transmit$).tw.
19. (antisept$ or anti-sep$).tw.
20. disinfect$ .tw.
22. (antibacteria$ or anti-bacteria$).tw.
23. microbicid$.tw.
24. bacteriocid$.tw.
25. germicid$.tw.
26. (hospital adj2 (acquir$ or associat$) adj2 infect$).tw.
27. (healthcare adj2 (acquir$ or associat$) adj2 infect$).tw.
28. (healthcare adj2 (acquir$ or associat$) adj2 infect$).tw.
29. hai.tw.
30. nosocomial.tw.
31. hygien$.tw.
32. ethanol/ use mesz
33. isopropanol/ use mesz
34. 1-propanol/ use mesz
35. alcohols/ use mesz
36. ethanol?.tw.
37. isopropanol.tw.
38. 1-propanol.tw.
39. n-propanol.tw.
40. propanol.tw.
41. isopropyl alcohol.tw.
42. alcohol?.tw.
43. chloroxylenol.tw.
44. or/5-31
45. or/32-43
46. 4 and 44
47. 4 and 45
48. 46 or 47
49. (alcohol? adj2 (rub$ or wip$ or gel$ or spray$)).tw.
50. hand?.tw. or hand/ use mesz
51. 49 and 50
52. 48 or 51
53. hand washing/ use emez
54. (hand? adj3 (wash$ or clean$ or disinfect$ or hygien$ or decontamin$ or antisept$ or anti-sep$ or rub? or wip$ or gel?)).tw.
55. (handwash$ or handclean$ or handrub? or handwip$).tw.
56. or/53-55
57. infection control/ use emez
58. cross infection/ use emez
59. hospital infection/ use emez
60. disease transmission/ use emez
61. antiseptic/ use emez
62. disinfection/ use emez
63. skin decontamination/ use emez
64. antiinfective agent/ use emez
65. topical antiinfective agent/ use emez
66. disinfectant agent/ use emez
67. hygiene/ use emez
68. hospital hygiene/ use emez
69. personal hygiene/ use emez
70. (infection$ adj2 control$).tw.
71. (prevent$ adj3 infect$).tw.
72. cross infection$ .tw.
73. (disease$ adj2 transmit$).tw.
74. (antisept$ or anti-sep$).tw.
75. disinfect$ .tw.
76. (antiinfect$ or anti-infect$).tw.
77. (antibacteria$ or anti-bacteria$).tw.
78. microbicid$.tw.
79. bacteriocid$.tw.
80. germicid$.tw.
81. (hospital adj2 (acquir$ or associat$) adj2 infect$).tw.
82. (healthcare adj2 (acquir$ or associat$) adj2 infect$).tw.
83. (healthcare adj2 (acquir$ or associat$) adj2 infect$).tw.
84. hai.tw.
85. nosocomial.tw.
86. hygien$.tw.
87. or/57-86
88. 56 and 87
89. alcohol/ use emez
90. 2 propanol/ use emez
91. propanol/ use emez
92. alcohol?.tw.
93. isopropanol.tw.
94. 1-propanol.tw.
95. n-propanol.tw.
96. propanol.tw.
97. isopropyl alcohol.tw.
98. ethanol?.tw.
99. chloroxylenol.tw.
100. or/89-99
101. 56 and 100
102. 88 or 101
103. (alcohol? adj2 (rub$ or wip$ or gel$ or spray$)).tw.
104. hand?.tw. or hand/ use emez
105. 103 and 104
106. 102 or 105
107. hand washing/ use nursing
108. (hand? adj3 (wash$ or clean$ or disinfect$ or hygien$ or decontamin$ or antisept$ or anti-sep$ or rub? or wip$ or gel?)).tw.
109. (handwash$ or handclean$ or handrub? or handwip$).tw.
110. or/107-109
111. infection control/ use nursing
112. cross infection/ use nursing
113. disease transmission, patient-to-professional/ use nursing
114. disease transmission, professional-to-patient/ use nursing
115. "sterilization and disinfection"/ use nursing
116. antineffective agents, local/ use nursing
117. disinfectants/ use nursing
118. hygiene/ use nursing
119. (infection$ adj2 control$).tw.
120. (prevent$ adj3 infect$).tw.
121. cross infection$ .tw.
122. (disease$ adj2 transmi$).tw.
123. (antisept$ or anti-sep$).tw.
124. disinfect$.tw.
125. (antiinfect$ or anti-infect$).tw.
126. (antibacteria$ or anti-bacteria$).tw.
127. microbicid$.tw.
128. bacteriocid$.tw.
129. germicid$.tw.
130. (hospital adj2 (acquir$ or associat$ adj2 infect$)).tw.
131. (health care adj2 (acquir$ or associat$ adj2 infect$)).tw.
132. (healthcare adj2 (acquir$ or associat$ adj2 infect$)).tw.
133. hai.tw.
134. nosocomial.tw.
135. hygien$.tw.
136. 110 and 136
137. alcohol?.tw.
138. isopropanol.tw.
139. 1-propanol.tw.
140. n-propanol.tw.
141. propanol.tw.
142. isopropyl alcohol.tw.
143. chloroxylenol.tw.
144. or/138-148
145. 100 and 149
146. 100 and 150
147. alcohol? adj2 (rub$ or wip$ or gel? or spray$)).tw.
148. hand?.tw. or hand/ use nursing
149. 150 and 153
150. 151 or 154

Search 2

1. handwashing/ use mesz
2. hand washing/ use emez
3. handwashing/ use nursing
4. (hand? adj2 (wash$ or clean$ or disinfect$ or hygien$ or decontamin$ or antisept$ or anti-sep$ or rub? or wip$ or gel?)).tw.
5. (handwash$ or handclean$ or handrub? or handwip$ or handgel?).tw.
6. or/1-5
7. "attitude of health personnel"/ use mesz
8. guideline adherence/ use mesz
9. health knowledge, attitudes, practice/ use mesz
10. health behavior/ use mesz
11. attitude/ use emez
12. practice guideline/ use emez
13. health behavior/ use emez
14. "attitude of health personnel"/ use nursing
15. professional compliance/ use nursing
16. health behavior/ use nursing
17. exp education/
18. comply$.tw.
19. compli$.tw.
20. accordance.tw.
21. observance.tw.
22. adher$.tw.
23. abid$.tw.
24. or/7-23
25. 6 and 24
26. remove duplicates from 25

Literature searches for economics

Sources

In addition to scanning the results retrieved in the scoping search and clinical effectiveness systematic search, the following sources were searched for economic evaluations and other literature relating to costs and cost effectiveness:

- Health Economics Research Unit, Aberdeen, www.abdn.ac.uk/heru
- Centre for Health Economics, York, www.york.ac.uk/inst/che/
- Health Economics Research Centre, Oxford, www.ihs.ox.ac.uk/herc/
- Health Economics Research Group, Brunel, www.brunel.ac.uk/depts/herg
- ESHER, University of Newcastle, www.ncl.ac.uk/pahs/research/services/economics/index.htm
- SCHARR (School of Health and Related Research), Sheffield, www.shef.ac.uk/uni/academic/R-Z/scharr/
- LSE (London School of Economics and Political Science), www.lse.ac.uk/
- Southampton University Economics Department, www.economics.soton.ac.uk
- Pharmaco Economics Research Centre, University of St Andrews, www.st-andrews.ac.uk/academic/management/index_perc.htm
- Centre for Health Economics Research and Development (CHERE), University of Sydney and Central Sydney Area Health Service, www.chere.uts.edu.au
- Institute of Health Economics (IHE), Alberta, Canada, www.ihe.ab.ca/
• Centre for Health Economics and Policy Analysis (CHEPA), McMaster University, www.chepa.org/
• Centre for Health Program Evaluation (CHPE), University of Melbourne and Monash University, Australia, www.chpe.buseco.monash.edu.au/
• Health Economics.com, www.healtheconomics.com/
• NetEc, www.netec.mcc.ac.uk/NetEc.html
• RePEc, www.repec.org/
• International Health Economics Association (IHEA), www.healtheconomics.org/cgi-bin/WebObjects/ihea
• Audit Scotland, www.audit-scotland.gov.uk/
• The King’s Fund, www.kingsfund.org.uk/
• Web search using Google.

The search terms used were adapted from those used in the clinical effectiveness MEDLINE systematic search. Full details of the searches can be obtained by contacting NHS QIS.
Flow Chart – Clinical effectiveness literature selection process

All references identified by systematic literature searches n=5,236

Search strategy

Reading title and abstract (with selection criteria)

Not relevant n=4,967

Potentially relevant n=269

Order literature

Submissions/additional searching/bibliographies

Available

Systematic search n=257

Submissions and other searches n=40

Evaluation of full manuscript (with selection and quality criteria)

