Guidelines for the control and prevention of meticillin-resistant *Staphylococcus aureus* (MRSA) in healthcare facilities: joint Healthcare Infection Society (HIS) and Infection Prevention Society guidelines.

**Authorship – TBC**

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**Authors’ contribution:**

All authors except AB/GM and MS provided advice and contributed to writing; AB/HL/GM/MS/JW conducted searches and evidence syntheses.

*“NICE has accredited the process used by the Healthcare Infection Society to produce ‘Guidelines for the control and prevention of meticillin-resistant Staphylococcus aureus (MRSA) in healthcare facilities: joint Healthcare Infection Society (HIS) and Infection Prevention Society (IPS) guidelines’. The NICE accreditation of HIS methodology is valid for 5 years from March 2020. More information on accreditation can be viewed at* [*http://www.nice.org.uk/about/what-we-do/accreditation*](http://www.nice.org.uk/about/what-we-do/accreditation)*”*

# Executive summary

Methicillin-resistant *Staphylococcus aureus* (MRSA) infections remain a serious cause of healthcare-acquired infection in many countries. MRSA is easily spread by multiple routes and can persist in the environment for long periods. Infection prevention and control (IPC) measures and control of the use of antimicrobials are effective in reducing prevalence of MRSA. There have been many publications related to MRSA since the last guideline was published in 20061 and this update contains further measures that are clinically effective for preventing transmission when used by healthcare workers.

Methods for systematic review were in accordance with NICE-approved methodology and critical appraisal followed SIGN and other standard checklists. Articles published between 2004 and 2018 were included in the search but more recent studies were cited where expert consensus deemed necessary. Questions for review were derived from a stakeholder meeting, which included patient representatives in accordance with the Patient Intervention Comparison Outcome (PICO) process. Recommendations are made in the following areas: screening, management of colonised healthcare staff, environmental screening and cleaning, surveillance, infection control precautions, including isolation and movement of patients and equipment, and patient information. Antibiotic stewardship and treatment are covered in a separate publication.2

***Table I:*** *Summary of the changes to the recommendations from previous guidelines1*

Please see the separate document

# Lay summary

‘MRSA’ stands for methicillin-resistant Staphylococcus aureus, which is a type of bacteria that can cause infection. Infection with MRSA mainly occurs in people who are already ill and can occur wherever healthcare is given. This can be in hospital or in the community such as in residential or nursing care homes or in your own home. Treating MRSA is difficult because the bugs are resistant to some types of antibiotics (penicillins) that would often be used to fight MRSA. This means these types of antibiotics won’t work for MRSA infections.

The good news is that the number of MRSA infections in UK hospitals has fallen since 2008, but it does still remain a problem. This guideline is intended to help the doctors and other healthcare staff to try and prevent patients from getting MRSA and becoming ill. It may also be of use to patients who already have MRSA, those who care for them (relatives, care staff etc) and the general public, by helping them to understand which things work and which do not work to prevent MRSA in hospitals. The guideline contains explanation, scientific evidence and a glossary of terms to make it easy to read and use (Supplementary Materials A).

# Introduction

Infections due to methicillin-resistant *Staphylococcus aureus* (MRSA) decreased significantly in the UK and elsewhere but they continue to cause significant morbidity and mortality. Hence, control and prevention measures remain important.

There has been significant progress in recent years in managing MRSA in the healthcare settings. However, despite these advances the control of MRSA remains demanding, and should be based on the best available evidence, to ensure the appropriate use of healthcare resources. This document updates the recommendations for the control and prevention of MRSA in healthcare facilities.

A Joint Working Party of the Healthcare Infection Society and the Infection Prevention Society has updated previous guidelines and has prepared the following recommendations to provide advice on procedures and precautions needed to prevent the spread of MRSA. This includes recommendations on patient and staff screening, patient management, testing strategies, eradication/suppression of carriage, reduction of environmental contamination, surveillance, and feedback to minimize transmission and drive system improvement, and the information needs of patients and healthcare professionals.

The process used for the development of this updated version of the guidance was accredited by the National Institute for Health and Care Excellence (NICE). This is an important step in the evolution of the guidance and helps to ensure that users of the document can have confidence in the underlying basis for the recommendations made. Although the guidance is most relevant in the UK context, the recommendations will be relevant to healthcare settings in other countries and are based upon a systematic review of UK and the international literature.

# Guideline Development Team

## 4.1 Acknowledgements

APRW was supported, in part, by the National Institute for Health Research University College London Hospitals Biomedical Research Centre.

## 4.2 Source of funding

There was no external funding for this work.

## 4.3 Disclosure of potential conflict of interest

HH has been in receipt of research funding from Astella and Pfizer in recent years and has received a consultancy fee from Pfizer in the last three years.

APRW: Consultant on Drug Safety Monitoring Board for Roche, Advisory Board for Pfizer.

JRP received a consultancy fee from Imperial College London.

DAE received a consultancy fees and speaker fees from commercial organisations.

LB received consultancy fee from a commercial organisation.

All declarations of interest are available in Supplementary Materials B.

## 4.4 Relationship of authors with sponsor

The Healthcare Infection Society (HIS) and the Infection Prevention Society (IPS) commissioned the authors to undertake the Working Party Report. The authors are members of both societies.

## 4.5 Responsibility for guidelines

The views expressed in this publication are those of the authors and have been endorsed by HIS and IPS and following a four-week external consultation.

# Working Party Report

Date of publication: XXX (published online XXX).

## 5.1 What is the Working Party Report?

The report is a set of recommendations covering key aspects of prevention and control of MRSA in the healthcare settings. The guidelines review the evidence for screening, surveillance and management of the individuals who are found to be colonised or infected with MRSA. The treatment of MRSA infections is outside of scope of these guidelines.

## 5.2 Why do we need a Working Party Report for this topic?

The previous guidelines relating to this topic were published in 2006. MRSA is still an important nosocomial pathogen which can be controlled effectively by evidence-based infection prevention and quality improvement methods. However, there have been many publications on the subject since 2006 and new technologies have emerged. The effect of these studies on recommended practice needs to be reviewed.

## 5.3 What is the purpose of the Working Party Report’s recommendations?

The main purpose of these guidelines is to inform the IPC practitioners about the current UK policy and best available options for preventing and controlling MRSA. This document also highlights current gaps in knowledge, which will help to direct future areas of research.

## 5.4 What is the scope of the guidelines?

The main scope of the guidelines is to provide advice for the optimal provision of an effective and safe healthcare service while reducing the risk of MRSA transmission in healthcare settings. The guidelines are suitable for patients of all age groups. These guidelines were largely developed with hospitals in mind but may be useful in other settings where MRSA is a concern, e.g., long-stay units.

## 5.5 What is the evidence for these guidelines?

Topics for these guidelines were derived from stakeholder meeting including patient representatives and were designed in accordance with the Population Intervention Comparison Outcomes (PICO) process (Appendix 1). To prepare these recommendations, the working group collectively reviewed relevant evidence from peer-reviewed journals subject to validated appraisal. Methods, which were in accordance with National Institute for Health and Care Excellence (NICE) methodology for developing guidelines, are described fully below.

## 5.6 Who developed these guidelines?

The Working Group included infectious diseases/microbiology clinicians, IPC experts, systematic reviewers, and two patient representatives.

## 5.7 Who are these guidelines for?

Any healthcare practitioner may use these guidelines and adapt them for their use. It is anticipated that users will include clinical staff and, in particular, IPC teams.

## 5.8 How are the guidelines structured?

Each section comprises an introduction, a summary of the evidence with levels (known as evidence statements), and a recommendation graded according to the available evidence.

## 5.9 How frequently are the guidelines reviewed and updated?

The guidelines will be reviewed at least every four years and updated if change(s) are necessary or if new evidence emerges that requires a change in practice.

## 5.10 Aim

The primary aim of these guidelines was to assess the current evidence for all aspects relating to IPC of MRSA. A secondary aim was to identify those areas in particular need of further research to inform future MRSA guidelines.

# Implementation of these guidelines

## 6.1 How can these guidelines be used to improve clinical effectiveness?

Primarily, these guidelines will inform the development of local protocols for preventing MRSA transmission and managing patients colonised or infected with MRSA. They also provide a framework for clinical audit, which will aid in improving clinical effectiveness. In addition, the future research priorities identified by the working group will allow researchers to refine applications to funding bodies.

## 6.2 How much will it cost to implement these guidelines?

Provided that existing practice follows current recommendations, it is not expected that significant additional costs would be generated by the recommendations in this document. However, failure to follow best practice, for example, not screening in a population with high prevalence, would be expected to result in higher costs.

## 6.3 Summary of audit measures

Regular audit remains an important part of any guideline implementation. Audit is effective only when the results are fed back to staff and when there is a clear plan for implementation of improvements. Many NHS Trusts also require that the results of audits and interventions to help reduce MRSA burden are reported through Clinical Governance structures and to the Hospital IPC Committees. The MRSA Working Party suggests the following aspects of patient care to be audited:

* Compliance to screening protocol
* Compliance to decolonisation regimes
* Compliance to prescribed isolation precautions
* Cleaning standards
* Antimicrobial Stewardship (please refer to recent MRSA treatment guidelines2)
* Emergence of resistance, especially to mupirocin and chlorhexidine, if used extensively
* IPC practices e.g., hand hygiene, aseptic non touch technique
* Compliance with informing the receiving ward/unit/care home and the ambulance/ transport service that patient is colonised/infected with MRSA.

## 6.4 Supplementary tools

Lay materials and continuing professional development questions (CPD) are available in the Supplementary Materials (files C and D).

# Methodology

## 7.1 Evidence appraisal

Topics for these guidelines were derived from stakeholder meeting including patient representatives. To prepare these recommendations, the Working Party collectively reviewed relevant evidence from published, peer-reviewed journals. Methods were in accordance with NICE-approved methodology for developing guidelines (Supplementary Materials B).

## 7.2 Data sources and search strategy

Three electronic databases (Medline, CINAHL/EMCare and EMBASE) were searched for articles published between July 2004 and February 2021. The searches were restricted to English language studies, non-animal studies and non-in vitro studies. Search terms were constructed using relevant MeSH and free text terms (provided in appendices for each question cluster). Reference lists of identified systematic reviews, guidelines and included papers were scanned for additional studies. Search strategies and the results are available in Appendix 1.

## 7.3 Study eligibility and selection criteria

Search results were downloaded to Endnote database and screened for relevance. Two reviewers (MS, AM, AB, GM, JW or HL) independently reviewed the title and abstracts. Disagreements were addressed by a third reviewer. Two reviewers (MS, AM, AB, GM, JW or HL) independently reviewed full texts. If there were disagreements, these were first discussed between the two reviewers and if the consensus was not reached, a third reviewer was consulted. The guidelines included any controlled trials, cohort studies, interrupted time series studies, case control studies, diagnostic accuracy studies and controlled before/after studies. Due to a limited number of studies, uncontrolled before/after studies were included and described narratively. These were not used to make recommendations but were included to inform the Working Party of the additional evidence that existed. Similarly, data from mathematical model studies and excluded studies which provided additional evidence were included for each section but were not used when making recommendations. Results of study selection are available in Appendix 2.

