Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting (Review)


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<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEADER .................. 1</td>
</tr>
<tr>
<td>ABSTRACT ................ 1</td>
</tr>
<tr>
<td>PLAIN LANGUAGE SUMMARY .... 2</td>
</tr>
<tr>
<td>BACKGROUND ................. 3</td>
</tr>
<tr>
<td>OBJECTIVES ................. 5</td>
</tr>
<tr>
<td>METHODS .................. 5</td>
</tr>
<tr>
<td>Figure 1. ................. 10</td>
</tr>
<tr>
<td>RESULTS .................. 17</td>
</tr>
<tr>
<td>DISCUSSION ................. 17</td>
</tr>
<tr>
<td>AUTHORS’ CONCLUSIONS ....... 20</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS .......... 21</td>
</tr>
<tr>
<td>REFERENCES ................. 22</td>
</tr>
<tr>
<td>CHARACTERISTICS OF STUDIES .... 36</td>
</tr>
<tr>
<td>DATA AND ANALYSES .......... 41</td>
</tr>
<tr>
<td>ADDITIONAL TABLES .......... 41</td>
</tr>
<tr>
<td>APPENDICES ................. 46</td>
</tr>
<tr>
<td>HISTORY .................. 68</td>
</tr>
<tr>
<td>CONTRIBUTIONS OF AUTHORS .... 68</td>
</tr>
<tr>
<td>DECLARATIONS OF INTEREST ...... 69</td>
</tr>
<tr>
<td>SOURCES OF SUPPORT .......... 69</td>
</tr>
<tr>
<td>DIFFERENCES BETWEEN PROTOCOL AND REVIEW ... 70</td>
</tr>
<tr>
<td>INDEX TERMS ................. 74</td>
</tr>
</tbody>
</table>
**Intervention Review**

**Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting**

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**ABSTRACT**

**Background**

Meticillin-resistant Staphylococcus aureus (MRSA; also known as meticillin-resistant *S aureus*) is a common hospital-acquired pathogen that increases morbidity, mortality, and healthcare costs. Its control continues to be an unresolved issue in many hospitals worldwide. The evidence base for the effects of the use of gloves, gowns or masks as control measures for MRSA is unclear.

**Objectives**

To assess the effectiveness of wearing gloves, a gown or a mask when contact is anticipated with a hospitalised patient colonised or infected with MRSA, or with the patient’s immediate environment.

**Search methods**

We searched the Specialised Registers of three Cochrane Groups (Wounds Group on 5 June 2015; Effective Practice and Organisation of Care (EPOC) Group on 9 July 2013; and Infectious Diseases Group on 5 January 2009); CENTRAL (The Cochrane Library 2015, Issue 6); DARE, HTA, NHS EED, and the Methodology Register (The Cochrane Library 2015, Issue 6); MEDLINE and MEDLINE In-Process & Other Non-Indexed Citations (1946 to June week 1 2015); EMBASE (1974 to 4 June 2015); Web of Science (WOS) Core Collection (from inception to 7 June 2015); CINAHL (1982 to 5 June 2015); British Nursing Index (1985 to 6 July 2010); and ProQuest Dissertations & Theses Database (1639 to 11 June 2015). We also searched three trials registers (on 6 June 2015), reference list of articles, and conference proceedings. We finally contacted relevant individuals for additional studies.
Selection criteria

Studies assessing the effects on MRSA transmission of the use of gloves, gowns or masks by any person in the hospital setting when contact is anticipated with a hospitalised patient colonised or infected with MRSA, or with the patient’s immediate environment. We did not assess adverse effects or economic issues associated with these interventions.

We considered any comparator to be eligible. With regard to study design, only randomised controlled trials (clustered or not) and the following non-randomised experimental studies were eligible: quasi-randomised controlled trials (clustered or not), non-randomised controlled trials (clustered or not), controlled before-and-after studies, controlled cohort before-after studies, interrupted time series studies (controlled or not), and repeated measures studies. We did not exclude any study on the basis of language or date of publication.

Data collection and analysis

Two review authors independently decided on eligibility of the studies. Had any study having been included, two review authors would have extracted data (at least for outcome data) and assessed the risk of bias independently. We would have followed the standard methodological procedures suggested by Cochrane and the Cochrane EPOC Group for assessing risk of bias and analysing the data.

Main results

We identified no eligible studies for this review, either completed or ongoing.

Authors’ conclusions

We found no studies assessing the effects of wearing gloves, gowns or masks for contact with MRSA hospitalised patients, or with their immediate environment, on the transmission of MRSA to patients, hospital staff, patients’ caregivers or visitors. This absence of evidence should not be interpreted as evidence of no effect for these interventions. The effects of gloves, gowns and masks in these circumstances have yet to be determined by rigorous experimental studies, such as cluster-randomised trials involving multiple wards or hospitals, or interrupted time series studies.

**Plain Language Summary**

**Use of gloves, a gown or a mask for contact with hospitalised patients with *Staphylococcus aureus* resistant to a common antibiotic (MRSA)**

**What is MRSA, and why is it a problem in hospitals?**

MRSA stands for ‘meticillin- (or methicillin-) resistant *Staphylococcus aureus*’. This is a common type of bacterium (*Staphylococcus aureus*) that is no longer killed by meticillin (also known as ‘methicillin’, an antibiotic) or other antibiotics that are frequently used to treat infections. MRSA can live on people without making them ill, and without them showing any symptoms, but is dangerous when it infects people who are unwell.

MRSA is easily transferred from one patient to another in hospitals, where it causes severe infections and can cause death. This transmission occurs mainly through healthcare workers when their hands, clothes, or equipment become contaminated with MRSA during routine care of patients who have MRSA. Later contact of the contaminated hands, clothes or equipment with other patients allows MRSA to spread within the hospital.

**Why might use of gloves, gowns or masks help prevent transmission of MRSA between patients in hospitals?**

It is possible that the use of disposable gloves with or without the use of disposable or washable gowns could prevent transmission of MRSA, as they would protect the healthcare workers’ hands and clothes from becoming contaminated with MRSA. The gloves and gowns would be discarded after one patient had been cared for, and clean ones used to visit the next patient. The use of masks might also prevent spread of MRSA through the air.

It is not known whether use of gloves, gowns or masks reduces the spread of MRSA when they are used individually, or whether combining two of the three, or all three, produces better results.

**The aim of this research and what the researchers found**

The researchers aimed to find out whether the use of gloves, a gown or a mask by any person in the hospital (for example, a doctor) getting close to a patient found to have MRSA prevents the transmission of MRSA from this patient to other people in the hospital.
The researchers made a wide search of the medical literature, up to June 2015, but did not find any rigorous studies that addressed this topic.

At present there is no scientific evidence that the wearing of gloves, a gown, or a mask by people getting close to patients with MRSA reduces the transmission of MRSA to other people in the hospital. However, this should not be interpreted as demonstrating that gloves, gowns or masks are not effective; it means that the research that would be required to measure an effect - if there is one - has not been done yet.

**BACKGROUND**

**Description of the condition**

Meticillin-resistant *Staphylococcus aureus*, commonly known as MRSA, is a bacterium that is resistant to meticillin (better known as ‘methicillin’, which is its United States Adopted Name) and the rest of the beta-lactam antibiotics (penicillins, cephalosporins and carbapenems). MRSA is a strain of *S aureus* that acquired a gene that confers resistance to these common antibiotics (Hartman 1981; Livermore 2000).

MRSA can colonise or infect people. A colonisation occurs when the micro-organism is present without causing adverse clinical signs or symptoms. On the other hand, an infection implies a localised or systemic condition that results from an adverse reaction to the presence of an infectious agent or its toxins (Garner 1996). The normal bacterial flora of humans often includes *S aureus* (APIC 2010), with the epithelium of the anterior nares (the inside of the nose) being its predominant point of colonisation in adults (Wertheim 2005). Risk factors for MRSA colonisation at hospital admission include: prior healthcare contact (for example, hospitalisation in the past 12 months, or a stay in a nursing home), history of exposure to healthcare-associated pathogens (such as history of MRSA carriage, *Clostridiun difficile* infection, or recent antibiotic use), and co-morbidity (such as congestive heart failure, diabetes or renal failure; McKinnell 2013).

The prevalence of nasal MRSA colonisation varies across populations. For example, in some European countries it is between 0.1% and 0.7%, in the non-institutionalised population (den Heijer 2013), compared with 1.5% in the USA (Gorwitz 2008). At admission of patients to hospital prevalence rises to between 3% and 11% (Troillet 1998; Harbarth 2008; Baker 2010; Morgan 2010), and between 5.8% and 8.3% at patient admission to intensive care units (ICU; Zikas 2014); and can be up to 15% in healthcare workers (Albrich 2008; Bisaga 2008; Suffoletto 2008; Elie-Turenne 2010). *S aureus* can also colonise the face, throat, hands, axilla (armpit), groin, rectum and perineum (area between the anus and vagina or scrotum; Williams 1963; Mertz 2009).

Therefore, as normally only the anterior nares are used as a sampling site for MRSA, the true prevalence of MRSA carriage may be higher.

Since the 1960s, MRSA has been recognised as a source of healthcare-associated infections (HAI; Barrett 1968; Benner 1968). HAIs (formerly known as ‘nosocomial infections’) are infections that were not present or incubating on admission to a healthcare facility (CDC 2014), and therefore, were acquired in the facility while receiving care. MRSA colonisation in adults is a known risk factor for the development of MRSA infection: 18% to 33% of adult patients colonised with MRSA will develop an MRSA infection, such as pneumonia, or a soft tissue or bloodstream infection (Calfee 2014), and 8.5% of paediatric (child) patients colonised with MRSA will also develop an infection (Calfee 2014). The risk of HAI is even greater in adults who are colonised by MRSA in the hospital, up to 30% of whom will develop an MRSA infection (Huang 2003). Risk factors for MRSA infection include: MRSA colonisation; advanced age; prolonged hospital stay; previous use of broad-spectrum antimicrobials; a stay in a burn or intensive care unit; severe underlying illness; invasive procedures during hospitalisation (such as insertion of central venous catheters; or surgical wounds), and frequent contact with the healthcare system or healthcare workers (Peacock 1980; Boyle 1981; Ward 1981; Boyle 1983; Boyle 1989; Jernigan 1996; Davis 2004; Calfee 2014). Colonisation pressure (the ratio of MRSA carrier-days to total patient-days) is an independent risk factor for hospital acquisition of MRSA (Merrer 2000; Calfee 2014).

The rates of MRSA in the hospital setting have increased worldwide during the last few decades (Turnidge 2000; Fridkin 2002; Tiemersma 2004; Grundmann 2006). At present, its occurrence is stabilising, or even decreasing in some countries (Burton 2009; Kallen 2010; Wilson 2011; ECDC 2013; Sievert 2013), as are the rates of invasive infections caused by MRSA (Dantes 2013). However, MRSA continues to be one of the commonest antibiotic-resistant pathogens in the hospital setting in many parts of the world. The proportion of *S aureus* isolates resistant to meticillin remains over 25% in many countries, for example, in eastern and southern Europe (ECDC 2013; WHO 2014), and MRSA ac-
counts for 8.5% to 10.7% of HAIs in hospitals in the USA (Sievert 2013; Magill 2014). Although these findings suggest some success in controlling MRSA, many patients continue to be at risk (Calfee 2014), indeed, in the USA there were no significant reductions in healthcare-associated MRSA infections among paediatric populations between 2005 and 2010 (Iwamoto 2013). MRSA causes skin and wound infections (such as surgical site infections), pneumonia and bloodstream infections (Sievert 2013). Therefore, MRSA infections increase healthcare-associated morbidity, mortality and costs significantly (Crowcroft 2002; Cosgrove 2003; Engemann 2003; Cosgrove 2005). Its economic impact includes direct costs (prolonged hospital stay, additional diagnostic procedures and antibiotic use, and costs for containment of outbreaks) and indirect costs (loss of productivity, long-term disability and excess mortality; Gould 2006; Grundmann 2006; Goetghebeur 2007; Gould 2010; WHO 2014). However, it has also been suggested that there is a lack of properly designed and conducted studies to compare the resource use associated with resistant versus nonresistant pathogens (WHO 2014).

**Description of the intervention**

Various strategies exist to reduce the transmission of MRSA (Loeb 2003; Gould 2009; APIC 2010; Calfee 2014; Loveday 2014). In practice, multiple interventions are often employed in hospitals (Lee 2011), such as the following.

- Decontamination and disinfection of the environment and equipment.
- Rational antibiotic use.
- Hand hygiene, that is, actions to maintain healthy hands and fingernails, for example, handwashing or hand antisepsis (Public Health Agency of Canada 2012a).
- Identification of carriers through early detection (laboratory surveillance and screening for MRSA, that is, the sampling and culture of sites, such as skin lesions, nose, perineum and throat, that are associated with the carriage of MRSA; Cooper 2003).
- Decolonisation therapy to eradicate MRSA from colonised people.
- Isolation of patients to stop the transmission.

Isolation is the physical segregation of patients colonised or infected with a micro-organism, such as MRSA (or of patients awaiting screening results), for reducing its transmission to other patients. Isolation strategies can be categorised in descending grades of intensity (Cooper 2003), usually involving the use of disposable gloves, gowns and masks.

- Placement of patients in an isolation unit or isolation ward (either a purpose-built or improvised ward used for the isolation of MRSA patients).
- Nurse cohorting, which implies the physical segregation of a group of patients with MRSA from patients not known to harbour MRSA in a geographically distinct area of the same ward; the MRSA patients are nursed by designated staff who do not nurse non-MRSA patients during the same shifts.
- Isolating patients in a single-room.
- Cohorting without designated staff.
- The use of aprons or gowns, gloves and, in some cases, masks as the only physical barriers to transmission used by healthcare workers when contact with MRSA-colonised or infected patients, or their immediate environment (that is, the patient’s room, cubicle or operating room), is anticipated.

Therefore, gloving, gowning and masking are barrier methods of infection control used to restrict the transmission of pathogens in hospitals.

**How the intervention might work**

MRSA transmission in hospitals has been well documented using molecular typing techniques (Muto 2003). Hospitalised patients who are colonised or infected with MRSA provide the main reservoir of the pathogen (Thompson 1982; Rebolli 1990; Davis 2004; Hidron 2005), and generally MRSA spreads from patient to patient via the transiently contaminated hands, clothing and equipment of healthcare workers (Thompson 1982; Muto 2003; Calfee 2014).

Healthcare workers’ hands, clothes or equipment can become contaminated with MRSA as they care routinely for patients (Blok 2003; Snyder 2008). Moreover, MRSA can also survive on objects in the environment and be spread from these to patients, often via healthcare workers (Rutala 1983; Oie 1996; Devine 2001; Srinivasan 2007). Some older studies suggested a role for airborne transmission of *S. aureus* (Rammelkamp 1964; Williams 1966; Selkon 1980), and more recent studies also support the possibility that personnel with persistent MRSA nasal colonisation may spread the micro-organism via droplet transmission (see glossary in Appendix 1; Gaynes 1991; Reagan 1991; Boyce 1993; Sheretz 1996; Shimomori 2001; Wilson 2004). MRSA affects a large proportion of hospitalised patients and is transferable from person-to-person. Moreover, there are studies that point to a positive effect of the use of gloves, gowns and masks in reducing MRSA transmission in both outbreak and non-outbreak situations (Hartstein 1995; Jernigan 1996; Karchmer 2002; Mangini 2007; Johnston 2009). Therefore, it is postulated that the use of gloves, gowns and masks by hospital staff or visitors when in contact with an MRSA patient, or with his/her immediate environment, could prevent the transmission of MRSA (Siegel 2007; Calfee 2014).

The use of gloves during routine hospital procedures has been shown to prevent hand contamination by several organisms (Leclair 1987; Johnson 1990; Olsen 1993; Tenorio 2001), and their appropriate use may be as effective as the isolation of patients in containing multidrug resistant organisms, particularly when isolation is not feasible (Trick 2004; Bearman 2007; NHMRC 2010).
Furthermore, gowning by hospital staff can reduce the transient contamination of their clothes (Zachary 2001; Puzniak 2002), and the use of masks by healthcare workers during close contact with MRSA colonised patients may prevent healthcare workers' nasal colonisation with MRSA (Lacey 2001).

**Why it is important to do this review**

While some studies point to a positive effect of gloves, gowns and masks in reducing MRSA transmission (Arnow 1982; Safdar 2008), others suggest that gloving and gowning do not decrease HAs (Yap 2004; Chai 2005; Johnston 2009), or that MRSA can be successfully controlled without some of these barriers (Pan 2005; Grant 2006). A number of systematic reviews assessed the effectiveness of different strategies for controlling micro-organisms in hospitals (Cooper 2003; Aboelela 2006; Loveday 2006; Halcomb 2007; Ranji 2007; Glick 2013, among others), and several Cochrane reviews have focused on the use of barrier precautions (Webster 2003; Tanner 2006; Pammi 2011; Jefferson 2011; Hughes 2013; Lipp 2014; Mischke 2014). However, none of these reviews attempted to disentangle the specific effects of gloving, gowning or masking when contact with MRSA inpatients, or their immediate environment in the hospital, is anticipated.

Professional organisations and national institutions have issued guidelines for MRSA control in the hospital setting (NZMoH 2002; Coia 2006; Grundmann 2006; Rodriguez-Baño 2006; APIC 2010; NHMRC 2010; Lee 2011; Coia 2013; WIP 2012; Calfee 2014), but their recommendations for practice can be inconsistent or inconclusive (Johnston 2009). For example, some guidelines pointed out that the use of a mask for MRSA remains controversial (APIC 2010), and that it represents an area for further research (Irish department of Health 2013). The low quality of the evidence identified may explain the existing reservation for the use of gloves, gowns and masks to prevent transmission of MRSA in the hospital setting (Johnston 2009; Hansen 2010), and the varying ways in which these guidelines are applied in practice (Hails 2003; Gastmeier 2004; Sunenshine 2005; Jarvis 2007; Lee 2011; Zastrow 2011; Pogorzelska 2012; Loveday 2014).

On the other hand, there are some concerns about the potential harms associated with the use of gloves, gowns and masks (Evans 2003; AHRQ 2013; Zahar 2013; Calfee 2014). Contact precautions restrict the patients’ autonomy (Santos 2008; Lee 2011; Zastrow 2011), and may be related to increased symptoms of depression and anxiety (Day 2011), and to a decreased patient satisfaction with care (Mehrotra 2013). They could also cause a deterioration of the quality of care due to increased noninfectious adverse events (e.g. falls, pressure ulcers) caused by poorer compliance with hand hygiene or a reduction in visits by medical staff (Girou 2004; Bearman 2007; Morgan 2009; Fuller 2011; Morgan 2011; Karki 2013). In addition, gloves become contaminated and their inappropriate use can result in the transmission of micro-organisms (Public Health Agency of Canada 2012b). However, additional studies are needed to confirm this increase of adverse events (Zastrow 2011; BUGG Study 2013; Calfee 2014). Finally, as contact precautions require resources that may be limited in hospitals, their cost-effectiveness should also be determined. Moreover, given the difficulties that health professionals have in adhering to preventive measures and precautions, it is essential to identify the most effective measures for preventing MRSA transmission in order to choose wisely the minimum number of interventions to implement.

