Optimisation of infection prevention and control in acute health care by use of behaviour change: a systematic review

Rachel Edwards, Esmita Charani, Nick Sevdalis, Banos Alexandrou, Eleanor Sibley, David Mullett, Heather P Loveday, Lydia N Drumright, Alison Holmes

Changes in the behaviour of health-care workers (HCWs) are required to improve adherence to infection prevention and control (IPC) guidelines. Despite heavy investment in strategies to change behaviour, effectiveness has not been adequately assessed. We did a systematic review to assess the effectiveness and sustainability of interventions to change IPC behaviour and assessed exploratory literature for barriers to and facilitators of behaviour change. 21 studies published from 1999 to 2011 met our inclusion criteria: seven intervention studies and 14 exploratory studies. Of the intervention studies none explicitly incorporated psychological theory and only two contained elements of social marketing in the design, although five addressed sustainability. All elicited behaviour change, reduction in infection risk, or both. The exploratory studies identified social and cultural factors that affect the IPC behaviour of HCWs. To improve the standard of research and broaden the evidence base, we recommend that quality criteria are added to existing systematic review guidelines to enable the inclusion of qualitative research and to ensure robust design, implementation, and reporting of interventions.

Introduction

Health-care-associated infection (HAIs) and increased resistance to antimicrobials have put infection prevention and control (IPC) at the forefront of initiatives to improve quality of care. Since 2007, the incidence of meticillin-resistant Staphylococcus aureus (MRSA) bloodstream infections and Clostridium difficile infections in England, have decreased by 59% and 64%, respectively. These falls have been attributed to the UK Government policy of increased mandatory surveillance, the publication of evidence-based guidelines, and the introduction of national HAI reduction programmes.1,2 The guidelines and policies, however, have not led to the standardisation of best practice.16-20 A review of evidence concluded that “compliance to infection control precautions is internationally suboptimal”.26 Hand hygiene, which is a cornerstone of IPC, illustrates this issue; despite the introduction of many initiatives, adherence to this practice remains at around 40%.29 Effective methods for changing the IPC behaviours of health-care workers (HCWs) are needed to reduce HAIs and improve patients’ safety, although this area is currently understudied.29

Strategies to lower HAI rates have focused largely on widened implementation of standard IPC precautions. This approach assumes that the behaviour of HCWs is uniformly congruent with institutional policies,36 but in translation of these strategies into practice, social, cultural, and environmental factors that might affect behaviour are rarely taken into account. Despite the development of quality standards for the research and reporting of IPC intervention studies in hospitals,37 systematic reviews show inadequate study designs and poor efficacy, which suggests that interventions are insufficiently rigorous, even for activities such as hand hygiene38-39 or MRSA prevention in nursing homes.39 Studies have rarely demonstrated understanding of how context affects the behaviour of HCWs during development, implementation, and assessment of interventions,39 even though the need to ground complex interventions in a theoretical framework that is supported by exploratory research is well recognised.22 Additionally, theoretical frameworks from psychology, social marketing, or other social sciences that address the issues of how to change behaviour and sustain such changes over time, remain underused.

Successful interventions to change behaviour implemented in community settings have generally been grounded in psychological frameworks.16-20 Crucially, these approaches have taken into account multiple factors that affect human behaviour, including rational (eg, motivation to comply with a best practice), contextual (eg, environmental factors that improve or impede a behaviour, such as access to sinks), and emotional features (eg, excessive stress). Thus, these approaches are likely also to be effective in changing the behaviour of HCWs. Although direct evidence for effectiveness among HCWs remains to be proven, the IPC context seems a likely area for further research.30 Additionally,26 particularly because guidelines, policy, and education initiatives have so far broadly yielded no sustained behaviour changes.16-20

Social marketing is a behaviour-change framework that has received growing support as a model for use in relation to IPC.40-44 Since the UK Government published its white paper Choosing health: making health choices easier, social marketing frameworks have been widely applied within community interventions and national46 and international48 IPC campaigns. The social marketing approach involves the application of commercial marketing strategies to promote behaviour change,40 and draws on psychological theory, persuasion psychology, and marketing science.40,49 Campaigns are customer-centred initiatives based on the following features: an understanding of the target audience’s experiences; analysis of current and formulation of desired future behaviours; consideration of what competes for people’s time and attention; and development of an approach that is focused but avoids reliance on one method of behaviour change.40,46-48 Marketing approaches are increasingly being used in health care to improve...
dissemination of information to HCWs and to promote behaviour change. The extent to which social marketing can enable behaviour change and effectively sustain change in IPC, however, is unknown.