## 7.4 Data extraction and quality assessment

Data collection and synthesis for these guidelines started before the NICE update for guideline methodology was published in 2018. Prior of this update, some studies were assessed using the quality assessment tools previously recommended. To ensure consistency, it was decided that the same checklists would be used for the remaining studies. For the type of studies where previous methodology did not recommend the specific checklists, they were assessed using the checklists recommended in the updated methodology. The quality checklists included:

* Controlled trials: The Scottish Intercollegiate Guidelines Network (SIGN) Methodology Checklist 2: Controlled Trials
* Cohort studies: SIGN Methodology Checklist 3: Cohort Studies
* Interrupted time series (ITS): Cochrane Effective Practice and Organisation of Care (EPOC) Risk of bias for interrupted time series studies
* Case-controlled studies: SIGN Methodology Checklist 4: Case-control studies
* Controlled before/after (CBA) studies: EPOC Risk of Bias (RoB) Tool (for studies with a control group)
* Uncontrolled before/after (UBA) studies: Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Quasi-Experimental Studies (non-randomized experimental studies)
* Diagnostic accuracy studies (DAS): SIGN Methodology Checklist 5: Studies of Diagnostic Accuracy

Studies were appraised independently by two reviewers (MS, AM, AB, GM, JW or HL) and any disagreements were resolved through discussion. Results of quality appraisal are available in Appendix 3.

Data were extracted by one reviewer and checked/corrected by another. For each question cluster the data from the included studies were extracted to create the tables of study description, data extraction and summary of findings tables (Appendix 4). The list of the studies rejected at full text stage with a reason for this decision, was included in the excluded study tables. Due to a limited evidence, most of the data were described narratively. Where meta-analysis was possible, this was conducted in Review Manager 5.3 software for systematic reviews. This software only allows the entry for dichotomous data; hence it was not suitable for meta-analysis for decolonisation where a range of different decolonisation therapies was used. For this, the analyses were calculated manually, with sample proportion and confidence intervals obtained using Wilson score interval (epitools.ausvet.com.au). For the therapies which showed a significant benefit, the risk ratios were calculated using MedCalc software (medcalc.net).

## 7.5 Rating of evidence and recommendations

For each outcome of the review question the certainty/confidence in the findings was established using considered judgment forms. The evidence was considered and judged using the following ratings: high, moderate, low, and very low, based on the characteristics of the studies included in evidence tables.

When writing recommendations, the Working Party considered the following:

* Who should act on these recommendations?
* What are the potential harms and benefits of the intervention and any unintended consequences?
* What is the efficacy and the effectiveness of each intervention?
* Is it possible to stop another intervention because it has been superseded by the new recommendation?
* What is the potential effect on health inequalities?
* What is the cost-effectiveness of the intervention, including staff resources other economic concerns?
* Can the recommended interventions be feasibly put into practice?

The wording of the evidence statements and the recommendations reflected the strength of the evidence and its classification. The following criteria were used:

* ‘offer’, ‘measure’, ‘advise’, ‘refer’, ‘use’ or similar wording was used if the Working Party believed that most practitioners/commissioners/service users would choose an intervention if they were presented with the same evidence; this usually means that the benefits outweigh harms, and that the intervention is cost-effective. This reflects a strong recommendation for the intervention. If there is a legal duty, or if not following a recommendation may have serious consequences, the word ‘must’ was used.
* ‘do not offer’ or similar wording was used if Working Party believed that harms outweigh the benefits or if an intervention is not likely to be cost-effective. This reflects a strong recommendation against the intervention. If there is a legal duty, or if not following a recommendation may have serious consequences, the word ‘must not’ was used.
* ‘consider’ was used if Working Party believed that the evidence did not support the strong recommendation, but that the intervention may be beneficial in some circumstances. This reflected a conditional recommendation for the intervention.
* ‘do not offer, unless…’ recommendation is made if Working Party believed that the evidence did not support the strong recommendation, and that the intervention was likely not to be beneficial, but could be used in some circumstances e.g., no other options were available. This reflected a conditional recommendation against the intervention.

## 7.6 Consultation process

Feedback on draft guidelines was received from the HIS Guideline Committee, and final changes made. These guidelines were then opened to consultation with relevant stakeholders (Supplementary Materials E - TBC). The draft report was available on the HIS website for four weeks. Views were invited on format, content, local applicability, patient acceptability, and recommendations. The working group reviewed stakeholder comments, and collectively agreed revisions.

# Rationale for recommendations

## 8.1 What is the clinical and cost effectiveness of universal vs targeted screening in minimising the transmission of MRSA?

While in certain instances screening is implemented for every patient entering the healthcare unit, it is not in the current UK NICE guidelines for healthcare facilities to implement universal screening. Screening is completed largely for some pre-operative patients or other high-risk patients, such as those entering the intensive care unit (ICU). Despite this, there is disagreement in the literature about the clinical effectiveness of targeted screening in preventing the transmission of MRSA. Moreover, there is also a debate about the cost-effectiveness of universal screening. The effectiveness of universal vs targeted screening was not assessed in previous MRSA guidelines,1 although the recommendation endorsed the use of targeted approach.

There was weak evidence of no benefit from one interrupted series study3 which investigated the incidence of MRSA acquisition in all patients, excluding new-borns, admitted to hospital with the use of universal screening (n=61,782) as compared to targeted screening (n=76,273). The study found no significant difference in the incidence of MRSA acquisition in patients screened universally (47.5/100,000) as compared to those when a targeted approach was in use (41.8/100,000; p=0.923).

There was weak evidence of no benefit from one interrupted series study3 and one controlled before-after study4 which investigated the incidence of MRSA infection in patients admitted to hospital with the use of universal screening as compared to targeted screening. One study3 of all patients, excluding new-borns, admitted to hospital found no significant difference in the incidence of MRSA bloodstream infection in patients screened universally (1.8/1000pd n=61,782), as compared to those when a targeted approach was in use (2.1/1000pd n=76,273; p value not reported). Another study4 of adult patients admitted to hospital for at least 24 hours with universal screening (n=61,782) compared to targeted screening (n=76,273) found that the rate of HCAI-MRSA did not reduce significantly (0.27% before vs 0.15% after the switch to universal screening), while the rate in the control hospital remained the same throughout the study period (0.10%, p=0.34).

There was weak evidence of no benefit from one controlled before-after study4 which investigated the cost saving from a reduced incidence of HCA-MRSA per each additional dollar spent on screening in adult patients admitted to hospital for at least 24 hours with the use of universal screening (n=3255) as compared to targeted screening (n=2037). The study found lower cost savings when screening patients universally ($0.50 saved) as compared to those when targeted approach was in use ($1.00 saved).

The Working Party considered the evidence and concluded that the universal screening strategy had no benefit over targeted screening. However, the clinical experience of the Working Party suggests that universal screening may be easier and more time-effective for the nursing staff as it removes the need to perform additional assessments to determine whether the patients require such screening. When a targeted approach is used, careful consideration is needed to establish which patients should be considered at risk and that local risk factors are taken into account. The Working Party also concluded that for screening to be effective, it needs to be linked to a specific action that either attempts to eradicate the MRSA in patient (decolonization) or minimizes contact with MRSA colonized patients (isolation).

**Recommendations:**

**1.1** Targeted or universal patient MRSA screening must be performed and must be linked to a specific point of action such as decolonization or isolation (or both).

**1.2** Use at least a targeted approach but consider using universal screening as appropriate depending on local facilities.

**1.3** If a targeted approach is used, define risk factors for MRSA carriage as appropriate for your area.

**Good Practice points**

**GPP 1.1** Establish local protocols for how swabs should be taken. The swabs should include a minimum of two sites and should include the following nose, perineum, device entry sites, wounds, urine, and sputum, as appropriate depending on clinical presentation.

## 8.2 What is the clinical and cost effectiveness of repeat screening people who screen negative/positive on pre-admission/admission to prevent the transmission of MRSA?

If patients screen negative at admission, repeat screening can identify whether they acquired MRSA during their stay, so that appropriate actions can be taken. On the other hand, for those who screen positive, repeated screen can show whether MRSA was successfully eradicated. However, it is currently unclear whether repeat MRSA screening is clinically and cost effective and how the repeat screen should be performed. Effectiveness of repeated screening was not assessed in previous MRSA guidelines1 and no recommendation was endorsed for its use.

No evidence was found from the studies published since 2004, meeting the inclusion criteria for the study design, which assessed the benefit of repeated screening for people who screen negative or positive on pre-admission/admission screening, to prevent the transmission of MRSA.

The Working Party considered the evidence from the excluded studies which reported some benefit of repeated screening and, together with the clinical experience of the group members, suggested that repeated screening could be beneficial in some circumstances.

**Recommendations**

**2.1** Do not perform repeat MRSA screening for patients who screen positive at admission unless the patient undergoes decolonization therapy.

**2.2** If the patient undergoes decolonization therapy, consider repeat MRSA screening 2-3 days following the therapy, to determine whether decolonization was successful or not. Do not delay a surgical procedure if patient still tests positive.

**2.3** Do not perform repeat MRSA screening routinely.

**2.4** Consider re-screening the patient if there is a significant MRSA exposure risk (e.g., contact of a confirmed MRSA case) or where there is a locally assessed risk of late acquisition.

## 8.3 What is the clinical and cost effectiveness of rapid molecular diagnostics vs culture in screening to prevent the transmission of MRSA in hospital and non-acute care settings?

During the screening process for MRSA at a hospital or healthcare setting, a swab is taken from the patient and is usually analysed in conventional culture-based assays. This may include enrichment in broth, the use of selective media or chromogenic agar. While this process is straightforward and is considered the gold-standard diagnostic method, the turnaround time (TAT) for results can be more than 48 hours. This delay may result in the patient or healthcare staff transmitting MRSA to others or acquiring MRSA. Moreover, whilst waiting for results and trying to prevent patients from potentially transmitting MRSA, healthcare workers may need to implement preventative measures such as isolating patients, which are costly. To receive rapid results, rapid diagnostic techniques such as the polymerase chain reaction (PCR) method have been used for screening samples to establish the presence of MRSA in the swab. These molecular techniques may require the use of commercial tests and as a result, they tend to be costlier than culture, although laboratories may also develop their own in-house methods. However, it is currently unknown whether molecular diagnostic techniques are beneficial in clinical practice in comparison to conventional culture methods, in terms of diagnostic accuracy, TAT, transmission rates and costs. Effectiveness of these methods of screening was not assessed in previous MRSA guidelines1 and no recommendation was endorsed for their use.

There was strong evidence of similar diagnostic accuracy from the meta-analysis of 61 studies5-65 which investigated the diagnostic accuracy of PCR vs culture screening (n=72,952 samples). The results of meta-analysis demonstrated that the overall sensitivity was 91.54% [CI95% 90.75-92.28], specificity was 97.00% [CI95% 96.86-97.12], positive predictive value was 70.03% [CI95% 69.11-70.94] and negative predictive value was 99.33% [CI 95% 99.27-99.39]. The overall accuracy of PCR compared to culture results was 96.61% [CI95% 96.47-96.74]. There were an additional nine studies, which were not included in meta-analysis, either because they did not provide data on the number of positive and negative values but reported sensitivity and specificity66-71 or were identified later in the review process.72-74 All these studies reported results similar to those obtained from meta-analysis.

There was strong evidence of no benefit from the meta-analysis of three RCTs and one non-randomised trial33,71,75,76 which investigated the incidence of MRSA colonisation when using PCR screening (n=16,773) vs culture (n=17,754). The results of meta-analysis showed that the incidence of colonisation did not decrease significantly in the PCR group (n=268, 1.51%) when compared to culture (n=324, 1.94%, OR 0.86 [95% CI 0.73-1.01]). These results are consistent with the results of studies which reported colonisation per 1000 patient days or 1000 patient days at risk, with one RCT75 reporting significantly lower incidence in the PCR group (2.86 vs 4.10/1000pd, p=0.002) while four other studies reported non-significant differences (0.39 vs 0.35/1000pd, p=0.39,77 4.4. vs 4.9/1000pd at risk, p= 0.27,33 2.57 vs 2.83/1000pd at risk, p=0.66,76 4.60 vs 5.39/1000pd at risk p value not reported71).