Articles reviewed but not referenced in report n=192

Articles referenced in report n=122

Not available n=14
## Appendix 3 Compliance data tables

<table>
<thead>
<tr>
<th>Reference</th>
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<tbody>
<tr>
<td>Avila-Aguero et al. (1998)</td>
<td>Medical, nursing, paramedical (112)</td>
<td>Paediatric hospital, Costa Rica</td>
<td>Prospective, no concurrent controls</td>
<td>Movies, brochures giving handwashing tips, posters containing feedback of compliance data.</td>
<td>Before and after patient contact. Direct observation.</td>
<td>Compliance before/after patient contact: Baseline (3 weeks): 52%/49% (of 143) Observation with prior notification (2 weeks): 55%/52% (of 153) Intervention (4 weeks): 74%/69% (of 555) (p&lt;0.01 compared to baseline) Follow up (3–7 weeks post-intervention): 49%/52% (of 272) (p&lt;0.01 compared to intervention)</td>
<td>Observation was 'unobtrusive' during baseline and follow up. Compliance did not rise significantly when notified of observation during subsequent, pre-intervention phase.</td>
</tr>
<tr>
<td>Berg et al. (1995)</td>
<td>Professions not stated (123 pre-intervention; 130 post-intervention)</td>
<td>Medical-surgical ICU, Guatemala</td>
<td>Prospective, no concurrent controls</td>
<td>Educational sessions (lectures, demonstrations, positive and negative feedback), signs at bedside of patients with particular pathogens.</td>
<td>After patient contact. Direct observation.</td>
<td>Baseline (2 months): 5% (13/251) Post-intervention (Months 2 and 3): 63% (267/426) (p&lt;0.001) Continued to increase during post-intervention – 88% in Month 3.</td>
<td>Staff told that the observer was charting inventory in the ICU.</td>
</tr>
<tr>
<td>Bischoff et al. (2000)</td>
<td>All</td>
<td>MICU, USA</td>
<td>Prospective, no concurrent controls</td>
<td>Education sessions, feedback of compliance data, introduction of alcohol agent.</td>
<td>Before and after specified high-risk events. Direct observation.</td>
<td>Baseline (6 weeks): 10% (17/173) / 22% (42/188) Education/feedback (6 weeks): 16% (18/112, p=0.17) / 25% (31/122, p=0.63) Alcohol 1 dispenser to 4 beds (6 weeks): 19% (18/96) / 41% (43/106) Alcohol 1 dispenser to 1 bed (6 weeks): 23% (18/79) / 48% (45/93), p&lt;0.05, chi square for linear trend.</td>
<td>During control period, not informed of purpose of observing physician.</td>
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<td>Bittner et al. (2002)</td>
<td>Nurses</td>
<td>MICU, SICU, USA</td>
<td>Prospective, non-randomised controls</td>
<td>Feedback of estimated number of handwashing episodes per occupied bed per hour (based on soap and paper towel consumption)</td>
<td>Handwashing episodes per occupied bed hour. Direct observation.</td>
<td>SICU (intervention unit): Baseline (24 days): 2.68 ± 0.72 (mean ± standard deviation) Follow-up (24 days during end of 4 month intervention): fell 28% to 1.92 ± 1.35, p=0.001</td>
<td>Estimated handwashing episodes calculated throughout the study. Demonstrated that live observers were associated with increased handwashing, even when they did not offer feedback.</td>
</tr>
<tr>
<td>Brown et al. (2003)</td>
<td>Physician, nurse, respiratory therapist, student</td>
<td>NICU, Russia</td>
<td>Prospective, no concurrent controls</td>
<td>Alcohol agent and education, followed by opinion leader, training, feedback (compliance and colonisation)</td>
<td>Before and/or after patient contact and specified procedures. Direct observation.</td>
<td>Baseline: 44% (of 283) 0–2 months after introduction of alcohol agent: 42% (of 421) (p=0.6) 0–2 months after quality improvement intervention: 48% (of 323) (p=0.12 compared with baseline)</td>
<td>'Covert observation' but difficult to know the extent to which observers were not detected. Was a significant improvement from baseline to Period 3 if using relaxed criteria ie glove use before contact is adequate hand hygiene (65% vs 79%, p=0.004). Both intervention periods were independently predictive of compliance under relaxed criteria (adjusted odds ratios 1.59, p=0.039 and 2.82, p&lt;0.001).</td>
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| Colombo et al.  | Nurses and nursing assistants | Four medical and six surgical wards, Switzerland | Prospective, non-randomised controls | Education, additional hand-carried alcohol dispensers | Ratio between measured use and calculated need for alcohol agent. | **Intervention wards** (two medical, three surgical)  
Pre-intervention: medical 0.40, surgical 0.44  
Intervention: medical 0.84, surgical 0.83 (98% increase overall)  
Follow up: medical 0.67, surgical 1.28  
**Control wards** (two medical, three surgical)  
Pre-intervention: medical 0.44, surgical 0.64  
Intervention: medical 0.75, surgical 0.65 (29% increase overall)  
Follow up: medical 0.82, surgical 0.56 | Analysed time trends – due to the small number of individually measured units, hypothesis tests for statistical significance were not carried out.  
Timescales not specified. |
| Conly et al.    | All                | MICU, Canada              | Prospective, no concurrent controls | Education, feedback on handwashing compliance, reminders | Before and after patient contact.  
Direct observation. | Intervention in Year 1 and Year 5 of the five-year study.  
Intervention 1 (2 months)  
Baseline (1 month): 14%/28% (of 92)  
1-month post-intervention: 73%/81% (of 83)  
p<0.001 for both before and after patient contact.  
Intervention 2 (8 months)  
Baseline (1 month): 26%/23% (of 97)  
1-month post-intervention: 38%/60% (of 55)  
p<0.01 for before contact (not significant), p<0.001 for after contact | Observations performed without staff knowledge. |
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<td>Conrad (2001)</td>
<td>Physicians, nurses, physiotherapists, laboratory technicians</td>
<td>General hospital, Switzerland</td>
<td>Prospective, no concurrent controls</td>
<td>Ongoing training programme for new staff, including UV lamp demonstrations</td>
<td>Hand alcohol consumption rates per capita</td>
<td>Increased steadily from 5.7 litres per capita in 1990 to 9.7 litres in 1998.</td>
<td>Many possible confounders. Amount used does not necessarily equate with compliance.</td>
</tr>
<tr>
<td>Doebbeling et al. (1992)</td>
<td>All (577 in total)</td>
<td>SICU, MICU, cardiovascular ICU, USA</td>
<td>Prospective, multiple crossover</td>
<td>Chlorhexidine vs alcohol</td>
<td>Indications for hand hygiene not specified. Direct observation.</td>
<td>1,233 total opportunities over an eight-month period. Chlorhexidine 44% (252/579) Alcohol-soap 37% (244/654)</td>
<td>Mantel-Haenszel summary adjusted risk ratio, adjusted for ICU according to the number of patient-days: 1.28 (95% CI 1.02, 1.60)</td>
</tr>
<tr>
<td>Dorsey et al. (1996)</td>
<td>Physicians, nurses, nurse practitioners</td>
<td>Emergency dept, USA</td>
<td>Prospective, no concurrent controls</td>
<td>Brightly coloured reminder signs at sinks, and distribution of educational material</td>
<td>Before and/or after specified procedures. Direct observation.</td>
<td>Baseline (12 days): 54% (of 132) 5–16 days post-intervention: 64% (of 120) p=0.05</td>
<td>Informed that their patient encounters were being monitored, but nature of study kept confidential.</td>
</tr>
<tr>
<td>Dubbert et al. (1990)</td>
<td>12 nurses</td>
<td>ICU</td>
<td>Prospective, no concurrent controls</td>
<td>Education, followed by performance feedback</td>
<td>After patient contact or specified procedures. Direct observation.</td>
<td>591 patient contacts in total. Baseline (6 weeks): 81% Education (4 weeks): 86% (94% in Week 1, then steadily declined to baseline levels) Feedback (4 weeks): 92% (no immediate effect, 97% in Week 2, maintained until end of Week 4).</td>
<td>All staff aware of purpose throughout. Same 12 nurses observed throughout all three phases. Averaging across phases obscures detail.</td>
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<tr>
<td>Earl et al. (2001)</td>
<td>All (nursing, ancillary and physicians)</td>
<td>SICU, MICU, USA</td>
<td>Prospective, no concurrent controls</td>
<td>Availability of alcohol gel; introduced to staff members at meetings, through flyers, and by labelling the dispensers with content information and usage instructions</td>
<td>Before and/or after patient contact and specified procedures. Direct observation.</td>
<td>Baseline: 40% (432/1,090). 2–6 weeks post-installation: 53% (574/1,091) – 33% above baseline (95% CI 30.8%, 34.8%). 10–14 weeks post-installation: Overall 57% (475/834) – 44% above baseline (95% CI 41.6%, 46.2%)</td>
<td>Managers informed of study purpose, but staff were not. If asked, told staff they were conducting an infection control study for the medical centre’s epidemiology unit.</td>
</tr>
<tr>
<td>Girard et al. (2001)</td>
<td>All</td>
<td>Rheumatology, urology, and paediatric units, and paediatric ICU, France</td>
<td>Prospective, no concurrent controls</td>
<td>Introduction of alcohol handrub, incentive stickers, information meetings.</td>
<td>Indications for hand hygiene not specified. Direct observation.</td>
<td>Baseline (11 weeks): 62% (382/614) 2–7 weeks after introduction of alcohol handrub: 67% (290/421), p=0.15</td>
<td>Secondary outcomes – rate of procedures adapted appropriately for the situation and performed correctly – did improve significantly.</td>
</tr>
<tr>
<td>Girou &amp; Oppenheim (2001)</td>
<td>All</td>
<td>Two medical wards, two ICUs, France</td>
<td>Prospective, no concurrent controls</td>
<td>Alcohol agent, education, feedback, policy. Before and/or after specified procedures. Direct observation.</td>
<td>Baseline: less than 50% (of 877) Six-month follow up: 66% (609/925) Authors state that this was significant.</td>
<td>Staff were ‘observed in an open manner’.</td>
<td></td>
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<tr>
<td>Gould &amp; Chamberlain (1997)</td>
<td>Nurses (31 out of 50 could be followed up)</td>
<td>Four surgical wards (in a single hospital), UK</td>
<td>Prospective, non-randomised controls</td>
<td>Education (ward-based teaching package)</td>
<td>After initiation of clinical contact. Direct observation.</td>
<td>Each nurse observed for 2 hours. Baseline: Intervention group 14%, controls 13%. Post-intervention (3 months after baseline): Intervention group 13%, controls 15%. Not significant at 0.05 level using ANCOVA.</td>
<td>Attempted to blind both the study group and investigators to intervention. Also collected data on 'essential decontaminations' and duration of handwashing – no significant effect of the intervention on either of these. Problems with implementation of intervention.</td>
</tr>
<tr>
<td>Graham (1990)</td>
<td>Nurses, medics, physios, radiologists, orderlies</td>
<td>ICU, Australia</td>
<td>Prospective, no concurrent controls</td>
<td>Alcohol agent (instructions on the use of the handrub lotion were made available to all staff)</td>
<td>After patient contact. Direct observation.</td>
<td>Baseline: 32% (140/440) 1-3 weeks post-introduction: 45% (201/444), p&lt;0.01</td>
<td>Staff told it was an audit of infection control procedures (not told that handwashing practices were specifically being observed).</td>
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<td>Harbarth et al. (2002)</td>
<td>All</td>
<td>PICU, NICU, CICU, USA</td>
<td>Prospective, no concurrent controls</td>
<td>Alcohol agent, education, feedback, opinion leaders</td>
<td>Before and after completed or interrupted patient contact (clean gloves acceptable alternative before contact). Direct observation.</td>
<td>12,216 hand hygiene opportunities in total. Baseline (2.5 months): decreased in all three units after the first 2 weeks of observation from a median of 43% (IR 30 to 56%) to 28% (IR 19 to 39%). Introduction of the hand gel without any quality improvement (QI) support in the CICU and implementation of QI interventions without hand gel in the PICU (2.5 months): decreased to 23% (IR 15 to 33%, p&lt;0.001). Introduction of the hand gel plus QI support in all three units (3 months): increased to 33% (of 3,983, IR 22 to 43%, p&lt;0.001). Gel in CICU and PICU, gel plus QI in NICU (2.5 months): overall, 37% (of 3,003, IR 26 to 44%), but fell to 30% during the last weeks of the study. Adjusted ORs for compliance increased significantly in the last two phases (1.6 and 1.9, both p&lt;0.001).</td>
<td>Told staff it was a study of medication errors and other QI issues. Did not include the first 2 weeks of baseline in the logistic regression model.</td>
</tr>
<tr>
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<td>Kim et al. (2002)</td>
<td>Physicians, respiratory therapists, registered nurses, nurses' aides</td>
<td>Two ICUs, USA</td>
<td>Prospective, no concurrent controls</td>
<td>Alcohol handrub</td>
<td>Indications for hand hygiene not specified. Direct observation.</td>
<td>Baseline (5 months): 22% (of 589) Follow-up (for 1 month post-intervention): 26% (of 602) (p=0.11, 95% CI 0.96, 1.62)</td>
<td>Although overall compliance increased marginally, most professions had a dramatic increase. Compliance increased to 30% when the analysis excluded physicians (p=0.01; 95% CI 1.05, 1.66).</td>
</tr>
<tr>
<td>Larson et al. (1997)</td>
<td>Nurses</td>