Investment in initiatives aimed at changing the IPC-related behaviour of HCWs has been extensive. Interventions that effectively bring about sustained behaviour change are, therefore, clearly needed. The primary objectives of this systematic review were to assess the effectiveness and sustainability of interventions to change HCWs’ behaviour and improve adherence to IPC guidelines within acute care. In this Review we define IPC behaviour as practices aimed at reducing or preventing the spread of HAIs, which we have based on the description “any infection by any infectious agent acquired as a consequence of a person’s treatment in a hospital (or equivalent health facility), or which is acquired by a health care worker in the course of their duties”. In recognition that behaviour-change interventions do not typically conform to randomised controlled trial designs, we aimed to assess all controlled and non-controlled intervention studies. Our secondary objectives were to assess the extent to which psychological and social marketing frameworks were used to change IPC behaviour and, if they were, whether these frameworks were related to intervention effectiveness, and to assess exploratory literature for HCWs’ perceptions of the facilitators and barriers to the adoption of new IPC behaviours. As our systematic review revealed that the use of social marketing and psychological theory in intervention studies is in its nascent stage, we assessed the exploratory literature to assist in informing future behavioural interventions.

Methods

This systematic review was done according to PRISMA guidelines. Assessment of antibiotic prescribing studies was part of the systematic review, but the results are reported separately.

Search strategy and selection criteria

We searched Medline, Embase, ASSIA, Business Source Complete, The Cochrane Library, PsycINFO, DARE, and HMIC for studies published in English between January, 1999, and April, 2011. Search terms were tailored to each database and its indexing system (webappendix pp 2–8) and covered the areas of infection control and prevention, behaviour change, social marketing, IPC-related interventions, and barriers to and facilitators for adherence to IPC guidelines by HCWs. We also retrieved and manually searched articles with relevant titles but unclear or no abstracts. Reference lists of retrieved articles were searched to identify further relevant papers.

Study inclusion and exclusion criteria

Studies that assessed medical, non-medical, and other HCW professionals, such as pharmacists and health-centre volunteers, were eligible. We included quantitative intervention studies that used recognised methods to assess interventions intended to change behaviour and improve adherence to IPC procedures, or guidelines for acute settings. We also included qualitative or quantitative exploratory studies that investigated the attitudes, beliefs, views, and behaviour of HCWs related to IPC. Only studies done in countries defined as having a developed health-care system were included (webappendix p 9). We excluded articles without primary data and studies set in primary-care settings.

We developed quality criteria for intervention and exploratory studies by drawing from the critical appraisal skills programme tool, Cochrane risk of bias tool, and the effective practice and organisation of care (EPOC) model (table 1).

<table>
<thead>
<tr>
<th>Basis of quality criteria</th>
<th>Quality criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>All studies</td>
<td>CASP&lt;sup&gt;17&lt;/sup&gt;, Cochrane risk of bias&lt;sup&gt;15&lt;/sup&gt;, EPOC&lt;sup&gt;60&lt;/sup&gt; Clearly stated aims, objectives, or both; complete outcome data; data collection appropriate and addressed research aims; analysis sufficiently rigorous and free from bias; conclusions clear and justified, and limitations addressed; minimum risk of bias (eg, threats to internal or external validity, researcher bias); ethical issues addressed</td>
</tr>
<tr>
<td>RCTs and CRCTs</td>
<td>Cochrane risk of bias&lt;sup&gt;15&lt;/sup&gt; Adequate sequence generation; adequate allocation concealment; adequate blinding</td>
</tr>
<tr>
<td>Controlled quasiexperimental studies</td>
<td>EPOC for CBA&lt;sup&gt;60&lt;/sup&gt; Adequate baseline measurement; explanation of choice of intervention and control group; protection against selection bias</td>
</tr>
<tr>
<td>Interrupted time series</td>
<td>EPOC&lt;sup&gt;60&lt;/sup&gt; Adequate protection against contamination; adequate protection against secular change; adequate rationale for number of measurements before and after intervention; rational explanation of shape of intervention effect</td>
</tr>
<tr>
<td>Non-controlled quasiexperimental studies</td>
<td>Adaptation of EPOC&lt;sup&gt;60&lt;/sup&gt; Adequate baseline measurement; justification for sample choice (addressing protection against selection bias); explanation of the likely effects of the lack of control on study outcomes; attempt to mitigate against effects of no control on outcomes</td>
</tr>
<tr>
<td>Exploratory</td>
<td>CASP&lt;sup&gt;17&lt;/sup&gt;, Cochrane risk of bias&lt;sup&gt;15&lt;/sup&gt;, EPOC&lt;sup&gt;60&lt;/sup&gt; Appropriateness of exploratory methodology, adequate sampling</td>
</tr>
</tbody>
</table>

CASP=critical appraisal skills programme tool. EPOC=effective practice and organisation of care criteria. CBA=controlled before and after studies. RCTs=randomised controlled trials. CRCTs=cluster randomised controlled trials.

Table 1: Quality criteria used to assess different types of studies
created separate criteria for interventional and exploratory studies, as well as a set of overarching criteria applicable to all study designs (table 1).

Data extraction

Each eligible paper was assessed in two phases: first by title and abstract, and then by full-text review against the quality criteria. The first assessment was done by ES, with an independent review of a random sample of 1500 papers by EC without knowledge of initial decisions. RE assessed a further random sample of 100 studies with details masked. The second assessment was done by two teams of researchers (RE and EC, and ES and DM), each of which was given an equal number of randomly apportioned studies. A further random sample of 200 studies with details masked was reviewed by both teams to ensure consistency of approach and outcomes. BA arbitrated where there was uncertainty. All disputes were resolved by discussion.