There was moderate evidence of no benefit from two RCTs33,76 which investigated the incidence of MRSA infection when using PCR screening vs culture. One study33 found no difference in MRSA bloodstream infection in the group of patients where PCR was used (1/3553, 0.03%) compared to patients where culture was used (2/3335, 0.06%, p value not reported) and no difference in MRSA wound (included but not limited to surgical wound) infection (21/3335, 0.6% in PCR vs 22/3553, 0.7% in culture, p=0.77). Another study76 found no significant difference in a rate of infection/1000pd in patients with PCR (5/1063, 4.06/1000pd) vs culture (2/1121, 1.57/1000pd, p=0.281).

There was strong evidence of benefit from 14 studies,10,15,27,33,38,42,45,53,59,62,71,75-77 which investigated the turnaround time (TAT) of PCR and culture. There was a high degree of heterogeneity as to how TAT was reported across these studies, but they consistently showed significantly decreased TAT for PCR samples. The studies showed that the time from patient admission to results being available for PCR was under 24 hours33,71,76 and just over 24 hours for admission until isolation,62,76 while results for culture using the same TAT were 40.4 hours or longer.33,62,71,76 Turnaround time defined as the time from the collection of the screening sample until results were available showed that these results could be available in less than two hours38 and are typically available under 24 hours for PCR.27,59,75 while the results of culture take at least 28 hours59 and may sometimes be more than two days.27,38,75 The studies which assessed TAT as arrival at the laboratory to results available15,27,42,45,53,62 reported the shortest time for PCR as 1.8 hours and average time as 8 hours while the shortest time for culture was 24 hours and average time longer than 40 hours.

There was strong evidence of no benefit from eight studies10,15,33,56,62,76-78 investigating the ---cost of PCR vs culture. One UK study15 reported that the cost of one screen is approximately 2.5 times more when using PCR than culture (£4.29 vs £1.71, total cost £14,328.60 vs £5711.40 for a total sample of 3340). Another study10 estimated this cost to be higher: $6.71 and $7.52 (approx. £5.17 and £5.79) for culture (negative and positive result, respectively) and $25.50 (approx. £19.60) for PCR. This study, besides the cost of materials necessary for screening, also considered the cost of staff required to process the samples (1.5-2min for culture and 5-9min for PCR per sample). Other studies also reported 4-5 times higher screening costs comparing to culture, although it is not possible to determine what was included in the estimation of the costs.56,78 Two studies did not provide data on the cost of culture but reported that screening with PCR required an additional €4.961 (approx. £4.27)76 and €56.22/€69.62 (approx. £48.45/£59.99)62 depending on an assay. Three studies reported33,62,78 a potential cost saving when screening with PCR. One of these studies78 of 232 participants reported that while the PCR screening cost itself was higher (additional CHF104,328.00, approx. £80,332.56 for universal screening and CHF11,988.00 approx. £9,230.76 for targeted screening), there is potential for reducing costs of pre-emptive isolation by CHF38,528.00, approx. £29,666.56. Hence, while the net cost of universal isolation was still higher (CHF91,509.00, approx. £70,461.93), the targeted screening reduced the net costs by CHF14,186.00 (approx. £10,923.22). Another study,62 also using targeted screening reported a reduction in the daily cost of isolation as €95.77 (approx. £73.74) and €125.43 (approx. £96.58) when using two PCR screening methods compared to culture. The last study,33 which used a universal screening approach reported that PCR screening reduced the number of inappropriately used isolation days from 399 to 277. While the authors did not provide the cost analysis, they suggested that there was a potential to counterbalance the cost of PCR screening with the benefit from reducing the number of isolation days. Lastly, one study77 reported that the total cost of screening with PCR was more expensive (CAN 3,656.92, approx. £2,281.92) than culture methods (CAN 2,937.06, approx. £1,832.73), although they did not provide any information on how this cost was estimated.

Further evidence came from uncontrolled before after studies, three of which reported a decrease in the incidence of MRSA acquisition when PCR screening was introduced,79-81 four in reducing TAT,11,79,81-83

There was strong evidence from a total of 45 studies,5,7-11,13,14,16,17,19,22-24,27,29-32,35,37-41,43,45,47-51,53,57,58-61,62,64,65,67,69,72,73,78,84 which reported the occurrence of PCR inhibition rates. This is important because sometimes these can be mistaken for negative results. Overall, the inhibition rate was 2.98% [CI 95% 2.80-3.17], although one study73 which used a Point-of-Care Testing device, reported the inhibition rates as high as 8.1%.

The Working Party considered the evidence and concluded that diagnostic accuracy of PCR is similar to culture and there is a benefit in obtaining results in a shorter time. However, these benefits do not translate into clinical benefit of reducing the incidence of MRSA acquisition or infection and PCR screening may incur higher cost.

**Recommendation:**

**3.1** Use either PCR or traditional culture methods for MRSA screening as you consider appropriate depending on the local facilities.

**Good practice point**

**GPP 3.1** If using PCR methods, maintain access to culture methodology for specific circumstances such as outbreak investigation or sensitivity testing, and to support molecular technologies.

## 8.4 What is the clinical and cost effectiveness of screening staff to prevent the transmission of MRSA?

Members of staff in healthcare settings are not routinely screened for MRSA. Usually, they will undergo screening if an MRSA outbreak persists, staff are suspected to be carriers or when the source of the outbreak is unclear. MRSA can be traced back to staff if the strain of MRSA is the same as in patients. Screening under these three circumstances is the most common approach to staff screening, but there are some who argue that screening should be expanded, although the clinical and cost effectiveness of this approach is not established. Our previous MRSA guidelines1 did not recommend routine screening of staff, but the Working Party considered that it could be valuable under certain circumstances (e.g., when transmission of MRSA continues despite implementing preventative measures and epidemiological data suggest staff carriage).

No evidence was found from the studies published since 2004 meeting the inclusion criteria for the study design, which assessed the benefit of performing staff screening on any patient related-outcomes.

There was weak evidence from one UBA study85 which assessed the benefit of performing staff screening on the prevalence of staff MRSA carriage. Authors reported that a total of 27/566 (4.77%) of the staff were colonised with MRSA at their first screening, while 14/445 (3.15%) of staff were colonised at least once at subsequent screenings. While it is not possible to directly compare the before/after prevalence (some staff were screened more than once at subsequent screenings), the authors reported that 9/201 (4.48%) staff were colonised in 2005 and the prevalence from 2006-2008 was 12/207 (5.80%), 11/237 (4.64%) and 7/186 (3.76%) respectively. This suggests that overall, the prevalence did not change. However, the authors also reported that for the staff who were screened more than once (n=221) and were given the decolonisation treatment following the positive screen, the colonisation rate dropped for this group from 5.88% to 2.71% (p=0.55) and the odds ratio of being colonised at second screen was 0.45 (confidence intervals not provided) comparing to the first screen. It is not possible to determine whether the staff were subsequently recolonised at the follow-up screenings.

The Working Party considered the evidence from the excluded studies, which did not meet the inclusion criteria for study design and reported no benefit in routine staff screening, and together with the clinical experience of the Working Party members, concluded that staff screening is not beneficial except in certain circumstances described above.

**Recommendations:**

**4.1** Do not routinely screen staff for MRSA.

**4.2** Consider screening staff for MRSA if there is an epidemiological reason for suspecting a staff member as a source of MRSA, e.g., if transmission continues on a unit despite active control measures, if epidemiological aspects of an outbreak are unusual, or if they suggest persistent MRSA carriage by staff.

**Good practice points**

**GPP 4.1** Screen staff at the beginning of the shift to avoid mistaking the transient carriage for persistent carriage. Appropriate sampling sites for staff screening include anterior nares and any areas of abnormal or broken skin.

**GPP 4.2** For staff who test positive, consider additionally screening throat, hairline, and groin/perineum as these if positive, increase the risk of shedding into the environment and transmission.

## 8.5 What approaches to the management of healthcare staff who are colonised with MRSA are most practical and effective at minimising the risk to patients?

If a member of staff tests positive for MRSA, the hospital is required to report the results and take proper measurements to ensure that the risk of acquisition, and potentially infection, is minimised among the patients. This includes sending staff home, reducing their interaction with patients or treatment with topical antimicrobials, however the cost-effectiveness and clinical benefit have not been established. Effectiveness of managing staff who screen positive for MRSA was not assessed in previous MRSA guidelines,1 although the Working Party recommended developing local protocols which assess the individual staff member’s risk of transmission to patients when agreeing their continuation or return to work. It was recommended that only staff members with colonized or infected hand lesions should be off work while receiving courses of eradication therapy, but this decision should be based on local risk assessments. To aid staffing resources, it was also recommended to temporarily re-allocate staff carriers temporarily to low-risk tasks or to non-patient contact activities. The management of staff with nasal carriage was not include in previous guidelines.

No evidence was found from the studies published since 2004 meeting the inclusion criteria for the study design, which assessed the management of staff who tested positive for MRSA carriage.

The Working Party considered previous recommendations from MRSA guidelines and, together with the clinical experience of the members, suggested that staff who are identified as MRSA positive may need a course of decolonisation therapy and sometimes may need to be excluded from clinical areas.

**Recommendations:**

**5.1** Consider excluding staff from work, reducing their interaction with patients, or offering decolonization therapy as deemed appropriate.

**5.2** Consider investigating the risk factors for staff MRSA carriage. Investigate staff members with persistent carriage in a multi-disciplinary setting to determine any associated factors.

**Good practice points**

**GPP 5.1** For staff members with nasal carriage only: offer decolonisation therapy, exclusion is not required. For staff with infected hand lesion/skin rash: offer decolonisation therapy AND re-deploy to low risk areas or exclude from work.

**GPP 5.2** Develop local policies to guide the decision when staff should be excluded from work and when they should return, taking into consideration the individual’s risk of transmission to patients (e.g., a staff member colonized with MRSA who is working in an ICU or neonatal unit represents a greater potential risk to patients than a staff member with MRSA working in an outpatients’ department).

## 8.6 What is the evidence that topical therapy is clinically and cost effective in minimising the transmission or eradication of MRSA? What is the evidence that the selected strategy for topical suppression results in resistance?

The most common topical suppression therapy offered to patients and staff is mupirocin. There is some disagreement in the literature over the clinical effectiveness of topical suppression in preventing MRSA colonisation. Moreover, there are risks that over-use of topical suppression therapies lead to resistance. This has led some healthcare facilities to implement non-suppression therapies such as putting patients in single rooms. Where that is not possible, patients may be offered topical suppression therapy, with or without chlorhexidine (CHG) bathing. There is a need to understand clearly the clinical and cost effectiveness as well as antimicrobial resistance risks of different suppression therapies compared to the best standard of care, including those from no suppression therapy. Previous MRSA guidelines1 recommended prophylactic use of mupirocin in conjunction with CHG for patients undergoing some operative procedures. This was also recommended in outbreak situations. Throat decolonisation with systemic therapy was recommended only on the advice of the consultant microbiologist and was recommended in conjunction with nasal and skin decolonisation therapy with mupirocin and CHG. Skin decolonisation was recommended for pre-operative patients who were found positive for the carriage of MRSA. Skin decolonisation with 4% CHG wash, 7.5% povidone iodine or 2% triclosan was recommended.