<td>SICU, neuro-surgical ICU, USA</td>
<td>Prospective, non-randomised controls</td>
<td>Education (focus groups), feedback on handwashing frequency, automated sinks (sink automation incrementally increased)</td>
<td>Before and/or after specified procedures. Direct observation.</td>
<td>Baseline (4 months): Intervention 56% (85/151) Controls 53% (172/310), p=0.95 2 months at end of intervention period, with sink fully automated: Intervention 83% (190/229) Controls 48% (110/157), p=0.004 2-8 months follow up (automated sinks still in place): Intervention 76% (210/313) Controls 65% (226/328), p=0.68</td>
<td></td>
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<tr>
<td>Larson et al. (2000)</td>
<td>All</td>
<td>Two MICUs, two NICUs (one of each in two hospitals), USA</td>
<td>Prospective, non-randomised controls</td>
<td>Top-level administrative intervention, using a framework for changing organisational culture and including education, opinion leaders, feedback, incentives (handwashing made a core competency)</td>
<td>Mean handwashes per patient-care day, estimated by counting devices in soap dispensers.</td>
<td>Baseline (6 months): Intervention 42.6 (58.722/1,380) Controls 30.3 (41.644/1,375) RR 1.4 (95% CI 1.3, 1.52) Implementation (3 months): Intervention 43 (148.562/3,458) Controls 39.2 (132.944/3.389) RR 1.1 (95% CI 1.04, 1.15) 6-9 months after implementation: Intervention 116.6 (270.396/2.319) Controls 30.3 (208.299/3.751) RR 2.1 (95% CI 1.99, 2.21)</td>
<td>Staff in both hospitals generally aware that an infection study was ongoing, but not of the specific outcomes being measured. Counting devices were not visible.  No attempt was made to account for multiple dispenser activations during a single wash.</td>
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<td>Lohr et al. (1991)</td>
<td>Doctors</td>
<td>Paediatric outpatient clinics</td>
<td>Prospective, no concurrent controls</td>
<td>Reminder signs, reminders from head nurse, group feedback of baseline performance</td>
<td>Before patient contact. Direct observation.</td>
<td>Observed by medical students accompanying the providers, without the knowledge of the providers.</td>
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<td>Maury et al. (2000)</td>
<td>Nursing and medical staff</td>
<td>MICU, France</td>
<td>Prospective, no concurrent controls</td>
<td>Alcohol handrub introduced. Staff informed via wall posters and programme of meetings (before baseline period)</td>
<td>After patient care and specified events. Direct observation.</td>
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<td>Mayer et al. (1986)</td>
<td>Nurses and nursing assistants</td>
<td>MICU, SICU</td>
<td>Prospective, non-randomised controls</td>
<td>Introduction of moisturised handwashing soap, then feedback on handwashing frequency</td>
<td>After completed or interrupted patient contact, critical procedures. Direct observation.</td>
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<td>Baseline (5 weeks): 61% (of 805) (p&lt;0.001)</td>
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<td>Follow up (4 months post-intervention for 5 weeks): 51% (p=0.007 compared with baseline)</td>
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<td>Baseline (3 weeks): Intervention 63% (89/142) Controls 63% (34/54)</td>
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<td>Irrelevant feedback (5 weeks): Intervention 65% (114/176) Controls 68% (47/69)</td>
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<td>New soap (3 weeks): Intervention 59% (80/135) Controls 58% (28/48)</td>
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<td>Feedback (3 weeks): Intervention 92% (144/157) Controls 77% (41/53), p&lt;0.05</td>
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<td>Follow up (at 6 months post-intervention): Intervention 50% (7/14) Controls 57% (8/14)</td>
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<td>Both medical and non-medical staff members were aware of the study, but did not know exactly when they were being observed.</td>
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<td>Used irrelevant feedback about frequency of smiling by staff during interactions. Only blinded to purpose of observations for new soap intervention – staff’s knowledge of being observed could not be evaluated separately from the feedback intervention.</td>
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<td>Attempted to ensure same personnel across all phases.</td>
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<td>Follow-up observations – very small numbers and a different observer.</td>
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| McGuckin et al. (2001) | All                | Medical and surgical patients, UK | Prospective, crossover design | "Partners in Your Care"  
On admission, patients visited by member of staff to discuss importance of hand hygiene, instructed to ask staff "Did you wash/sanitise your hands?", and given brochure and prompting aids. | Hand hygiene episodes per resident-day, estimated from hand hygiene product usage. | 39 (40%) patients agreed to participate.  
Soap and gel usage (units):  
Baseline (6 weeks) 12.3  
Control (6 weeks, either before or after intervention) 15.6  
Intervention (6 weeks) 18.5  
Soap usage/handwashings an average of 50% higher during intervention compared to baseline (p<0.05), and 10% higher compared with control (p<0.05). |                                                                                       |
| McGuckin et al. (1999) | All                | Four community hospitals, USA     | Prospective, crossover design | "Partners in your care" (see above)                                           | Hand hygiene episodes per resident-day, estimated from hand hygiene product usage. | 441 patients enrolled in the study.  
Two consecutive six-week periods – two hospitals control then intervention period, two hospitals intervention then control period.  
Soap usage/handwashings an average of 34% higher during intervention than control period (p<0.021). |                                                                                       |
| McGuckin et al. (2004) | All                | Rehabilitation unit, USA          | Prospective, no concurrent controls | "Partners in your care" (see above)                                           | Hand hygiene episodes per resident-day, estimated from hand hygiene product usage. | Baseline (6 weeks): 5  
Intervention (6 weeks): 9.7  
(p<0.001)  
Post-intervention (6 weeks): 6.7  
(p<0.001)  
Follow-up (3 months post-baseline): 7  
(p<0.001)  
Sustained increase at 3 months post-baseline of 40%. | During follow up, re-introduced one component of the intervention (educational brochure to patients on admission). |
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<tr>
<td>Mody et al. (2003)</td>
<td>Registered nurses and nurses’ aides. (38 completed all three questionnaires)</td>
<td>Community-based long-term care facility, USA</td>
<td>Prospective, non-randomised controls</td>
<td>Education in both, then compared areas using alcohol agent with controls</td>
<td>Frequency of hand hygiene (number of times hands cleansed per hour). Self-report.</td>
<td>Baseline: No significant difference between groups. Following three-week educational intervention: No significant increase in either ward or difference between wards (p=0.48). 4–12 weeks after introduction of alcohol agent: significant increase from baseline in intervention group (14.55 ± 5.32 vs 7.91 ± 1.92, p=0.04). Significant difference between groups at 12 weeks (15.81 ± 4.08 vs 7.11 ± 1.05, p=0.04).</td>
<td>Direct observation more accurate but intrusive and difficult (residents living in private rooms with sinks located in their bathrooms).</td>
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<tr>
<td>Muto et al. (2000)</td>
<td>Physicians, technologists, nurses, housekeepers</td>
<td>Two medical wards (MICU and its step-down unit), USA</td>
<td>Prospective, no concurrent controls</td>
<td>Educational and motivational campaign (meetings, signs, reminders), and introduction of alcohol gel</td>
<td>After contact with patient or surfaces in patient’s room. Direct observation.</td>
<td>Baseline: 60% (76/126) Follow-up (at 2 months post-intervention): 52% (59/113), p=0.26</td>
<td>'Unobtrusive counting methods'. Decrease attributed to change in rotations of physicians – not same group before and after. Physician compliance decreased from 83 to 29%. Nurses 60 vs 67%, technologists 56 vs 57%, housekeepers 36 vs 23%.</td>
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<td>Ndawula &amp; Cutter (2001)</td>
<td>All</td>
<td>Renal unit ward, UK</td>
<td>Prospective, no concurrent controls</td>
<td>Signs with brief instructions</td>
<td>Amount of soap and disinfectants used.</td>
<td>Baseline (3 weeks): Hibiscrub 22 x 500 ml bottles; Hibisolv 8 x 500 ml bottles; soap 17 pouches. Three-week period with signs in place: Hibiscrub 22 x 500 ml bottles (0% change); Hibisolv 22 x 500 ml bottles (17% increase); soap 24 pouches (41% increase).</td>
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<td>Pittet et al. (2000)</td>
<td>Nurse, nursing assistants, doctors, other healthcare workers</td>
<td>All wards (acute hospital), Switzerland</td>
<td>Prospective, no concurrent controls</td>
<td>Poster display, performance feedback, individual bottles of alcohol handrub, senior management support</td>
<td>'According to recommended guidelines'. Direct observation.</td>
<td>Compliance improved progressively. Baseline: 48% (of 2,834); 95% CI 46.8, 48.5 At 3 years: 66% (of 2,569); 95% CI 65.1, 67.2; p&lt;0.001 Univariate OR 2.15 (1.78–2.60) Adjusted (for ward, profession, risk and activity) OR 1.92 (1.59–2.33). Compliance through handwashing with soap and water remained stable at around 30%, while compliance through use of alcohol rub increased from 14% to 37% (p&lt;0.001).</td>
<td>HCWs did not know the schedule of the observation periods. Observers as unobtrusive as possible but not hidden. Significant improvement in medical, surgical, and intensive-care wards (all p&lt;0.001). Non-significant improvement in gynaecology/obstetrics (p=0.17), and paediatric wards (p=0.12).</td>
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<td>Raju &amp; Kobler (1991)</td>
<td>Doctors, nurses, other health care professionals</td>
<td>Newborn nursery, NICU</td>
<td>Prospective, no concurrent controls</td>
<td>Education, feedback, reminders Before patient contact and after contact with an object or one's own body. 15 seconds, antiseptic soap, thorough scrubbing. Direct observation.</td>
<td>Five 1-week periods: December 1988, March, June, October and December 1989. Baseline (first two periods): 28% (73/257) Follow-up (final three periods): 63% (97/155), p&lt;0.001</td>
<td>Staff aware that they were being observed during the intervention but not during baseline. Observer performed her regular duties, so staff would not suspect anything unusual.</td>
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<td>Rosethall et al. (2003b)</td>
<td>Physicians, nurses, ancillary staff</td>
<td>Three hospitals, Argentina</td>
<td>Prospective, no concurrent controls</td>
<td>Education alone, followed by education and performance feedback</td>
<td>Before patient contact. Direct observation.</td>
<td>Three consecutive phases – differing timescales among the three hospitals. Baseline (2–4 months): 17% (371/2249) Education (1–4 months): 44% (625/1428) vs baseline RR 2.65 (95% CI 2.33, 3.02; p=0.000001) Education and feedback (5–24 months): 58% (687/11854) vs education RR 1.33 (95% CI 1.22, 1.44; p=0.000001)</td>
<td>Staff aware that hand hygiene being observed but did not know when.</td>
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<td>Sharek et al. (2002)</td>
<td>House staff/nurse practitioners, surgeons, X-ray technicians</td>
<td>NICU, USA</td>
<td>Prospective, no concurrent controls</td>
<td>Policy (with open book test to determine comprehension), education (sessions and notices), reminders (stickers and posters), feedback (of compliance and infection data)</td>
<td>Between patients: Direct observation. Baseline (4 months): Whole group 70% (32/46) Subgroup 47% (9/19) 2, 3 and 6 months post-introduction of intervention: Subgroup 85% (41/48), p=0.001 vs baseline.</td>
<td>Observation by staff nurses. Staff unaware that compliance was being observed. Seven categories of healthcare workers were evaluated at baseline. Three groups with the lowest baseline compliance were combined for comparison before and after the intervention.</td>
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<td>Simmons et al. (1990)</td>
<td>Nurses</td>
<td>MICU, SICU</td>
<td>Prospective, no concurrent controls</td>
<td>Education, reminders (buttons), feedback</td>
<td>Appropriate hand hygiene. Direct observation.</td>
<td>Interventions implemented over a five-month period.</td>
<td>Secret observations, under the guise of studying traffic patterns in the ICUs. End of study questionnaire indicated that no nurses had guessed purpose of study/observer. Linear regression (using the average handwashing rate for the first 5 months as the first point before the intervention and the remaining 6 months as individual points after the intervention) demonstrated a significant linear trend, indicating that the handwashing rate was increasing after the interventions.</td>