Therefore, an accurate determination of the benefits, potential harms and cost-effectiveness of the use of gloves, gowns and masks, alone or in combination, is needed.

**OBJECTIVES**

To assess the effectiveness of wearing gloves, a gown or a mask when contact is anticipated with a hospitalised patient colonised or infected with MRSA or with the patient’s immediate environment. See Differences between protocol and review for this section.

**METHODS**

Criteria for considering studies for this review

**Types of studies**

This review considered randomised controlled trials (RCTs) and certain non-randomised experimental designs as eligible, irrespective of their language or publication status. In particular, we considered the following study designs to be eligible (Table 1 details the ‘study design features’ that we assessed to decide on eligibility).

- RCTs.
- Cluster-RCTs (CI-RCTs).
- Non-randomised controlled trials (NRCTs).
- Cluster non-randomised controlled trials (CI-NRCTs).
- Controlled before-and-after studies (CBA).
- Controlled cohort before-after studies (CCChBA).
- Interrupted time series studies (ITS).
- Controlled interrupted time series studies (CITS).
- Repeated measures studies (RMSs).

Eligible study designs included only experimental designs, as they can minimise some biases usually present in infection control studies (Stone 2007). We defined a study as experimental always that the intervention had been deliberately allocated by the researcher to observe its effects (Shadish 2002). In particular, we considered...
the following minimum requirements for a study to be defined as experimental: a prospective baseline assessment; a prospective allocation of the intervention; and a prospective outcome assessment.

We excluded observational studies (see glossary in Appendix 1), and outbreak reports (the description of outbreaks and the subsequent interventions adopted for their control; Stone 2007). We also excluded in vitro laboratory-based studies that assessed the efficacy of gloves, gowns or masks impregnated with antiseptic or anti-infective agents to prevent the contamination of the outer surface of the barrier with pathogens.

The RCT is the experimental design that is considered to have the highest level of internal validity (through elimination of selection bias) for assessing the efficacy of an intervention. However, non-randomised studies (NRS) are ubiquitous in the area of interventions for decreasing the spread of antibiotic-resistant pathogens (Harris 2004). Whilst more prone to bias (Deeks 2003), we accepted some types of NRS as eligible. We based this decision on the difficulties of randomising the use of gloves, gowns and masks due to the following circumstances that are present in the context of infection control.

- Ethical concerns: gloves and gowns can be perceived by healthcare workers as effective interventions (Seibert 2014), so it can be difficult to withhold treatment in the control group (Ijaz 2014).
- Logistical difficulties: gloves, gowns, and masks are usually applied as part of complex interventions, which are difficult to implement and evaluate. Moreover, infection control interventions are usually applied in clusters, and the number of clusters available may be low.
- The need to intervene quickly (for example, in outbreak situations).

Therefore, we considered that a disinterested (free from bias and partiality) review that systematically reports the findings and limitations of available NRS could be useful. See Differences between protocol and review for this section.

Types of interventions

Interventions

The use of gloves, gowns, aprons or masks by any hospital staff (healthcare or non-healthcare professionals) or by any patient’s caregiver or visitor for interactions with a patient colonised or infected with MRSA or with potentially contaminated areas in the patient’s environment, for example in the patient’s room, cubicle or operating room. We considered the use of ‘medical gloves’. To be eligible, gloves needed to be disposable and intended for single patient use and then to be discarded. We considered the use of ‘gowns’, either ‘isolation gowns’ or ‘surgical gowns’. For ‘masks’, we considered the use of ‘procedure masks’ and ‘surgical masks’, as well as ‘particulate respirators’ (see glossary in Appendix 1 for a definition of all these terms).

We defined as eligible any ‘care bundle’ (see Appendix 1) that considered the use of gloves, gowns or masks, or any combination thereof. Therefore, gloves, masks and gowns could be used in the following ways:

- on their own as a single intervention, for example, the use of gowns alone;
- as a combination, for example, the use of gowns and gloves;
- combined with any other barrier precaution, such as the placement of MRSA patients in isolation units to be attended by staff using gowns, gloves and masks; or
- combined with any other infection control intervention, such as the decolonisation of patients with MRSA.

Only studies in which gloves, gowns or masks were used with patients who had MRSA were eligible. As a consequence we excluded studies that investigated the effects of the following interventions:

- gloves, gowns or masks as ‘routine practice’ or ‘standard precautions’, that is, when there is anticipated exposure to a patient’s blood, body fluids, secretions, and excretions (except for sweat), non-intact skin, draining wounds and mucous membranes (Siegel 2006; Johnston 2009). Therefore, we excluded studies assessing gloving, gowning or masking during routine vascular catheter insertion, surgical procedures, and patient care after organ transplantation (Stewart 2006; Tanner 2006; Lipp 2014; Mischke 2014);
- the universal use of gloves, gowns or masks, that is, their use for contacts with all patients (Webster 2003); or
- the pre-emptive use of gloves, gowns or masks, that is, their use for all new admissions or for all patients admitted to a specific unit, until a negative screening culture for the target organism is reported (Siegel 2006).
Comparators
We considered any comparator, provided that it allowed the effects of gloving, gowning or masking (used on their own or in combination) for interactions with patients colonised or infected with MRSA or with their environment to be assessed in their own right. In practical terms, we would have included those studies in which co-interventions were similar in the study groups, as this would allow us to assess the specific impact of the use of gloves, gowns or masks.

We excluded studies that evaluated the effects of MRSA screening programs, isolation of MRSA patients (such as placement in an isolation unit or ward, nurse cohorting or cohorting without designated staff), or campaigns to increase the use barrier precautions, as these do not allow the effects of the use of gloves, gowns or masks to be assessed in their own right. For example, in studies evaluating MRSA screening programmes the observed effects could be attributed to early detection of MRSA carriers (which implies that they do not become a continuous source of MRSA), and not only to the use of gloves, gowns or masks.

See Differences between protocol and review for this section.

Types of outcome measures

Primary outcomes

Outcomes measured in patients
- Healthcare-associated MRSA colonisations (see glossary in Appendix 1). We would have considered this outcome only in the studies reporting an existing screening policy at admission (and throughout the study), as if this is not the case colonisation data would be incomplete owing to failure to detect asymptomatic MRSA-colonised patients (Cooper 2003).
  - Healthcare-associated MRSA infections (see glossary in Appendix 1).
  - Healthcare-associated MRSA bacteraemias (see glossary in Appendix 1).
  - Healthcare-associated MRSA pneumonias (see glossary in Appendix 1).
- Mortality attributable to MRSA.

We would have accepted the study authors’ report regarding the methods used to diagnose healthcare-associated MRSA colonisations, infections, bacteraemias or pneumonias and considered any measure of frequency. We would have considered total MRSA colonisations, infections, bacteraemias or pneumonias only if studies did not report healthcare-associated events as outcomes. We would have admitted any definition used for healthcare-associated infections and colonisations, as they are not standardised (Cohen 2008), and any metric for quantifying healthcare acquisition of pathogens, such as incidence rate or incidence density rate.

Outcomes measured in hospital staff, patient’s caregivers or visitors
- Healthcare-associated MRSA colonisations (only in the articles reporting an existing screening policy during the study).
- Prevalence of carriers of MRSA.

The primary objective of a Cochrane review should be to assess the effects of one or more healthcare interventions on stakeholder-important outcomes, both intended and unintended (MECIR Conduct 2013). Although there are some concerns about the potential harms of the use of gloves, gowns or masks (see Why it is important to do this review), we did not assess them, as we considered that in order to do this adequately we would need to apply different selection criteria for study designs - and include NRS, such as cohort studies, as well - and that it might not be enough to restrict participants to those with demonstrated MRSA. Therefore, this process would have consumed too many of the review team’s resources and means that another systematic review that focuses on the unintended effects is warranted.

Secondary outcomes
- MRSA to meticillin-susceptible S aureus (MSSA) ratios.
- Length of stay, measured in days (see glossary in Appendix 1).
  - Antibiotic use.
  - All cause mortality.

We did not exclude any study solely because no outcomes of interest were reported. We did not attempt to assess issues of equity and relevance of evidence to specific populations. See Differences between protocol and review for this section.

Search methods for identification of studies

Electronic searches
We searched the following electronic databases for potentially relevant studies.
- The Cochrane Wounds Group Specialised Register (searched 5 June 2015).
- The Cochrane EPOC Group Specialised Register (searched 9 July 2013).
- The Cochrane Infectious Diseases Group Specialised Register (searched 5 January 2009).
- The Cochrane Central Register of Controlled Trials (CENTRAL; The Cochrane Library 2015, Issue 6).
- The Database of Abstracts of Reviews of Effects (DARE; The Cochrane Library 2015, Issue 6).
- The Health Technology Assessment Database (HTA; The Cochrane Library 2015, Issue 6).
Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting  

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Data collection and analysis

We searched the following clinical trials registries:
- ClinicalTrials.gov (www.clinicaltrials.gov/);
- WHO (World Health Organization) International Clinical Trials Registry Platform (http://apps.who.int/trialsearch/Default.aspx); and
- International Standard Randomised Controlled Trial Number Register (http://controlled-trials.com/isrctn/search.asp).

Searching other resources
- We checked the reference lists of relevant studies in the subject area (including systematic reviews) for additional relevant papers.
- We contacted relevant individuals for information about further studies.
- We checked the abstracts from the following conference proceedings (see Differences between protocol and review).
- IDWeek 2012: Epidemiology and Infection Control track (https://idsa.confex.com/ida/2012/viewsessionpdf.cgi).
- IDWeek 2013: Epidemiology and Infection Control track (https://idsa.confex.com/ida/2013/viewsessionpdf.cgi).
Selection of studies
At least two review authors (JLA and MM, MG, LOC, or SC) screened all titles and abstracts independently to select potentially relevant studies. Where there was any uncertainty based on this information we obtained the full text for further assessment. At least two review authors (JLA and MM, MG, LOC, or SC) assessed the eligibility of the retrieved full text versions independently. We resolved disagreements by discussion between the two authors. If there was no consensus, a third author (IS) was consulted. We were not blinded to the authors’ names of the publications, or their institutions, journals or results during the selection process. We did not exclude studies solely on the basis of the reporting of the outcome data, since this might have introduced bias due to selective outcome reporting (O’Connor 2011). We completed a PRISMA flow chart (Figure 1) and a Characteristics of excluded studies table.
Figure 1. Study flow diagram.

2191 records identified through database searching

4456 records after duplicates removed.

4456 records screened

4174 records excluded

383 full-text articles included. Reasons:
- Not primary study (43)
- Not experimental study (59)
- Uncontrolled before-after study (3)
- Laboratory-based or simulation study (5)
- Not confirmed MRSA patients (18)
- Not hospital inpatient (3)
- Not possible to discriminate effects (103)
- Effects of gloves, gowns or masks not evaluated (8)

382 full-text articles assessed for eligibility

0 studies included in qualitative synthesis

0 studies included in quantitative synthesis (meta-analysis)
Differences between protocol and review for this section.

Data extraction and management

We had planned to design a data extraction form and pilot its template for usability. This form would have been adapted from the following templates and tailored to the review question.

- EPOC Data Abstraction form (EPOC 2013b).
- ORION Statement checklist (Stone 2007).
- CONSORT statement (CONsolidated Standards of Reporting Trials) 2010 (Schulz 2010).
- CONSORT extension for non-pharmacological interventions (Boutron 2008).
- CONSORT extension for cluster randomised trials (Campbell 2012).
- Template for intervention description and replication (TIDieR) checklist (Hoffmann 2014).
- Cochrane Handbook for Systematic Reviews of Interventions: study design checklist (tables 13.2.a and 13.2.b), following the guidance provided in Box 13.4.a (Reeves 2011), and the templates for collecting information about confounding factors, their comparability at baseline, methods used to adjust for confounding, and effect estimates in non-randomised studies (NRSMG 2011).

For each included study we would have extracted details of participants, setting, methods, intervention and control, outcome data, funding source, and declaration of interests for the primary investigators. We would have collected this information in sufficient detail to populate a table of ‘characteristics of included studies’. Moreover, we would have extracted data related to the risk of bias (RoB) and the study results. We would have examined any relevant retraction statements and errata for relevant information regarding each included study.

As infection control interventions usually have several components, we would have created a graphical depiction of the experimental and control interventions using the Pat Plot tool (Perera 2007); once created, a PaT Plot is easy to interpret and would have helped us to establish clear comparisons between different arms of a study (CEBM 2009). For studies with more than two intervention arms, we would have considered only the intervention and control groups that met the eligibility criteria.

At least for outcome data, two review authors would have extracted data independently from reports of each included study. If possible, this dual data extraction would have been applied for the data extraction of all the characteristics of the included studies. We would have resolved any discrepancy in the extraction of the data by consensus. In the case of no consensus, a third review author, or the editorial base of the Cochrane Wounds Group, would have settled the discrepancies. We would have written to authors or organisations to obtain important missing information or clarification, and we would have checked accuracy of numeric data in the review, as suggested by MECIR (MECIR Conduct 2013). See Differences between protocol and review for this section.

Assessment of risk of bias in included studies

All study designs (clustered or not) except for ITS, CITS and RMS

We would have assessed the RoB according to the domains proposed by the Cochrane Collaboration’s RoB tool and the Cochrane EPOC group (Higgins 2011a; EPOC 2013c).

- Random sequence generation (selection bias).
- Allocation concealment (selection bias). This domain also considers the presence of recruitment bias in cluster-designs.
- Imbalance in baseline characteristics (selection bias), in terms of either the individuals or the clusters (when it is a cluster design). See Appendix 3 for the list of potential confounders to consider. This domain will not be assessed for RCTs allocated at the individual level with an adequate sample size as we will assume that baseline imbalances in these designs are caused by chance.
- Imbalance in baseline outcome measurements (selection bias), when applicable (assessments to be made for each outcome (or class of outcomes); EPOC 2013c).
- Blinding of participants and personnel (performance bias).
- Blinding of outcome assessment (detection bias). We planned to group the outcomes by the susceptibility of their measurement to the lack of blinding (with assessments to be made for each outcome (or class of outcomes), as follows:
  - high susceptibility: healthcare-associated MRSA colonisations; healthcare-associated MRSA infections; healthcare-associated MRSA bacteraemias; healthcare-associated MRSA pneumonias; mortality attributable to MRSA; prevalence of carriers of MRSA.
  - low susceptibility: MRSA to MSSA ratios; length of stay; antibiotic use; all cause mortality.
Incomplete outcome data (attrition bias; with assessments to be made for each outcome (or class of outcomes); loss of clusters in cluster-designs will be also assessed).
- Selective reporting (reporting bias).
- Protection against contamination (EPOC 2013c).
- Timing of the assessments of the outcomes (with assessments to be made for each outcome (or class of outcomes).
- Statistical methods taking the clustering into account (only for cluster designs; Higgins 2011b).

See Appendix 4 for details of criteria on which the judgements would have been based. This tool contains also the domains that would have been considered when assessing the RoB of cluster designs. The following were defined as ‘key domains’ for the analysis: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, and incomplete outcome data.

ITS, CITS and RMS

We would have considered the tool proposed by the Cochrane EPOC group (EPOC 2013c), which has the following domains.

- Was the intervention independent of other changes?
- Was the shape of the intervention effect pre-specified?
- Was the intervention unlikely to affect data collection? (Assessments made for each outcome (or class of outcomes)).
- Blinding of outcome assessment (detection bias; assessments made for each outcome (or class of outcomes)).
- Incomplete outcome data (attrition bias; assessments made for each outcome (or class of outcomes)).
- Wás the study free of selective outcome reporting (reporting bias)?

See Appendix 5 for details of criteria on which the judgements would have been based. All the domains except for ‘selective reporting’ were defined as ‘key domains’ for the analysis.

As this systematic review focuses on non-pharmacological interventions, we would have assessed the blinding of participants and personnel and the blinding of outcome assessors following the suggestions of the ‘CLEAR NPT checklist’ (Boutron 2005). We also planned to assess the quality of reporting of the blinding of patients, ‘care providers’, ‘persons caring for participants’ and ‘data analyst’ as this checklist proposes, but these items would not have been considered for the global rating of the RoB of the study.

We planned to assess most of the domains for each study as a whole (therefore, by a single entry in the RoB tool for each study). However, some domains would have been assessed separately for each individual outcome (and for each time point for the same outcome if several time points are considered). Therefore, we would have assigned a single entry in the RoB tool for each outcome-time point. On the other hand, we planned to limit the number of entries used by grouping outcomes within every study, the same grouping would have been applied to every study in the review. Appendix 6 details how we planned to group the outcomes for the RoB assessment.

At least two review authors would have independently assessed the RoB of each included study (not masked to the study details). Each domain of the RoB tool would have been labelled as ‘low RoB’ (plausible bias unlikely to seriously alter the results), ‘high RoB’ (plausible bias that seriously weakens confidence in the results); or ‘unclear RoB’ (plausible bias that raises some doubt about the results). We planned to obtain the information from the reports but, if there had been not enough information we would have contacted the authors or the organisations for clarification. If clarification had not been obtained, we would have assigned a grading based on the available information and the consensus between the review authors. Disagreements would have been resolved by discussion and consensus, and by consulting a third review author if necessary. We planned to assess inter-rater reliability for the key domains by using the kappa statistic (Higgins 2003), and we planned to report relevant discrepancies in the assessments.

We would have justified judgements of RoB and provided this information in a ‘Risk of bias table’ for each included study; we would have reported the source of information for each RoB judgement, including those based on assumptions made on information provided outside publicly available documents. We would have reported the results of assessments of confounders in an additional table, listing the pre-stated confounders as columns and the studies as rows (Reeves 2011; see Appendix 3 for the list of potential confounders). Two figures would have been also included: a ‘Risk of bias graph’, presenting an overview of our judgements across each RoB domain, and a ‘Risk of bias summary’, to show an overview of judgements for each RoB domain for each study.

We planned to summarize the RoB for each outcome (or class of similar outcomes) in two different manners, ‘within each study’ and ‘across studies’ (Higgins 2011a):

<table>
<thead>
<tr>
<th>Interpretation</th>
<th>RoB for each outcome across different domains within each study</th>
<th>RoB for each outcome across studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low RoB</td>
<td>Plausible bias unlikely to seriously alter the results</td>
<td>Low risk of bias for all key domains</td>
</tr>
</tbody>
</table>
We would have provided a narrative summary of the RoB among the included studies. Summary assessments of RoB for each outcome across studies would have been incorporated into explicit measures of the quality of evidence for each important outcome using the GRADE system (Guyatt 2008). See Differences between protocol and review for this section.

**Measures of treatment effect**

We planned to report the estimate of the effect and its 95% confidence interval (CI) for each study, organised by type of intervention and study design.