***Chlorhexidine***

There was strong evidence of benefit from twelve RCTs,86-98 four controlled trials,99-102 eleven ITS studies,103-113 two retrospective cohort studies114,115 and one controlled before-after study116 which investigated the effectiveness of CHG washing on the prevalence of MRSA colonisation, incidence of MRSA acquisition, incidence of MRSA infection and the eradication of MRSA. The results of the meta-analyses showed that suppression therapy with CHG, either alone or in combination with another agent (PVP, polysporin or mupirocin), was consistently better than comparison group (either no decolonisation or placebo) for all outcomes, except for incidence of MRSA acquisition when CHG was used alone. When CHG was used alone, the prevalence of MRSA was 2.1% in CHG group vs 25.5% in control group (p<0.001), the incidence of MRSA acquisition was 3.55% vs 3.04% (p<0.0001), the incidence of MRSA acquisition/1000pd was 2.35 vs 3.10, p=0051, incidence of infection was 1.11% vs 1.49%, p=0.0361 and the incidence of infection per 1000pd was 0.22 vs 0.46, p<0.0001. When CHG was used alone or in combination with another therapy (PVP or mupirocin), the prevalence of MRSA was 5.3% vs 25.5%, p<0.0001, the incidence of MRSA acquisition was 1.57% vs 3.04%, p<0.0001, the incidence of acquisition per 1000pd was 0.89 vs 3.10, the incidence of infection was 1.11% vs 1.49%, p=0.0361, the incidence of infection per 1000pd was 0.08 vs 0.46, p<0.0001 and the rate of MRSA eradication was 60.5% vs 34.5%, p<0.0001, thus showing that CHG performs better when used in combination with nasal suppression therapy. The results remained significant when stratified by different types of setting (e.g., surgical, ICU, general ward) or when using a selective (only for MRSA positive patients) or universal (blanket) approaches, although there was large heterogeneity in the reported results between the individual studies. Additional evidence from the studies which provided data not compatible for entry into metanalysis, did not show a significant benefit of using CHG. One small ITS,112 which used nasal mupirocin and 4% CHG wipes for patients colonised with MRSA in neonatal ITU did not report a significant decrease in the incidence of MRSA acquisition in the intervention period in comparison to pre-intervention (2.00 vs 2.38 events/1000pd, IRR=1.85 [CI 95% 0.80–1.73], p=NR). An RCT98 conducted in adult ICU patients with treatment group receiving daily 4% CHG wash and control group receiving daily soap and water wash reported no significant decrease in the incidence of MRSA HCAI (2/226, 0.9% or 1.08/1000pd vs 6/223, 2.7% or 3.80/1000pd, RR=0.33, [CI 95% 0.07-1.61], p=0.1704). Considering the small sample sizes, these two studies were likely underpowered, resulting in type I error. Further evidence came from eighteen UBA studies117-134 which used CHG either in combination or alone. These studies also showed heterogenous results with eleven studies reporting a benefit118,120-124,128,130-132,134 and seven reporting no significant change.117,119,125-127,129,133

There was inconsistent evidence from two RCTs86,95 which assessed the effectiveness of CHG mouth rinse on the presence of MRSA in the oral cavity in patients admitted to ICUs. One study reported no effect of CHG on the presence of MRSA in dental plaque,86 while another found a significantly lower prevalence of MRSA in both dental plaque (15.2 vs 37.3%, p=0.006) and oral mucosa (18.6 vs 39.7%, p= 0.011).95 The difference may be explained by the differences in CHG concentrations with 0.2% and 2% used respectively. A small study assessing the effectiveness of CHG on the incidence of MRSA acquisition in patients with a peritoneal catheter found a benefit, although the sample size was too small to show a significant effect.96

There was strong evidence from the meta-analysis of five studies97,102,105,108,132 and one narratively described cross-sectional study135 which investigated resistance to CHG. Meta-analysis showed a high proportion of isolates which were resistant to CHG in the group of patients with CHG bathing, although the rates were still high (27.7%) in the comparison group where CHG was not used. The use of CHG significantly increased the incidence of resistant isolates (OR 2.79 [CI 95% 1.81-4.26], p<0.0001). There were not enough data to establish whether a universal approach to decolonisation carried a higher risk of developing resistance. One cross-sectional study,135 which evaluated MRSA isolates obtained from the patients for resistance patterns, reported that those patients who were exposed to CHG were more likely to carry MRSA isolates with disinfectant resistance genes *qacA/B* and *qacC* than those who were not exposed (70.0% vs 43.4%, AOR=7.80 [CI 95% 3.25-18.71], p<0.001 and AOR=0.18 [CI 95% 0.04-0.94], p=0.04 respectively). Additionally, authors reported that a higher proportion of isolates obtained from patients previously exposed to CHG had a reduced susceptibility to CHG (MIC levels ≥4 mg/L) than the isolates from patients with no exposure history AOR=3.15, [CI 95% 1.14-8.74], p=0.03.

There was moderate evidence from fourteen studies,86,88-94,96,97,99,100,102,109,121 which reported adverse events associated with the use of CHG. These included rash,91,94,100 burning sensation,92,97 itching,92,94,97,100,109 redness,92,109 dryness,92 irritation,97 fissures97and other not specified skin reactions.90 Three studies reported allergy to CHG88/89,96,102 and two reported discontinuation of CHG due to adverse events.97,100 Another three studies reported adverse events, but did not specify what they were.86,93,99 Despite the many studies reporting adverse events, meta-analysis showed that the overall rate of occurrence was low (0.15%) and not significantly different than the rate reported for studies which did not use skin decolonisation therapy or used placebo (0.12%, OR 1.30 [95% 0.97-1.76], p=0.0811). However, the use of oral CHG was associated with a higher risk of adverse events (24% vs 0% in comparison group, OR 85.07 [95% CI 5.08-1424.00], p=0.0020) including burning sensation, unpleasant taste, dryness of the mouth and tenderness. These results are based on one study92 which reported the side effects when 2% CHG was used. Another study86 which used 0.2% CHG reported no adverse events.

No evidence was found from the studies published since 2004 meeting the inclusion criteria for the study design, which assessed the cost-effectiveness of CHG bathing.

***Mupirocin***

There was strong evidence of benefit from the meta-analyses of ten RCTs,88/89,91-94,96,136-139 two control trials,140,141 three ITS,104,105,111 and two retrospective cohort studies,115,142 which investigated the effectiveness of nasal mupirocin on prevalence of MRSA colonisation, incidence of MRSA acquisition, incidence of MRSA infection and eradication of MRSA. The results of the meta-analyses showed that mupirocin was not effective when used alone but was effective when used in combination with a skin decolonisation agent (e.g., CHG, triclosan or octenidine). When mupirocin was used alone, the prevalence of MRSA was 21.1% in mupirocin group vs 25.5% in control group (p=0.1636), the incidence of infection was 2.54% vs 1.49%, p=0.1100, and the eradication rate was 60.5% vs 34.5%, p<0.0001. When mupirocin was used alone or in combination with another therapy, the prevalence of MRSA was 15.5% vs 25.5%, p=0.0001, the incidence of MRSA acquisition was 1.12% vs 3.04%, p<0.0001, the incidence of acquisition per 1000pd was 0.62 vs 3.10, p<0.0001, the incidence of infection was 0.20% vs 1.49%, p<0.001, the incidence of infection per 1000pd was 0.02 vs 0.46, p<0.0001 and the rate of MRSA eradication was 63.2% vs 34.5%, p<0.0001. It is noteworthy that two studies included a follow-up period (one month or longer) after successful decolonisation and reported that in a large proportion of patients, MRSA was redetected at follow-up.93,97 Both studies used mupirocin in combination with CHG, but this finding needs to be considered as a possible outcome for other protocols such as mupirocin alone or in combination with other agents. There was additional evidence from one small ITS,112 which used nasal mupirocin and 4% CHG wipes for patients colonised with MRSA in a neonatal ITU and did not report a significant decrease in the incidence of MRSA acquisition in the intervention period in comparison to pre-intervention (2.00 vs 2.38 events/1000pd, IRR=1.85 [CI 95% 0.80–1.73], p=NR). This study had a small sample size; thus, it was likely to be underpowered and at risk of type I error. Further evidence was obtained from thirteen UBA studies,119,121,122,123,124,126,130-132,134,143-146 which found similar results. Introduction of mupirocin itself was beneficial in one study144 and not significantly reduced in another.145 Application of mupirocin in combination with skin decolonisation agent was beneficial in eight studies122,123,124,130-132,134,143 while three studies119,126,146 reported no significant benefit.

There was strong evidence of no relationship between mupirocin use and resistance from eight studies.92,93,97,105,132,138,141,147 Meta-analysis showed that the prevalence was slightly higher in the group where mupirocin alone was used as compared to the no mupirocin group (13.27% vs 11.18%), although the difference was not significant (OR 1.21 [CI 95% 0.64-2.29]).

There was moderate evidence from twelve studies,88/89,92-94,111,126,131,137,139,142 which reported adverse events associated with the use of mupirocin. The studies reported discomfort,88/89 burning sensation,92 itching,92 dryness,92 rhinorrhoea,94 nasal irritation,94 nose bleeds,139 headaches,94 congestion,94 cough,94 pharyngeal pain94 and unspecified adverse events.92,93,111,126,131,137,138,142 Two studies reported that treatment had to be discontinued due to adverse events associated with mupirocin use in some patients94,138 and one study reported that 38% of the patients considered the treatment to be unpleasant, regardless of whether they experienced adverse events.94 The results of meta-analysis showed that the use of mupirocin was associated with an over six times higher risk of experiencing adverse events when compared to a group that used no decolonisation or placebo (RR 6.44 [95% CI 4.85-8.54], p<0.0001). However, when comparing to nasal placebo only, the incidence of adverse events with mupirocin was significantly lower (RR 0.30 [95% CI 0.16-0.57], p=0.0002).

No evidence was found from the studies published since 2004 meeting the inclusion criteria for the study design, which assessed the cost-effectiveness of mupirocin.

***Octenidine***

There was moderate evidence of benefit from one ITS,104 one controlled trial148 and one controlled before after study101 which investigated the effectiveness of skin decolonisation with octenidine on the incidence of MRSA acquisition and the incidence of MRSA infection. The results of the meta-analyses showed that octenidine alone or in combination with nasal decolonisation agent was more effective when compared to no decolonisation or placebo. For octenidine alone, the incidence of MRSA acquisition was 2.96% in the octenidine group vs 3.04% in the control group (p=0.7361), the incidence of infection was 0.81% vs 1.49%, p=0.001. When octenidine was used in combination with a nasal decolonisation agent, the incidence of MRSA acquisition/1000pd was 0.19 vs 3.10, p<0.001, and the incidence of infection per 1000pd was 0.01 vs 0.46, p<0.0001.

There was weak evidence of benefit from one controlled before after study101 and one ITS113 which investigated the effectiveness of nasal decolonisation with octenidine gel in combination with either CHG101,113or octenidine wash.101 The controlled before and after study101 reported that octenidine gel significantly reduced the MRSA prevalence rates as compared to the MRSA before decolonisation was in place (19.3% vs 38.5%, p=0.007 and 34.4% vs 48.1%, p=0.001 for octenidine wash and CHG wash, respectively) while the prevalence on the control ward where no decolonisation was in place remained the same (38.9% vs 43.4%, p=0.554). Another study,113 conducted in extended care facilities for stroke and trauma patients reported that the incidence of MRSA acquisition decreased from 4.4 to 7.0 events per 1000pd (p<0.0001).