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<td>Swoboda et al. (2002)</td>
<td>All</td>
<td>Intermediate care unit, USA</td>
<td>Prospective, non-randomised controls</td>
<td>Electronic sensors monitored room entries, exits, use of toilets. Automatic voice messages urging hand hygiene when appropriate (in isolation rooms; non-isolation rooms as control).</td>
<td>Electronic sensors monitored use of sinks and soap/alcohol dispensers.</td>
<td>14.5 months, three phases (baseline, intervention, post-intervention with no prompts). Baseline (1,616 patient days): 46% more likely to wash hands in isolation rooms vs non-isolation rooms (OR 1.46; CI 0.97, 2.2). Intervention (1,390 patient days) and post-intervention (548 patient days) combined: 84% more likely to wash hands in isolation rooms vs non-isolation rooms (OR 1.84; CI 1.34, 2.53; p=0.00 (sic).</td>
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<td>Tibballs (1996)</td>
<td>Medical staff (61 in total)</td>
<td>PICU, Australia</td>
<td>Prospective, no concurrent controls</td>
<td>Performance feedback</td>
<td>Before and after patient contact. Direct observation.</td>
<td>Compliance before/after contact: Baseline (4 weeks): 12%/11% (of 161) Observation with prior notification (5 weeks): 33%/33% (of 168) Intervention (4 weeks): 68%/65% (of 315) Follow up (7–12 weeks after feedback ended): 55%/55% (of 295)</td>
<td>Observation was unobtrusive during baseline and follow-up. Not clear how ‘unobtrusive observation’ was achieved.</td>
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<tr>
<td>Van de Mortel &amp; Heyman (1995)</td>
<td>All</td>
<td>ICU and HDU, Australia</td>
<td>Prospective, no concurrent controls</td>
<td>Performance feedback</td>
<td>After direct patient contact. Direct observation.</td>
<td>Baseline (6 weeks) / Intervention (5 months) / Follow up (6–8 months post-intervention): Registered nurses (n=45) 69%/74%/69% (p&gt;0.50) Visiting medical officers (n=10) 20%/28%/77% (p&lt;0.001) Resident medical officers (n=25) 41%/42%/54% (p&gt;0.25) Physiotherapists (n=11) 57%/94%/93% (p&lt;0.001) Radiographers (n=15) 35%/30%/41% (p&gt;0.25) Wardsmen (n=14) 90%/81%/82% (p&gt;0.10)</td>
<td>Covert observation during baseline and follow up. During intervention, staff aware of observations but not identity of observer. At end of intervention, staff informed the study was over. Staff turnover was high among resident medical officers and radiographers – cannot assume same individuals monitored over time.</td>
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<tr>
<td>Van de Mortel et al.</td>
<td>All (214 in total)</td>
<td>ICU and HDU, Australia</td>
<td>Prospective, no concurrent controls</td>
<td>Performance feedback</td>
<td>After direct patient contact. Direct observation.</td>
<td>Baseline (5 weeks): 61% (of 143) Intervention (2 weeks): 83% (of 399), p=0.001 compared with baseline. Follow up 6-months post-intervention (2 weeks): 76% (of 260), p=0.06 compared with intervention phase. Follow up 12-months post-intervention (2 weeks): 65% (of 125), p=0.0001 compared with intervention phase.</td>
<td>Covert observation (participant observers) during baseline and follow up. During intervention, staff aware of observations but not identity of observer (determined by asking staff after study ended). Aim was to determine optimum time to repeat performance feedback – concluded it should be repeated within 12 months.</td>
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<td>Vernon et al. (2001)</td>
<td>Not stated</td>
<td>Hospital-wide (acute and long term beds), USA</td>
<td>Prospective, no concurrent controls</td>
<td>Alcohol handrub and education</td>
<td>Quarterly hand hygiene rates after patient contact. Direct observation.</td>
<td>140 hours of observations. Baseline (6–8 months pre-intervention): 23% 6–8 months post-intervention: 55% (p=0.001)</td>
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<td>Won et al. (2004)</td>
<td>Nurses, physicians and other healthcare workers in the ICU</td>
<td>NICU, Taiwan</td>
<td>Prospective, no concurrent controls</td>
<td>Lectures, written instructions, posted reminders, financial incentives (not for physicians), feedback on compliance</td>
<td>After patient contact and before and/or after specified activities. Direct observation.</td>
<td>312 hours of observation in total. Baseline (3 months): 43% First year of intervention: 74% Second year of Intervention: 80% (p=0.01 compared with baseline) Follow up for 16 months after lectures discontinued (all other aspects of intervention still in place); 81% (p&lt;0.01 compared with baseline)</td>
<td>Covert observation by randomly assigned NICU nurses.</td>
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<td>Berg et al. (1995)</td>
<td>Adult medical/surgical ICU, Guatemala</td>
<td>Prospective study, no concurrent controls</td>
<td>Changes in procedures for endotracheal suction catheters and urinary drainage systems and hand hygiene educational programme.</td>
<td>Reduction in nosocomial infection rate from 43% pre-intervention to 29% post intervention (p=0.02). Rate of infections per 1,000 device days reduced from 150 to 94 (p&lt;0.05).</td>
<td>Majority of infections both pre and post-intervention were ventilator-associated pneumonia. Rates of nosocomial infections most likely to be reduced by improvements in hand hygiene did not change significantly.</td>
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<td>Brown et al. (2003)</td>
<td>Neonatal ICU, Russia</td>
<td>Prospective study, no concurrent controls</td>
<td>Two-stage intervention: introduction of alcohol handrub at sinks and patient dispensers with mandatory education session; development of quality improvement programme including feedback of infection surveillance data.</td>
<td>Colonisation with Klebsiella pneumoniae ‘decreased markedly’. Enterococcus and Candida species also decreases. Enterobacter agglomerans increased slightly following first intervention and ‘decreased significantly’ after the second intervention.</td>
<td>Only histogram of cases of infection given. No quantitative data or statistical analysis of infection rates presented.</td>
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<td>Conly et al. (1989)</td>
<td>Medical ICU, Canada</td>
<td>Prospective study, no concurrent controls</td>
<td>Intervention was implemented on two occasions during first and fifth years of five-year study. Multi-component intervention including education, feedback on handwashing compliance and reminders.</td>
<td>Pre-first intervention infection rate was &gt; 30%. Post-intervention infection rate dropped to 12%. Progressive increase to almost 30% with drop to 10% after second Intervention. Infection rates when poor handwashing practices were observed were significantly higher than when improved handwashing practices were observed (p=0.02).</td>
<td>Gradual deterioration in hand hygiene compliance and associated infection rates. Unclear what data was included in test for significant differences. Authors acknowledge that intervention may have affected other aspects of infection control which may in turn have affected infection rates.</td>
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<td>Coopersmith et al. (2002)</td>
<td>Surgical/burn/trauma ICU, USA</td>
<td>Prospective study, no concurrent controls</td>
<td>10-page self-study module on catheterisation incorporating specific risk reduction strategies including handwashing and aseptic technique, routine catheter site care, etc.</td>
<td>Before intervention, 10.8 infections per 1,000 catheter days, after intervention 3.7 per 1,000 catheter days, decrease of 66% (p&lt;0.0001).</td>
<td>Only registered nurses required to participate in intervention. A minority of other clinical staff participated. Infection rates above national average before intervention.</td>
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<tr>
<td>Coopersmith et al. (2004)</td>
<td>Surgical ICU, USA</td>
<td>Prospective study, no concurrent controls</td>
<td>Behavioural interventions stressing compliance with best practice for catheter insertion including hand hygiene and using sterile precautions.</td>
<td>3.4 catheter-related bloodstream infections per 1,000 catheter days before intervention and 2.8 per 1,000 catheter days post intervention (p=0.40).</td>
<td>Behavioural intervention and subsequent audit of compliance identified deficiencies then highlighted in behavioural intervention (Coopersmith et al., 2002). Only 16 catheter insertions included in this study therefore likely to be insufficient power to draw conclusions.</td>
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<td>Doebbeling <em>et al.</em> (1992)</td>
<td>Three adult ICUs, USA</td>
<td>Prospective, non-randomised controls, multiple crossover design</td>
<td>For a period of one month, units were provided with either chlorhexidine or 60% isopropyl handrub. In subsequent months, the pattern was alternated. Study continued for 8 months.</td>
<td>Ratio of number of infections per 1,000 patient days with chlorhexidine 0.73 (95% CI 0.59, 0.90) compared with alcohol hand rub. There were significantly fewer gastrointestinal infections, but no significant differences in other infection types.</td>
<td>Although there was a statistically significant difference in the number of nosocomial infections when the two agents were compared, there was no difference in the number of patients infected. Time-series analysis would be required to ensure findings not related to outbreak of gastrointestinal infections in one unit in one month.</td>
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<td>Eggimann <em>et al.</em> (2000)</td>
<td>ICU, Switzerland</td>
<td>Prospective study, no concurrent controls</td>
<td>Baseline surveillance period of 5 months. Educational campaign including demonstrations and guidelines on intravascular device insertion and maintenance including importance of hand disinfection. Follow-up surveillance period of 8 months.</td>
<td>Rate of ICU-acquired infections pre-intervention 12.7/100 admissions, and post intervention 8.1/100 admissions. (RR 0.64; 95% CI 0.50, 0.81) There were statistically significant differences in rates of pre and post-intervention bloodstream infections, catheter exit site infections and skin or mucous membrane infections. No differences in respiratory tract, urinary tract or other infections. Rates of nosocomial bloodstream infections in surgical ICU (comparator) remained stable during study period.</td>
<td>An ongoing hand hygiene programme was in place in the hospital at the time of the study although compliance was described as low. Authors acknowledge weakness of multi-factorial intervention in determining the components of the programme which had greatest impact. Also acknowledge lack of randomisation and short follow-up period which prevents conclusive determination of an association between intervention and outcomes.</td>
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<td>Reference</td>
<td>Setting</td>
<td>Study design</td>
<td>Intervention</td>
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<tr>
<td>Fendler et al. (2002)</td>
<td>Extended care facility, USA</td>
<td>Prospective, non-randomised controls</td>
<td>Alcohol hand sanitiser provided to two units in facility with other units acting as comparator. Nurses instructed to use sanitiser rather than handwashing and to wash hands with antimicrobial soap after five uses of sanitiser. Control units provided with same antimicrobial soap.</td>
<td>Infection rate in intervention unit 2.27 per 1,000 patient days compared with control rate of 3.19 per 1,000 patient days over 34-month period. 30.4% reduction (p&lt;0.05).</td>
<td>Intervention and control groups had different medical conditions. Study assumed that infection rates in the control group and intervention groups would have been same without intervention, but there is no baseline data to support this.</td>
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<tr>
<td>Hilburn et al. (2003)</td>
<td>Orthopaedic surgical unit, USA</td>
<td>Prospective study, no concurrent controls</td>
<td>Baseline infection rates established for 6 months prior to introduction of alcohol hand sanitiser. Patient information, posters, written material, feedback of infection rates to staff.</td>
<td>Urinary tract and surgical site infections primary infection types. A 36.1% reduction was reported.</td>
<td>No indication if reduction in infection rate was statistically significant. Comparison made with rest of hospital, but no baseline surveillance data for rest of hospital therefore cannot be considered as control.</td>
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<td>Hirschmann et al. (2001)</td>
<td>Three hospitals, Austria</td>
<td>Cross sectional</td>
<td>At insertion or removal of peripheral venous catheters, a proforma was completed documenting hand hygiene procedures and outcomes.</td>