**All study designs except for ITS, CITS and RMS**

We planned to present the following estimates of the effect with their associated 95% CI.

- **Risk ratio (RR):** for dichotomous data, such as prevalence of carriers of MRSA.
- **Odds ratio (OR):** for counts of rare events and rates, such as incidence density rate of HAIs.
- **Mean difference (MD):** for continuous data, such as length of stay (or standardised mean difference (SMD) if the continuous data require standardisation across studies).

**ITS, CITS and RMS**

We planned to present, if possible, the results for each outcome as changes along two dimensions (EPOC 2013d).

- **Change in level:** reflecting the immediate effect of the intervention, measured as the difference between the fitted value for the first post intervention data point (one month after the intervention) minus the predicted outcome one month after the intervention based on the pre-intervention slope only.
- **Change in slope:** reflecting the long-term effect of the intervention, this is the change in the trend from pre- to post-intervention.

The preferred analysis method for ITS and RMS is either a regression analysis with time trends before and after the intervention, which adjusted for autocorrelation and any periodic changes, or auto regressive integrated moving average (ARIMA) analysis (EPOC 2013d). We planned not to include, and therefore, not re-analyse, ITS studies or RMS that had an inappropriate analysis of results.

**Adjustment of the estimates of the effects**

This review considered randomised and non-randomised studies as eligible. Susceptibility to selection bias (understood as mean differences in the baseline characteristics of individuals in different intervention groups) is widely regarded as the principal difference between randomised and non-randomised studies. NRS are more prone to confounding (that is, selection bias that gives rise to imbalances between intervention and control groups on prognostic factors because the distributions of the factors differ between groups, and the factors are associated with outcome(s); Reeves 2011).

Randomisation with adequate allocation concealment reduces the possibility of selection bias, so that differences in characteristics between groups can be attributed to chance (Reeves 2011). Therefore, for studies described by the study authors as ‘randomised’ we would have used unadjusted effect estimates, that is, crude estimates that have not been corrected for the effects of confounding factors. We planned to assess the effects of this decision through Sensitivity analysis (see Differences between protocol and review). As a result of the need to control for confounding as best as possible in NRS, we would have preferred to use adjusted estimates from these studies, that is, estimates that have been corrected for the effects of confounding factors. If the study report did not provide the adjusted effect estimate, we would have attempted to obtain it by following the guidance provided by the Cochrane EPOC Group (EPOC 2013d). If the study report presented alternative adjusted estimates for the same outcome, by preference we would have used the estimate that was identified as the primary adjusted model (Reeves 2011). We would have assessed the effects of this decision through Sensitivity analysis.
Summary effect measures derived from the meta-analyses
For each comparison and outcome, a meta-analysis would have generated a summary effect estimate with its corresponding 95% CI. The results of each meta-analysis would have been re-expressed to easily interpretable statistics in the standard Cochrane ‘Summary of findings’ table, generated with the GRADEpro software (GRADEpro 2014).

- Dichotomous outcomes and counts of rare events and rates: we planned to provide both a relative measure (e.g. RR or OR) and measures of absolute risk, all of them with their corresponding CI 95%. By preference, we would have expressed the relative measure as RR, because the OR is the hardest summary statistic to understand and to apply in practice, and many practising clinicians have reported difficulties in using it (Deeks 2011); therefore, if the meta-analysis were based on ORs its global estimate would have been an OR, but we would have re-expressed it as RR by applying the formula described in section 12.5.4 of the Cochrane Handbook for Systematic Reviews of Interventions (Schünemann 2011). In addition, we planned to re-express the relative measure using absolute effect measures (risk differences). We would have calculated RRs and risk differences from a plausible range of control group event rates from the individual trials.

- Continuous data: we planned to provide an absolute measure alone, the MD or SMD, and its 95% CI.

See Differences between protocol and review from this section.

Unit of analysis issues
We had planned to examine the unit of analysis of the studies looking for potential ‘unit of analysis errors’ (see glossary in Appendix 1).

Studies with allocation to interventions at the group level
We expected that many eligible studies would be cluster designs (studies in which the unit of allocation is not a person, but instead is a group of people). If these designs were included, we would have determined whether the data were correctly analysed: comparisons that allocate clusters (for example, groups of professionals or wards) but do not account for clustering during analysis have potential ‘unit of analysis errors’, resulting in artificially extreme P values (see Appendix 1) and over-narrow confidence intervals (Ukoumunne 1999). For cluster designs, we would have considered data as analysed correctly if:

- the analysis was conducted at the level of the individual, but the sample size was reduced to its ‘effective sample size’, or the variance was inflated by the design effect.

If the data analysis had been performed incorrectly we would have attempted to perform an ‘approximately correct analysis’ following the guidance of Section 16.3 of the Cochrane Handbook for Systematic Reviews of Interventions (Higgins 2011b). We planned to contact the authors to obtain relevant data, when necessary. If, finally, these data were not available, the results of the study would have been reported as point estimates of the intervention effect without presentation of any statistical analysis (P values) or confidence intervals and they would have not been included in the meta-analysis (Higgins 2011b).

Sample size calculation
We planned to assess whether the unit of allocation had been taken into consideration in the sample size calculation or power calculation. In cluster designs the sample size estimate has to be inflated to take account of the cluster design (Ukoumunne 1999), so we planned to evaluate whether the sample size had been estimated based on the intra-cluster correlation co-efficient (see Appendix 1), however, this would have not been considered for the assessment of the RoB.

Outcome is an event that may re-occur
If the outcome of interest would have been an event that may re-occur (such as HAIs), we would have assessed whether the count data had been treated erroneously, that is, as if they were dichotomous data (Deeks 2011).

Additional analysis issues
We planned to examine critically the statistical approaches of the included studies.

- We would have assessed whether the statistical approach relating to infection or colonisation outcomes was adequate. For communicable diseases, unless outcomes are independent, the risk to one patient will depend on the status of other patients. For this reason, the use of approaches that assume independence (which include the Chi² test, Fisher’s exact test, linear regression, etc.) can lead to false inferences, and statistical approaches able to account for dependencies in the outcome data should be used instead (Stone 2007). We did not plan to consider our conclusion regarding the statistical approach as part of the global rating of the RoB of the studies.

- For ITS and RMS designs we would also have assessed whether the statistical approach had ignored secular (trend) changes. Analysis of aggregated data of the pre and post intervention phases should be avoided because it does not provide information about trends over time. We had planned to
exclude ITS and RMS that did not have a parallel control group that ignored secular changes, and had performed a simple test of the pre versus post intervention periods, from the review without further justification (these studies will be considered as uncontrolled before-and-after studies).

See Differences between protocol and review for this section.

**Dealing with missing data**

**Missing outcome data**

As far as possible, we planned to apply an 'intention-to-treat' analysis for all outcomes, that is, an analysis that fulfils the following principles (Higgins 2011b).

- Participants are kept in the intervention groups to which they were randomised, regardless of the intervention they actually received.
- There is a measurement of outcome data for all participants.
- All randomised participants are included in the analysis.

We planned to contact the primary authors for missing data and clarification of issues. If we could not obtain this information, we would have documented this on the data extraction form and within the text of the review, and we would have performed an 'available case analysis', that is, an analysis that includes data on only those participants whose results are known, and that uses as denominator the total number of people who had data recorded for the particular outcome in question. In the available case analysis the participants would have been analysed according to the group to which they were randomised. If possible, we would have 're-included' avoidable exclusions done by the authors (Higgins 2011b). We planned to perform Sensitivity analysis to assess how sensitive results were to changes in the assumptions made in the available case analysis.

We would have described missing outcomes for the included studies by reporting proportions of allocated participants for whom no outcome data were obtained (with reasons) by outcome and by study group. We planned to explore the impact of the missing outcome data in the overall treatment effect through Sensitivity analysis by excluding studies with high RoB for the domain 'Incomplete outcome data' from the meta-analysis. We would have described in the Discussion the impact of the missing outcome data on the findings of the review.

**Other missing data**

If other relevant data were not directly reported (for example, standard deviation for continuous data), we would have obtained this information by looking carefully in the report for statistics that would allow its calculation. If this was not possible, we would have tried to contact the primary authors. If, finally, we could not obtain the information, we would have recorded this in the data extraction template and we would have imputed this information following the suggestions provided in Higgins 2011c. See Differences between protocol and review for this section.

**Assessment of heterogeneity**

For each review outcome, we planned to assess heterogeneity of the results across studies qualitatively and quantitatively.

- **Qualitative methods**
  - We would have prepared tables summarising the characteristics of the included studies. This would have allowed us to examine the similarity between the studies for relevant factors.
  - We would have created forest plots of the study results (effect estimates and their CI 95%) to assess the potential disparities of the effect estimates and the degree of overlap among the CIs.

- **Quantitative methods**
  - We would have examined the results of the Chi² test for statistical heterogeneity (we would have considered a P value of less than 0.10 to be significant).
  - We would have examined the results of the I² statistic for the quantification of statistical heterogeneity (Higgins 2003). The I² statistic describes the percentage of total variation across studies that is due to heterogeneity rather than chance. We would have judged the importance of the observed value of the I² statistic depending on the magnitude and direction of effects and the strength of evidence for heterogeneity (we would have interpreted values of I² greater than 50% as potentially representing substantial heterogeneity; Deeks 2011).

We recognise that a low number of studies are expected to be included in future updates of this review and that there is considerable uncertainty in tests such as Chi² test or I² when there are few studies. Therefore, use of simple thresholds to diagnose heterogeneity will be avoided (Deeks 2011). See Differences between protocol and review for this section.

**Assessment of reporting biases**

We would have attempted to minimise the risk of reporting bias by:

- including both published and unpublished studies;
- extracting data on outcomes from the publication with the most mature data (in the case of studies with multiple publications); and
- not excluding studies solely on the basis of the publication language.

We planned to look for evidence of publication bias for each outcome. In order to do so, we would have assessed the funnel plot of the results of the meta-analysis for each outcome in two different ways: graphically, by visual assessment; and statistically (funnel
Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting (Review)
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plots will not give meaningful results if there are fewer than 10 studies in the meta-analysis, or if all the studies are the same size). Funnel plots can be produced in Review Manager 5.3 (RevMan; RevMan 2014), which takes the results of a meta-analysis and plots the results of each individual study against a measure of the study's size (usually represented by a measure of variance like standard error; Sterne 2011). We would have followed the guide provided by Sterne 2011 for statistical testing for funnel plot asymmetry. Results from tests for funnel plot asymmetry would have been interpreted cautiously: if there had been evidence of small-study effects, that is, when the results of the small studies are consistently different to the larger studies, either more positive or more negative, we would have considered publication bias as only one of a number of possible explanations. If we suspected a small-study effect, we planned to determine its impact on the results by performing a sensitivity analysis: we would have compared the fixed-effect and random-effects meta-analyses (see Sensitivity analysis), as suggested by the Cochrane Handbook for Systematic Reviews of Interventions (Sterne 2011). See Differences between protocol and review for this section.

Data synthesis

We would have performed the analyses using RevMan 5 (RevMan 2014), the statistical package provided by the Cochrane Collaboration. We would have combined the outcome measures from the individual trials in meta-analyses to provide a pooled effect estimate if there had been at least two studies that were sufficiently similar in terms of clinical setting, participants, intervention, comparison, outcomes and study design.

We would have presented all estimates of treatment effects with their associated 95% CI (see Measures of treatment effect). Estimated intervention effects for different study designs can be expected to be influenced to varying degrees by different sources of bias. As a consequence, results from different study designs should be expected to differ systematically, resulting in increased heterogeneity (Reeves 2011). Therefore, we would have combined the following study designs in different meta-analyses.

- Randomised controlled trials (RCTs) and quasi-randomised controlled trials (Q-RCTs).
- Non-randomised controlled trials (NRCRTs).
- Controlled before-and-after studies (CBA) and controlled cohort before-after studies (CChBAs).
- Interrupted time series studies (ITS) and repeated measures studies (RMS).
- Controlled interrupted time series studies (CITS).

We would have meta-analysed all the included studies independently of their RoB. We acknowledge that such an analysis may fail to down-weigh studies at a high risk of bias, and hence will lead to an overall intervention that is too precise, as well as being potentially biased (Higgins 2011a). However, we expected a low number of studies to be included, and we planned to explore the impact of this decision by carrying out Sensitivity analysis.

Cluster-designs would have been combined with the corresponding individually allocated trials in the same meta-analysis. However, in the sensitivity analysis we would have considered the possibility of important differences in the effects being evaluated that would depend on the unit of allocation (see Sensitivity analysis). For comparable studies, we would have displayed their results graphically and looked at sizes and directions of effects to assess heterogeneity qualitatively. In addition, we would have assessed heterogeneity statistically (see Assessment of heterogeneity). If no relevant heterogeneity was detected, we would have pooled data according to a random-effects model, as we considered that it would be very likely that the subjects or interventions in these studies would have differed in ways that would have had an impact on the results, and therefore we should not assume a common effect size (Borenstein 2009). We would have ensured robustness of the model chosen through Sensitivity analysis. The results from tests for heterogeneity would have been interpreted cautiously: if there had been evidence of small-study effects, that is, when the results of the small studies are consistently different to the larger studies, either more positive or more negative, we would have considered publication bias as only one of a number of possible explanations. If we suspected a small-study effect, we planned to determine its impact on the results by performing a sensitivity analysis: we would have compared the fixed-effect and random-effects meta-analyses (see Sensitivity analysis), as suggested by the Cochrane Handbook for Systematic Reviews of Interventions (Sterne 2011). See Differences between protocol and review for this section.

Quality of the body of the evidence

We would have assessed the quality of the body of the evidence according to the GRADE approach (Schünemann 2011). We would have presented at least one standard ‘Summary of findings’ table developed using GRADEprofiler (GRADEpro 2014). A ‘Summary of findings’ table provides key information concerning the quality of evidence, the magnitude of effect of the interventions examined, and the sum of available data on all important outcomes for a given comparison. See Differences between protocol and review for this section.

Subgroup analysis and investigation of heterogeneity

We would have explored potential sources of heterogeneity by conducting the following subgroup analyses.

- Patients’ age: neonate and paediatric versus adult versus elderly.
  - Type of patient: medical patients versus surgical patients versus patients in ‘high risk units’ (i.e. intensive care, neonatal intensive care, burn, or dialysis units; Wenzel 1998).
  - Number of wards in which the measures are applied: one versus more than one, versus the whole hospital.
  - MRSA outbreak situation versus no MRSA outbreak situation (as defined by the authors of the original article).
• Adjustment of estimates of the effects in meta-analyses of non-randomised studies: studies with adjusted estimates versus studies without adjusted estimates.

If sufficient studies had been available, we would have used a formal statistical test to compare the results of the subgroups. If subgroup analyses had been conducted, we would have followed the subgroup analysis plan specified in the protocol without undue emphasis on particular findings (MECIR Conduct 2013). See Differences between protocol and review for this section.

Sensitivity analysis
We planned to restrict sensitivity analysis to the review’s primary outcomes.

• Risk of bias
  ○ Excluding studies with unclear or high RoB for random sequence generation or allocation concealment.
  ○ Excluding studies with high RoB (Differences between protocol and review).
  ○ Excluding studies with high or unclear RoB (Differences between protocol and review).

• Missing outcome data: excluding studies with high RoB for the domain ‘Incomplete outcome data’.

• Unit of allocation: excluding studies allocated at the individual level.

• Statistical model chosen for meta-analysis: we would have used a fixed-effect model.

• Adjustment of the estimates:
  ○ In RCTs with unclear or high RoB for randomisation or allocation concealment we would have used adjusted estimates.
  ○ For NRS we would have considered adjusted estimates from the model with the largest number of confounders defined as important by the review team (see Appendix 3 for list of confounders).

• Assumptions taken in the ‘available case analysis’ for dichotomous data: we would have imputed missing data by considering the ‘best case’ and ‘worst-case’ scenarios (Gamble 2005).
  ○ ‘Best-case’ scenario: all participants with missing outcomes in the intervention group are assumed to have had good outcomes, and all those with missing outcomes in the control group to have had poor outcomes.
  ○ ‘Worst-case’ scenario: the opposite to the ‘best-case’ scenario above (Higgins 2011b).

• Study funding: we would have excluded industry-funded studies from the meta-analysis.

See Differences between protocol and review in this section.

Results of the search
After removal of duplicates, the search strategy of the electronic databases to June 2015 generated 4456 records. We examined the titles and the abstracts of these records to assess their potential relevance, and we subsequently retrieved 282 full texts for further examination as they appeared to be potentially eligible (62 articles), or because the title and abstract suggested that the record should be excluded but some key information had to be checked (220 articles). We did not identify any studies that met the eligibility criteria. We identified a total of 1061 records through searching trial registries (duplicates not eliminated), but we found no eligible trials. No additional references were identified after checking the abstracts of relevant conferences, or through personal contact with researchers in the field. See the study flow diagram (Figure 1), which follows the template described in the PRISMA statement (Liberati 2009).

Included studies
No eligible studies were found, neither completed nor ongoing, that could be included in this review.

Excluded studies
We excluded all the records after full-text assessment of eligibility. The reasons for their exclusion are summarised in the flow diagram (Figure 1). The Characteristics of excluded studies table lists the studies that we considered that a reader of the review might reasonably expect to find in the review, with at least one reason for each exclusion.

Risk of bias in included studies
No studies met the eligibility criteria, so we could not assess RoB.

Effects of interventions
We could not determine the effects of the use of gloves, gowns or masks as there were no eligible studies for this review, either completed or ongoing.

Discussion

Summary of main results
There were no eligible studies for this review, either completed or ongoing. Consequently, this systematic review could not determine the effects on MRSA transmission of wearing gloves, a gown or a mask for contact with MRSA hospitalised patients or with their immediate environment.

**Overall completeness and applicability of evidence**

**Completeness of the evidence**

We identified a large number of potential studies for consideration for the review, but none of them was eligible. The evidence is strikingly incomplete and the effectiveness of the use of gloves, a gown or a mask for hospitalised patients colonised or infected with MRSA remains uncertain. We were surprised by the lack of studies, as the topic area is not immature and the interventions evaluated are commonly used in practice, however, there may be a number of reasons that explain this absence of studies.

Firstly, we considered a narrow population. We specified that trial participants should be hospitalised patients colonised or infected with MRSA, that is, the population considered in both the intervention and control arms of studies must have MRSA. Thus we would have excluded certain studies that the reader might plausibly expect to see amongst the included studies. For example, we excluded those studies assessing the generalised use of gloves and gowns for all patients independent of their MRSA status (BUGG Study 2013), or those assessing the effectiveness of MRSA screening (MOSAR study 2014), as not all participants had MRSA at the time of being recruited.

Secondly, we attempted to disentangle the effects of three particular infection control interventions: gloves, gowns and masks. Therefore, we excluded studies which reported the effect of multiple interventions, which meant we could not elucidate the relative contribution of the review interventions. We expected this, as gloves, gowns and masks are rarely implemented alone in clinical practice (Zastrow 2011), but rather with other interventions as part of care bundles, such as MRSA screening, patient isolation or hand hygiene (usually as part of quality improvement initiatives).