There was weak evidence of resistance from one cross-sectional study,135 which evaluated MRSA isolates obtained from patients. The study reported that those patients who were exposed to octenidine were more likely to carry MRSA isolates with disinfectant resistance genes *qacA/B* than those who were not exposed (AOR=11.79, [CI 95% 5.14-27.04], p<0.001) but not more likely to carry the isolates with the *qacC* genes (AOR=0.55 [CI 95% 0.23-1.31], p=0.18). Authors also reported that a higher proportion of isolates obtained from patients previously exposed to octenidine had reduced susceptibility to octenidine (MIC levels ≥2 mg/L) than the isolates from patients with no exposure history AOR=0.27, [0.08-0.95], p<0.01.

There was moderate evidence from two studies101,148 which reported adverse events associated with the use of octenidine. One study which assessed adverse events when using octenidine soap reported no events in a sample of 5277 patients148 while another assessing octenidine nasal gel reported one case (1/731, 0.14%) of adverse events (not specified) which resulted in discontinuation of use of the nasal gel in the affected patient.101

No evidence was found from the studies published since 2004 meeting the inclusion criteria for the study design, which assessed the cost-effectiveness of octenidine.

***Povidone-iodine (PVP)***

There was weak evidence from one RCT,94 which investigated the effectiveness of 5% PVP vs 2% nasal mupirocin alone and in combination with CHG wash on the incidence of deep surgical site infections (SSI) caused by MRSA in surgical patients (no denominator). The study reported a very low incidence of MRSA SSI and eradication of MRSA, with one case (0.12%) occurring in each group. There was further evidence from UBA studies, two of which reported a benefit of introducing PVP in combination with CHG when compared to CHG alone149 or to no decolonisation protocol.120 The remaining UBA study150 reported no difference in clinical outcomes when mupirocin was replaced by PVP while reporting better patient experience in PVP group.

No evidence was found from the studies published since 2004 meeting the inclusion criteria for the study design, which assessed the resistance of MRSA to PVP.

There was weak evidence from one RCT94 which reported adverse events associated with the use of PVP. The study reported some adverse events including headache, rhinorrhoea, nasal irritation, congestion, cough and pharyngeal pain. However, these were less prevalent than those for mupirocin (1.78% vs 8.90%, p<0.0001). The authors also reported that significantly fewer patients considered the treatment unpleasant (3.6% vs 38% in mupirocin group, p<0.0001), and concluded that this was possibly related to the fact that PVP was applied only twice on the day of the surgery as opposed to two applications for five days for the standard mupirocin treatment.

No evidence was found from the studies published since 2004 meeting the inclusion criteria for the study design, which assessed the cost-effectiveness of PVP.

***Other suppression therapies***

There was weak evidence from nine other studies, which investigated the effectiveness of other agents on the prevalence of MRSA colonisation, the incidence of MRSA acquisition, the incidence of MRSA infection and the eradication of MRSA. The studies used a skin decolonisation regimen with 1% triclosan,138,151 5% tea tree oil,152 polyhexanide cloths,153 3% hexachlorophene139 as well as the nasal application of 30% medical grade honey ointment,138 polyhexanide gel,152 polysporin triple ointment,93 ofloxacin drops for eradication of MRSA in the ears,136 gentamicin cream for peritoneal catheter exit sites140 and alcohol-based nasal antiseptic.154 One of these studies,154 which was UBA suggested a potential benefit when using selective alcohol-based nasal antiseptic administered twice daily in addition to CHG bathing in place of extensively used contact precautions for all MRSA colonised patients. The authors reported that the incidence of MRSA bloodstream infection remained the same (data not provided) while they successfully reduced the number of isolation days by 88.33% (p<0.0001) as well as a reduction in glove and gown use, which provided a saving of $430,604 (approx. £314,315) for the 10-month period in seven hospitals participating in the intervention. None of the therapies were reported to be effective.

The Working Party considered the evidence and concluded that high quality studies support the use of chlorhexidine and mupirocin, either used alone or in combination, while the effectiveness of alternative agents is yet to be adequately assessed, although octenidine and PVP show promising results. Concern remains about resistance associated with the use of CHG and mupirocin.

**Recommendation**

**6.1** Continue to use mupirocin for nasal decolonisation, either selectively or universally, in high-risk patients

**6.2** Continue to use chlorhexidine, either selectively or universally, for body decolonisation to reduce MRSA carriage.

**6.3** Consider alternatives where mupirocin and chlorhexidine are not feasible.

**6.4** Monitor the emergence of resistance, especially to mupirocin and chlorhexidine, if used extensively

**Good Practice Points**

**GPP 6.1** Follow manufacturers’ guidance when using suppression/decolonisation products.

**GPP 6.2** For skin decolonisation, if 4% CHG wash is used, moisten the skin, apply the wash, and leave for 1-3min before rinsing off; if 2% CHG wipes are used, do not rinse off.

**GPP 6.3** For skin decolonisation, pay special attention to known carriage sites such as the axilla, groin, and perineal area.

**GPP 6.4** After each bath and wash, provide clean clothing, bedding, and towels.

**GPP 6.5** Consider using chlorhexidine in neonates only if there is no alternative and there is no broken skin present (for evidence on CHG safety in neonates, see Appendix 5).

## 8.7 What is the clinical and cost effectiveness of environmental screening/sampling in minimising the transmission of MRSA?

MRSA resists desiccation and can survive in hospital dust for up to a year. It is found throughout the hospital environment, particularly around patients known to be colonised or infected with the bacterium. This environmental contamination with MRSA may contribute to transmission when healthcare workers contaminate their hands or gloves by touching contaminated surfaces, or when patients come into direct contact with contaminated surfaces. There is little understanding whether environmental screening/sampling has a beneficial effect on the environmental MRSA contamination or clinical outcomes. Previous MRSA guidelines did not assess this outcome and did not provide any recommendation.

There was weak evidence from one stepped wedge trial155 which assessed the effectiveness of the cleaning bundle on the rates of bloodstream infection in hospitals with ICUs. The bundle consisted of training and providing advice on the use of cleaning agents and the feedback to staff after cleaning. The study reported a beneficial improvement in overall cleanness, but no effects on MRSA bloodstream infection (n=22, 0.17/10,000pd vs n=66, 0.19/10,000pd, p=0.7674). Further evidence came from one UBA study156 which reported an intervention where the environmental services staff received training, following which audits were periodically conducted. General cleanness was assessed using ATP and results were fed back to the staff. Authors reported that no changes were observed in the incidence of MRSA acquisition in the pre- and post-intervention periods (n= 171 acquisitions vs=178 respectively, p value not reported).

No evidence was found from the studies published since 2004 meeting the inclusion criteria for the study design, which assessed the cost-effectiveness of environmental screening/sampling.

The Working Party considered the evidence and together with clinical experience of the Working Party members, concluded that there is currently insufficient evidence to support the routine use of screening/sampling of equipment. However, they recognised that there may be circumstances (e.g., outbreaks) where this may be beneficial.

**Recommendation**

**7.1** Do not screen/sample the environment routinely

**7.2** Consider using environmental screening/sampling as part of targeted investigation of an outbreak.

## 8.8 What are the most effective cleaning agents and technologies for reducing environmental contamination in the near patient environment and minimising transmission of MRSA?

There is plenty of evidence supporting the role of cleaning in hospitals as an important intervention in the control of MRSA. Unfortunately, it often constitutes part of an overall IPC package in response to an outbreak and its importance as a stand-alone activity remains controversial. There are a variety of cleaning agents and technologies available for reducing environmental contamination but guidance regarding the best approaches for cleaning is limited and cleaning policies vary considerably between hospitals. Traditional cleaning agents include alcohols (e.g., isopropyl, ethyl alcohol, methylated spirit), quaternary ammonium compounds (QATs) (e.g. alkyl dimethyl benzyl ammonium chloride, alkyl dimethyl ethyl benzyl, ammonium chloride), phenolics (e.g. benzyl-4-chlorophenol, amylphenol, phenyl phenol) and sodium hypochlorite (e.g. sodium dichloroisocyanurate). It has been suggested that these traditional cleaning methods are notoriously inefficient for decontamination, and new approaches have been proposed, including room decontamination with ultraviolet (UV) irradiation or hydrogen peroxide vapour (HPV) systems or the use of antimicrobial surfaces.

There was moderate evidence for benefit from two controlled trials157,158 and one ITS159 which investigated the effectiveness of HPV on hospital cleanness. All studies reported that using HPV in addition to the standard cleaning regime resulted in significantly lower number of sites contaminated with MRSA. One study157 in particular showed that the terminal cleaning with standard sanitiser resulted in 66.1% of sites still being contaminated with MRSA as opposed to 1.2% when HPV was added to post-manual cleaning (OR 0.02 [95% CI 0.00-0.13], p<0.0001). Another trial158 which assessed the number of rooms contaminated with MRSA found a lower rate of contamination in rooms where HPV was used in conjunction with manual cleaning, although the difference was not significant (2.02% vs 3.80%, OR 0.53 [CI 95% 0.21-1.31], p=0.1708) compared to the rooms terminally cleaned with quaternary ammonium only. The last study159 showed a significantly lower proportion of sites contaminated with MRSA (6.2% vs 7.2%, OR 0.86 [CI 95% 0.79-0.94], p=0.0008). This also translated to a significant reduction of MRSA acquisition (186 vs 334 cases, p<0.0001) and a small, non-significant decrease in MRSA bloodstream infection (0.11 vs 0.16 cases/1000pd, p=0.58). Further evidence came from one UBA study160 which reported that significantly fewer sites were contaminated with MRSA following the use of HPV when compared to a standard cleaning with ammonium and sodium hypochlorite (0.06% vs 2.14%, OR 0.03 [95% CI 0.01-0.11], p<0.0001).

There was inconsistent evidence of the benefit from one RCT,161-163 one controlled trial,164 one ITS165 and two controlled before/after studies166,167 which assessed the effectiveness of UV devices on the colony counts and the reduction of MRSA contamination163,164 and MRSA acquisition rates.161,162,165-167 One RCT, which was described in three separate articles161-163 reported that MRSA acquisition and infection rates were not affected using UV-C light devices. This was regardless of whether the outcomes were assessed on the whole hospital population162 (n=259, 0.31% in ammonium + UV-C light arm, n=242, 0.29% bleach + UV-C arm vs n=204, 0.27% in ammonium arm) or just patients in rooms previously occupied by MRSA carriers161 (n=54, 1.6% in ammonium + UV-C light arm, n=89, 2.3% bleach + UV-C arm vs n=73, 2.1% in ammonium arm). However, these studies showed that UV-C light may be used as a part of an IPC strategy due to their benefits in controlling bacteria other than MRSA. Authors also collected environmental samples and published the data in a separate article.163 The mean number of colony forming units in rooms and bathrooms was 8.52 in the ammonium group, 4.34 in hypochlorite group and 0.11 and 0.85 for ammonium and hypochlorite with UV-C groups, respectively (significance not reported). Another controlled trial164 reported that the colony counts and the reduction of MRSA contamination from baseline did not improve following the introduction of the UV-C light system (99.4% vs 91.1% bleach alone). However, this study reported a high variation in colony counts in the manual cleaning arm, which was attributed to inconsistencies in cleaning by the personnel. Two low-quality controlled before/after studies166,167 conducted in ICUs and one ITS165 showed the benefit of adding pulsed-xenon UV (PX-UV) device to standard cleaning with either ammonium,166 hypochlorite,167 or standard cleaning (details not provided).165 The first CBA study21 reported that the incidence of MRSA acquisition in the intervention ICUs decreased from 3.56 to 2.21 events per 1000 patient days (IRR=0.556 [CI 95% 0.309–0.999], p=0.0497) following the use of PX-UV device, while it significantly increased from 0.33 to 0.38 events per 1000 patient days (IRR=10.967 [CI 95% 7.061–17.033], p <0.0001) in other hospital wards. The second study167 reported a decrease from 14.02 to 9.5 MRSA acquisitions per 10,000 patient days (IRR=0.71 [CI 95% 0.57-0.88], p<0.002) in the intervention ICUs using PX-UV device, while reporting that the neighbouring high care units and the general wards did not experience a decrease in MRSA acquisitions (IRR=0.85 [CI 95% 0.65-1.12], p=0.283 and IRR=1.14 [CI 95% 0.62-2.12], p=0.663 respectively). Finally, one ITS165 also reported a benefit of adding a UV-C device to standard cleaning (not described) in general acute wards. The device resulted in the incidence of MRSA HCAIs decreasing from 0.7% (91/12,747 or 1.42/1000pd) to 0.5% (61/13,177, RR=0.65 [CI 95% 0.47-0.70], p=0.0087 or 0.98/1000pd), which in ITS analysis corresponded to a 30.79% reduction, p=0.02. The authors also reported annual savings of $1,219,878 (approx. £889,474) mostly due to a decreased length of stay. Further evidence came from two UBA studies which used UV-C devices and found no effect on MRSA colonisation168 or infection.169