Data extracted from the included studies were recorded on standard forms by four reviewers (RE, EC, ES, and DM), and all were subject to further critical appraisal during narrative synthesis. Included intervention studies were assessed for efficacy, evidence of the use of psychological or social marketing frameworks, and for consideration of sustainability (ie, cost-effectiveness and sustained effect of the intervention).

Results

We reviewed 9123 abstracts and titles in the first assessment, and from these 573 full-text articles were selected, of which 382 focused on IPC behaviour or behaviour-change interventions. 21 (5·5%) of these 382 studies met the quality criteria and were included (figure). Meta-analysis of results was not possible because of the lack of homogeneity in study designs and interventions.

Seven of the included studies assessed interventions (table 2). No studies documented psychological approaches as part of intervention development, and only two included elements of social marketing. Five of the seven studies took sustainability into account and all interventions seemed to be efficacious in eliciting behaviour change, reductions in infection outcomes, or both. The interventions could be classified into three main groups: those dealing with hand hygiene, IPC in surgical settings, or use of information technology to prompt behaviour change.

Lederer and colleagues investigated the effect of a communication campaign and feedback programme across nine hospitals aimed at creating a culture in which non-adherence to hand hygiene was unacceptable. The multimodal approach included assessments of and activities to improve behaviour, which is consistent with a social marketing framework, although it was not specifically designed as such. The audit and feedback element led to improved adherence to hand-hygiene protocols that developed quickly and was sustained, but the effects of the additional activities aimed at changing behaviour were less clear. A concomitant reduction in MRSA infection rates was reported and attributed to increased hand hygiene, although whether the two outcomes were connected was unclear.

Lam and colleagues also implemented a multimodal intervention that used elements not specified but consistent with social marketing. The goals of improved adherence to hand-hygiene protocols and reductions in duration of contact with patients in a neonatal intensive care unit were clear. The intervention was also tailored to different groups of HCWs (which is similar to segmentation in social marketing approaches), but the intervention was not based on psychological theory. The problem-based and task-oriented programme increased...
frequencies of desired IPC behaviours, and regular use of educational interventions was taken to be a major contributor to sustainability. Whether a direct association existed between reductions in HAI rates and reported behaviour changes, however, was unclear.

Trick and colleagues\(^6\) introduced an interactive educational programme and communication campaign to promote hand hygiene, but HAI rates were lowered in only one of the three intervention hospitals. The study had a clear behavioural aim but did not explicitly apply any psychological framework. Although effective and sustained behaviour change was reported, it was not clear which element or elements led to these changes. Whether specific features of the intervention altered behaviour was, therefore, difficult to determine. Social marketing was not part of this intervention.

Schelenz and colleagues\(^64\) developed an enhanced IPC programme that focused on risk factors for infection of surgical sites in patients undergoing elective coronary artery bypass grafting. Although the effects of the various interventions on behaviour were not reported, some evidence suggests that concerted activities can change the behaviour of HCWs and potentially infection outcomes. Intervention sustainability and use of psychological or social marketing frameworks were not shown. Similarly, Howard and colleagues\(^65\) assessed a simplified clean practice protocol for surgical teams. Some significant increases in hand-hygiene practices were seen. The behavioural aims were clearly stated, but no consideration was given to which elements of the intervention led to behaviour changes and the study did not explain how change could be maintained long term. Social marketing and psychological frameworks were not used.

Two studies concerned with isolation of patients with infections showed that information technology could be used to promote awareness, best practice, and appropriate decision making. Kac and colleagues\(^66\) reported significant