<td>Where hand disinfection or gloves worn carried out, significantly lower rates of symptoms of infection (RR = 0.59, 0.66 respectively) compared with normal hand washing. Normal handwashing no better than no hand hygiene.</td>
<td>There were also significant associations between infection and duration of catheterisation, sex of patient and place where catheterisation carried out. No blinding of proforma respondents, so potential for bias. No objective measures of infection.</td>
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<td>Reference</td>
<td>Setting</td>
<td>Study design</td>
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<tr>
<td>Kilbride et al. (2003)</td>
<td>Six neonatal ICUs, USA</td>
<td>Prospective study, no concurrent controls</td>
<td>Development by consensus, and implementation of evidence-based guidelines for hand hygiene, indwelling catheter management and accuracy of diagnosis of CONS.</td>
<td>Before intervention, mean incidence of CCNS was 24.6%. Post-intervention, mean incidence was 16.4% (RR 0.67, 95% CI 0.51, 0.87). Only mean incidence rates given so no indication of variability within and between units. Authors emphasised that the development of guidelines resulted in culture change in units.</td>
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<tr>
<td>King (2004)</td>
<td>Surgical ward, UK</td>
<td>Prospective study, no concurrent controls</td>
<td>Bedside holders of alcohol handrub for three-month trial, with educational support, and promotional material.</td>
<td>During Three-month trial period, four new cases MRSA compared with range 5–10 (mean 8) in same period during the previous 4 years. Five new cases of C. difficile compared with none in previous 12 months. Study too short to determine if change in infection rates associated with intervention. Confounder in that softer paper towels also introduced during trial period.</td>
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<tr>
<td>Kuriat et al. (1998)</td>
<td>Neonatal ICU, Argentina</td>
<td>Prospective study, no concurrent controls</td>
<td>Three-stage intervention programme: (1) surveillance of NICU practices, (2) development of guidelines for high-risk practices, including handwashing, (3) training in guidelines.</td>
<td>Bacteraemia rate 20/1,000 patient days before intervention and 12.4/1,000 patient days post intervention (p&lt;0.004). Gram-negative bacteraemia rate 7.7/1,000 patient days before intervention and 2.2/1,000 patient days post intervention (p&lt;0.0002). Statistically significant changes in rates per 1,000 patient days but not per 100 admissions which authors attribute to larger proportion of lowest birthweight infants surviving in post-intervention period.</td>
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<td>Reference</td>
<td>Healthcare workers</td>
<td>Setting</td>
<td>Study design</td>
<td>Intervention</td>
<td>Primary hand hygiene compliance outcome</td>
<td>Results</td>
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<tr>
<td>Gould &amp; Chamberlain (1997)</td>
<td>Nurses (31 out of 50 could be followed up)</td>
<td>Four surgical wards (in a single hospital), UK</td>
<td>Prospective, non-randomised controls</td>
<td>Education (ward-based teaching package)</td>
<td>After initiation of clinical contact. Direct observation.</td>
<td>Each nurse observed for 2 hours. Baseline: Intervention group 14%, controls 13%. Post-intervention (3 months after baseline): Intervention group 13%, controls 15%. Not significant at 0.05 level using ANCOVA.</td>
<td>Attempted to blind both the study group and investigator intervention. Also collected data on 'essential decontaminations' and duration of handwashing – no significant effect of the intervention on either of these. Problems with implementability of intervention.</td>
</tr>
<tr>
<td>Graham (1990)</td>
<td>Nurses, medics, physios, radiologists, orderlies</td>
<td>ICU, Australia</td>
<td>Prospective, no concurrent controls</td>
<td>Alcohol agent (instructions on the use of the handrub lotion were made available to all staff)</td>
<td>After patient contact. Direct observation.</td>
<td>Baseline: 32% (140/440) 1–3 weeks post-introduction: 45% (201/444), p&lt;0.01</td>
<td>Staff told it was an audit of infection control procedures (told that handwashing practices were specifically being observed).</td>
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<tr>
<td>Reference</td>
<td>Health care workers</td>
<td>Setting</td>
<td>Study design</td>
<td>Intervention</td>
<td>Hygiene compliance outcome</td>
<td>Results</td>
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<td>Harbarth et al. (2002)</td>
<td>All</td>
<td>PICU, NICU, CICU USA</td>
<td>Prospective, no concurrent controls</td>
<td>Alcohol agent, education, feedback, opinion leaders</td>
<td>Before and after completed or interrupted patient contact (clean gloves acceptable alternative before contact). Direct observation.</td>
<td>12,216 hand hygiene opportunities in total. Baseline (2.5 months): decreased in all three units after the first 2 weeks of observation from a median of 43% (IR 30 to 56%) to 28% (IR 19 to 39%). Introduction of the hand gel without any quality improvement (QI) support in the CICU and implementation of QI interventions without hand gel in the PICU (2.5 months): decreased to 23% (IR 15 to 33%, p&lt;0.001). Introduction of the hand gel plus QI support in all three units (3 months): increased to 35% (of 3,983, IR 22 to 43%, p&lt;0.001). Gel in CICU and PICU, gel plus QI in NICU (2.5 months): overall, 37% (of 3,003, IR 26 to 44%), but fell to 30% during the last weeks of the study. Adjusted ORs for compliance increased significantly in the last two phases (1.6 and 1.9, both p&lt;0.001).</td>
<td>Told staff it was a study of medication errors and other issues. Did not include the first 2 weeks of baseline in the logistic regression model.</td>
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<td>Reference</td>
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<td>Study design</td>
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<tr>
<td>Pittet et al. (2000)</td>
<td>Acute hospital, Switzerland</td>
<td>Prospective study, no concurrent controls</td>
<td>Hand hygiene promotion programme including bedside and individual supplies of alcohol handrub, poster displays, performance feedback on handwashing compliance and senior management support.</td>
<td>Nosocomial infection, alcohol handrub consumption and antimicrobial usage were secondary outcomes. Prevalence of nosocomial infections reduced from 16.9% to 9.9% over the four-year study period (p=0.04). The MRSA attack rate decreased from 2.16/10,000 patient days to 0.93/10,000 patient days over same period (p&lt;0.001).</td>
<td>Long-term sustainability attributed to sustained intervention and involvement of institutional leaders. Programme includes infection control measures unlikely to affect hand hygiene compliance.</td>
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<td>Rao et al. (2002)</td>
<td>Teaching hospital, UK</td>
<td>Prospective study, no concurrent controls</td>
<td>Provision of alcohol handgel at patient’s bedside, senior management support, promotional material, educational events.</td>
<td>Proportion of MRSA cases which were hospital acquired was 50% pre intervention and 39% post intervention. Cases of C. difficile pre-intervention 11.5/1,000 admissions and post intervention 9.5/1,000 admissions. Reduction not statistically significant.</td>
<td>No control to assess if changes in infection rates were confined to intervention hospital. No indication if change in proportion of MRSA cases which were hospital acquired was significantly different. Alcohol handrub manufacturer provided financial support for study.</td>
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<td>Rosenthal et al.  (2003a)</td>
<td>Two medical/surgical ICUs and two coronary ICUs, Argentina</td>
<td>Prospective study, no concurrent controls</td>
<td>Phase 1: baseline surveillance for intravascular device (IVD)-associated infection and compliance with IVD site care, Phase 2: education and training in central venous catheter care, Phase 3: performance feedback.</td>
<td>Combined infection rate at Phase 2 and 3 vs Phase 1 RR=0.25 (p&lt;0.001), Phase 2 vs Phase 1 RR=0.37 (p&lt;0.001), Phase 3 vs Phase 2 RR=0.58 (p=0.11). Overall rate reduced from 46.63/1,000 IVD days to 11.10/1,000.</td>
<td>A handwashing programme was also implemented during the study period, but no details were given.</td>
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<td>Reference</td>
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<tr>
<td>Salemi et al. (2002)</td>
<td>Medical/surgical ICU, cardiac care unit, USA</td>
<td>Prospective study, no concurrent controls</td>
<td>Educational programme and feedback of compliance with handwashing over 22 months.</td>
<td>No significant differences in ventilator-associated pneumonia rates. Rate of central line-related bloodstream infections 3.0/1,000 central line days before intervention and 1.4/1,000 central line days after intervention.</td>
<td>No data on variability of infection rates across time periods or analysis of significance of difference in rates. Only physicians targeted by this intervention although other professional groups may have been aware of intervention.</td>
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<tr>
<td>Sharek et al. (2002)</td>
<td>Neonatal ICU, USA</td>
<td>Prospective study, no concurrent controls</td>
<td>Handwashing policy development and implementation with educational material, compliance and infection data feedback.</td>
<td>Pre-intervention positive blood and cerebrospinal fluid cultures for CONS 6.1 ± 2.3 per 1,000 patient days, post intervention 3.2 ± 1.6 per 1,000 patient days (p=0.005). False-positive cultures (reflecting colonisation rather than infection) accounted for most of this reduction (p=0.42).</td>
<td>The rate of cultures for CONS reduced but this was mostly false-positive cultures. True-positive cultures did not reduce significantly. No reduction in rates of other infections shown.</td>
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<td>Simmons et al. (1990)</td>
<td>One medical and one surgical ICU, USA</td>
<td>Prospective study, no concurrent controls</td>
<td>Four-stage intervention to improve hand hygiene compliance: (1) observations and feedback, (2) lecture, (3) literature, (4) button campaign.</td>
<td>Number of infected patients in 6 months before intervention 50/327, and in 6 months post intervention 53/362. No significant differences were observed.</td>
<td>Only crude infection rates per patient presented, no account taken of days in ICU and no control group. Physicians were not included in intervention programme which may account for lack of change in infection rates.</td>
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<td>Reference</td>
<td>Healthcare workers</td>
<td>Setting</td>
<td>Study design</td>
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<td>Primary hand hygiene compliance outcome</td>
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<tr>
<td>McGuckin et al. (2001)</td>
<td>All</td>
<td>Medical and surgical patients, UK</td>
<td>Prospective, crossover design</td>
<td>&quot;Partners in Your Care&quot;&lt;br&gt;On admission, patients visited by member of staff to discuss importance of hand hygiene, instructed to ask staff &quot;Did you wash/sanitise your hands?&quot;, and given brochure and prompting aids.</td>
<td>Hand hygiene episodes per resident-day, estimated from hand hygiene product usage.</td>
<td>39 (40%) patients agreed to participate.</td>
<td>Soap and gel usage (units): Baseline (6 weeks) 12.3 Control (6 weeks, either before or after intervention) 15.6 Intervention (6 weeks) 18.5 Soap usage/handwashings an average of 50% higher during intervention compared to baseline (p&lt;0.05), and 10% higher compared with control (p=0.05).</td>
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<tr>
<td>McGuckin et al. (1999)</td>
<td>All</td>
<td>Four community hospitals, USA</td>
<td>Prospective, crossover design</td>
<td>&quot;Partners in your care&quot; (see above)</td>
<td>Hand hygiene episodes per resident-day, estimated from hand hygiene product usage.</td>
<td>441 patients enrolled in the study, two consecutive six-week periods – two hospitals control then intervention period, two hospitals intervention then control period. Soap usage/handwashings an average of 34% higher during intervention than control period (p=0.021).</td>
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<tr>
<td>McGuckin et al. (2004)</td>
<td>All</td>
<td>Rehabilitation unit, USA</td>
<td>Prospective, no concurrent controls</td>
<td>&quot;Partners in your care&quot; (see above)</td>
<td>Hand hygiene episodes per resident-day, estimated from hand hygiene product usage.</td>
<td>Baseline (6 weeks): 5 Intervention (6 weeks): 9.7 (p&lt;0.001) Post-intervention (6 weeks): 6.7 (p&lt;0.001) (p&lt;0.001) Follow-up (3 months post-baseline): 7 (p&lt;0.001) Sustained increase at 3 months post-baseline of 40%.</td>
<td>During follow up, re-introduc one component of the intervention (educational brochure to patients on admission).</td>
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</table>
## Appendix 5 Cost-effectiveness data extraction tables