There was weak evidence of no benefit from one controlled study with crossover170 and RCT171 which assessed the effectiveness of adding copper fittings to high-touch surfaces to prevent MRSA transmission. One study171 reported no difference in the incidence of MRSA infections in patients admitted to isolation rooms with copper surfaces (2/36) as compared to standard surfaces (3/34, OR 0.63 [95% CI 0.10-.4.00], p=0.6240). Another study170 reported that adding copper fixtures did not result in a decrease in the number of sites being contaminated with MRSA (2.3% vs 3.7% for the sites without copper, OR = 0.621, [CI 95% 0.306-1.262], p=0.217), Both studies concluded that copper surfaces can be used as a part of an IPC strategy due to their benefits in controlling bacteria other than MRSA.

There was weak evidence of benefit from one RCT of acceptable quality172 and low-quality controlled trial173 which assessed the effectiveness of antimicrobial curtains. The RCT172 compared the MRSA contamination of standard curtains and antimicrobial curtains impregnated with halamine (BioSmart®) with or without hypochlorite spray twice weekly. The authors described that halamine curtains can be ‘re-charged’ with hypochlorite, during which process amine polymers impregnated into the fabric are able to bind the chlorine ions, which in turn provide an antimicrobial benefit. The study reported no decrease in the number of curtains contaminated with MRSA when comparing the halamine and standard curtains (7/14, 50% vs 7/13, 53.8%, not significant). There was also no decrease when comparing the standard curtains to curtains pre-sprayedin halamine with the hypochlorite group (7/13, 53.8% vs 6/14 (42.9%, not significant), however, the number of contaminated curtains after spraying reduced from six (42.9%) to one (7.1%, significance not reported). Another study, which was a low-quality controlled trial173 compared two different types of antimicrobial curtain (impregnated with either silver, or quaternary ammonium compounds combined with polyorganosiloxane) to a standard curtain. There was a significant decrease in the number of curtains contaminated when comparing curtains impregnated with quaternary ammonium and polyorganosiloxane (3/580, 0.5%) and a standard curtain (204/507 (40.2%), RR=0.02 [CI 95% 0.00-0.04], p<0.0001, a difference of 39.7% [95% CI 34.8–44.0%], but no decrease in the number of curtains contaminated with MRSA when comparing silver impregnated (137/267, 51.3%) and the standard curtain (204/507 (40.2%), RR=1.28 [CI 95% 1.09-1.49], p=0.0025.

There was weak evidence from one UBA study174 assessing the effectiveness of titanium dioxide-based photocatalyst reactive to visible light, which was painted to the walls and high touch surfaces in medical ICU rooms. Authors reported a significant decrease in the number of MRSA acquisitions (4/280, 1.4% or 2.57/1000pd) from the pre-intervention period (15/341, 4.4% or 9.30/1000pd, p=0.01; IRR=0.26 [95% CI 0.06–0.81]).

There was inconsistent evidence of benefit reported by one RCT161/162, three controlled trials175-177 and two ITS178,179 studies investigating different types of cleaning agents. One ITS,178 which replaced hypochloric acid with chlorine dioxide reported a significant change in MRSA acquisition per 100 bed days/month at 12 months from the start of the intervention. Another ITS179 reported that switching from cleaning with detergent wipes followed by alcohol wipes to one wipe system (containing <0.5% benzalkonium chloride, <0.5% didecyl dimethyl ammonium chloride and <0.10% polyhexamethylene biguanide) in a general hospital setting, resulted in the reduction of the incidence of MRSA acquisition from 26.8 per 100,000pd to 9.4 per 100,000pd (p<0.0001). The authors reported that there was no significant difference in the incidence of MRSA bloodstream infection between the pre- and post-intervention periods (1.8 and 0.2 per 100,000, respectively, p value not reported). One controlled trial176 reported beneficial effects of bleach compared to Biomist (quaternary ammonium in alcohol), with the proportion of sites contaminated with MRSA in Biomist® group reported as 5/23 (21.7%), while there were no contaminated sites in the bleach group (0/40, 0%, p=0.0007). Other controlled trials did not report any difference in cleaning or clinical outcomes when using ammonium vs bleach,161/162 or ammonium vs hydrogen peroxide wipes175 or when comparing quaternary ammonium compounds, 10% hypochlorite, hydrogen peroxide with peracetic acid or ordinary detergent to each other.177 Further evidence came from two UBA studies. One study180 reported no change in environmental contamination after switching from standard detergent to sodium hypochlorite (13.2% vs 10.1%, OR 1.31 [95% CI0.70-2.46], p=0.4021). Another study181 used JUC® spray, a polymeric surfactant containing quaternary ammonium chloride, which was sprayed on the surfaces following the cleaning. The study found that none of the bed units (0/18, 0.0%) were contaminated with MRSA following the treatment. This was in contrast to 4/18 (22.2%) of sites cleaned with hypochlorite (OR 0.11 [95% CI 0.01-2.21], p=0.1501). The study was too small to draw inferences, but authors concluded that JUC® spray may be beneficial in controlling staphylococcal load for up to four hours following its application.

No evidence was found from the studies published since 2004 meeting the inclusion criteria for the study design, which investigated the cost-effectiveness of different cleaning agents or hands-free devices.

The Working Party considered the data above and, together with clinical experience of the Working Party members, concluded that there is no evidence that antimicrobial surfaces or touch-free devices can control MRSA specifically. However, these can be used as a part of wider IPC strategy to eliminate the inconsistencies associated with manual cleaning, while HPV is effective as a part of terminal cleaning. The Working Party also considered that cleaning agents have similar efficacy against MRSA.

**Recommendations**

**8.1** Continue using currently utilised products.

**8.2** Consider HPV or UV-C as an adjunct to terminal cleaning as a part of a wider IPC strategy.

**8.3** Consider antimicrobial surfaces and touch free devices as a part of a wider IPC strategy.

## 8.9 What is the evidence that local surveillance and feedback to staff is effective in minimising the transmission of MRSA?

Surveillance plays two roles with respect to IPC: it allows detection of infected/colonized individuals necessary for their removal from the general population, and it allows quantification of control success. Many hospitals have introduced surveillance systems to monitor MRSA cases. This surveillance can be used to assess the infection risk of people in hospital and inform the response.

There was moderate evidence from one RCT182 and two ITS183,184 studies which assessed the effectiveness of hospital surveillance on the incidence of MRSA bloodstream infection or MRSA acquisition.

One study,182 which recruited three units in participating hospitals and randomly assigned one unit into each intervention, used statistical process control charts (SPC) to monitor and feedback the MRSA acquisition rates to the staff on participating units. Authors reported a decrease in the average MRSA acquisition rates in the units which used either SPC charts alone or SPC charts with Pareto charts, which promoted IPC improvements on the units in comparison to the wards which did not use the charts. For the SPC group, the authors reported that the MRSA rate was stable during the baseline period with a possible increase in acquisition as observed from the last six points on the chart before the intervention was introduced. A monthly average of 48 cases was observed during the baseline period, which fell to 30 cases per month post intervention. For SPC + Pareto charts, continuous post-intervention improvements were observed with the average MRSA acquisition reduced from 50 to 26 cases per month. Lastly, the control arm experienced a slight pre-intervention reduction and a more significant post-intervention reduction from an average of 49 cases to 36 per month. However, this decrease was not sustained, and in the last six out of seven points shown on SPC charts, an increase in the number of MRSA acquisitions was observed. One ITS183 showed a marked reduction in bloodstream infection in ICU as well as other hospital patients even though the surveillance was limited to ICU only. The authors did not provide a p-value, but the prevalence rate was 1.6/1000pd in ICU and 0.6/1000pd in hospital. These rates are substantially lower than those predicted by ITS analysis which would have been 4.1/1000pd and 1.4/1000pd, respectively, if surveillance was not in place. The authors did not provide any information about the interventions which were introduced following the surveillance. The last ITS study,184 which also used SPC charts to feed the data back to staff to drive the improvement across the hospital, reported that the incidence of MRSA acquisition across the hospital decreased from 3.0 [CI 95% 2.8-3.2] to 1.7 [CI 95% 1.6-1.8] events per 100 patient admissions (p<0.001). The decrease was also observed in ICUs (9.3 [CI 95% 7.5-11.2] vs 6.7 [CI 95% 5.2-8.5], p=0.047). The authors also reported that a significant decrease was observed in hospital MRSA bloodstream infection (0.45 [CI 95% 0.38-0.52] pre-intervention vs 0.27 [CI 95% 0.24-0.32] per 100 patient admissions, p=0.02 post-intervention) as well as in ICU MRSA Central Line Associated Bloodstream Infections (CLABSI) (2.0 [CI 95% 1.3-3.0] vs 1.1 [CI 95% 0.7-1.7] per 100 device days, p=0.018 for pre- and post-intervention respectively).

Further evidence of the benefit came from a total of eight uncontrolled before-after studies.185-192 Two of these studies reported a decreased prevalence of MRSA colonised patients in their hospitals.186,187 One study,185 which reported a very low baseline prevalence of MRSA demonstrated that five years after the start of a mandatory surveillance of MRSA bloodstream infection cases, the prevalence of MRSA did not decrease significantly in their hospital (4.3% vs 12.2%, p=0.317) when comparing all MRSA isolates. However, they noticed a significant change when only non-bacteraemic isolates were included (3.5% vs 8.6%, p<0.001). While the rate of MRSA bloodstream infection remained unchanged throughout the five years (data not reported, p=0.555), the rate of non-bacteraemic isolates decreased each quarter by 0.47-1.61 cases/1000 patient episodes, which was significant (p=0.007). Authors concluded that since the rate of MRSA bloodstream infection was very low in their setting, surveillance of non-bacteraemic cases may be more beneficial. Furthermore, of the UBA studies which reported incidence of MRSA infection, four reported that the incidence of MRSA bloodstream infection declined following the introduction of surveillance,187,190-192 two reported no benefit185,189 and, one reported the benefit on some but not all units in the hospital.188

The Working Party considered the evidence from the included studies and together with the evidence from previous guidelines and the clinical experience of the Working Party members, concluded that hospital surveillance must remain a component of any strategy to prevent and control MRSA infections.