<table>
<thead>
<tr>
<th>Study aim and intervention features</th>
<th>Design and methods</th>
<th>Sample size and study duration</th>
<th>Study outcomes</th>
<th>Evidence of review factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Howard et al, 2009, UK</strong></td>
<td>Assessed efficacy of simplified evidence-based CPP to improve adherence to IPC by surgical teams by sharing of audit results, implementation of a simple education and awareness programme outlining the CPP, and distribution of a poster depicting international guidelines on major IPC activities</td>
<td>Before and after observation of consultations, undisclosed audits of staff who had contact with patients, and ward environment assessed with CPP</td>
<td>85 patient consultations before, 74 after intervention; study period 3 months</td>
<td>Increases: hand decontamination (28% to 87%, p&lt;0.0001); correct use of gloves (3% to 50%, p&lt;0.0001); instrument cleaning (6% to 63%, p&lt;0.0001); case notes not contaminated (66% to 95%, p&lt;0.0001); overall IPC activity (63% to 89%, p&lt;0.05)</td>
</tr>
<tr>
<td><strong>Kac et al, 2007, France</strong></td>
<td>Assessed effect of implementing two successive electronic alert systems dedicated to patients with MRB on adherence to isolation precautions; patients with MRB recorded in database and new cases admitted/readmitted to hospital or transferred between wards flagged with electronic alerts: one dispatched to physician and nurse in charge of infection control on ward then one to IPC team, both requesting isolation</td>
<td>Interrupted time series study with five observational audits undertaken before and during interventions, done by IPC technician over 7–9 weeks, plus check of appropriate isolation after MRB alerts</td>
<td>643 alerts generated over 4 years</td>
<td>Increases: nurses’ awareness of MRB cases (24% to 59% 4% 1 year after first intervention and to 93% 1 year after second intervention), implementation of isolation precautions (15% to 50% 1 year after first intervention and to 90% 2% 1 year after second intervention)</td>
</tr>
<tr>
<td><strong>Kho et al, 2008, USA</strong></td>
<td>Assessed an intervention to improve contact isolation rates in patients with known history of MRSA and VRE infection; all physicians involved in patient care received computer-based reminders to isolate patients with MRB</td>
<td>Before and after observation of isolation measures aggregated from 4 months before intervention and 12 months after, convenience sample of physicians surveyed to ascertain attitudes towards intervention</td>
<td>109 (1.9%) of 5825 admissions with MRSA or VRE before intervention, 520 (2.9%) of 17961 after intervention, 27 physicians surveyed 6 months after intervention</td>
<td>Increase: appropriate writing of isolation orders (33% to 89%, p&lt;0.0001); Decrease: median time to writing contact isolation orders (16.6 to 0 h). Physicians accepted 80% of orders to isolate on first or second presentation, and 95% of physicians felt that the reminders saved time or had no negative effect on workflow</td>
</tr>
<tr>
<td><strong>Lam et al, 2004, Hong Kong</strong></td>
<td>Assessed effect of multimodal programme on nature and frequency of patient contact in NICUs and adherence to policies/techniques for HH; used problem-based and task-oriented HH education, clustering of nursing care, improvement in HH facilities, ongoing regular HH audit, and implementation of HAI surveillance</td>
<td>Before and after observation of HH adherence and techniques; 4 weeks before and 6 months after intervention; observation consistency validated</td>
<td>666 patient contacts observed before, and 317 after intervention; intervention period 1 year</td>
<td>Increases: HH (40% to 53% before patient contact, 39% to 59% after; 35% to 60% for high-risk procedures); Decreases: average number of patient contacts (2.8 to 1.8 per patient per h); HAI rate (11.3 to 6.2 per 1000 patient-days) Improvement in most features of HH technique</td>
</tr>
</tbody>
</table>

(Continues on next page)
increases in nurses’ awareness of and isolation of patients who had multidrug-resistant bacterial infections after an electronic alert system was introduced. Changes were sustained for at least 1 year. No psychology or social marketing theories were, however, included in the development of the intervention. Kho and colleagues similarly reported significant increases in the rate of appropriate isolation and time to writing isolation orders with a computerised reminder system. Physicians accepted a high proportion of orders to isolate on first or second receipt. Although behaviour change mainly consisted of physicians considering an electronic order, the study illustrates the potency of electronic systems. The application of psychological or social marketing frameworks were absent from this study, but the simplicity of the intervention and its timing at a crucial point in the practice pathway led to a small change in behaviour that had a large and potentially sustainable effect on care.

From the I4 exploratory studies included in the review, four main themes emerged in relation to HCWs’ perceptions of the facilitators and barriers to changing IPC behaviour: effect of society and culture; behaviour and reason; perceptions of efficacy and safety in practice; and perspectives on best practice (table 3). Barrett and Randle found that student nurses’ desire to fit in was crucial to hand-hygiene behaviour. This finding indicates the early stage from which nurses’ practice is shaped by peers and the importance of social