<table>
<thead>
<tr>
<th>Study paper</th>
<th>(Plowman et al., 1999a; Plowman et al., 1999b)</th>
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</thead>
<tbody>
<tr>
<td>Study type</td>
<td>Cost of illness study</td>
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</tbody>
</table>
| Study site and population | District general hospital in England  
- 4,000 patients (specialities: medical, surgical, urology, gynaecology, ear, nose and throat, elderly people and obstetrics (caesarean section patients only)).  
- 1,449 patients were followed up post discharge. |
| Study period | April 1994 to May 1995                          |
| Clinical data sources | Clinical outcomes observed at study site |
| Economic data sources | Resource use measured directly on a patient-to-patient basis. Cost used were the actual costs incurred by hospital. |
| Outcome measures | Incidence rate observed, resource use and costs of resources, cost of HAI by site. |
| Method of analysis | Observational data  
Regression analysis used to estimate additional costs and length of stays, at national level, which controlled for age, sex, admission specialty, diagnosis, number of co-morbidities and admission type. |
| Discounting | N/A                                             |
| Assumptions | Estimate of cost of HAI at a national level  
Incidence of HAI, ratio of increase in costs and mean costs of treating patients observed at study site were applicable at a national level. |
| Results | Results reported from regression model:  
Hospital level (study site):  
- 7.8% (95% CI 7.0, 8.6) of patients identified as having one or more HAI while in hospital, incurring a cost 2.5 (95% CI 2.3, 2.7) times greater than non-HAI patients. The average additional length of stay was 11 days and additional cost was £2,917.  
- 30% of patients who had contracted an HAI in hospital reported post-discharge symptoms of urinary tract infection, chest and surgical wound infections.  
- 19% of non-HAI patients reported post-discharge symptoms of urinary tract infection, chest and surgical wound infections.  
- HAI patients estimated to cost the study hospital £3.6 million in 1994–1995.  
National estimates:  
- Costs to the hospital sector – £930.6 million (95% CI £780.26m, £1,080.97m)  
- Treatment costs post discharge – £56 million  
- Number of HAI among adult inpatients – 320,994 (95% CI 288,071, 353,916)  
- Additional bed days used as a result of HAI – 3.64 million (95% CI 3.01 m, 4.27 m) |
<table>
<thead>
<tr>
<th>Study paper</th>
<th>(Walker, 2001)</th>
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<tbody>
<tr>
<td>Study type</td>
<td>Estimates cost of HAI at a national level using healthcare provider perspective</td>
</tr>
<tr>
<td>Study site and population</td>
<td>Scotland</td>
</tr>
<tr>
<td>Study period</td>
<td>Estimates at 1999 prices</td>
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<tr>
<td>Clinical data sources</td>
<td>Incidence rates for different types of infections as per Plowman report</td>
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<tr>
<td>Economic data sources</td>
<td>Plowman report, Scottish hospital activity data (ISD)</td>
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<tr>
<td>Outcome measures</td>
<td>Cost of HAI (national level):</td>
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<tr>
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<td>Number of bed days saved</td>
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<td>Number of infections by site for 1999–2000</td>
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<tr>
<td>Method of analysis</td>
<td>Applies Scottish hospital activity data to incidence rates and costs reported by Plowman.</td>
</tr>
<tr>
<td>Discounting</td>
<td>N/A</td>
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<tr>
<td>Assumptions</td>
<td>Method – Scottish hospital activity applied to Plowman model</td>
</tr>
<tr>
<td></td>
<td>• Data from ISD on Scottish hospital activity applied to Plowman data on HAI rates in different specialities</td>
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<tr>
<td></td>
<td>Method – Plowman model applied to English hospital activity pro rated for Scotland</td>
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<tr>
<td></td>
<td>• Prevalence is 9.2%</td>
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<td></td>
<td>• Incidence is 7.8%</td>
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<td></td>
<td>• Additional inpatient stay for HAI patients is 11 days</td>
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<td></td>
<td>• Effectiveness of infection control policies</td>
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<td></td>
<td>• Intensive policy 15%</td>
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<td></td>
<td>• Moderate intensity 7.5%</td>
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<td>• Low intensity 0%</td>
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<td>Specialities covered by Plowman’s account for 58.6% of English inpatient admissions.</td>
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<tr>
<td>Results</td>
<td>Cost and resource use of HAI estimated for Scotland</td>
</tr>
<tr>
<td></td>
<td>• Scottish hospital activity applied to Plowman model – £139 million</td>
</tr>
<tr>
<td></td>
<td>• Plowman model applied to English hospital activity pro rated for Scotland – £186 million.</td>
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<tr>
<td></td>
<td>• 378,484 additional bed days occupies as a result of HAI (approximately 1,000 beds annually full time).</td>
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<td>• 457 deaths estimated where HAI is a major factor.</td>
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<td>• Further 1,372 deaths where HAI is a contributory factor.</td>
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<tr>
<td>Study paper</td>
<td>(MacDonald et al., 2004)</td>
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<tr>
<td>Study type</td>
<td>Observational study</td>
</tr>
<tr>
<td>Study site and population</td>
<td>Pilot ward (plastic surgery) in a district general hospital</td>
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<tr>
<td>Study period</td>
<td>Not explicit</td>
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<tr>
<td>Clinical data sources</td>
<td>Observed rate of new MRSA cases, hand hygiene audit and feedback</td>
</tr>
<tr>
<td>Economic data sources</td>
<td>Actual cost of alcohol-based products incurred by hospital</td>
</tr>
<tr>
<td>Outcome measures</td>
<td>Rate of new MRSA cases before and after hand hygiene audit</td>
</tr>
<tr>
<td>Method of analysis</td>
<td>Hand hygiene carried out in March 2000, feedback given to staff in April 2000. Second hand hygiene audit carried out in November 2000. Number of new cases of MRSA judged to have been acquired during patient’s hospital stay monitored 12 months before first hand hygiene audit and 12 month after audit.</td>
</tr>
<tr>
<td>Discounting</td>
<td>N/A</td>
</tr>
<tr>
<td>Assumptions</td>
<td>N/A</td>
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<tr>
<td>Results</td>
<td>Rate of new MRSA cases</td>
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<tr>
<td></td>
<td>• 1.9% (SE 0.39%) before hand hygiene audit (April 1999–March 2000)</td>
</tr>
<tr>
<td></td>
<td>• 0.9% (SE 0.26) after hand hygiene audit (April 2000–March 2001)</td>
</tr>
<tr>
<td>Compliance rates before clinical contact</td>
<td>20% March 2000</td>
</tr>
<tr>
<td></td>
<td>47% November 2000</td>
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<tr>
<td>Compliance rates after clinical contact</td>
<td>42% March 2000</td>
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<td></td>
<td>78% November 2000</td>
</tr>
<tr>
<td>Alcohol gel usage (750ml units @ £5.50 per unit)</td>
<td>6 x 750 ml units (April 1999–March 2000)</td>
</tr>
<tr>
<td></td>
<td>21 x 750 ml units (April 2000–March 2001)</td>
</tr>
<tr>
<td>Telicoplanin</td>
<td>• 1,460 ampoules @ total cost of £35,596 (April 1999–March 2000)</td>
</tr>
<tr>
<td></td>
<td>• 1,195 ampoules @ total cost of £21,730 (April 2000–March 2001).</td>
</tr>
<tr>
<td>Study paper</td>
<td>(Pittet et al., 2004)</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Study type</td>
<td>Observational</td>
</tr>
<tr>
<td>Study site and population</td>
<td>Swiss teaching hospital, inpatients only</td>
</tr>
<tr>
<td>Study period</td>
<td>8 years</td>
</tr>
</tbody>
</table>
| Clinical data sources | Effectiveness of a hand hygiene campaign based on previous study (Pittet et al., 2000)
Annual hospital-wide prevalence survey (to measure the number of nosocomial infection) |
<p>| Economic data sources | Costs observed at study hospital |
| Outcome measures | Consumption of alcohol handrub, total cost of promotional campaign, number of nosocomial and primary bloodstream infections and infection rates |
| Method of analysis | Cost-effectiveness analysis |
| Discounting Assumptions | None |
|                  | - Compliance with hand hygiene increases from 48% in Year 1 to 66% in Year 3. |
|                  | - Direct costs cover alcohol handrub, posters and display materials. |
|                  | - Indirect costs cover staff costs for participating staff and office supplies. |
|                  | - Additional inpatient stay is 2.5 days for any HAI. |
|                  | - Infection rates estimated from hospital wide prevalence survey. |
| Results          | Nosocomial infection rate fell from 16.9% in Year 1 to 9.5% in Year 8. |
|                  | Hand hygiene programme was cost saving if less than 1% of the reduction in infection rates during the study period is due to improved hand hygiene practice. |
|                  | Concludes promotion of hand hygiene from a hospital perspective is probably cost effective. |</p>
<table>
<thead>
<tr>
<th>Study paper</th>
<th>(National Patient Safety Agency, 2004c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study type</td>
<td>Estimates costs and benefits at a hospital and national level</td>
</tr>
<tr>
<td>Study site and population</td>
<td>England</td>
</tr>
<tr>
<td>Study period</td>
<td>Time horizon of evaluation – 5 years</td>
</tr>
<tr>
<td>Clinical data sources</td>
<td>Increase in handwashing compliance and usage of alcohol-based products taken from pilot study (National Patient Safety Agency, 2004a)</td>
</tr>
<tr>
<td>Economic data sources</td>
<td>Patient benefits and reduced healthcare costs based on (Plowman et al., 1999b)</td>
</tr>
<tr>
<td>Outcome measures</td>
<td>Cost savings, QALYs gained</td>
</tr>
<tr>
<td>Method of analysis</td>
<td>Cost-effectiveness and cost-utility analysis</td>
</tr>
<tr>
<td>Discounting</td>
<td>Financial costs/benefits – 3.5%, health benefits – 1.5%</td>
</tr>
<tr>
<td>Assumptions</td>
<td>• Compliance with hand hygiene increased from 28% to 76% in Year 1 and was sustained at 76% thereafter.</td>
</tr>
<tr>
<td></td>
<td>• Direct cost of purchasing alcohol-based products included, promotional and installation costs were excluded.</td>
</tr>
<tr>
<td></td>
<td>• HAI rate fell by 9% (ie from 7.8% to 7.1%).</td>
</tr>
<tr>
<td></td>
<td>• Amount of alcohol-based products used per patient per day was 6.5 ml.</td>
</tr>
<tr>
<td></td>
<td>• Patient benefits were a gain of 0.007 QALYs for every non-fatal HAI avoided (based on quality of life reported in Plowman) and 7 QALYs for every fatal HAI avoided.</td>
</tr>
<tr>
<td>Results</td>
<td>For a 500-bed hospital (annually):</td>
</tr>
<tr>
<td></td>
<td>• Net cash savings approx £460,000</td>
</tr>
<tr>
<td></td>
<td>• 12 QALYs gained.</td>
</tr>
<tr>
<td></td>
<td>England (annual):</td>
</tr>
<tr>
<td></td>
<td>• Net cash savings approximately £137 million (£2 million expenditure on alcohol-based products products and savings of £139 million)</td>
</tr>
<tr>
<td></td>
<td>• 3,246 QALYs gained.</td>
</tr>
<tr>
<td></td>
<td>• Sensitivity analysis shows that a net saving is made even if a 1% reduction in HAI rated is achieved.</td>
</tr>
<tr>
<td>Study paper</td>
<td>(Yoss &amp; Widmer, 1997)</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Study type</td>
<td>Model to compare time spent on hand hygiene using soap and water or alcohol-based products</td>
</tr>
<tr>
<td>Study site and population</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Study period</td>
<td></td>
</tr>
<tr>
<td>Clinical data sources</td>
<td>Time spent on each handwashing (minimum, average, maximum: 40, 60, 80 seconds) or using alcohol-based products (20 seconds) observed in ward.</td>
</tr>
<tr>
<td>Economic data sources</td>
<td>N/A</td>
</tr>
<tr>
<td>Outcome measures</td>
<td>Total staff time spent on hand hygiene per shift</td>
</tr>
<tr>
<td>Method of analysis</td>
<td>Model developed to predict the time spent daily on hand hygiene depending on level of compliance, duration of hand disinfection, use of soap or alcohol-based products.</td>
</tr>
<tr>
<td>Discounting</td>
<td>N/A</td>
</tr>
<tr>
<td>Assumptions</td>
<td></td>
</tr>
<tr>
<td>Results</td>
<td>At compliance rate of 100% and assuming 60 seconds per hand hygiene with soap and water, total staff time spent on:&lt;br&gt;• Hand hygiene with soap and water – 12 hours&lt;br&gt;• Hand hygiene with alcohol-based products – 4 hours.</td>
</tr>
<tr>
<td></td>
<td>At compliance rate of 100% and assuming 80 seconds per hand hygiene with soap and water total staff time spent on:&lt;br&gt;• Hand hygiene with soap and water – 16 hours&lt;br&gt;• Hand hygiene with alcohol-based products – 4 hours.</td>
</tr>
<tr>
<td></td>
<td>Study concluded that using alcohol-based products for hand hygiene uses less staff resources when compared with using soap and water.</td>
</tr>
</tbody>
</table>
Appendix 6
Questionnaire to assess the current provision of hand hygiene arrangements