**Recommendations**

**9.1** Surveillance must be undertaken routinely as part of the hospital’s infection control strategy. Be aware that:

* There may be a potential lag period before the benefits are evident.
* Surveillance is only effective if followed by feedback to staff and when feedback drives the implementation of specific interventions to help reduce MRSA burden.

**9.2** In settings where MRSA prevalence is low, consider surveillance of non-bacteraemic cases of MRSA to monitor the MRSA epidemiology.

## 8.10 What is the evidence that local and/or national surveillance for MRSA is effective in driving service/ system improvement?

Beyond the hospital-wide surveillance system further extensive surveillance of MRSA cases may be performed at unit level. Previous MRSA guidelines concluded that surveillance must be undertaken routinely as part of the hospital’s IPC programme and that it must be a recognized element of the clinical governance process. Thus, there should be clear arrangements identifying those responsible for acting on the results in individual hospital directorates. This question was not assessed in our previous MRSA guidelines and no recommendation was made.

No evidence was found from the studies published since 2004 meeting the inclusion criteria for the study design, which assessed the effectiveness of local vs national surveillance for MRSA in driving service or system improvement and other sources of evidence were considered. One excluded study,193 which did not meet the criteria for this review, reviewed the data of the mandatory surveillance of MRSA in England. Since 2001 when the mandatory surveillance was introduced, all acute trusts reported the data quarterly. This data was publicly published, and the feedback was given to the trusts. Additionally, the trusts were given a target to reduce their MRSA bloodstream infection rates by 50% by 2008 and all trusts not meeting their trajectories were audited. The overall rate of bloodstream infection in England decreased by 56% between 2004 and 2008 and further decreased by 50% from 2008 to 2011, reaching 1.8 cases per 100,000pd. Authors reported that mandatory surveillance and feedback from the surveillance drove the implementation of interventions which ultimately contributed to reduced incidence of MRSA bloodstream infection.

Data on MRSA bloodstream infection surveillance for England, Scotland, Wales and Northern Ireland as well as all European Union countries are available ([https://www.gov.uk/government/statistics/mrsa-bloodstream infection-annual-data](https://www.gov.uk/government/statistics/mrsa-bacteraemia-annual-data); <https://ecdc.europa.eu/en/antimicrobial-resistance/surveillance-and-disease-data/report> ).

The Working Party considered the evidence from the above study, and together with the evidence from previous guidelines and the clinical experience of the Working Party members, concluded that recommendation cannot be made based on current knowledge.

**Recommendation**

**10.1** No recommendation

**Good Practice Point**

**GPP 10.1** Consider using local surveillance of MRSA acquisition (colonisation and infection) as a component of local strategies to prevent and control MRSA and drive improvement where needed.

## 8.11 To what extent are contact precautions (CP) effective in minimising the transmission of MRSA? To what extent does the isolation or cohorting of patients minimise the transmission of MRSA and what are the costs?

Transmission of MRSA may occur via direct contact involving body-surface to body-surface contact and physical transfer of microorganisms between an infected or colonized person and a susceptible person, or indirect contact involving contact between a susceptible person and a contaminated intermediate object such as needles, dressings, gloves or contaminated (unwashed) hands. Most hospitals routinely screen patients for MRSA and use CP, in addition to standard precautions such as hand washing, for those who screen positive to prevent its transmission. CP require gloves and gowns or aprons to be used by health care providers and visitors when in the infected patient's room and for all care procedures. Previous MRSA guidelines recommended that routine isolation should be adopted rather than introducing specific guidance for MRSA positive patients. Patients should be managed in accordance with the type of setting, resources available and the risk that they pose to others or that is posed to them.

There was inconsistent evidence from two cluster RCT194,195 and three ITS196-198 studies which investigated the effectiveness of CP on MRSA acquisition and infection. One study,194 which used active surveillance combined with CP for MRSA positive patients and universal gloving until patients were confirmed as MRSA negative, reported no significant difference in the incidence of new MRSA acquisitions. However, this study used CP in both groups, with one arm extending the application of CP (universal gloving) to a broader set of potential carriers in combination with enhanced surveillance and screening. Another study195 compared universal gloving for all patient contacts with CP (gloves/gowns) for patients known to be MRSA positive. Universal gloving was associated with a significant decrease in new MRSA acquisitions (-2.98 risk difference between intervention and control group; p = 0.46) but the effect of CP vs no CP was not tested. One ITS196 found no difference in MRSA acquisition in MRSA colonised or infected patients placed in single room or nurse cohorted patients as compared to patients with no single room or cohorting. Standard precautions were used with all patients, but this included elements of CP (aprons for all patient contact, gloves for all devices and washing patients). Another ITS197 found a 60% reduction in MRSA acquisition associated with rapid screening, CP and isolation, compared to no isolation and standard precautions (adjusted HR 0.39, 95CI 0.24-0.62; p <0.001; segmented regression change in slope p<0.001). However, this study was sensitive to bias as a stricter screening method was used during the intervention period, the separate effect of single room and CP were not distinguished, and the study was conducted in an ICU where MRSA was endemic, and decolonisation was not a routine practice. One very low quality ITS198 in acute hospital found a decrease in MRSA device-associated infection rates associated with discontinuing CP for known MRSA positives, but other practice changes were introduced at the same time.

There was moderate evidence of a negative effect of CP on the patient experience and mental wellbeing from and five qualitative studies.199-203 These studies focused specifically on the impact of isolation for MRSA colonisation or infection. These studies concluded that isolation had an impact on patient experience and resulted in increased anxiety and low mood.198-202 Additionally, in a study of 57 Dutch MRSA colonised patients,203 it was reported that a substantial proportion of MRSA carriers reported stigma due to MRSA, and stigma was associated with poor mental health. These studies were all small scale, in different populations and for varying durations of isolation. They reported mixed findings but suggested that isolation should be of as short a duration as possible to avoid anxiety and potential depression.

No evidence was found from the studies published since 2004 meeting the inclusion criteria for the study design, which assessed the cost-effectiveness of CP.

Additional evidence was obtained from national guidelines204 and two recent UBA studies154,205 which attempted to discontinue CP in hospitals (including ICU and general wards). Both studies reported that their baseline MRSA prevalence was low, which may be a factor for making decisions about CP discontinuation. One of these studies205 used standard precautions for nursing MRSA colonised and infected patients, while the other154 used alcohol-based nasal antiseptic to decolonise the carriers and also reported that CHG was used in the pre- and post-intervention period. Both studies reported no changes in bloodstream infection rates while significantly reducing CP days by 90%205 and 88.3%.154 Both studies reported a reduction in costs associated with the decreased number of isolation days, less use of gloves and gowns and the use reduced use of staff resources required.

The Working Party considered the evidence from the included studies and together with the evidence from previous guidelines and the clinical experience of the Working Party members and concluded that the decision to isolate or cohort patients colonised with MRSA should be based on risk assessment and patient experience.

**Recommendation**

**11.1** Use standard infection control precautions in the care of all patients to minimise the risk of MRSA transmission.

**11.2** For patients known to be colonised/infected with MRSA, use CP (gloves and plastic aprons) for direct contact with the patient or their bed space.

**11.3** Gloves and aprons must be changed between care procedures and hand hygiene must be performed.

**11.4** Consider placing patients colonised or infected with MRSA in a single room. The decision to use a single room should be based on a risk assessment that considers the risk of transmission associated with the patient’s condition and the extent of colonisation or infection (e.g., sputum, exfoliating skin condition, large open wounds) and the risk of transmission to other patients in the specific care setting e.g., in burns units.

**11.5** Where isolation is deemed necessary, isolate patients for the shortest possible time to minimise feelings of stigma, loneliness, and low mood.

**11.6** Provide clear information to patients about the need for the use of protective equipment to reduce feelings of stigma.

**11.7** Be consistent in the use of protective equipment to ensure that patients have confidence in the decision to place them in isolation.

**Good Practice Points**

**GPP 11.1** Advise the visitors about the need and available facilities for hand hygiene.

**GPP 11.2** Where applicable, advise the visitors about the use gloves and aprons.

**GPP 11.3** When considering the need to isolate a patient with MRSA in a single room, other demands on single room use may take priority and alternative strategies such as nurse cohorting may be appropriate.

## 8.12 What is the evidence that transfer of patients who are colonised or infected with MRSA between wards/ other care settings contributes to the transmission of MRSA?

Patients who are colonised or infected with MRSA have the potential to transmit MRSA to other patients in the same clinical area. Frequent movement of patients within a single healthcare setting or movement between related healthcare settings has the potential to increase the transmission of MRSA within the healthcare population and between different care setting such as a hospice or residential home. The evidence is currently lacking in establishing the effect of intra- and inter- hospital transfers of patients with MRSA on the rate of new acquisition of MRSA. Evidence for the impact that transferring patients between different units has on the transmission of MRSA can be derived from studies that have used genotyping of isolates to track the transmission of MRSA between patients. In this way, epidemiological links can be established to provide evidence for the extent to which the transfer of patients within and between healthcare facilities contributes to the transmission of infection. Previous MRSA guidelines recommended that patient transfers should be kept to minimum.

There was moderate evidence from two cross-sectional surveys206,207 one prospective cohort study208 and one surveillance study209 which investigated the effect of patient transfer on MRSA transmission. One study206 using a whole genome sequencing (WGS) to investigate the origins of 685 MRSA isolates identified in a 13-month period from a total of 610 patients in a single healthcare network comprising of three hospitals, outpatients and community settings, found that 41% (248/610) of the MRSA patients were linked in a total to 90 transmission clusters (defined as at least two patients), most of which (68%, 61/90) involved multiple settings. Of these clusters, 42 (38%) involved different settings within one hospital and 30% (n=27) involved more than one hospital. One transmission cluster involved 32 patients between all three. Complex patterns of frequent hospital stays resulted in 81% (26/32) of the MRSA patients who were identified, having had multiple contacts with one another during ward stays at any hospital but no outpatient contact, and had shared GP or residential area, thus suggesting that MRSA was transmitted on the wards and spread to other settings as a result of transfers. Another study207 used a social network approach by analysing Hospital Episode Statistics (HES) data in England from April 2006 to March 2007 to determine how movements between healthcare institutions, which were derived from patient admissions, affected the incidence of bloodstream infections. The MRSA incidence rate for a hospital (adjusted for cluster-specific mean MRSA BSI rates) was found to be contingent on the number of patients it shared with other hospitals within its cluster. The incidence of MRSA BSI increased with the increasing connectedness of hospitals, with strongly connected hospitals in large clusters found to have significantly higher MRSA BSI rates than less connected hospitals. Another study208 obtained genotypes and matched the MRSA screening results from admission and discharge from all patients previously admitted to 36 general specialty wards at two Scottish hospitals. The prevalence of MRSA in discharge screens was 2.9% (95%CI 2.43-3.34) and in the set of 2724 patients with paired screens, the odds ratio of acquiring MRSA was 2.64 for patients who stayed on four or more wards compared to those who stayed in three or less. In the last study,209 surveillance cultures were obtained from 584 residents admitted to nursing facilities within one healthcare network, represented approximately half of the residents who were admitted to these facilities during the study period. Surveillance cultures were obtained at admission together with data on healthcare contact and antimicrobial use. WGS was performed and the analysis focused on isolates which appeared genetically similar. The gene flow in these facilities was estimated based on single nucleotide variants using Wright’s F statistic. A total of 89/117 (76%) MRSA isolates belonged to ST5 or closely related isolates. The authors observed a positive correlation between patient sharing between hospitals and nursing facilities and concluded that the burden of antibiotic resistant organisms (including MRSA) was endemic in their healthcare network and driven by patient sharing in these institutions.