Thirdly, the difficulties associated with the evaluation of complex and non-pharmacological interventions may explain also the scarcity of studies. Gloves, gowns and masks are usually implemented as part of ‘complex interventions’, that is, interventions with several interacting components. Complex interventions present a number of special problems for evaluators, in addition to the practical and methodological difficulties that any successful evaluation must overcome (MRC 2008). Moreover, the review interventions are non-pharmacological, so the evaluation presents additional methodological challenges, such as the difficulty of blinding participants and care providers, or the unfeasibility of implementing a sham intervention as a comparison group (Boutron 2005; Boutron 2012).

Fourthly, we restricted our review to the strongest feasible study designs given the particular circumstances of infection control studies. For example, we attempted to include only those studies with a prospective baseline assessment, a prospective allocation of the intervention, and a prospective outcome assessment (see Types of studies). Therefore, we excluded studies that used retrospectively gathered data, which are very common in the field of infection prevention. Moreover, we excluded uncontrolled before-and-after designs, which are very common as well, as the validity of their estimates is questionable (Shadish 2002; Cooper 2003; Stone 2007). These studies collect data on one group of participants before the introduction of the intervention and, then, further data after the intervention has been introduced; they finally present MRSA rates as averages in the pre- and post-intervention phases, and use conventional statistical approaches, such as the Chi² test (see Potential biases in the review process).

**Applicability of the evidence**

In the context of systematic reviews, applicability is the assessment of whether the findings of a review can be applied in a particular context or population (Burford 2013). We cannot assess applicability in this review as we identified no relevant evidence for consideration. However, if future updates include relevant evidence, the applicability of the review findings may be still limited due to the review eligibility criteria.

Firstly, we do not plan to attempt to investigate all relevant outcomes. In particular, we will not assess the harms associated with the use of gloves, gowns or masks. We acknowledge that a Cochrane review should assess the effects of one or more healthcare interventions on outcomes that are important to stakeholders, both intended and unintended (MECIR Conduct 2013). In fact, there are some concerns about the potential harms associated with the use of gloves, gowns or masks (see Why it is important to do this review). However, we consider that the lack of assessment of harms in this review is justified (see Potential biases in the review process).

Secondly, we attempted to disentangle the effectiveness of the use of gloves, gowns, or masks, however, these interventions are commonly used with other interventions. Nonetheless, determining the role of a particular infection control intervention is relevant, as it allows the most effective, safe, and cost-effective interventions to be identified, and provides evidence-based information to implement the minimum interventions needed to reduce transmission of micro-organisms in hospitals (Aboelela 2006). Moreover, quantifying the beneficial effects of the use of gloves, gowns and masks is a critical part of assessing the need for additional or alternative measures (such as MRSA screening) and the uncertainty in estimates of their effectiveness highlights the need for well-designed prospective intervention studies to evaluate their effects.
with greater precision.

Thirdly, we focus on the effects these barrier precautions have on a single pathogen, MRSA. This review addresses what is called a 'vertical program', in which specific organisms are targeted (for example, active MRSA surveillance plus contact isolation), compared with 'horizontal programs', that is, broad programs that attempt to reduce the rates of all infections due to all pathogens (for example universal contact precautions in high-risk settings; Wenzel 2010). At present there is great debate over whether vertical or horizontal approaches should be used to prevent HAIs (Wenzel 2010; AHRQ 2013). In particular, gloves, gowns and masks are not usually applied to prevent the transmission of just one microorganism, as target pathogens are MRSA, vancomycin-resistant Enterococcus (VRE) species, Clostridium difficile, and multidrug-resistant Gram-negative bacilli. This may limit the applicability of the review results, however, focusing on MRSA can be justified by the presence of differential methods for transmission of different bacteria (Siegel 2007), and by the results of some trials that suggest that infection control interventions may have differing effects on specific antibiotic-resistant bacteria (BUGG Study 2013; Climo 2013); for example, the use of gloves and gowns by healthcare workers for all patient contact in the intensive care unit reduced the acquisition of MRSA, but not of VRE (BUGG Study 2013). Fourthly we focus on the use of these barrier precautions in hospitals, but it is plausible that the effectiveness of these interventions varies in different types of services within the hospital (for example, medical ICUs may derive the most benefit from barrier precautions; Kypraios 2010), or in other settings, such as nursing homes (Lee 2013). This should be taken into consideration when trying to apply the results of this review to particular settings. It is noteworthy that another Cochrane review that assessed the effects of infection control strategies for preventing the transmission of MRSA in nursing homes for older people also concluded that there is a lack of research in this field (Hughes 2013). If future updates of this review identify any relevant studies we will follow the guidance of Burford 2013 and address applicability. In particular we will:

- conduct analyses to answer questions relevant for judging applicability (see Subgroup analysis and investigation of heterogeneity);
- collect, and report transparently, information that readers of systematic reviews can use to make judgments about applicability (e.g. population and intervention characteristics as well as characteristics of context and setting);
- appraise applicability for at least one primary target population, setting, and context, for example, future updates of this review will present a 'Summary of findings' table tailored to a specific population and setting, as suggested by the GRADE approach (Schünemann 2011).

Quality of the evidence

Since we identified no relevant studies for inclusion in this review, we are unable to comment on the quality of the evidence in this field.

Potential biases in the review process

Relevance of the review question for key stakeholders

This review did not assess the harms associated with the use of gloves, gowns or masks. This is a limitation as there are concerns about the unintended effects associated with the use of these interventions (see Why it is important to do this review). We did not assess harms for the following reasons:

- rigorous systematic review of harms requires applying methods different to those used for beneficial outcomes. This might require consideration of a variety of study designs (such as, cohort studies, case-control studies or even case reports), the checking of additional sources of information, and the design of highly sensitive searches, as well as assessment of the RoB of the included studies with specific tools (Loke 2011; Golder 2009);
- the participants would need to be defined more widely, for example, not restricted to those with demonstrated MRSA or who attended in the hospital setting.

We encourage the undertaking of a systematic review that will focus on the unintended effects of the use of gloves, gowns and masks, as providing the best available evidence for benefits and harms will make balanced information about the effects of these interventions available.

Study designs

We considered RCTs and some types of NRS as eligible, although the latter are more prone to bias. However, we consider that the inclusion of NRS is justified (see Types of studies), and we focused on certain NRS that allow the major threats to the validity of inferences drawn from studies of infection control interventions to be minimised. We excluded observational studies and outbreak reports, as well as other study designs. Outbreak reports, which are very common in the infection prevention field, are observational studies that describe a new phenomenon (such as, a new epidemic strain of MRSA) or the resources used to control an outbreak (Sanchez 2010); they are useful for generating hypotheses, but of limited value for assessing the effectiveness of interventions (Grimes 2002; Stone 2007). The experimental designs defined as eligible for this review minimise the biases usually present in infection control intervention studies including history, secular trends, seasonal effects and regression to the mean (Shadish 2002; Cooper 2003; Stone 2007; Bland 1994; Morton 2003).
Equity issues
In future updates of this review, if we consider that equity may be an issue, we will attempt to follow the guidance proposed by the Campbell & Cochrane Equity Methods Group (Equity Checklist 2012).

Search methods for identification of studies
The searches were as extensive as possible in order to reduce the risk of publication bias and to identify as much relevant evidence as possible. Searches were carefully designed using the expertise of healthcare librarians, and adapted to existing terminology.

Agreements and disagreements with other studies or reviews
As there are no included studies in this review we were unable to locate any evidence that could be compared with other studies. On the other hand, several systematic reviews have assessed the effectiveness of a variety of strategies for preventing the transmission of micro-organisms in the hospital setting (Aboelela 2006; Ranji 2007; Schlesinger 2009; Backman 2011; AHRQ 2013), some of them focusing on MRSA (Cooper 2003; Loveday 2006; Halcomb 2007; Glick 2013). However, these reviews did not assess the relative effect of gloves, gowns or masks when managing patients colonised or infected with MRSA.

AUTHORS’ CONCLUSIONS

Implications for practice
We found no studies assessing the effects of wearing gloves, gowns or masks for contact with MRSA hospitalised patients or with their immediate environment on the transmission of MRSA. Thus, we cannot conclude on the impact of these interventions in hospitalised patients (in terms of healthcare-associated MRSA colonisations, infections, bacteraemias, or pneumonias, or mortality attributable to MRSA), or in hospital staff, patients’ caregivers or visitors (in terms of healthcare-associated MRSA colonisations or prevalence of carriers of MRSA).

This absence of evidence of an effect for these interventions should not be interpreted as the evidence of no effect; it means that research that would have been eligible for inclusion in this review has not been conducted.

Implications for research
This is an ‘empty review’, that is, a review that reports no studies eligible for inclusion. This highlights the need for robust studies to determine the effectiveness of using gloves, a gown, and/or a mask for contact with MRSA hospitalised patients or with their immediate environment. A rigorous evaluation of this topic is relevant as it would allow:

- detection of the effects of these interventions that are impossible to predict with modelling or to disentangle from confounding in observational or non-randomised studies (Ioannidis 2013);
- identification of the most effective, safe, and cost-effective interventions, which will provide evidence-based information to implement the minimum level of interventions needed to reduce transmission of MRSA in hospitals (Aboelela 2006); and
- assessment of the incremental benefit of the addition of these interventions to other interventions (such as universal MRSA decolonisation; BUGG Study 2013; Calfee 2014).

On the basis of the evidence gap identified, this review highlights the need for randomised controlled trials to determine if the use of gloves, a gown, and/or a mask for contact with hospitalised patients colonised or infected with MRSA or with their immediate environment reduces the transmission of MRSA in hospitals. See Table 3 detailing the nature of the further research that would be most desirable according to the ‘Evidence-Population(s)-Intervention-Comparison-Outcomes-Time stamp’ (EPICOT) format (Brown 2006b).

The most robust method to determine if the use of gloves, gowns or masks prevents the transmission of MRSA in hospitals is the randomised controlled design (Ioannidis 2013; Safdar 2014). In particular, researchers should put more effort into conducting cluster-randomised controlled trials (cluster-RCTs) because they have a number of advantages compared to patient-randomised trials as listed below (Ioannidis 2013; Safdar 2014).

- They can be used to test interventions that are difficult to allocate at an individual level, such as the use of gloves, gowns or masks. In the last few years there has been an increase in cluster-RCTs for testing of interventions to prevent infection (Platt 2010; Ioannidis 2013; Safdar 2014).
- They may be less costly and time-consuming than ordinary randomised controlled trials (RCTs), as they can harness the healthcare system’s existing administrative capacities, including quality improvement programs and data collection systems. This simplifies the logistics of implementation and reduces study costs (Smith 2008; Platt 2010; Safdar 2014).
- They control for confounding (Safdar 2014).
- They minimise treatment “contamination” between intervention and control participants (Hayes 2000). In a controlled trial “contamination” is the inadvertent application of the intervention being evaluated to people in the control group;
or the inadvertent failure to apply the intervention to people assigned to the intervention group (Higgins 2005).

- They are better for measuring the overall group effect of an intervention (Hayes 2000).
- They are better for judging effectiveness (performance under conditions of actual use), as the interventions are applied at the hospital, practice, or health plan level, which is a better reflection of the way interventions are implemented in usual practice (Platt 2010; Safdar 2014).
- They have broader generalisability due to the following reasons (Platt 2010; Ioannidis 2013; Safdar 2014):
  - patient-randomised trials usually require more standardisation and level of care than occurs in practice;
  - cluster-RCTs minimise the Hawthorne effect, which is the effect (usually positive or beneficial) of being under study upon the persons being studied (Porta 2008);
  - if applied across a variety of healthcare facilities, cluster-RCTs enhance generalisability.

Future cluster-RCTs should be rigorous in design and delivery, with adequate reporting to enable appraisal and interpretation of results.

**Reporting**

Researchers should report the studies in a standardised, explicit, informative and transparent manner. In order to do so, the following guidelines should be followed, among others:

- CONSORT statement (CONsolidated Standards of Reporting Trials 2010; Schulz 2010)
- CONSORT extension for cluster randomised trials (Campbell 2012)
- CONSORT extension for non-pharmacological interventions (Boutron 2008)
- ORION Statement (Stone 2007): guidelines for transparent reporting of outbreak reports and intervention studies of nosocomial infections
- TIDieR checklist: template for intervention description and replication checklist (Hoffmann 2014)
- SQUIRE: Standards for Quality Improvement Reporting Excellence (Davidoff 2008)
- Reporting guideline for health equity concerns in randomised controlled trials (under development; Welch 2014).

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References to studies excluded from this review

Agbayani 1981 [published data only]

Alvarez-Lerma 2002 [published data only]

Assadian 2014 [published data only]

Batra 2010 [published data only]

Bearman 2007 [published data only]

Bearman 2010 [published data only]

Bertrand 2012 [published data only]

Bischoff 2007 [published data only]

Boyce 1998 [published data only]
Boyce JM, Chenever C. Isolation gowns prevent health care workers (HCWs) from contaminating their clothing, and possibly their hands, with methicillin-resistant Staphylococcus aureus (MRSA) and resistant enterococci. *Infection Control and Hospital Epidemiology* 1998;19(9):74.

BUgg Study 2013 [published data only]


Burden 2011 [published data only]

Camus 2011 [published data only]

Duquette-Petersen 1999 [published data only]
Ellingson 2011 [published data only]

Evans 2013 [published data only]

Eveillard 2001 [published data only]

Gandra 2014 [published data only]

Gilmore 1986 [published data only]

Gilroy 2009 [published data only]

Grant 2006 [published data only]

Ho 2012 [published data only]

Huang 2011 [published data only]

Jain 2011 [published data only]

Kappstein 2009 [published data only]

Kaufman 2014 [published data only]

Kirkland 2007 [published data only]

Klein 1989 [published data only]

Koss 2001 [published data only]

Lacey 2001 [published data only]

Maki 1996 [published data only]
Maki DG, Zilz MA, Mc Cormick R. The effectiveness of using preemptive barrier precautions routinely (protective isolation) in all high-risk patients to prevent nosocomial infection with resistant organisms, especially MRSA, VRE and C. difficile. *Clinical Infectious Diseases* 1996;23(4):43.

Mangini 2007 [published data only]
Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting (Review)

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**Marshall 2011** (published data only)


**Marshall 2013** (published data only)


**Matsumoto 2012** (published data only)


**Matsushima 2011** (published data only)


**Moore 2010** (published data only)


**Morioka 2013** (published data only)


**MOSAR study 2014** (published data only)


**Moylan 1987** (published data only)


**Muroya 2009** (published data only)


**Raad 1994** (published data only)


**Reitzel 2009** (published data only)


**Ribner 1986** (published data only)


**Rijnders 2003** (published data only)


**Rodríguez-Baño 2010** (published data only)


**Shenoy 2013** (published data only)

Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting

(Review)

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Slaughter 1996 (published data only)

Sloota 2001 (published data only)

Spence 2012 (published data only)

STAR ICU Trial 2011 (published data only)

Trick 2004 (published data only)

Trick 2007 (published data only)

Williams 2015 (published data only)

Yin 2013 (published data only)

Additional references
Aboelela 2006

AHRQ 2013

Albrich 2008

APIC 2010

Arnow 1982

Backman 2011

Baker 2010

Barrett 1968

Benner 1968

Bisaga 2008

Bland 1994
Brown 2006a

Brown 2008

Burford 2013

Burton 2009

Calfee 2014

Campbell 2012

CDC 2014

CEBM 2009

Chai 2005

Climo 2013
Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting

(Review)

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**EPOC 2007**


**EPOC 2009**


**EPOC 2013a**

Effective Practice, Organisation of Care (EPOC). EPOC Resources for review authors. What study designs should be included in an EPOC review and what should they be called? Oslo: Norwegian Knowledge Centre for the Health Services; 2013. Available from: http://epoc.oslo.cochrane.org/epoc-specific-resources-review-authors (accessed 7 June 2014).

**EPOC 2013b**


**EPOC 2013c**


**EPOC 2013d**


**Equity Checklist 2012**


Evans 2003


FDA 2008


FDA 2014a


FDA 2014b


Fridkin 2002


Fuller 2011


Gamble 2005


Garner 1996


Gastmeier 2004


Gaynes 1991

Glovess, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting

(Review)

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Gould 2004

Glick 2013

Goetghebeur 2007

Golder 2009

Gorwitz 2007

Gould 2006

Gould 2009

Grimes 2002

Grundmann 2006

Guyatt 2008

Hails 2003

Halcomb 2007

Hansen 2010

Harbarth 2008

Harris 2004

Hartling 2010

Hartman 1981

Hartstein 1995
Gloves, gowns and masks for reducing the transmission of methicillin-resistant Staphylococcus aureus (MRSA) in the hospital setting

(Review)

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Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting

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References

Johnson 1990

Johnston 2009

Kallen 2010

Karchmer 2002

Karki 2013

Kypraios 2010

Leclair 1987

Lee 2011

Lee 2013

Lefebvre 2011

Liberati 2009

Lin 2012

Lipp 2014

Livermore 2000

Loeb 2003

Looke 2011

Lovenday 2006

Lovenday 2014

Magill 2014

McKinell 2013
McKinell JA, Miller LG, Eells SJ, Cai E, Huang SS. A systematic literature review and meta-analysis of factors associated with meticillin-resistant Staphylococcus aureus colonization at time of hospital or intensive care unit admission. *Infection Control and Hospital Epidemiology: the*
Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting

Review

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MECIR Conduct 2013

Mehrotra 2013

Mertz 2000

MeSH Browser 2014

Mischke 2014

Morgan 2009

Morgan 2010

Morgan 2011

Morton 2003

MRC 2008

Muto 2003

NHMRC 2010

Noorani 2013

NRSMG 2011

NZMoH 2002

O’Connor 2011

Oie 1996

Olsen 1993
Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting

(Review)

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Pammi 2011
Pammi M, Eddama O, Weisman LE. Patient isolation measures for infants with candida colonization or infection for preventing or reducing transmission of candida in neonatal units. *Cochrane Database of Systematic Reviews* 2011, Issue 11. [DOI: 10.1002/ 14651858.CD006068.pub3]

Pan 2005

Peacock 1980

Perera 2007

Platt 2010

Pogorzelska 2012

Porta 2008

Public Health Agency of Canada 2012a

Public Health Agency of Canada 2012b

Puzniak 2002

Rammelkamp 1964

Ranji 2007

Reagan 1991

Reboli 1990

Reeves 2011

RevMan 2014 [Computer program]

Rodríguez-Baño 2006

Rutala 1983

Safdar 2008
Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting

(Review)