1. In your hospital(s), what is the highest number of beds to a wash-hand basin?

2. Is there a clinical wash-hand basin for each bed in an adult and/or neonatal intensive therapy unit (ITU)?

3. In your opinion, what percentage of clinical areas in your hospital(s) require more wash-hand basins?

4. What percentage of wash-hand basins in your hospital have the following features?
   - Mixer taps giving a good flow of water
   - Liquid soap
   - Paper towels

5. Are alcohol hand hygiene products available for use by all frontline healthcare staff in your hospital?

   YES / NO

   If alcohol hand gel/rub is available for only certain staff groups or in some clinical areas, please explain and detail the reasons why:

6. What alcohol-based hand hygiene products are provided for staff use in your hospital(s)? Please give details:

7. Are wall-mounted alcohol hand gel/rub dispensers provided in your hospital(s)?

   YES / NO
8. Are personal supplies of alcohol hand gel/rub available to all frontline staff in your hospital? 

   YES / NO

   If personal supplies are available for only certain staff groups or in some clinical areas, please explain and detail the reasons why:

9. Is alcohol hand gel/rub available in any other type of dispenser in your hospital(s) e.g. in bottles for clinical trolleys? 

   YES / NO

   If yes, please describe below:

10. What volume (in litres) of alcohol hand gel/rub is used by your hospital per annum?

11. We need to obtain an estimate of the annual cost of provision of alcohol hand products, and the costs of monitoring usage and refilling and replacing broken dispensers. If you are able to provide this information, please give this in the box below. If you do not have these costs but are aware of a possible source, please give details of the appropriate department so we can follow this up.
12. Is hand cream provided for use by all frontline staff in your hospital(s)?