<table>
<thead>
<tr>
<th>Study aim and intervention features</th>
<th>Design and methods</th>
<th>Sample size and study duration</th>
<th>Study outcomes</th>
<th>Evidence of review factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lederer et al, 2009, USA</td>
<td>Tested effectiveness of system-wide programme to improve HH adherence; HH defined as a corporate goal, performance assessed by dedicated HH monitors with immediate feedback introduced after validation exercise, and memoranda, posters, fairs, visitor education programmes, and marketing campaign used to disseminate information</td>
<td>Observational (validated) time series study; monthly HH audits and HAI incidence rates recorded</td>
<td>2000–2500 observations per month; study duration 3 years</td>
<td>Increases: HH adherence (49% to 90% at 3 years); rates &gt;90% sustained since 11 months after intervention; average MRSA per 1000 patient-days (0.52 to 0.24 at 3 years)</td>
</tr>
<tr>
<td>Trick et al, 2006, USA</td>
<td>Assessed effect of a multimodal intervention to improve adherence to HH and glove-use recommendations and decrease antimicrobial resistance; alcohol-based hand rub availability increased, interactive educational programme and poster campaign introduced</td>
<td>Prospective observational control study in three intervention hospitals (acute and long-term care, community, and teaching hospitals) and one control hospital (alcohol-based hand rub only) plus validated observational survey and assessment of incidence of resistant bacteria among isolates from clinical culture</td>
<td>1353 observation sessions; 6948 HH opportunities across control and study sites; programme run over 3 years</td>
<td>Maximum quarterly frequency of HH performance or glove use higher in intervention hospitals than in control hospital (74%, 80%, and 77%, vs 59%); Multivariable analysis showed alcohol-based hand rub preferred to soap and water (adjusted OR 4.6, 95% CI 3.3–6.6) and more likely to be used by physicians than nurses (1.4, 1.2–1.8); Incidence of antimicrobial resistant bacteria significantly reduced at one intervention hospital that had the greatest increase in HH</td>
</tr>
<tr>
<td>Shelenz et al, 2005, UK</td>
<td>Assessed effect of IPC programme targeting identified risk factors for surgical-site infections in elective CABG patients; Intervention features: senior staff engagement and meetings, ward-based education programme, improved ward and theatre design and cleaning, MRSA screening before and after admission, dedicated nurses for MRSA patients and improved nurse-to-patient ratio, improved surgical skin preparation, and revision of antimicrobial surgical prophylaxis</td>
<td>Before and after observation with retrospective analysis of computerised data on acquisition of MRSA in the 16 months before and after intervention</td>
<td>1075 operations before intervention, 956 after; study duration 32 months</td>
<td>Nine patients cleared of MRSA carriage before admission after intervention</td>
</tr>
</tbody>
</table>

CPP=clean-practice protocol. IPC=Infection prevention and control. MRB=multidrug-resistant bacteria. MRSA=meticillin-resistant Staphylococcus aureus. VRE=vancomycin-resistant enterococcus.

NICU=neonatal intensive-care unit. HH=hand hygiene. HAI=health-care-associated infection. OR=odds ratio. CABG=coronary artery bypass graft. RR=relative risk. *Study effective in changing behaviours, reducing infection-related outcomes, or both. †Cost-effective and sustained effect. ‡Evidence of customer-oriented, behavioural focus, basis in social marketing theory, driven by insight, acknowledgment of exchange, awareness of competition, appropriate segmentation, use of mixed methods, or a combination of these features. §Evidence of application of psychological theory to understand reasons behind behaviour patterns and consideration of the process by which desired change is delivered.

Table 2: Details of intervention studies
identity and cultural norms. Similarly, Lusardi\textsuperscript{69} found that student nurses accepted responsibility for adherence to hand-hygiene practices, but were keen to highlight poor performance or complacency in other staff. This study suggests that poor practice can be learned in the absence of appropriate role models and accountability. Lymer and colleagues\textsuperscript{70} analysed factors that promoted HCWs’ adherence to universal precautions. For some nurses and nursing assistants, a barrier to reporting needle-stick injuries was the perception that peers would consider them professionally incapable. The authors suggested that adherence to universal precautions is a sociocultural phenomenon, and that social and cultural factors can affect personal safety.

Hand hygiene was explained in several studies as non-rational behaviour. Sladek and colleagues\textsuperscript{71} showed that observational data on consultants’ behaviour correlated with responses to a survey designed to assess thinking styles. The authors concluded that adherence to hand-hygiene practices was related to experience-based rather than rational thinking. They proposed, therefore, strategies to change hand-hygiene behaviour should take thinking style into account as a cognitive determinant of actions and use insight, experiential communication,

<table>
<thead>
<tr>
<th>Study aims</th>
<th>Study methods</th>
<th>Sample</th>
<th>Key findings and conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrett and Randle, 2008,\textsuperscript{8} UK</td>
<td>Investigate nursing students’ perceptions of HH practice and training</td>
<td>Interpreting, descriptive design, semistructured interviews</td>
<td>Ten students who had done ≥1 clinical placement</td>
</tr>
<tr>
<td>Chan et al, 2007,\textsuperscript{9} Hong Kong</td>
<td>Assess relation of knowledge, attitudes and behaviour of surgical nurses and support staff towards precautions and effects of demography, knowledge, and attitudes</td>
<td>Two-step cluster analysis based on self-completed questionnaires and survey of demography, knowledge, behaviour and attitudes to precautions; survey instrument validated</td>
<td>142 questionnaires circulated</td>
</tr>
<tr>
<td>Crawford and Brown, 2008,\textsuperscript{10} UK</td>
<td>Explore role of modern matrons in reduction risk of HAIs</td>
<td>Grounded theory, purposely selected sample, semistructured in-depth interviews, and thematic analysis to explore nature of role, understanding of central tasks and organisation of others to accomplish them, and addressing of issues, especially related to MRSA</td>
<td>Ten matrons</td>
</tr>
<tr>
<td>Creamer, 2000,\textsuperscript{11} Ireland</td>
<td>Assess surgical and medical nurses’ understanding of risk-reduction issues related to patients with peripheral venous cannulas</td>
<td>Grounded theory, purposely selected sample, semistructured interviews, and data saturation</td>
<td>Ten nursing staff</td>
</tr>
<tr>
<td>Elder et al, 2008,\textsuperscript{12} USA</td>
<td>Explore ICU nurses’ perceptions of patients’ safety after participation in a project to decrease catheter-related bloodstream infections</td>
<td>Eight focus groups (convenience sample) across four hospitals and survey of nurses and managers</td>
<td>33 nurses in focus groups, 230 surveys circulated</td>
</tr>
<tr>
<td>Jang et al, 2010,\textsuperscript{13} Canada</td>
<td>Assess HCWs’ (physicians, nurses, other HCWs, and support staff) behavioural determinants of HH</td>
<td>17 focus groups (convenience sample) in one hospital, semistructured interviews after introductory HH video, and analysis of transcribed interviews for themes</td>
<td>153 HCWs</td>
</tr>
<tr>
<td>Joseph et al, 2007,\textsuperscript{14} USA</td>
<td>Identify factors affecting HCWs’ (clinical and non-clinical) adherence to employee health programme involving routine testing for and treatment of latent tuberculosis infections</td>
<td>Grounded theory, purposely selected sample, 16 focus groups across two hospitals and two health departments</td>
<td>106 HCWs</td>
</tr>
</tbody>
</table>
and cognitive-behavioural approaches. Additionally, Nicol and colleagues found that individuals’ experiences rather than formal training were important to hand hygiene. They recommended that graphic emotion-arousing narratives or videos should be used in training to elicit behaviour change.