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Safdar 2014

Sanchez 2010

Santos 2008

Schlesinger 2009

Schulz 2010

Schünemann 2011

Seibert 2014

Selkon 1980

Shadish 2002

Sheretz 1996

Shiomori 2001

Siegel 2006

Siegel 2007

Sievert 2013

SIGN 2011

Smith 2008

Snyder 2008

Srinivasan 2007
Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting  

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WHO 2014

Williams 1963

Williams 1966

Wilson 2004

Wilson 2011

WIP 2012

Yap 2004

Zachary 2001

Zahar 2013

Zastrow 2011

Ziakas 2014

* Indicates the major publication for the study
### CHARACTERISTICS OF STUDIES

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

<table>
<thead>
<tr>
<th>Study</th>
<th>Reason for exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agbayani 1981</td>
<td><strong>Participants:</strong> the study considered the use of gloves, gowns or masks for patients with or without confirmed MRSA colonisation or infection</td>
</tr>
<tr>
<td>Alvarez-Lerma 2002</td>
<td><strong>Study design:</strong> the investigator did not allocate the intervention (not an experimental study)</td>
</tr>
<tr>
<td>Assadian 2014</td>
<td><strong>Participants:</strong> RCT that considered the use of gloves for patients with or without confirmed MRSA colonisation or infection</td>
</tr>
<tr>
<td>Batra 2010</td>
<td><strong>Comparison (ITS):</strong> not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients</td>
</tr>
<tr>
<td>Bearman 2007</td>
<td><strong>Study design:</strong> uncontrolled before-after study</td>
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<tr>
<td>Bearman 2010</td>
<td><strong>Study design:</strong> uncontrolled before-after study</td>
</tr>
<tr>
<td>Bertrand 2012</td>
<td><strong>Study design:</strong> ITS study in which the assessment of outcomes (in the pre- and post-intervention phases) and the administration of the intervention were done retrospectively</td>
</tr>
<tr>
<td>Bischoff 2007</td>
<td><strong>Study design:</strong> simulation study that investigated the impact of barrier precautions on the spread of airborne <em>S aureus</em> by volunteers with experimentally induced common cold</td>
</tr>
<tr>
<td>Boyce 1998</td>
<td><strong>Study design:</strong> uncontrolled before-after study</td>
</tr>
<tr>
<td>BUGG Study 2013</td>
<td><strong>Participants:</strong> cluster-RCT that considered the use of gloves, gowns or masks for patients with or without confirmed MRSA colonisation or infection. The study assessed whether wearing gloves and gowns for all patient contact in the ICU decreased acquisition of MRSA or VRE compared with usual care. Usual care consisted of healthcare workers using gloves and gowns for patients known to have infection or colonisation with antibiotic-resistant bacteria such as VRE and MRSA</td>
</tr>
<tr>
<td>Burden 2011</td>
<td><strong>Participants:</strong> RCT that considered the use of gloves, gowns or masks for patients with or without confirmed MRSA colonisation or infection</td>
</tr>
<tr>
<td>Camus 2011</td>
<td><strong>Comparison (RCT):</strong> not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients</td>
</tr>
<tr>
<td>Duquette-Petersen 1999</td>
<td><strong>Participants:</strong> RCT that considered the use of gloves, gowns or masks for patients with or without confirmed MRSA colonisation or infection. The study examined the protective benefit of using gown and shoe covers to prevent infection when caring for patients undergoing transplantation</td>
</tr>
<tr>
<td>Ellingson 2011</td>
<td><strong>Comparison:</strong> not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients</td>
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<tr>
<td>Study</td>
<td>Comparison/Study design</td>
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<tr>
<td>Evans 2013</td>
<td><strong>Comparison</strong>: not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients</td>
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<tr>
<td>Eveillard 2001</td>
<td><strong>Study design</strong>: the investigator did not allocate the intervention (not an experimental study)</td>
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<tr>
<td>Gandra 2014</td>
<td><strong>Study design</strong>: the investigator did not allocate the intervention (not an experimental study)</td>
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<tr>
<td>Gilmore 1986</td>
<td><strong>Study design</strong>: the investigator did not allocate the intervention (not an experimental study)</td>
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<tr>
<td>Gilroy 2009</td>
<td><strong>Study design</strong>: the investigator did not allocate the intervention (not an experimental study)</td>
</tr>
<tr>
<td>Grant 2006</td>
<td><strong>Comparison</strong>: not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients</td>
</tr>
<tr>
<td>Ho 2012</td>
<td><strong>Setting</strong>: cluster-RCT that did not consider hospital inpatients</td>
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<tr>
<td>Huang 2011</td>
<td><strong>Comparison (ITS)</strong>: not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients</td>
</tr>
<tr>
<td>Jain 2011</td>
<td><strong>Comparison</strong>: not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients. The study assessed the effects of a 'MRSA bundle' on healthcare-associated MRSA infections</td>
</tr>
<tr>
<td>Kappstein 2009</td>
<td><strong>Study design</strong>: the investigator did not allocate the intervention (not an experimental study)</td>
</tr>
<tr>
<td>Kaufman 2014</td>
<td><strong>Participants</strong>: RCT that considered the use of gloves for patients with or without confirmed MRSA colonisation or infection</td>
</tr>
<tr>
<td>Kirkland 2007</td>
<td><strong>Study design</strong>: the investigator did not allocate the intervention (not an experimental study)</td>
</tr>
<tr>
<td>Klein 1989</td>
<td><strong>Participants</strong>: quasi-RCT that considered the use of gloves, gowns or masks for patients with or without confirmed MRSA colonisation or infection. The study examined whether the use of gowns and gloves reduced nosocomial infections in children who required prolonged intensive care</td>
</tr>
<tr>
<td>Koss 2001</td>
<td><strong>Participants</strong>: RCT that considered the use of gloves, gowns or masks for patients with or without confirmed MRSA colonisation or infection. It compared contact isolation with standard 'universal precautions' when caring for intubated patients</td>
</tr>
<tr>
<td>Lacey 2001</td>
<td><strong>Study design</strong>: uncontrolled before-after study</td>
</tr>
<tr>
<td>Maki 1996</td>
<td><strong>Study design</strong>: the investigator did not allocate the intervention (not an experimental study)</td>
</tr>
<tr>
<td>Mangini 2007</td>
<td><strong>Study design</strong>: uncontrolled before-after study</td>
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<tr>
<td>Marshall 2011</td>
<td><strong>Comparison (ITS)</strong>: not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients</td>
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<tr>
<td>Study</td>
<td>Design/Comparison</td>
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<tr>
<td>Marshall 2013</td>
<td><strong>Comparison (ITS):</strong> not possible to separate out the effects of gloves, gowns or masks for contact with patients with MRSA. The study compared rapid PCR detection and use of long sleeved gowns and gloves (contact precautions) plus single room isolation or cohorting of MRSA colonised patients with a control group</td>
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<tr>
<td>Matsumoto 2012</td>
<td><strong>Study design:</strong> the investigator did not allocate the intervention (not an experimental study)</td>
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<tr>
<td>Matsushima 2011</td>
<td><strong>Comparison:</strong> not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients</td>
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<tr>
<td>Moore 2010</td>
<td><strong>Comparison:</strong> not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients</td>
</tr>
<tr>
<td>Morioka 2013</td>
<td><strong>Study design:</strong> uncontrolled before-after study assessing the effects of pre-emptive contact precautions for all transferred outborn neonates while awaiting the results of active surveillance cultures on admission</td>
</tr>
<tr>
<td>MOSAR study 2014</td>
<td><strong>Comparison (cluster-RCT):</strong> not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients. The study evaluated the impact of different MRSA screening methods, among other interventions</td>
</tr>
<tr>
<td>Moylan 1987</td>
<td><strong>Participants:</strong> the study considered the use of gloves, gowns or masks for patients with or without confirmed MRSA colonisation or infection. The study examined whether the wearing of a disposable gown and drape system by the surgical team reduce surgical wound infection</td>
</tr>
<tr>
<td>Muoya 2009</td>
<td><strong>Participants:</strong> considered the use of gloves, gowns or masks for patients with or without confirmed MRSA colonisation or infection</td>
</tr>
<tr>
<td>Raad 1994</td>
<td><strong>Participants:</strong> RCT that considered the use of gloves, gowns or masks for patients with or without confirmed MRSA colonisation or infection. It evaluated the effects of barrier precautions during catheter insertion in hospital outpatients</td>
</tr>
<tr>
<td>Reitzel 2009</td>
<td><strong>Study design:</strong> in vitro laboratory-based study that assessed the efficacy of gloves impregnated with anti-septic in preventing contamination on their outer surface</td>
</tr>
<tr>
<td>Ribner 1986</td>
<td><strong>Comparison:</strong> not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients</td>
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<tr>
<td>Rijnders 2003</td>
<td><strong>Participants:</strong> RCT that considered the use of gloves, gowns or masks for patients with or without confirmed MRSA colonisation or infection. It evaluated the effects of barrier precautions during catheter insertion</td>
</tr>
<tr>
<td>Rodríguez-Baño 2010</td>
<td><strong>Comparison (ITS):</strong> not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients</td>
</tr>
<tr>
<td>Shenoy 2013</td>
<td><strong>Comparison (RCT):</strong> not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients. The study compared two methods of MRSA screening for discontinuation of MRSA contact precautions</td>
</tr>
<tr>
<td>Study Year</td>
<td>Type</td>
</tr>
<tr>
<td>------------</td>
<td>------</td>
</tr>
<tr>
<td>Slaughter 1996</td>
<td>Participants: non-randomised clinical trial that considered the use of gloves, gowns or masks for patients with or without confirmed MRSA colonisation or infection</td>
</tr>
<tr>
<td>Slota 2001</td>
<td>Participants: RCT that considered the use of gloves, gowns or masks for patients with or without confirmed MRSA colonisation or infection. It evaluated whether strict handwashing, compared with protective gown and glove isolation, prevents nosocomial infections in children with transplants</td>
</tr>
<tr>
<td>Spence 2012</td>
<td>Study design: uncontrolled before-after study</td>
</tr>
<tr>
<td>STAR ICU Trial 2011</td>
<td>Comparison (cluster-RCT): not possible to separate out the effects of gloves, gowns or masks for contact with MRSA patients</td>
</tr>
<tr>
<td>Trick 2004</td>
<td>Setting: interventions applied in a long-term care facility (not in a hospital setting)</td>
</tr>
<tr>
<td>Trick 2007</td>
<td>Study design: the investigator did not allocate the intervention (not an experimental study)</td>
</tr>
<tr>
<td>Williams 2015</td>
<td>Participants: study that considered the use of gloves and gowns for patients with or without confirmed MRSA colonisation or infection</td>
</tr>
<tr>
<td>Yin 2013</td>
<td>Participants: retrospective cohort study that considered the use of gloves, gowns or masks for patients with or without confirmed MRSA colonisation or infection. It assessed the effects of wearing gloves for all patient contacts in paediatric units during the respiratory Syncytial virus season</td>
</tr>
</tbody>
</table>

**Abbreviations**
- ICU: intensive care unit
- ITS: interrupted time series
- MRSA: meticillin-resistant *Staphylococcus aureus*
- PCR: polymerase chain reaction
- RCT: randomised controlled trial
- VRE: vancomycin-resistant *Enterococcus*
### DATA AND ANALYSES

This review has no analyses.

### ADDITIONAL TABLES

Table 1. Study designs labels and features

<table>
<thead>
<tr>
<th>Features</th>
<th>Study design labels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RCT(^1)</td>
</tr>
<tr>
<td>Allocation unit</td>
<td>Individual</td>
</tr>
<tr>
<td>Minimum number of allocated units</td>
<td>NA</td>
</tr>
<tr>
<td>Method to assign allocation units to study arms</td>
<td>Random</td>
</tr>
<tr>
<td>Assessment of baseline and allocation to intervention</td>
<td>Prospective</td>
</tr>
<tr>
<td>Assessment of outcomes</td>
<td>Prospective</td>
</tr>
<tr>
<td>Data collection</td>
<td>NA</td>
</tr>
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</table>
Table 1. Study designs labels and features  (Continued)

<table>
<thead>
<tr>
<th>Choice of control group</th>
<th>NA</th>
<th>Study and control sites should be comparable with respect to setting of care (EPOC 2009)</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data points</td>
<td>NA</td>
<td>At least 3 data points before and 3 after the intervention (EPOC 2013a)</td>
<td>NA</td>
</tr>
<tr>
<td>Analysis</td>
<td>NA</td>
<td>Must not ignore secular (trend) changes. For example, a simple t-test of the pre versus post intervention periods must be avoided (EPOC 2013a)</td>
<td>NA</td>
</tr>
<tr>
<td>Other</td>
<td>NA</td>
<td>Clearly defined point in time when the intervention occurred (reported by the researchers) (EPOC 2013a)</td>
<td>NA</td>
</tr>
</tbody>
</table>

Abbreviations
- CBA: controlled before-and-after study
- CChBA: controlled cohort before-after study
- ClQ-RCT: cluster-QRCT
- Cl-NRCT: cluster-NRCT
- Cl-RCT: cluster-RCT
- CITS: controlled ITS
- ITS: interrupted time series study
- NA: not assessed
- NRCT: non-randomised controlled trial
- Q-RCT: quasi-RCT
- RCT: randomised controlled trial
- RMS: repeated measures study

1The stepped wedge design applied in RCT and CI-RCT was also eligible. In this design an intervention is rolled-out sequentially to all the trial participants (either as individuals or clusters of individuals) over a number of time periods. The order in which the different individuals or clusters receive the intervention is determined at random and, by the end of the allocation, all individuals or groups will have received the intervention. Stepped wedge designs incorporate data collection at each point where a new group (step) receives the intervention (Brown 2006a). This is a design increasingly used to assess the effectiveness of patient safety interventions (Brown 2008), as it is particularly relevant where it is predicted that the intervention will do more good than harm and/or where, for logistical, practical or financial reasons, it is impossible to deliver the intervention simultaneously to all participants (Brown 2006a; see Differences between protocol and review).

2RMS is an ITS study where measurements are made in the same individuals at each time point. This study design label is not detailed in the Cochrane Handbook of Systematic Reviews of Interventions (Reeves 2011), but it is suggested as eligible by the guidance of the EPOC group (EPOC 2013a).
In cluster studies with only one intervention or control site the intervention (or comparison) is completely confounded by study site, which makes it difficult to attribute any observed differences to the intervention rather than to other site-specific variable (EPOC 2013a).

4Not specified in the protocol of the review (see Differences between protocol and review). In order a study to be defined as ‘experimental’, the assessment of baseline, the allocation to intervention, and the assessment of outcomes should be done prospective.

5In infection control studies seasonality may be an issue, i.e. if January to June comprises the intervention group and July to December the control group, the ‘seasons’ could cause a spurious effect (Stone 2007).

6For ITS and RMS we will assess if the statistical approach has ignored secular (trend) changes. Analysis of aggregated data of the pre- and post-intervention phases should be avoided because it does not provide information about trends over time (Stone 2007). We excluded ITS studies or RMS without a parallel control group that had ignored secular changes by performing, for example, a simple t test of the pre- versus post-intervention periods (we considered these studies as uncontrolled before and after studies).

Table 2. Databases searched

<table>
<thead>
<tr>
<th>Database</th>
<th>Interface</th>
<th>Coverage</th>
<th>Date searched</th>
<th>Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cochrane Wounds Register</td>
<td></td>
<td></td>
<td>5 June 2015</td>
<td>94</td>
</tr>
<tr>
<td>Cochrane EPOC Register</td>
<td></td>
<td>As the EPOC register has not been updated since July 2013, we did not search this source since then</td>
<td>9 July 2013</td>
<td>54</td>
</tr>
<tr>
<td>Cochrane Infectious Diseases Register</td>
<td></td>
<td></td>
<td>5 January 2009</td>
<td>8</td>
</tr>
<tr>
<td>CENTRAL</td>
<td><em>The Cochrane Library</em></td>
<td>Issue 6 2015</td>
<td>5 June 2015</td>
<td>72</td>
</tr>
<tr>
<td>DARE; HTA; NHS EED; Methodology Register</td>
<td></td>
<td>Issue 6 2015</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEDLINE</td>
<td>Ovid</td>
<td>1946 to June Week 1 2015</td>
<td>5 June 2015</td>
<td>1430</td>
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<tr>
<td>MEDLINE (In-Process &amp; Other Non-Indexed Citations)</td>
<td>Ovid</td>
<td>1946 to June Week 1 2015</td>
<td>5 June 2015</td>
<td>105</td>
</tr>
<tr>
<td>EMBASE</td>
<td>Ovid</td>
<td>1974 to 4 June 2015</td>
<td>5 June 2015</td>
<td>1470</td>
</tr>
<tr>
<td>CINAHL</td>
<td>EBSCO</td>
<td>1982 to 5 June 2015</td>
<td>5 June 2014</td>
<td>684</td>
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Table 2. Databases searched (Continued)

<table>
<thead>
<tr>
<th>Database Type</th>
<th>Database Name</th>
<th>Search Dates</th>
<th>Last Updated</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>BNI</td>
<td>Ovid</td>
<td>1985 to 6 July 2010</td>
<td>6 July 2010</td>
<td>60</td>
</tr>
<tr>
<td>Dissertations &amp; Theses</td>
<td>ProQuest</td>
<td>1639 to 11 June 2015</td>
<td>11 June 2015</td>
<td>263</td>
</tr>
<tr>
<td>Total results</td>
<td></td>
<td></td>
<td></td>
<td>7191</td>
</tr>
<tr>
<td>Total results without duplicates</td>
<td></td>
<td></td>
<td></td>
<td>4456</td>
</tr>
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<td>Trials registers</td>
<td>ClinicalTrials.gov</td>
<td>6 June 2015</td>
<td></td>
<td>308</td>
</tr>
<tr>
<td></td>
<td>WHO International Clinical Trials Registry Platform</td>
<td>6 June 2015</td>
<td></td>
<td>624</td>
</tr>
<tr>
<td></td>
<td>International Standard Randomised Controlled Trial Number Register</td>
<td>31 July 2014</td>
<td></td>
<td>129</td>
</tr>
</tbody>
</table>

1 Searched 6/07/2010 as we did not have access to this database since then.
2 Searched 31/07/2014 as this service was under review in 2015 (http://www.isrctn.com/page/mrct)

Abbreviations
BNI: British Nursing Index
CENTRAL: The Cochrane Central Register of Controlled Trials
DARE: The Database of Abstracts of Reviews of Effects
EPOC: the Effective Practice and Organisation of Care (Group)
HTA: The Health Technology Assessment Database
NHS EED: The NHS Economic Evaluation Database
WHO: World Health Organization

Table 3. Research recommendation according to the 'Evidence-Population(s)-Intervention-Comparison-Outcomes-Time stamp' (EPICOT)

Does the use of gloves, a gown, and/or a mask for contact with hospitalised patients colonised or infected with MRSA or with their immediate environment reduce the transmission of MRSA in hospitals?