If hand cream is available for only certain staff groups or in some clinical areas, please explain and detail the reasons why:

13. Please give details of circumstances when visitors are encouraged to use alcohol hand gel/rub, eg for patients in isolation.

14. Are there any changes in the provision of alcohol hand gel/rub which you think could result in increased use by staff in your hospital(s)?

If yes, please indicate what measure(s) you consider necessary to improve these arrangements, eg increase in number of dispensers, provision of personal supplies.

15. What is the procedure to identify empty alcohol hand gel/rub dispensers and to refill these when required? Please give details:

16. Are all alcohol hand gel/rub dispensers single use?
17. If dispensers are refillable, what is the procedure to identify broken or malfunctioning dispensers and to have these repaired or replaced? Please give details below:

18. We are interested in how provision of hand hygiene facilities may affect compliance rates with hand hygiene policies. Have you conducted a local audit of hand hygiene compliance in your hospital in the last 2 years?

If yes, please attach any report of the findings of the audit(s) or give brief details below of the results of the audit:

19. Please describe below or attach a description of where hand hygiene is included in infection control education programmes. Please indicate where hand hygiene education forms a separate programme.

20. Have there been any initiatives to involve patients in improving staff compliance with handwashing?

If yes, please describe these initiatives, and report on outcomes:
21. Have any other initiatives to improve or maintain compliance with hand hygiene been carried out in the last 2 years?  
   YES / NO  
   If yes, please describe these initiatives, and report on outcomes:

22. Are there initiatives at management level to improve compliance with hand hygiene, eg in senior management key result areas?  
   YES / NO  
   If yes, please describe these initiatives

23. Is ongoing surveillance of compliance with hand hygiene carried out, eg by assessing consumption of hand hygiene products, self-assessments.

   YES / NO  
   If yes, please give details of ongoing surveillance of compliance:

24. What initiatives or changes within your hospital do you think might improve compliance with hand hygiene e.g. wider provision of alcohol hand gel/rub, education of junior doctors, ongoing infection surveillance and feedback to staff? Please give details:

25. How many infection control nurses (ie whole-time equivalents [WTE]) are employed in your hospital(s)?
26. Approximately how many WTE frontline healthcare workers are employed in your hospital(s)?

27. In your hospital(s), what is the total annual number of patient bed days?

If you have any further comments regarding hand hygiene in your hospital, please give these below:

Your name:
Job title:
Hospitals/areas for which you have responsibility:

Your Address:

Telephone number:
E-mail address:

Please return this form to:

Emma Williams
NHS Quality Improvement Scotland
FREEPOST NAT19799
GLASGOW
G1 2BR
REFERENCES
12 REFERENCES


Conrad C. 2001. Increase in hand-alcohol consumption among medical staff in a general hospital as a result of introducing a training program and a visualization test. Infect Control Hosp Epidemiol, 22(1), 41-42.


Scottish Executive Health Department. 2002. Preventing infections acquired while receiving health care: the Scottish Executive’s action plan to reduce the risk to patients, staff and visitors. Edinburgh: SEHD.


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Scottish Executive Health Department. 2004c. The NHSScotland code of practice for the local management of hygiene and healthcare associated infection. Edinburgh: SEHD.


GLOSSARY
13 GLOSSARY

acute setting
Hospital-based health services which are provided on an inpatient or outpatient basis.

adverse event
An unfavourable incident or situation, which occurs in a particular place during a particular interval of time.

alcohol-based hand hygiene product
A preparation that contains 60–95% alcohol that does not require the use of water. After application of the product, the hands are rubbed together until the product has evaporated.

antimicrobial
An agent that kills microorganisms.

antisepsis
Refers to antiseptic handwashing or antiseptic handrubbing to reduce bacterial flora.

antiseptic agent
Antiseptic agents that are applied to the hands to reduce the number of viable microorganisms. Examples include alcohol, chlorhexidine, chlorine, iodine and triclosan.

antiseptic handwash
The action of washing the hands with water and a soap or detergent containing an antimicrobial agent.

antiseptic handrubbing
Refers to the application of an antiseptic handrub to all surfaces of the hands.

audit
A process which allows for the systematic and critical analysis of the quality of care.

catheterisation
The insertion of a flexible hollow tube (a catheter) into an organ of the body – for example, the bladder, either for investigative purposes or to give some form of treatment. Performed under strict sterile conditions.

CDC
US Centre for Disease Control and Prevention.

CDSR
Cochrane Database of Systematic Reviews.

CI
Confidence interval. An interval likely to contain the true value of an unknown quantity (eg the true sensitivity of a test). For a 95% CI, if the experiment were repeated many times, 95% of the intervals would contain the value of the unknown quantity that is being estimated.

clinical effectiveness
The evaluation of the balance between benefits and risks in a standard clinical setting using outcomes of importance to the patient.

cost effectiveness
Used in its broadest form, this term encompasses all forms of economic analysis.

decontamination
A process which removes or destroys contamination and thereby prevents microorganisms or other contaminants reaching a susceptible site in sufficient quantities to initiate infection or any other harmful response.

discharge
A discharge marks the end of an episode of care. Types of discharge are inpatient discharge, day-case discharge, day-patient discharge and outpatient discharge.

disinfection
A process used to reduce the number of viable microorganisms but which may not necessarily inactivate some microbial agents, such as certain viruses and bacterial spores. Disinfection may not achieve the same reduction in microbial contamination levels as sterilisation.

discharge
A discharge marks the end of an episode of care. Types of discharge are inpatient discharge, day-case discharge, day-patient discharge and outpatient discharge.

evidence based
The process of systematically finding, appraising and using contemporaneous research findings as the basis for clinical decisions.

guidelines
Systematically developed statements which assist in decision making about appropriate actions.

HAI
Healthcare associated infection. An infection acquired via the provision of healthcare in either a hospital or community setting.

hand decontamination
Hand decontamination describes reducing bacterial counts on the hands through antiseptic handrubbing or antiseptic handwashing.

hand hygiene
Hand hygiene is a term used to encompass all methods of hand decontamination. It includes handwashing, antiseptic handwashing, antiseptic handrubbing and surgical hand antisepsis. In the context of this report, hand hygiene excludes surgical hand antisepsis.

handwashing
The action of washing hands with plain (non-antimicrobial) soap and water.

healthcare professional
A person qualified in a health discipline.
HEED
Health Economic Evaluation Database.

heterogeneous
When pertaining to meta-analysis, it means that the results of any individual trial are not compatible with those of any of the other trials.

HTA
Health Technology Assessment. It is a multidisciplinary field of policy analysis which studies the medical, social, ethical and economic implications of development, diffusion and the use of health technology.

ICU
Intensive care unit.

incidence
Rate at which new cases occur.

infection
Invasion and multiplication of harmful microorganisms in body tissues.

infection control nurse
A registered general nurse, normally with higher specialist training in infection control.

intervention
In the context of this report, a measure designed to improve hand hygiene compliance.

MRSA
Methicillin-resistant Staphylococcus aureus.

multi-component intervention
In the context of this report, a strategy that includes several interventions to improve hand hygiene compliance, eg alcohol-based hand hygiene products, education programmes, staff feedback.

multidisciplinary
A multidisciplinary team is a group of people from different disciplines (both healthcare and non-healthcare) who work together to provide care for patients with a particular condition.

NHS EED
NHS Economic Evaluation Database.

NHS operating division
On 1 April 2004, NHS Trusts in Scotland were replaced by NHS operating divisions. NHS operating divisions are committees of an NHS Board, with schemes of delegated authority setting out operational freedom for delivery of services. While they are successors to the NHS Acute and Primary Care Trusts, they have no separate legal identity from the NHS Board.

NHS QIS
NHS Quality Improvement Scotland. NHS QIS is a statutory body, established as a Special Health Board in January 2003. Its role is to focus on improving the quality of patient care and the health of patients. It has a particular emphasis on the quality of care and the patient journey for vulnerable groups. Website: www.nhshealthquality.org

NHSScotland
The National Health Service in Scotland.

NICE
National Institute of Clinical Excellence.

nosocomial infection
See HAI.

NPSA
National Patient Safety Agency.

patient
A person who is receiving medical treatment, (especially in a hospital). A person who is registered with a doctor, dentist, etc and is treated by him/her when necessary. Sometimes referred to as user.

PRECEDE
Predisposing, reinforcing and enabling factors in educational and health diagnosis and evaluation.

prevalence
The overall proportion of the population who have the disease.

primary care
The conventional first point of contact between a patient and the NHS. This is the component of care delivered to patients outside hospitals and is typically, though by no means exclusively, delivered through general practices. Primary care services are the most frequently used of all services provided by the NHS. Primary care encompasses a range of family health services provided by family doctors, dentists, pharmacists, optometrists and ophthalmic medical practitioners.

protocol
A policy or strategy which defines appropriate action. Also covers the adoption, by all staff, of national or local guidelines to meet local requirements in a specified way.

QALY
Quality-adjusted life year. A means of adjusting the benefits accruing to patients that takes into account the quality of each life year.

RCT
Randomised controlled trial.
resistance
The capacity of an organism or a tissue to withstand the effects of a harmful environmental agent or disease.

relative difference
Difference between the measurements at baseline and follow up as a proportion of the baseline.

risk factor
A clearly defined occurrence or characteristic that has been associated with the increased rate of a subsequently occurring disease. Risk factors include aspects of personal behaviour, lifestyle, environmental exposure, or inborn or inherited characteristics, which are known to be associated with the disease.

RR
Relative risk. A ratio of two risks.

SCIEH
Scottish Centre for Infection and Environmental Health (now Health Protection Scotland).

secondary care
Care provided in an acute sector setting. See acute setting.

SEHD
Scottish Executive Health Department.

single-component intervention
In the context of this report, a strategy that includes only one intervention to improve hand hygiene compliance, e.g. alcohol-based hand hygiene products.

surveillance
The ongoing systemic collection, analysis and interpretation of health data essential to the planning, implementation and evaluation of public health practice, closely integrated with the timely dissemination of these data to those who need to know.

TREND
Transparent Reporting of Evaluations with Nonrandomised Designs.

UK
United Kingdom.

US
United States.

VRE
Vancomycin-resistant enterococci.

WTE
Whole-time equivalent.
The provision of alcohol-based products to improve compliance with hand hygiene