In five studies, perceptions that the reduction of HAI was beyond HCWs’ control were noted, and had developed owing to fatalism, poor leadership, and organisational failures. Lines found that nurses might not understand the epidemiology of MRSA or the importance of adherence to topical treatment regimens.

<table>
<thead>
<tr>
<th>Study aims</th>
<th>Study methods</th>
<th>Sample</th>
<th>Key findings and conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lines, 2006</td>
<td>Assess staff nurses’ (≥5 years’ experience) perceptions of MRSA control and necessity of control methods</td>
<td>Random sample, semistructured interviews</td>
<td>Ten nurses*</td>
</tr>
<tr>
<td>Losardi, 2007</td>
<td>Investigate student nurses’ experiences of HH practice</td>
<td>Grounded theory, convenience sample, semistructured interviews</td>
<td>Nine students</td>
</tr>
<tr>
<td>Lymer et al, 2004</td>
<td>Investigate factors that promote adherence to universal precautions among nursing staff</td>
<td>Grounded theory, theoretical and strategic sample, semistructured interviews</td>
<td>Ten nurses, six nursing assistants</td>
</tr>
<tr>
<td>Mah et al, 2005</td>
<td>Assess how participation in influenza vaccination programme could be promoted among cancer care staff (physicians, nurses, and support staff)</td>
<td>Self-completion survey of participation in vaccination programme in previous 5 years, and of motivations, perceptions, and preferences</td>
<td>515 questionnaires circulated</td>
</tr>
<tr>
<td>Nicol et al, 2009</td>
<td>Investigate HCWs’ practices (physicians, nurses, physiotherapists, phlebotomists) and motivations to prevent infections in acute-care setting</td>
<td>Grounded theory, purposely selected sample, semistructured interviews</td>
<td>46 HCWs</td>
</tr>
<tr>
<td>Quiros et al, 2007</td>
<td>Assess attitudes of ICU staff towards practice guidelines (general and CDC guidelines) for HH in health-care settings and whether attitudes of staff correlate with staff and hospital characteristics</td>
<td>Cross-sectional survey (volunteer sample) of staff attitudes in 70 ICUs across 39 hospitals to assess barriers to HH adherence</td>
<td>1975 surveys distributed</td>
</tr>
<tr>
<td>Sladek et al, 2008</td>
<td>Investigate whether rational or experience-based thinking in physicians are associated with adherence to HH</td>
<td>Observational study of survey participants in connected study and data analysis with cognitive-experiential self theory</td>
<td>32 consultants</td>
</tr>
</tbody>
</table>

Table 3: Details of exploratory studies

HCWs = health-care workers. HH = hand hygiene; HAI = health-care-associated infection. ICU = intensive care unit. MRSA = meticillin-resistant Staphylococcus aureus. CDC = Centers for Disease Control and Prevention.

*Target sample was 15 nurses, but data saturation achieved on completion of ten interviews.
A substantial proportion of nurses (60%) felt their practice had limited efficacy in reducing the risk of MRSA infections. Similarly, in the study by Elder and colleagues, nurses most frequently perceived that the greatest risks to patients’ safety were related to environmental dangers and medication factors, and that management’s commitment to safety was not always reflected in practice. Participants reported that self-initiated learning achieved mainly through experience of immediate outcomes and first-degree problem solving had greater effects on practice than management-initiated learning or delayed outcomes. Hence, the view of IPC as a factor in patients’ practice and outcomes. Quiros and colleagues identified important disparities between the reality of the role of modern matrons in terms of IPC leadership and that described in policy documents, such as The Matron’s Charter. Matrons felt that formal structures of accountability and personal authority were lacking and that matron management of IPC is as much about self-management as it is about controlling the ward environment. Interventions that involve such senior staff, therefore, need to be realistic about their roles. A further study, by Creamer, which investigated best practices in the care of patients with peripheral venous cannulas, described factors affecting the duration of cannulation. Nurses reported that poor documentation and unclear assignment of responsibility hindered appropriate care, although they perceived their own knowledge of care and identification of critical issues as satisfactory. These nurses were, therefore, concerned with getting the system right rather than changing their own behaviour.