<table>
<thead>
<tr>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>This systematic review found no eligible studies for inclusion</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Population(s)</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitalised patients. The study may focus in one of the following populations.</td>
<td>Select the patient population according to the available infrastructure and hospital-specific characteristics (size, staffing for laboratory and nursing, patient population, MRSA prevalence, and information technology support;</td>
</tr>
<tr>
<td>● Patients in ICUs</td>
<td></td>
</tr>
<tr>
<td>● Patients in neonatal ICUs</td>
<td></td>
</tr>
<tr>
<td>● General medical inpatients</td>
<td></td>
</tr>
</tbody>
</table>

Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting (Review)
Copyright © 2015 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.
### Table 3. Research recommendation according to the 'Evidence-Population(s)-Intervention-Comparison-Outcomes-Time stamp' (EPICOT)  *(Continued)*

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Comparison</th>
<th>Outcomes <em>(Adapted from Noorani 2013)</em></th>
</tr>
</thead>
</table>
| Any infection control process considering the use of gloves, gowns and/or masks for contact with hospitalised patients colonised or infected with MRSA or with their immediate environment. Therefore, gloves, masks and gowns can be used in one of the following ways:  - On their own as a single intervention, for example, the use of gloves alone  - In a combination of gloves, gowns and masks, such as the use of gowns and gloves  - Combined with any other barrier precaution, such as the placement of MRSA patients in isolation units to be attended by staff using gowns, gloves and masks  - Combined with any other infection control intervention, such as the decolonisation of patients with MRSA | Any comparator, provided that it allows the effect of gloving, gowning or masking on MRSA transmission to be evaluated separately | Intermediate outcomes  - MRSA acquisition rate  - Mother-to-child transmission rate (for neonates only)  
**Health outcomes**  - MRSA infection rate  - Morbidity (e.g. complications of MRSA infection)  - MRSA-attributable mortality  - Total mortality  
**Harms, for example**  - Symptoms of depression  - Symptoms of anxiety  - Rate of falls  - Rate of pressure ulcers  
**Impact on clinical workflow, for example**  - Frequency of healthcare worker visits | **Outcomes** should be measured, collected and reported in an objective, reliable, accurate, and actionable way. This particularly applies to MRSA colonisation/infection outcomes, for which subjective elements in definitions and variations in the timing for the definition of 'hospital-associated' should be avoided *(Safdar 2014)*. Recognised standard definitions and criteria for all specific types of infections should be followed, such as those developed by the Centers for Disease Control and Prevention/National Healthcare Safety Network *(Cohen 2008; Calfee 2014; CDC 2014)*  
- If MRSA colonisations are evaluated, there should be an existing screening policy at admission that is applied |

- The study should be planned with few interventions to allow the relative contribution of the use of gloves, gowns or masks on outcome measures to be evaluated *(Zastrow 2011)*  
- The researchers should provide details of all the interventions and co-interventions undertaken, their compliance and their acceptability *(Stone 2007; MRC 2008)*  
- It is strongly recommended that phases are defined by a major change in specific infection control practices (with start and stop dates) and that a summary table with precise details of interventions, how and when were administered in each phase, is presented *(Stone 2007)*  
- The report of the study should avoid the use of terms that may not be universally understood, such as ‘contact precautions’ or ‘barrier nursing’ without a precise description of the interventions undertaken *(Stone 2007)*  
- In order to disentangle the effects of the use of gloves, gowns or masks on outcome measure, all the co-interventions must be similar in all the study groups |
Table 3. Research recommendation according to the 'Evidence-Population(s)-Intervention-Comparison-Outcomes-Time stamp' (EPICOT)  (Continued)

<table>
<thead>
<tr>
<th>Time stamp</th>
<th>Date of literature search: July 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study type</td>
<td>Cluster-randomised controlled trial</td>
</tr>
<tr>
<td></td>
<td>Trial that randomises groups (clusters) rather than individuals (see characteristics below)</td>
</tr>
<tr>
<td></td>
<td>• Blinding in studies of the effects of non-pharmacological interventions, such as gloves, gowns, or masks, is challenging. However, some suggestions about how to overcome this situation are described elsewhere (Brown 2008; Boutron 2008; Lin 2012). For example, assessment of study outcomes should be done through structured observation by external evaluators</td>
</tr>
<tr>
<td></td>
<td>• Another approach to limit detection</td>
</tr>
</tbody>
</table>

A P P E N D I C E S

Appendix 1. Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerosolised secretions</td>
<td>Microscopic particles (less than 5 µm in size) that are the residue of evaporated droplets and are produced when a person coughs, sneezes, shouts, or sings. These particles can remain suspended in the air for prolonged periods of time and can be carried on normal air currents (Siegel 2007)</td>
</tr>
<tr>
<td>Ambulatory care facility</td>
<td>Facility that administers health services to individuals who do not require hospitalisation or institutionalisation (MeSH Browser 2014)</td>
</tr>
<tr>
<td>Care bundle</td>
<td>“A collection of processes needed to effectively and safely care for patients undergoing particular treatments with inherent risks. Several interventions are bundled together and, when combined, significantly improve patient care outcomes” (IHI 2006)</td>
</tr>
<tr>
<td>Colonisation</td>
<td>The presence of micro-organisms (on skin, mucous membranes, in open wounds, or in excretions or secretions) that are not causing adverse clinical signs or symptoms (Garner 1996)</td>
</tr>
<tr>
<td>Controlled interrupted time series (CITS) study</td>
<td>Interrupted time series study with a parallel control group</td>
</tr>
<tr>
<td>Cluster non-randomised controlled trial (CJ-NRCT)</td>
<td>Type of non-randomised study in which the investigator prospectively allocates groups of participants to an intervention or to a control arm (or more) using a process that is clearly not random</td>
</tr>
<tr>
<td>Cluster-quasi-randomised controlled trial (CJQ-RCT)</td>
<td>Type of non-randomised study in which the investigator prospectively allocates groups of participants to an intervention or to a control arm (or more) using a process that attempts, but does not</td>
</tr>
<tr>
<td><strong>Cluster-RCT (CI-RCT)</strong></td>
<td>RCT in which the investigator prospectively allocates groups of participants (or clusters) to an intervention or to a control arm (or more than one control arm) using a process of random allocation (for example, random number generation or coin flips)</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Confidence interval (CI)</strong></td>
<td>A measure of the uncertainty around the main finding of a statistical analysis. Estimates of unknown quantities, such as the odds ratio comparing an experimental intervention with a control, are usually presented as a point estimate and a 95% confidence interval. This means that if someone were to keep repeating a study in other samples from the same population, 95% of the CIs from those studies would contain the true value of the unknown quantity. Alternatives to 95%, such as 90% and 99% CI, are sometimes used. Wider intervals indicate lower precision; narrow intervals, greater precision (Higgins 2005)</td>
</tr>
<tr>
<td><strong>Controlled before-and-after study (CBA)</strong></td>
<td>Type of non-randomised study in which the participants are allocated at the individual level to the study arms; those in the intervention arm receive an intervention and those in the control arm do not. The effect of the intervention is tested by comparison of the outcomes of participants within the same study arm before and after the intervention is introduced, and then, by comparing outcomes for participants in the control and intervention arms</td>
</tr>
<tr>
<td><strong>Controlled cohort before-after study (CChBA)</strong></td>
<td>Type of non-randomised study in which allocation to the study arms is at the cluster level. The clusters allocated to the intervention arm receive the intervention and those allocated to the control arm do not. The effect of the intervention is tested by assessment of outcomes within the same arm over time both before and after the intervention is introduced, and then, by comparing the control and intervention arms. Note that ‘cluster’ refers to an entity (e.g., an organisation), not necessarily to a group of participants, and ‘arm’ refers to one or more clusters (Reeves 2011). Here, the term ‘cohort’ designates the new sample of individuals that is drawn from each of the clusters at each measurement occasion (Shadish 2002)</td>
</tr>
<tr>
<td><strong>Droplets</strong></td>
<td>Solid or liquid particles suspended in the air, whose motion is governed principally by gravity and whose particle size is greater than 10 µm. Droplets are generated primarily as the result of an infected source coughing, sneezing or talking (Public Health Agency of Canada 2012b)</td>
</tr>
<tr>
<td><strong>Estimate of the effect</strong></td>
<td>The observed relationship between an intervention and an outcome expressed as, for example, a number needed to treat to benefit, odds ratio, risk difference, risk ratio, standardised mean difference, or weighted mean difference. Also called ‘treatment effect’</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Experimental study</td>
<td>Study in which an intervention is deliberately introduced by the researcher to observe its effects (Shadish 2002)</td>
</tr>
<tr>
<td>Gown</td>
<td>A impervious material worn to protect the wearer’s clothing from possible contamination with micro-organisms and exposure to blood, body fluids/secretions and excretions. The gown should be used only once, for one patient, and discarded or sent for laundering (WHO 2004)</td>
</tr>
<tr>
<td>Healthcare-associated colonisation (formerly nosocomial colonisation)</td>
<td>Colonisation that was not present at the time of admission to the hospital</td>
</tr>
<tr>
<td>Healthcare-associated infection (HAI; formerly nosocomial infection)</td>
<td>Infection that was not present or incubating at the time of admission to the healthcare facility. For most bacterial infections, this means that the infection usually becomes evident 48 hours or more after admission (the typical incubation period). However, because the incubation period varies with the type of pathogen, and to some extent with the patient’s underlying condition, each infection must be assessed individually (Garner 1996)</td>
</tr>
<tr>
<td>Healthcare-associated MRSA bacteraemia</td>
<td>Any MRSA bacteraemia identified more than 48 hours after admission to the setting (for example, ward) where the study is done</td>
</tr>
<tr>
<td>Healthcare-associated MRSA colonisations</td>
<td>MRSA colonisation of any site cultured, identified more than 48 hours after admission to the setting (for example, ward) where the study is done</td>
</tr>
<tr>
<td>Healthcare-associated MRSA infections</td>
<td>Any MRSA infection identified more than 48 hours after admission to the setting (for example, ward) where the study is done</td>
</tr>
<tr>
<td>Healthcare-associated MRSA pneumonia</td>
<td>Any MRSA pneumonia identified more than 48 hours after admission to the setting (for example, ward) where the study is done</td>
</tr>
<tr>
<td>Hospital</td>
<td>Institution with an organised medical staff which provides medical care to patients (MeSH Browser 2014)</td>
</tr>
<tr>
<td>Hospital outpatient clinic</td>
<td>Organised services in a hospital which provide medical care on an outpatient basis (MeSH Browser 2014)</td>
</tr>
<tr>
<td>Incidence</td>
<td>The number of new occurrences of events (for example, infections or colonisations) in a population over a particular period of time. Incidence of MRSA infection or colonisation usually is presented as number of MRSA infections or colonisations per 100 patients</td>
</tr>
<tr>
<td>Infection</td>
<td>Localised or systemic condition that results from an adverse reaction to the presence of an infectious agent(s) or it(s) toxin(s)</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
</tr>
<tr>
<td><strong>Interrupted time series (ITS) study</strong></td>
<td>A study that uses observations at multiple time points before and after an intervention (the ‘interruption’). The design attempts to detect whether the intervention has had a significantly greater effect than any underlying trend over time (EPOC 2013a).</td>
</tr>
<tr>
<td><strong>Intra-cluster correlation co-efficient</strong></td>
<td>The intra-cluster correlation coefficient is the proportion of the total variance of the outcome that can be explained by the variation between clusters (Campbell 2012).</td>
</tr>
<tr>
<td><strong>Isolation gown</strong></td>
<td>Gown, not sold as sterile product, usually intended to protect the wearer clothing/uniform from the transfer of micro-organisms and only small amounts of body fluids.</td>
</tr>
<tr>
<td><strong>Length of stay</strong></td>
<td>Number of days spent by a patient in a ward or hospital</td>
</tr>
<tr>
<td><strong>Mask</strong></td>
<td>A term that applies collectively to items used to cover the nose and mouth</td>
</tr>
<tr>
<td><strong>Medical gloves</strong></td>
<td>Disposable medical devices made of natural rubber latex or synthetic material that are intended to be worn on the hands to provide a barrier against potentially infectious materials and other contaminants. Medical gloves in general are used for tasks that do involve contact with patients or body fluids. They must be disposable and intended for simple patient use and then discarded. Medical gloves include patient examination gloves, surgical gloves (FDA 2008), or medical gloves for handling chemotherapy agents</td>
</tr>
<tr>
<td><strong>Non-randomised controlled trial (NRCT)</strong></td>
<td>Type of non-randomised study in which the investigator prospectively allocates each participant to an intervention or to a control group (or more) using a process that is clearly not random (for example, allocation by judgement of the clinician, or by preference of the participant).</td>
</tr>
<tr>
<td><strong>Observational study</strong></td>
<td>A study in which the investigators do not seek to intervene, and simply observe the course of events. Changes or differences in one characteristic (e.g. whether or not people received the intervention of interest) are studied in relation to changes or differences in other characteristic (e.g. whether or not they died), without action by the investigator. There is a greater risk of selection bias than in experimental studies (Higgins 2005).</td>
</tr>
<tr>
<td><strong>Outpatient</strong></td>
<td>Person who receives ambulatory care at an outpatient department or clinic without room and board being provided (MeSH Browser 2014).</td>
</tr>
</tbody>
</table>
### P value
The probability (ranging from zero to one) that the results observed in a study (or more extreme results) could have occurred by chance, if in reality the null hypothesis was true. In a meta-analysis, the P value for the overall effect assesses the overall statistical significance of the difference between the intervention groups, whilst the P value for the heterogeneity statistic assesses the statistical significance of differences between the effects observed in each study (Higgins 2005).

### Particulate respirators
A personal protective device worn by healthcare personnel to protect them from inhalation exposure to airborne infectious agents that are 5 µm in size or smaller. These include infectious droplet nuclei from patients (for example, *Mycobacterium tuberculosis*), and dust particles that contain infectious particles, such as spores of environmental fungi (for example, *Aspergillus* species). The N95 disposable particulate respirator is the type used most commonly by healthcare personnel (Siegel 2007).

### Patient examination gloves
A disposable device intended for medical purposes that is worn on the examiner’s hand or finger to prevent contamination between patient and examiner. They can be powdered internally (to make it easier to put them on) or be powder-free. They are not usually sold as sterile products (FDA 2014a).

### Procedure mask
Type of mask intended for use in general patient care situation.

### Quasi-randomised controlled trial (Q-RCT)
Type of non-randomised study in which the investigator prospectively allocates each participant to an intervention or to a control arm using a process that attempts, but does not achieve, true randomisation (for example, alternation of allocation, birth dates or week days).

### Randomised controlled trial (RCT)
Study in which the investigator prospectively allocates each participant to an intervention or to a control arm using a process of random allocation (for example, random number generation or coin flips).

### Rate
The number of new occurrences of events (for example, infections or colonisations) occurring per unit of time. Rate of MRSA infection or colonisation usually is presented as number of MRSA infections or colonisations per 1000 patients-days of hospital stay.

### Rehabilitation centre
Facility that provides programs for rehabilitating the mentally or physically disabled individuals (MeSH Browser 2014).

### Repeated measures study (RMS)
An interrupted time series study where measurements are made in the same individuals at each time point (EPOC 2013a).
### Residential facility
Long-term care facility which provides supervision and assistance in activities of daily living with medical and nursing services when required: assisted living facilities, group homes, halfway houses, homes for the aged, nursing homes or orphanages (MeSH Browser 2014)

### Routine practices
Measures that have been developed for use in the routine care of all patients at all times in all healthcare settings. Routine practices aim to minimise or prevent HAIs in all individuals in the healthcare setting including patients, healthcare workers, other staff, visitors, contractors, etc. (Public Health Agency of Canada 2012b)

### Surgeon’s gloves
A device made of natural or synthetic rubber intended to be worn by operating room personnel to protect a surgical wound from contamination (FDA 2014b)

### Surgical gown
Gown, usually packaged as sterile product or designed to be sterilised, made of fluid-resistant materials to reduce the transfer of body fluids. Some of them are disposable and others are made of fabric that is labelled as washable for multiple use

### Surgical mask
Type of mask worn by operating room personnel during surgical procedures to protect both surgical patients and operating room personnel from transfer of micro-organisms and body fluids

### Unit of analysis error
An error made in statistical analysis when the analysis does not take account of the unit of allocation. In some studies, the unit of allocation is not a person, but is instead a group of people, or parts of a person, such as eyes. Sometimes the data from these studies are analysed as if people had been allocated individually. Using individuals as the unit of analysis when groups of people are allocated can result in overly narrow confidence intervals. In meta-analysis, it can result in studies receiving more weight than is appropriate (Higgins 2005)

### Abbreviation
- CI: confidence interval
- MRSA: meticillin-resistant *Staphylococcus aureus*
Appendix 2. Additional search strategies

DARE, HTA, NHS EED, and the Methodology Register (The Cochrane Library 2015, Issue 6), searched 5 June 2015
We used the search string specified as having been used to search CENTRAL, in the Electronic searches section, for the DARE, HTA, NHS EED, and Methodology Register databases.

The Cochrane Wounds Group Specialised Register, searched 5 June 2015
((("Staphylococcus aureus" or "Staphylococcal Infections" or "aureus") near5 resistant*) or MRSA or "methicillin resistance" or "merticillin-resistant" or "meticillin resistant" or "meticillin-resistant" or "methicillin-resistant" or " meticillin-resistant" or "penicillin resistance" or "penicillin resistant" or "penicillin-resistant" or "merticillin-resistant" or "penicillin-resistant") and (glove* or gown* or mask* or barrier* or handwashing or "hand washing" or precaution* or isolation or "infection control" or "control measure" or "control measures" or "ward closure" or "cohort nursing" or "care bundling") AND (INREGISTER)

The Cochrane EPOC Group Specialised Register, searched 9 July 2013
((("Staphylococcus aureus" or "Staphylococcal Infections" or "s aureus") and resistant*) or MRSA or "Methicillin Resistance" or "Penicillin Resistance") and (barrier* or glove* or gown* or mask* or handwashing or "hand washing" or precaution* or isolation or "ward closure" or "cohort nursing" or "care bundling")

The Cochrane Infectious Diseases Group Specialised Register, searched 5 January 2009
((("Staphylococcus aureus" or "Staphylococcal Infections" or "s aureus") and resistant*) or MRSA or "Methicillin Resistance" or "Penicillin Resistance") and (barrier* or glove* or gown* or mask* or handwashing or "hand washing" or precaution* or isolation or "ward closure" or "cohort nursing" or "care bundling")

Ovid MEDLINE (1946 to June Week 1 2015), searched 5 June 2015
#1 exp Staphylococcus aureus/
#2 staphylococcus aureus.tw.
#3 exp Staphylococcal Infections/
#4 (staphylococ* adj2 infect*).tw.
#5 (staphylococc* adj2 (bacteremia or bacteraemia)).tw.
#6 or/1-5
#7 exp Penicillin Resistance/
#8 (penicillin adj2 resist*).tw.
#9 ((methicillin or meticillin) adj2 resist*).tw.
#10 (oxacillin* adj2 resist*).tw.
#11 multi-drug resistant*.tw.
#12 (antibiotic* adj2 resist*).tw.
#13 or/7-12
#14 6 and 13
#15 exp Methicillin-Resistant Staphylococcus aureus/
#16 (mrsa or emrsa or mdro).tw.
#17 or/14-16
#18 exp Protective Clothing/
#19 exp Masks/
#20 (glove* or gown* or apron* or mask*).tw.
#21 (barrier* or contact or universal or droplet or isolation or airborne) adj precaution*.tw.
#22 (contact or patient or ward* or unit*) adj2 isolation).tw.
#23 (isolated ward* or (ward adj2 clos*) or (clos* adj2 ward*)).tw.
Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting (Review)

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Web of Science Core Collection (Science Citation Index Expanded (SCI-EXPANDED) 1900 to 7 June 2015; Social Sciences Citation Index (SSCI) 1956 to 7 June 2015; Conference Proceedings Citation Index - Science (CPCI-S) 1990 to 7 June 2015); searched 7 June 2015

#1
TOPIC: (Methicillin-resistant Staphylococcus aureus) OR TOPIC: (mrsa) OR TOPIC: (emrsa) OR TOPIC: (mdro) OR TOPIC: ((staphylococcus aureus AND resistant))
Indexes=SCI-EXPANDED, SSCI, CPCI-S Timespan=All years

#2
TOPIC: (glove*) OR TOPIC: (gown*) OR TOPIC: (apron*) OR TOPIC: (mask*) OR TOPIC: (barrier*)
Indexes=SCI-EXPANDED, SSCI, CPCI-S Timespan=All years

#3
TS=(contact precaution*) OR TS=(universal precaution*) OR TS=(droplet precaution*) OR TS=(airborne precaution*) OR TS=(isolation precaution*) OR TS=(contact isolation) OR TS=(patient isolation) OR TS=(ward isolation OR ward isolated OR ward closure) OR TS=(unit isolation) OR TS=(cohort nursing) OR TS=(control measure)
Indexes=SCI-EXPANDED, SSCI, CPCI-S Timespan=All years

#4
#3 OR #2
Indexes=SCI-EXPANDED, SSCI, CPCI-S Timespan=All years

#5
#4 AND #1
Indexes=SCI-EXPANDED, SSCI, CPCI-S Timespan=All years

EBSCO CINAHL (1982 to 5 June 2015), searched 5 June 2015

S71 S56 OR S70
S70 S43 AND S69
S69 S57 or S58 or S59 or S60 or S61 or S62 or S63 or S64 or S65 or S66 or S67 or S68
S68 (MH "Quasi-Experimental Studies")

Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting (Review)
Copyright © 2015 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.
Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting

(Review)

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Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting (Review)

Ovid British Nursing Index (1985 to 6 July 2010), searched 6 July 2010

1 staphylococcus aureus.ti,ab.
2 (staphylococc* and Infectio*).ti,ab.
3 (staphylococc* and (bacteremia or bacteraemia)).ti,ab.
4 1 or 2 or 3
5 (methicillin* and resistan*).ti,ab.
6 (penicillin* and resistan*).ti,ab.
7 (oxacillin* and resistan*).ti,ab.
8 multi drug resistan*.mp.
9 antibiotic resistan*.mp.
10 5 or 6 or 7 or 8 or 9
11 4 and 10
12 mrsa.mp.
13 emrsa.mp.
14 mdro.mp.
15 11 or 12 or 13 or 14
16 glove*.ti,ab.
17 gown*.ti,ab.
18 apron*.ti,ab.
19 mask*.ti,ab.
20 barrier*.ti,ab.
21 contact precaution*.ti,ab.
22 universal precaution*.ti,ab.
23 droplet precaution*.ti,ab.
24 airborne precaution*.ti,ab.
25 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24
26 isolation precaution*.ti,ab.
27 contact isolation.ti,ab.
28 patient* isolation.ti,ab.
29 (ward* and isolation).ti,ab.
30 patient* isolated.ti,ab.
31 (ward* and isolated).ti,ab.
32 ward* closure.ti,ab.
33 unit isolation.ti,ab.
34 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33
35 cohort nursing.ti,ab.
Gloves, gowns and masks for reducing the transmission of meticillin-resistant Staphylococcus aureus (MRSA) in the hospital setting (Review)

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Appendix 3. List of potential confounders

1. Case mix
2. Length of stay
3. Seasonal effects
4. Strain type and properties of the organism
5. Numbers colonised on admission
6. Patient crowding/bed occupancy
7. Proportion of patients in isolation
8. Staffing levels
9. Staffing workloads
10. Hand-hygiene compliance
11. Handwashing agents used
12. MRSA clearance therapy (for studies considering MRSA)
13. Antibiotic consumption
14. Ward closures
15. Staff-patient contact patterns
16. Compliance with contact precautions
17. Processing of isolates
18. Screening practice or frequency
19. Colonisation pressure (the ratio of MRSA carrier-days to total patient-days)

Adapted from Cooper 2003 and Stone 2007 (no systematic review process was done to identify or select these factors).

Appendix 4. Risk of bias judgement criteria for non ITS studies

1. Random sequence generation (selection bias)

Selection bias (biased allocation to interventions) due to inadequate generation of a randomised sequence

Low risk of bias
The investigators describe a random component in the sequence generation process such as: referring to a random number table; using a computer random number generator; coin tossing; shuffling cards or envelopes; throwing dice; drawing of lots or minimisation (minimisation may be implemented without a random element, and this is considered to be equivalent to being random).

High risk of bias
Either of the following.
- The investigators describe a non-random component in the sequence generation process. Usually, the description would involve some systematic, non-random approach (often called ‘quasi-randomisation’), for example: sequence generated by odd or even date of birth; sequence generated by some rule based on date (or day) of admission; or sequence generated by some rule based on hospital or clinic record number.
• Other non-random approaches happen much less frequently than the systematic approaches mentioned above and tend to be obvious. They usually involve judgement or some method of non-random categorisation of participants, for example: allocation by judgement of the clinician; allocation by preference of the participant; allocation based on the results of a laboratory test or a series of tests; or allocation by availability of the intervention.

Non-randomised studies (including quasi-randomised) will be scored as being at 'high risk' for this domain.

Unclear risk of bias
Insufficient information about the sequence generation process is available to permit a judgement of 'low risk' or 'high risk'.

2. Allocation concealment (selection bias)

Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment.

Low risk of bias
Any of the following.
- Participants and investigators enrolling participants could not foresee assignment because one of the following, or an equivalent method, was used to conceal allocation: central allocation (including telephone, web-based and pharmacy-controlled randomisation); sequentially numbered drug containers of identical appearance; sequentially numbered, opaque, sealed envelopes.
- In cluster designs:
  - the unit of allocation was by institution, team or professional, and allocation was performed on all units at the start of the study (EPOC 2013c); and
  - the risk of recruitment bias is low:
    - recruitment of participants occurs prior to the point at which clusters are randomised; or
    - recruitment of participants occurs after clusters are randomised, but strategies to avoid recruitment bias have been put in place. For example, blinding participants or recruiters, or both to the cluster allocation.

High risk of bias
Either of the following.
- Participants or investigators enrolling participants could possibly foresee assignments and thus introduce selection bias, such as allocation based on: using an open random allocation schedule (e.g. a list of random numbers); assignment envelopes were used without appropriate safeguards (e.g. if envelopes were unsealed or non-opaque or not sequentially numbered); alternation or rotation; date of birth; case record number; or any other explicitly unconcealed procedure. Non-randomised studies (including quasi-randomised) will be scored as being at 'high risk' for this domain.
- In cluster designs, the risk of recruitment bias is high: recruitment of participants occurs after clusters are randomised with no strategies to avoid recruitment bias in place. In these instances, the allocation of the cluster is often known to the recruiter and may influence selection of participants for the trial and the application of any inclusion and exclusion criteria, thus negating the randomisation procedure (Brierley 2012).

Unclear risk of bias
Either of the following.
- Insufficient information available to permit a judgement of 'low risk' or 'high risk'. This is usually the case if the method of concealment is not described or not described in sufficient detail to allow a definite judgement - for example if the use of assignment envelopes is described, but it remains unclear whether envelopes were sequentially numbered, opaque and sealed.
- In cluster designs, the risk of recruitment bias is unclear (insufficient information available to permit a judgement of 'low risk' or 'high risk').
Recruitment bias is a type of selection bias. It occurs when the recruiter knows the allocation scheme, therefore this knowledge can influence selection of participants for the trial and the application of any inclusion and exclusion criteria, thus negating the randomisation procedure (Brierley 2012).

3. **Imbalance in baseline characteristics in terms of clusters or individuals (selection bias)**

This domain will be assessed for NRS or cluster randomised designs (not for RCTs with allocation at the individual level with an adequate sample size as we will assume that baseline imbalances in these designs are caused by chance). See Appendix 3 for the list of potential confounders to be considered.

**Low risk of bias**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>NRS with allocation at the individual level</th>
<th>RCT or NRS with allocation at the group level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individuals</td>
<td>● More than 80% of prognostic indicators (see Appendix 3) are reported and they are similar at baseline; or&lt;br&gt;● More than 80% of prognostic indicators (see Appendix 3) are reported and there are imbalances, but they are controlled for at the design or analysis stage of the study</td>
<td>● More than 80% of prognostic indicators (see Appendix 3) are reported and they are similar at baseline; or&lt;br&gt;● More than 80% of prognostic indicators (see Appendix 3) are reported and there are imbalances, but they are controlled for at the design or analysis stage of the study</td>
</tr>
<tr>
<td>Clusters</td>
<td>● Not applicable</td>
<td>● There are no relevant imbalances in the numbers of clusters allocated; or&lt;br&gt;● There are relevant imbalances in the numbers of clusters allocated, but they are controlled for at the analysis stage of the study</td>
</tr>
</tbody>
</table>

**High risk of bias**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>NRS with allocation at the individual level</th>
<th>RCT or NRS with allocation at the group level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individuals</td>
<td>● More than 20% of prognostic indicators (see Appendix 3) are imbalanced and were not controlled at the design or analysis stage of the study</td>
<td>● More than 20% of prognostic indicators (see Appendix 3) are imbalanced and were not controlled at the design or analysis stage of the study; or</td>
</tr>
<tr>
<td>Clusters</td>
<td>● Not applicable</td>
<td>● There are relevant imbalances in the numbers of clusters allocated that were not controlled for at the analysis stage of the study</td>
</tr>
</tbody>
</table>

**Unclear risk of bias**

Insufficient information available to permit a judgement of ‘low risk’ or ‘high risk’, for example, in NRS, less than 80% of the prognostic factors (Appendix 3) were reported.
4. Imbalance of baseline outcome measurement (assessments to be made per outcome or group of outcomes)

**Low risk of bias**

Either of the following.
- The outcome was measured prior to the intervention, and no important differences were present across study groups.
- The outcome was measured prior to the intervention, and it was imbalanced but appropriate adjusted analysis was performed (e.g. analysis of covariance).

**High risk of bias**

The outcome was measured prior to the intervention, and important differences were present and not adjusted for in analysis.

**Unclear risk of bias**

The baseline measure of the outcome was not reported (if RCTs have no baseline measure of outcome, score ‘unclear’).

Note: If scoring ‘high risk’ or ‘unclear risk’ but there are sufficient data in the paper to do an adjusted analysis (e.g. baseline adjustment analysis), the criteria should be scored as ‘low risk’.

5. Blinding of participants and personnel (performance bias)

Performance bias due to knowledge of the allocated interventions by participants and personnel during the study

**Low risk of bias**

Either of the following.
- Blinding of participants and key study personnel ensured, and unlikely that the blinding could have been broken.
- No blinding or incomplete blinding, but the review authors judge that the outcome is not likely to be influenced by lack of blinding.

**High risk of bias**

Either of the following.
- No blinding or incomplete blinding, and the outcome is likely to be influenced by lack of blinding.
- Blinding of key study participants and personnel attempted, but likely that the blinding could have been broken, and the outcome is likely to be influenced by lack of blinding.

**Unclear risk of bias**

Either of the following.
- Insufficient information available to permit a judgement of ‘low risk’ or ‘high risk’.
- The study did not address this outcome.

We decided that we would assess this domain for each study as whole, as we assumed that the lack of blinding of participants or healthcare providers would affect the actual results of all the review outcomes, with all of them being affected in a similar manner.
6. **Blinding of outcome assessment (detection bias; assessments to be made for each outcome (or class of outcomes))**

**Detection bias due to knowledge of the allocated interventions by outcome assessors**

**Low risk of bias**
Either of the following.
- Blinding of outcome assessment ensured, and unlikely that the blinding could have been broken.
- No blinding of outcome assessment, but the review authors judge that the outcome measurement is not likely to be influenced by lack of blinding.

**High risk of bias**
Either of the following.
- No blinding of outcome assessment, and the outcome measurement is likely to be influenced by lack of blinding.
- Blinding of outcome assessment, but likely that the blinding could have been broken, and the outcome measurement is likely to be influenced by lack of blinding.

**Unclear risk of bias**
Either of the following.
- Insufficient information available to permit a judgement of ‘low risk’ or ‘high risk’.
- The study did not address this outcome.

7. **Incomplete outcome data (attrition bias; assessments to be made for each outcome (or class of outcomes))**

**Attrition bias due to amount, nature or handling of incomplete outcome data**

**Low risk of bias**
Any of the following.
- No missing outcome data.
- Reasons for missing outcome data unlikely to be related to the true outcome (for survival data, censoring unlikely to be introducing bias).
- Missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups.
- For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk not enough to have a clinically relevant impact on the intervention effect estimate.
- For continuous outcome data, plausible effect size (difference in means or standardised difference in means) among missing outcomes not enough to have a clinically relevant impact on observed effect size.
- Missing data have been imputed using appropriate methods.

**High risk of bias**
Any of the following.
- Reason for missing outcome data likely to be related to true outcome, with either imbalance in numbers or reasons for missing data across intervention groups.
- For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk enough to induce clinically relevant bias in intervention effect estimate.
- For continuous outcome data, plausible effect size (difference in means or standardised difference in means) among missing outcomes enough to induce clinically relevant bias in observed effect size.
• ‘As-treated’ analysis done with substantial departure of the intervention received from that assigned at randomisation.
• Potentially inappropriate application of simple imputation.

Unclear risk of bias
Either of the following.
• Insufficient reporting of attrition/exclusions to permit judgement of ‘low risk’ or ‘high risk’ (e.g. number randomised not stated, no reasons for missing data provided).
• The study did not address this outcome.

Note: If scoring ‘unclear’ or ‘high’, but there are sufficient data in the paper to do an adjusted analysis (e.g. from ‘per protocol analysis to intention-to-treat analysis) the criteria should be scored as ‘low risk of bias’.
Note: in this domain loss of clusters in cluster-designs will be also assessed.

8. Selective reporting (reporting bias)

Reporting bias due to selective outcome reporting

Low risk of bias
Either of the following.
• The study protocol is available and all of the study’s pre-specified (primary and secondary) outcomes that are of interest in the review have been reported in the pre-specified way.
• The study protocol is not available but it is clear that the published reports include all expected outcomes, including those that were pre-specified (convincing text of this nature may be uncommon). For example, all relevant outcomes in the methods section are reported in the results section.

High risk of bias
Any of the following.
• Not all of the study's pre-specified primary outcomes have been reported.
• One or more primary outcomes is reported using measurements, analysis methods or subsets of the data (e.g. sub-scales) that were not pre-specified.
• One or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect).
• One or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis.
• The study report fails to include results for a key outcome that would be expected to have been reported for such a study.

Unclear risk of bias
Insufficient information available to permit a judgement of ‘low risk’ or ‘high risk’. It is likely that the majority of studies will fall into this category.

9. Protection against contamination
In a controlled trial, contamination refers to the inadvertent application of the intervention being evaluated to people in the control group; or the inadvertent failure to apply the intervention to people assigned to the intervention group (Higgins 2005). Cluster allocation usually reduces the likelihood of contamination.
Low risk of bias
Allocation was by group level (such as ward or hospital) and it is unlikely that the control group received the intervention, or that there was an inadvertent failure to apply the intervention to people assigned to the intervention group.

High risk of bias
It is likely that contamination occurred.

Unclear risk of bias
- Professionals were allocated within a clinic or practice but it is possible that communication between intervention and control professionals could have occurred (e.g. physicians within practices were allocated to intervention or control).
- Insufficient information available to permit a judgement of low or high risk of bias.

10. Timing of the assessment of the outcomes (Assessments to be made for each outcome (or class of outcomes))

Low risk of bias
The timing of the outcome assessment was similar in all groups.

High risk of bias
The timing of the outcome assessment was not similar in all groups: for example, studies with non-concurrent controls where seasonality is an issue (i.e. if January to June comprises the intervention group and July to December the control group, the 'seasons' could have caused a spurious effect).

Unclear risk of bias
Insufficient information available to permit a judgement.

11. Statistical methods taking the clustering into account (only for cluster designs)

Low risk of bias
The cluster-design was analysed by correct statistical methods, taking the clustering into account. Ways to avoid unit-of-analysis errors in cluster-designs include any of the following (see Cochrane Handbook for Systematic Reviews of Interventions 16.3.3, Higgins 2011b).
- The analysis is conducted at the same level as the allocation.
- The analysis is conducted at the level of the individual while accounting for the clustering in the data. Such an analysis might be based on a 'multilevel model', a 'variance components analysis' or a 'generalised estimating equations (GEEs)', among other techniques.

High risk of bias
The cluster-design was analysed by incorrect statistical methods, not taking the clustering into account. Such analyses tend to create a 'unit of analysis error' and produce over-precise results (the standard error of the estimated intervention effect is too small) and P values that are too small. Although they do not lead to biased estimates of effect, if they remain uncorrected, they will receive too much weight in a meta-analysis.
Unclear risk of bias
Insufficient information available to permit a judgement.

Appendix 5. Risk of bias judgement criteria for ITS studies

1. Was the intervention independent of other changes?

Low risk of bias
Either of the following.
- There are compelling arguments that the intervention occurred independently of other changes over time and the outcome was not influenced by other confounding variables/historic events during study period. If events/variables identified, note what they are.
- There is no evidence of seasonality being an issue; the study considers at least 12 monthly data points before and 12 monthly data points after the intervention.

High risk of bias
Either of the following.
- Reported that intervention was not independent of other changes in time.
- There is evidence of seasonality being an issue: the study does not consider at least 12 monthly data points before and 12 monthly data points after the intervention (for example, if January to June comprises the pre-intervention period and July to December the post, could the ‘seasons’ have caused a spurious effect).

Unclear risk of bias
Insufficient information available to permit a judgement of ‘low risk’ or ‘high risk.

2. Was the shape of the intervention effect pre-specified?

Low risk of bias
Point of analysis is the point of intervention or a rational explanation for the shape of intervention effect was given by the authors. Where appropriate, this should include an explanation if the point of analysis is not the point of intervention.

High risk of bias
It is clear that the condition above for low risk of bias is not met.

Unclear risk of bias
Insufficient information available to permit a judgement of ‘low risk’ or ‘high risk.