Four studies addressed how HCWs perceived best practice and evidence-based guidelines. Quiros and colleagues did a cross-sectional study of staff working in intensive-care units. Those working in paediatric intensive-care units felt more positive about guidelines than did other staff, which correlated positively with self-reported adherence. Thus the type of patient and a positive disposition to guidelines might affect the behaviour of HCWs. Several factors were cited as barriers to physicians’ adherence to hand hygiene, including lack of familiarity and disagreement with guidelines, expectation that guidelines will not improve patients’ outcomes, view of own effectiveness, motivation, and external barriers.

Chan and co-workers found that HCWs who achieved high scores in questionnaires of knowledge, attitudes, and self-reported behaviour in relation to transmission precautions were more likely to be women, had greater security of tenure, and to be better educated than those who achieved low scores. This study highlights that acceptance of guidelines varies across groups. Such knowledge might help to tailor and improve the effectiveness of interventions. In a similar way, Mah and colleagues suggested that separation of HCWs into groups of staff who have received no, some, or all previous vaccinations could improve uptake in an employee vaccination programme. The researchers used the transtheoretical model to show that vaccination behaviours represent different stages of behavioural contemplation and that demographics, such as age and professional role, affect vaccination uptake.

Joseph and colleagues investigated the perceptions among HCWs of tuberculosis testing and treatment policies and found that risk, convenience, and perceived availability of employee health provision all contributed. The range of cited barriers was diverse and, therefore, interventions such as increased availability and convenience of testing will not be enough to change the behaviour of HCWs with concerns about provision of medical care and follow-up. Furthermore, motivation of HCWs to undergo vaccination might differ from that in other areas of IPC practice, because vaccination is frequently viewed in relation to self-protection in addition to protection of patients.

Discussion
We identified few IPC intervention studies that met our quality criteria, which suggests that such work is at a very early stage. Few of the intervention studies explicitly incorporated any existing psychological or social marketing methods for behaviour change, although most assessed sustainability. Thus, despite social marketing gaining support as a model for behaviour change in IPC, this and psychological theory have yet to penetrate robust IPC intervention studies. Therefore, whether the application of social marketing is effective in changing the IPC behaviours of HCWs needs to be confirmed. The exploratory studies included in this Review frequently tied findings to psychological theory and provide useful insights into what affects the behaviour of HCWs. The application of this information to inform future behaviour-change interventions would be constructive.

Several studies assessed the experiential and habitual nature of IPC behaviours, which can be explained in non-rational terms, and provide insight into the choices of HCWs that seem less judicious than desired. These behavioural precursors mirror the basic principles of psychological theory, which proposes that not all behaviour is guided by perfect logic, but is instead led by social, emotional, and environmental factors that might cause inconsistencies. In addition, although HAI is an important concern for patients, prevention might not be a priority for some HCWs who see the physical environment, medication and personal protection as posing more important safety risks. The two studies that assessed the roles of the personal actions of HCWs...
compared with environmental factors found that nursing staff attributed more importance to external circumstances than to their own behaviours to improve infection outcomes.70,73 Belief that one’s own behaviour can alter infection outcomes is crucial to the achievement of sustained behaviour change.75 Clear demonstration and communication of the efficacy of individual actions might be essential to intervention design.73,75,77

Studies also showed the potential usefulness of distinguishing between the awareness, knowledge, experience, and attitudes of HCWs in relation to the application of evidence-based guidelines and universal precautions.8,80 Differentiation between HCWs in terms of their experience and the specific targeting of interventions to segmented groups by use of the trans-theoretical model is potentially effective. This model enables identification of the readiness of an individual to shift behaviour through recognition that change is a gradual and continual process.76 This framework may be a useful means of targeting behaviour-change interventions, particularly to improve vaccine uptake in employee health programmes.80

Psychological theory was used to interpret findings in some IPC exploratory studies, which suggests that these theories are not foreign to researchers. Nevertheless, the connections between good preliminary studies, psychological theory of behaviour change and the use of these in interventions have yet to emerge. Unfortunately, few studies that might have informed future interventions met our quality criteria, which indicates the need for more robust exploratory research in IPC.