3. Was the intervention unlikely to affect data collection? (Assessments to be made for each outcome (or class of outcomes))

Low risk of bias
Reported that intervention itself was unlikely to affect data collection (for example, sources and methods of data collection were the same before and after the intervention).
High risk of bias
The intervention itself was likely to affect data collection (for example, any change in source or method of data collection reported).

Unclear risk of bias
Insufficient information available to permit a judgement of ‘low risk’ or ‘high risk’.

4. Blinding of outcome assessment (detection bias; assessments to be made for each outcome (or class of outcomes))

Low risk of bias
Either of the following.
- Blinding of outcome assessment ensured, and unlikely that the blinding could have been broken.
- No blinding of outcome assessment, but the review authors judge that the outcome measurement is not likely to be influenced by lack of blinding.

High risk of bias
Either of the following.
- No blinding of outcome assessment, and the outcome measurement is likely to be influenced by lack of blinding.
- Blinding of outcome assessment, but likely that the blinding could have been broken, and the outcome measurement is likely to be influenced by lack of blinding.

Unclear risk of bias
Either of the following.
- Insufficient information available to permit a judgement of ‘low risk’ or ‘high risk’.
- The study did not address this outcome.

5. Incomplete outcome data (attrition bias; assessments to be made for each outcome (or class of outcomes))

Low risk of bias
Missing outcome measures were unlikely to bias the results (e.g. the proportion of missing data was similar in the pre- and post-intervention periods or the proportion of missing data was less than the effect size i.e. unlikely to overturn the study result).

High risk of bias
Missing outcome data was likely to bias the results. Score ‘unclear’ if not specified in the paper (do not assume 100% follow-up unless stated explicitly).

Unclear risk of bias
Insufficient information available to permit a judgement of ‘low risk’ or ‘high risk’ (do not assume 100% follow-up unless stated explicitly).
6. Was the study free from selective outcome reporting? (reporting bias)

**Low risk of bias**
Either of the following.
- The study protocol is available and all of the study’s pre-specified (primary and secondary) outcomes that are of interest in the review have been reported in the pre-specified way.
- The study protocol is not available but it is clear that the published reports include all expected outcomes, including those that were pre-specified (convincing text of this nature may be uncommon). For example, all relevant outcomes in the methods section are reported in the results section.

**High risk of bias**
Any of the following.
- Not all of the study’s pre-specified primary outcomes have been reported.
- One or more primary outcomes are reported using measurements, analysis methods or subsets of the data (e.g. sub-scales) that were not pre-specified.
- One or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect).
- One or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis.
- The study report fails to include results for a key outcome that would be expected to have been reported for such a study.

**Unclear risk of bias**
Insufficient information available to permit a judgement of ‘low risk’ or ‘high risk’. It is likely that the majority of studies will fall into this category.

### Appendix 6. Grouping of outcomes for RoB assessment

<table>
<thead>
<tr>
<th>RoB domain</th>
<th>Assessment level</th>
<th>Factor for grouping the outcomes</th>
<th>Groups of outcomes</th>
<th>Entries in the RoB tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imbalance in baseline outcome measurements</td>
<td>Outcome</td>
<td>None</td>
<td>RoB assessed for each outcome</td>
<td>One for each outcome</td>
</tr>
</tbody>
</table>
| Blinding of outcome assessment                  | Outcome          | Susceptibility of the measurement to lack or incomplete blinding of outcome assessment | **a. Low susceptibility**
Judged by the review authors as not likely to be influenced by lack or incomplete of blinding | Blinding of outcome assessment (detection bias)
(Low susceptibility: MRSA to MSSA ratios; length of stay; antibiotic use; all cause mortality) |
|                                                 |                  |                                  | **b. High susceptibility**
Judged by the review authors as likely to be influenced by lack or incomplete of blinding | Blinding of outcome assessment (detection bias)
(High susceptibility: remaining outcomes not listed above) |
Was the intervention unlikely to affect data collection?

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Susceptibility of the data collection to be affected by the introduction of the intervention</th>
<th>Susceptibility data collection to the intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Low susceptibility</td>
<td>Judged by the review authors as not likely to be influenced by lack or incomplete of blinding</td>
<td>(Low susceptibility: MRSA to MSSA ratios; length of stay; antibiotic use; all cause mortality)</td>
</tr>
<tr>
<td>b. High susceptibility</td>
<td>Judged by the review authors as likely to be influenced by lack or incomplete of blinding</td>
<td>(High susceptibility: remaining outcomes not listed above)</td>
</tr>
</tbody>
</table>

Timing of the assessments of the outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
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</tr>
</thead>
<tbody>
<tr>
<td>RoB assessed for each outcome</td>
<td>One for each outcome</td>
</tr>
</tbody>
</table>

Incomplete outcome data

<table>
<thead>
<tr>
<th>Outcome</th>
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</tr>
</thead>
<tbody>
<tr>
<td>RoB assessed for each outcome</td>
<td>One for each outcome</td>
</tr>
</tbody>
</table>

**HISTORY**


Review first published: Issue 7, 2015

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Description</th>
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<tr>
<td>7 September 2010</td>
<td>Amended</td>
<td>Contact details updated.</td>
</tr>
<tr>
<td>3 August 2010</td>
<td>Amended</td>
<td>Contact details updated.</td>
</tr>
<tr>
<td>7 August 2009</td>
<td>Amended</td>
<td>Contact details updated.</td>
</tr>
<tr>
<td>11 November 2008</td>
<td>Amended</td>
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</tr>
<tr>
<td>9 May 2008</td>
<td>Amended</td>
<td>External source of support added</td>
</tr>
<tr>
<td>18 April 2008</td>
<td>Amended</td>
<td>Converted to new review format.</td>
</tr>
<tr>
<td>10 January 2008</td>
<td>New citation required and major changes</td>
<td>Substantive amendment</td>
</tr>
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</table>
CONTRIBUTIONS OF AUTHORS

Jesus López-Alcalde (JLA): conceived, designed and coordinated the review. Extracted data, checked the quality of the data extraction, and analysed and interpreted data. Wrote and edited the review. Advised on the review and approved the final review prior to submission. Secured funding. Wrote to study authors/experts/companies. Is the guarantor of the review.

Marta Mateos (MM): analysed and interpreted data. Performed part of writing and editing the review. Advised on the review and approved the final review prior to submission. Wrote to study authors/experts/companies.

Marcela Guevara (MG): analysed and interpreted data. Performed part of writing and editing the review. Advised on the review and approved the final review prior to submission. Wrote to study authors/experts/companies.

Lucieni Oliveira Conterno (LOC): analysed and interpreted data. Performed part of writing and editing the review. Advised on the review and approved the final review prior to submission. Wrote to study authors/experts/companies.

Iván Solà (IS): conceived and designed the review. Analysed and interpreted data. Performed part of writing and editing the review. Advised on the review and approved the final review prior to submission. Performed previous work that was the foundation of the current review.

Sheila Cabir (SC): extracted data, checked the quality of the data extraction, and analysed and interpreted data. Performed part of writing and editing the review. Advised on the review and approved the final review prior to submission. Performed translations.

Xavier Bonfill (XB): conceived, designed and coordinated the review. Analysed and interpreted data. Performed part of writing and editing the review. Advised on the review and approved the final review prior to submission. Secured funding and performed previous work that was the foundation of the current review.

Contributions of editorial base:

Nicky Cullum: edited the review, advised on methodology, interpretation and review content. Approved the final review prior to submission.

Sally Bell-Syer: coordinated the editorial process. Advised on methodology, interpretation and content. Edited the review.

Ruth Foxlee: designed the search strategy, Amanda Briant ran the searches.

DECLARATIONS OF INTEREST

JLA: in 2011 JLA was paid by Angelini for participating as a speaker in one session (1 hour) about evidence-based medicine (not related to the topic of this review)

MM: none known

MG: none known

LOC: none known

IS: none known

SC: none known

XB: none known
**SOURCES OF SUPPORT**

**Internal sources**
- Iberoamerican Cochrane Centre, Spain.
- Hospital Universitario de Guadalajara, Spain.

**External sources**
- Agencia de Calidad del Sistema Nacional de Salud (Ministerio de Sanidad, Política Social e Igualdad), Spain.
- Cochrane Wounds Group (The University of York), UK.

The Cochrane Wounds Group, which is funded by the NIHR (National Institute of Health Research, UK), provided financial support to Jesús López Alcalde in the form of accommodation and working space.
- Instituto Ciencias de la Salud (Castilla la Mancha), Spain.

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- This project was supported by the National Institute for Health Research, via Cochrane Infrastructure funding to Cochrane Wounds. The views and opinions expressed therein are those of the authors and do not necessarily reflect those of the Systematic Reviews Programme, NIHR, NHS or the Department of Health, UK.

**DIFFERENCES BETWEEN PROTOCOL AND REVIEW**

On occasion we followed different methods from those detailed in the protocol because we could not apply the methods we had laid out due to the absence of included studies, or because we found a preferable alternative. It is noteworthy that the review protocol was published in 2008; since then the Cochrane Handbook for Systematic Reviews of Interventions has been updated several times, and the Cochrane Editorial Unit also developed its ‘Methodological Expectations of Cochrane Intervention Reviews (MECIR)’ (MECIR Conduct 2013). Therefore, we incorporated changes that need to be implemented for future updates of the review. Below we detail the particular modifications made in each section.

**Review information**
- Francisco Job Neto retired from the review team, while Xavier Bonfill and Sheila Cabir joined.

**Objectives**
- The objectives reported in the protocol were “To determine whether the wearing of gloves, gowns and/or masks by any person in the hospital setting in contact with an inpatient colonised or infected with MRSA, reduces the transmission of MRSA in the hospital setting”. We decided to rephrase these objectives to make it explicit that we also aimed to assess the effects of the use of these barrier precautions in the immediate environment of the MRSA patient (this refers to entering the room of the MRSA patient without planning to establish any contact with him or her).
Criteria for considering studies for this review

Type of studies

- The protocol did not detail that we would include experimental designs only; it reported that RCT, Q-RCT, CBA, and ITS would be eligible, defined according to the EPOC Group criteria (EPOC 2007). However, the application of these criteria did not allow us to separate ‘outbreak reports’ and ‘observational studies’ from ‘experimental studies’. This distinction is key according to the Outbreak Reports and Intervention Studies OfNosocomial infection (ORION) statement, as ‘experimental studies’ are less prone to bias when assessing the effects of infection control interventions (Stone 2007). For this reason, we decided to assess explicit study design features to decide on the experimental character of the studies. In particular, we considered that the minimum requirements for a study to be defined as experimental would be a prospective assessment of baseline, a prospective allocation of the intervention and a prospective assessment of outcomes.

- The ‘study design labels’ used in this review (detailed in tables 13.2.2 and 13.2.b of the Cochrane Handbook for Systematic Reviews of Interventions (Reeves 2011)), were not the same than those used in the protocol. This is justified by the fact that this chapter of the Cochrane Handbook was not published at the time of writing the protocol.

- For deciding on study design eligibility, we considered the ‘study design features’ detailed in tables 13.2.2 and 13.2.b of the Cochrane Handbook (Reeves 2011). This was not planned in the protocol due to this chapter was not published at the time of writing the protocol. We judged that the approach proposed in chapter 13 is useful to decide on the inclusion of non-randomised studies, as the terminology and classification systems used for these study designs are inconsistent, which may lead to a low reliability when deciding on which studies to include (Hartling 2010).

- The protocol did not detail explicitly that the stepped wedge design in RCTs or CI-RCTs would be eligible trial types.

- The protocol did not report that in vitro laboratory-based studies would be excluded.

Type of participants

- The protocol defined a ‘participant’ as the person on whom the outcome was measured. However, the review defined ‘participant’ according to the CONSORT statement definition, that is, the study subject who is selected to take part in a trial (CONSORT glossary 2014).

Type of interventions

The protocol did not specify that we would consider:

- the use of gloves, gowns, aprons or masks for interactions with the patient’s environment as an eligible intervention.

- any comparator provided that it allowed the effect of gloving, gowning or masking on MRSA transmission to be separated out.

This criterion was found to be key during the selection process of the studies in order to increase the consistency of the decisions.

Types of outcomes measures

- We used the term ‘healthcare-associated’ instead of ‘nosocomial’ (used in the protocol) as it is more widely used (CDC 2014).

- The protocol did not state that we would not exclude any study solely because no outcomes of interest were reported.

- The protocol did not state that issues of equity and relevance of evidence to specific populations would be assessed.
Search methods for identification of studies

- Initially we searched the Cochrane Infectious Diseases Group Specialised Register (5 January 2009), but we decided not to continue searching this source as it did not contain relevant records.
- We searched the BNI only up to 6 July 2010 as we did not have access to this database after this date.
- The protocol stated that we planned to access MEDLINE via PubMed, but we accessed it via OVID.
- The protocol stated that we planned to combine the MEDLINE, EMBASE and CINAHL search strategies with validated methodological filters, however, we did not combine MEDLINE with any methodological filter, in order to gain sensitivity.
- For EMBASE and CINAHL we used the most recent filters available.
- We checked the abstracts from relevant conferences in the field, which we did not plan to do in the protocol.

Selection of studies

- The protocol did not report that we would not exclude studies solely on the basis of reporting of the outcome data, that we would complete a PRISMA flow chart, or our approach to multiple reports of the same included study.
- For the review JLA assessed the eligibility of all the references and full texts, while in the protocol he had been assigned to the first half of the titles and abstracts and full texts.

Data extraction and management

In the review we state that:

- we would have adapted the data extraction form to several relevant existing guidelines (Stone 2007; Boutron 2008; Schulz 2010; NRS MG 2011; Reeves 2011; Campbell 2012; EPOC 2013b; MECIR Conduct 2013; Hoffmann 2014), some of these were not available when the protocol was published.
- had any study been included, we would have created a graphical depiction of the experimental and control interventions using the Pat Plot tool (Perera 2007); this was not reported in the protocol.
- had we included a study with more than two intervention arms, the review would include only the intervention and control groups that met the eligibility criteria; this was not detailed in the protocol.
- we would have examined any relevant retraction statements and errata for relevant information regarding each included study; this was not reported in the protocol.
- although the protocol stated that there would always be dual data extraction, we decided that this would be the case at least for outcome data (and if possible for the remainder study characteristics).

Assessment of risk of bias in included studies

In the protocol we did not plan to:

- assess the RoB according to the domains proposed by the Cochrane Collaboration’s new RoB tool (Higgins 2011a), and the new Cochrane EPOC group guidance (EPOC 2013c), as they were not available at the time of its submission.
- to assess the RoB for each outcome (or class of similar outcomes).
- summarize the RoB for each outcome (or class of similar outcomes) in two different manners, that is, 'within each study' and 'across studies'.
- assess the 'blinding of participants and personnel' and 'blinding of outcome assessment' separately.
- assess the domain 'timing of the outcomes assessments'; we considered it vital to discard the presence of seasonal effects that could have influence on MRSA outcome data, for example, there may be a higher bed occupancy in winter months, which can generate changes in MRSA rates.
- assess inter-rater reliability for the key domains only.
- report the results of assessments of confounders in an additional table.
- justify judgements of RoB and provide this information in the RoB tables.
- incorporate the summary assessments of the RoB for each outcome across studies into explicit measures of the quality of evidence for each important outcome using the GRADE system.
- assess RoB of cluster designs, or provide details of how we would do it.
We stated in the protocol, “All the quality assessment criteria will be considered equally important in terms of their contribution to study validity”, however, we defined ‘key domains’ for the analysis.

**Measures of treatment effect**
- The protocol did not report this section, as it was not present in RevMan 4, but was introduced with RevMan 5.

**Unit of analysis issues**
- In the protocol we did not plan to re-analyse the results of the included studies with unit of analysis errors, however, due to the paucity of studies expected, we plan to do it for future updates of this review.
- In the protocol we did not plan to assess whether count data had been treated erroneously as dichotomous data in the included studies.
- In this section of the protocol we stated that we planned to examine whether the method of analysis of CBA studies accounted for eventual baseline differences of the outcomes, however, we planned to do this as part of the RoB assessment (‘imbalance in baseline characteristics (selection bias)’).
- In the protocol we did not cover issues relating to 'Sample size calculation', 'Outcome of interest is an event that may re-occur' and 'Additional analysis issues' in this section. We decided to add them, as they are relevant to the review topic.

**Dealing with missing data**
- In the protocol we did not state explicitly how we would deal with missing data. This section was added to the protocol.

**Assessment of heterogeneity**
- RevMan 4.2, the software used to construct the protocol, did not allow us to detail this information in an independent section. However, the information presented in this review was detailed according to the protocol plan, although in a more detailed manner.

**Assessment of reporting biases**
- In the protocol we did not state explicitly how we would deal with reporting biases (this section was not available in RevMan 4.2).

**Data synthesis**
The protocol stated that:
- we would use RevMan 4.2 but we used RevMan 5.3;
- we would meta-analyse RCTs and Q-RCTs only. However, due the low number of included studies expected for future review updates, if the meta-analysis is appropriate and the study design eligible, we will not exclude of the meta-analysis any included study based on its design;
- we would meta-analyse only those studies with a low RoB. However, due the low number of studies expected to be included in future updates of the review, we now plan to meta-analyse all the included studies regardless of their RoB. The impact of this decision will be assessed through sensitivity analysis.

The protocol did not state that the narrative analysis of the included studies would provide a descriptive presentation of the results, grouped by outcome.
Subgroup analysis and investigation of heterogeneity

- As we intend to meta-analyse NRS too, we plan to determine whether the adjustment of the estimates may be a potential factor for explaining heterogeneity.
- In the protocol we did not specify that "If sufficient studies had been available, we would have used a formal statistical test to compare the results of the subgroups. If subgroup analyses had been conducted, we would have followed the subgroup analysis plan specified in the protocol without undue emphasis on particular findings (MECIR Conduct 2013徭)."

Sensitivity analysis

- In the protocol we did not specify that sensitivity analysis would be restricted to the review's primary outcomes, or that the statistical model chosen for meta-analysis would be tested.
- We decided to modify the sensitivity analyses to be performed in future updates of the review in order to focus on key methodological aspects that would allow us to assess the robustness of results. We did not plan to perform the following sensitivity analyses in the protocol:
  - repeat the meta-analysis to assess the effect of including only studies that report nosocomial MRSA colonisation, infection, bacteraemia or pneumonia.
  - repeat the meta-analysis to assess the effect of including only RCT designs.
  - repeat the meta-analysis to assess the effect of including only CBA designs.
  - repeat the meta-analysis to assess the effect of including only ITS designs.

Appendix I: Glossary

We added some terms in the review.

INDEX TERMS

Medical Subject Headings (MeSH)

*Mask; *Methicillin-Resistant Staphylococcus aureus; *Protective Clothing; Cross Infection [prevention & control; *transmission]; Gloves, Protective; Staphylococcal Infections [prevention & control; *transmission]

MeSH check words

Female; Humans