Our findings suggest that hand hygiene is an acquired habit rather than a reasoned process55 and that interventions designed to change behaviour are more effective if they target experiential thinking72 and socialisation factors. The sociocultural context is affected by lines of responsibility, provision of systems, and professional autonomy, all of which pose notable challenges to behaviour change. In the development of interventions HCWs’ perception of patients’ safety and inconsistencies in the reported and actual commitment of management to HAI prevention need to be taken into account. Evidence suggests that the inclusion of observational audit and feedback of IPC practice, as a mechanism for change and a tool for assessment of sustainability, should be considered in training, education, and communication programmes to improve individuals’ view of self-efficacy and to promote system-wide behaviour change. Differentiation between the perspectives of HCWs related to adherence to best practice guidelines should also be considered. Sex, age, and role (particularly the time employed within the facility) have been identified as useful demographic features to which interventions could be tailored.79

We found strategies implemented within IPC initiatives to have been pragmatic and multidisciplinary, aimed at addressing important health concerns, but to have lacked consideration of psychological theory or effective assessment design. There is some evidence to suggest that multimodal approaches can be effective in changing the behaviour of HCWs and in reducing HAI, but to what degree the different elements contributed to and sustained changes in behaviour or lowered infection rates is unclear. Thus, the attribution of modified behaviours to infection outcomes is difficult. The 2007 ORION statement25 aimed to improve standards in research and reporting of hospital epidemiology. A 22-point checklist was provided to facilitate the design of intervention studies and promote transparency in reporting. This move was a positive step towards acknowledgment that interventions aimed at changing the behaviour of HCWs frequently do not lend themselves to randomised controlled trials, and supported use of other experimental designs to establish the evidence base. Similarly, the STROBE56 and MOOSE59 statements aimed to improve the quality, reporting, and reviewing of observational studies, and the PRISMA statement53 discusses methods to improve the assessment of intervention studies for systematic review and meta-analysis. However, none of these statements considers an in-depth understanding of the behavioural issue in studies focused on behaviour change or how to assess the direct effects of interventions on behaviour. Hence, poor understanding of the role of primary research in IPC intervention development remains, and without assessment of the effects of interventions on the behaviours they set out to change, conclusive evidence that infection-related outcomes have been altered is weak. Therefore, the design, implementation, analysis, and reporting of behavioural interventions need to be improved.

In view of the substantial investment that has already been made into IPC initiatives, we believe quality criteria need to be developed to facilitate robust design, implementation, and reporting of behavioural interventions. Additionally, as the use of psychological and social marketing frameworks in IPC is an expanding area of research, there is a need for quality criteria to be established to facilitate the development of high-quality interventions. We recommend that the criteria (panel) be used in addition to those detailed in the ORION statement25 and other statements aimed at improving the standard of research and the evidence base.59,75,86 This approach is likely to greatly improve understanding of what methods effectively change the behaviour of HCWs in relation to social, cultural, and environmental factors. The criteria also acknowledge the usefulness of robust primary research to identify clearly the relevant behaviours to target in the development of interventions and to produce conclusive evidence of intervention efficacy.

A limitation of our Review was that we only considered published studies, which might have introduced publication bias. Our findings must, therefore, be
Interpreted with such bias in mind. Furthermore, we only reviewed studies published in English, although this restriction is unlikely to have affected our findings.  

In this Review, we identified very few studies that had robust methods and adequate study designs. Although psychological theory is being used in exploratory studies, intervention studies generally do not apply psychological or social marketing frameworks, despite social marketing gaining support as a model for behaviour change in IPC. Subsequently, direct evidence that these frameworks increase the sustainability or efficacy of behaviour-change interventions is still required. Institutional benefits of behaviour change are frequently quantified in terms of infection rates or adherence, but these indicators are inadequate to identify behaviour change. As most studies of behaviour change in IPC do not lend themselves to traditional clinical trial designs, the designs of interventions need to be based on high-quality exploratory data and psychological theory, and we recommend new quality criteria that take these features into account. Additionally, the usefulness of well designed quasi-experimental, repeated-measures studies in IPC should be recognised.

Acknowledgments
RE, EC, NS, LND, and AH are funded by grants from the National Institute for Health Research (NIHR) Biomedical Research Centre Funding Scheme at Imperial College and the National Centre for Infection Prevention and Management, which is funded by the UK Clinical Research Collaboration. NS and AH are affiliated with the Imperial Centre for Patient Safety and Service Quality, which is funded by the NIHR. We thank Federica Secci for her help with the searches.

References

Contributors
The content and structure of this paper were agreed by all authors. RE, EC, ES, and DM searched for published work, reviewed full-text articles, and extracted data. BA supervised the reviewing process and coordinated the analysis. RE wrote the first draft of the paper. All authors contributed to the writing of the paper and approved the final version.

Conflicts of interest
AH has received travel expenses from Pfizer and FIS. All the other authors declare that they have no conflicts of interest.
73 Lines L. A study of senior staff nurses’ perceptions about MRSA. Nurs Times 2006; 102: 32–35.
89 Pham B, Klassen TP, Lawson ML, Moher D. Language of publication restrictions in systematic reviews gave different results depending on whether the intervention was conventional or complementary. J Clin Epidemiol 2005; 58: 769–76.