There was moderate evidence from five epidemiological investigations of outbreaks,210-214 which assessed the effect of patient transfers on transmission of MRSA. These studies involved specific outbreak clones, which facilitated investigation of transmission events, and provided data on the role of hospital transfers. One study213 reported an outbreak of an unusual New York/Japan EMRSA clone in Western Australia in 22 patients and two healthcare workers who acquired the MRSA. Transfers between another acute hospital (n=3 patients), a community hospital (n=4 patients) and regional care facility (n=3 patients) illustrated how patients acted as vectors and contributed to the transmission of infection. Another study210 reported transmission of four new cases of a PVL-MRSA strain from a patient transferred from another hospital, while another study211 identified MRSA transmission to 13 patients and 9 healthcare workers from patients transferred from another hospital. One outbreak investigation214 identified that transfer of patients between neonatal and paediatric ICU was a key factor in the transmission of MRSA with a total of 13 patients in PICU and 14 patients in NICU acquiring the same MRSA strain. In another outbreak investigation,212 a total of 16 cases of MRSA transmission occurred from a baby, which was transferred from another hospital.

There was moderate evidence from eleven risk factor studies215-225 which investigated the risk of MRSA acquisition related to transfers between the healthcare settings. The studies found that admissions from other acute settings215,216,218,220 and long-term settings215-220 were significant risk factors for detection of MRSA on admission. In a logistic regression model analysis of 81,000 admissions to acute care in Scotland,222 admission ‘not from home’ was a significant risk factor for MRSA colonisation on admission (OR 3.025 (95%CI 2.685-3.407) and the risk of colonisation increased with the frequency of previous admissions (4 or more previous admissions OR 2.484 (95%CI 2.111-2.923). Although there was a higher incidence of MRSA acquisition for patients who stayed in more ward, this was not statistically significant (OR 1.91 [95% CI 0.97-3.98], p=0.061). Another multivariate analysis of 12,072 admissions (399 with MRSA) to a university hospital in Switzerland,217 found patients who were admitted as an inter-hospital transfer had an odds ratio of 2.4 (1.3-4.4) for MRSA carriage. Another Swiss study224 of 1621 patients admitted to a geriatric unit, identified an increased risk of MRSA on admission screening associated with intra-hospital transfer (adjusted OR 2.5; 95% CI1.2–5.3; P = 0.02) and hospitalisation within the last 2 years (adjusted OR 2.7; 95% CI 1.1–6.7; P = 0.03) and a small case control study of 187 admissions to surgical wards of a limited resource hospital in Indonesia, transfer from another hospital was associated with an increased risk of MRSA carriage (OR 7.7 95%CI 1.2-9.1).223 One case-control study,225 which investigated risk factors for MRSA acquisition in a neonatal ICU identified bed transfer as a potential risk factor, but this was insignificant in the multivariate analysis (43/67, 64% vs 103/201 (51%), OR 1.83 [CI95% 0.97–3.49], p=0.06).

Further cross-sectional studies investigated prevalence and reason for MRSA acquisition. These studies reported higher prevalence of MRSA in patients previously exposed to another ward,226 another hospital,227 or a long-term facility.228 Another cross-sectional study229 compared the incidence of MRSA acquisition for the patients who stayed in two, three or four and more wards to the patients who were in one ward during their hospital stay. When the groups of multiple wards were combined, there was a higher incidence of MRSA acquisition than for patients who stayed in one ward, although this was not significant (OR 1.91 [95% CI 0.97-3.98], p=0.061). When the groups were compared separately, the risk increased with the number of wards the patients stayed in, although this was still not significant. Lastly, one case control study230 which investigated the incidence of MRSA infection, reported no increased risk in patients transferred to another hospital to those who remained in one hospital throughout their stay.

The Working Party considered the above evidence and the recommendations from previous guidelines and concluded that evidence suggests that patient transfers contribute to transmission of MRSA.

**Recommendation**

**12.1** Do not transfer patients between wards, units, hospitals, or other clinical settings unless it is clinically necessary.

**12.2** Inform the receiving ward/unit/care home and the ambulance/transport service that patient is colonised/infected with MRSA.

**Good Practice Point**

**GPP 12. 1** MRSA colonisation should not be a barrier to discharging patients to another health care setting, their home or residential care.

## 8.13 What role does shared equipment have in the transmission of MRSA and how should shared equipment be decontaminated?

One of the risks for transmitting MRSA to patients within healthcare premises or long-term care facilities is the use of improperly cleaned and disinfected medical equipment. When equipment is shared and not cleaned in between patient use, transmission of organisms such as MRSA can occur. Examples of equipment that may be shared between patients include venepuncture tourniquets, stethoscopes, ultrasound transducers, thermometers, blood pressure cuffs, dermatoscopes, pulse oximeters, hoists, hand-held devices, and keyboards. Such equipment needs to be decontaminated after each patient use. Decontamination is the use of physical or chemical means (e.g., alcohol/detergent wipes/sprays, chlorine tablets) to remove, inactivate, or destroy pathogens on an item to prevent transmission of infectious agents and render the item safe for use on other patients. Previous MRSA guidelines recommended that patient shared equipment should either be suitable for decontamination or should be single-patient use and discarded as clinical waste after use.

There was weak evidence of potential risk of MRSA transmission from eight studies230-237 which evaluated microbial contamination of shared equipment. One experiment230 involved the contamination of stethoscope diaphragms with a known inoculum of MRSA. These were then a) pressed directly onto selective agar and b) onto a pig skin surface and then selective agar. The number of MRSA transferred directly to the agar was approximately 2 log10 (compared to 100% of *Clostridioides difficile* spores), with 1 to 1.5 Log10 fewer transferred by indirect transfer. Following simulated auscultation on 57 patients colonised with MRSA, stethoscopes were pressed onto selective agar and the same procedure was conducted with a sterile gloved hand for comparison. The stethoscope was less likely to transfer MRSA from the patients’ skin to agar than gloved hands [11/57 (19%) vs 15/57 (26%); p =0.5], with a mean of 5.9 (+/-8.6) vs 14.3 (+/-11.4) (p=0.01) acquired and transferred by stethoscopes compared to gloved hands. Wiping the diaphragm with 70% isopropyl alcohol, 70% ethanol, or sterile water, removed 100%, 100% and 94% of the MRSA respectively. Although this study provides evidence that MRSA are potentially transferred by stethoscopes, the number of organisms transferred is lower than would be transferred on hands. A 10-second wipe with alcohol removed all MRSA from the stethoscope and even wiping with water removed over 90% of the contamination. A similar study7 tested a stethoscope disinfection UV device in comparison to wiping the diaphragm with 70% alcohol during examinations of MRSA patients (six skin locations around heart and abdomen for 5-sec contact each). Authors reported that 17/45 (38%) of stethoscopes were contaminated with MRSA, and that after using the UV device, the number reduced to four (9%) (p<0.01). The mean number of colonies was also reduced from 4.00 to 0.08 cfu (p=0.45). In the 70% isopropyl alcohol pad group, a total of 7/20 (35%) stethoscopes were initially contaminated and cleaning with the pad removed microorganisms from all (0.0%) (p<0.01). The sample size was too small to make any inferences between the UV and the alcohol group.

Another study231 cultured the handles of 300 wall-mounted and portable digital thermometers in an acute and long-term care hospital, 8% were contaminated with one or more pathogens although only 1% of these pathogens were MRSA. To test the risk of cross contamination from contaminated thermometer handles, six handles on digital thermometers in portable units were inoculated with a DNA marker (generated from a mosaic virus) and an additional fluorescent marker was applied to assess if the thermometer handles were cleaned. The handles were checked at day 1 and 2 (acute setting) and 14 (long-term care setting) to assess if the fluorescent marker had been removed. High-touch surfaces (e.g., bed rails, call buttons), other portable equipment and ward areas (e.g., nursing station) and patient hands (acute setting) were sampled for the presence of the DNA marker on day 1 and day 2 (acute) and day 14 (long-term care). In the long-term care area, the DNA marker was detected on high-touch surfaces in 21% of 14 rooms sampled and 80% (4/5) of shared portable equipment not previously inoculated with the marker. In the acute setting, the marker was detected in 33% (2/6) of rooms and on the hands of 1 of 6 patients. None of the fluorescent markers were removed by day 2 (acute setting) or 14 (long-term care setting). This study provides evidence that reusable patient equipment does become contaminated with pathogens, although the frequency of contamination with MRSA was very low. If thermometer handles are contaminated, the model suggested there was a risk of transfer to both the patient and other sites in the care environment. Although not possible to generalise, in the study sites, this shared equipment did not appear to be cleaned.

Four studies evaluated methods of decontamination of shared equipment to minimise the risk of transmission of MRSA, two used UV light-based devices and one a hydrogen peroxide cabinet. However, all of the studies were laboratory-based experiments, and the findings are difficult to apply to a clinical setting. In one study,232 an ultraviolet-C cabinet designed to deliver large amounts of UV-C radiation for the disinfection of individual pieces of clinical equipment up to approximately 1m3 in size, was evaluated against known pathogens. Eight items were tested (blood pressure gauge and cuff, patient call button, infusion pump, tympanic thermometer, oximeter base unit, keyboard, TV remote control). They were inoculated at nine sample points with a known concentration of test organisms (including a clinical MRSA isolate) and exposed to UV-C for two 30-second doses of 1590 L/m2. Additional tests were conducted using bovine serum albumen to represent soiling with organic matter and performance was compared with wiping with an antimicrobial wipe. The cabinet cycle consistently reduced the number of organisms by at least 4.7 log10 or below 10cfu on 80% of sample sites but contamination persisted on other sites. The authors reported that efficacy was not affected by organic soil and that a thorough cleaning (4 strokes) with a wipe achieved similar log10 reductions as the cabinet for some items. The authors concluded the cabinet could provide a means of rapidly decontaminating patient-related equipment but that these laboratory-based findings might not be replicated in-use. Another study233 involved testing the efficacy of a portable, hand-held UV irradiation device (Sterilray) designed to be held over surfaces whilst emitting UV-C radiation. In the laboratory, a known concentration of MRSA was inoculated onto a plastic surface and at 100mJ/cm2 the UV device reduced MRSA cfu by 5.4 log10. A range of surfaces in 27 rooms where a patient was MRSA positive (call light, bedside table, telephone, bed rail) were also tested, by culturing before and after the use of the UV-device. A total of 106 sites were cultured and the number positive after use of the device was reduced from 46% to 27% (p = 0.007). The less effective reduction associated with in-use items may reflect the effect of organic contamination on the efficacy of the method.

The efficacy of a cabinet that uses 35% hydrogen peroxide mist to disinfect ultrasound transducers in an automated 7 min cycle was evaluated in simulated use tests in the laboratory.234 Standardised carrier tests included MRSA inoculated onto a hard plastic surface in combination with organic challenge (5% v/v horse serum). The process successfully eliminated MRSA from 20 carriers. In another study,235 decontamination of ultrasonographic probes inoculated with a known concentration of MRSA was evaluated using a three-step decontamination process (1. cleaning with a dry towel, 2. saline moistened towel, 3. QAT germicidal wipe) or by germicidal wipe alone. In surveillance cultures from probes used in the emergency department taken prior to the experiment, only one of 164 cultures recovered MRSA and only 1.2% of the probes were contaminated by clinically significant pathogens. In the 3-step decontamination process, MRSA was not eliminated after wiping with the towel but the germicidal wipe in both the 3-step and single step process, eliminated 100% and 90% of MRSA, respectively. The last study236 reported the effectiveness of using a small UV-C device worn in front of the pocket for disinfecting stethoscopes. The authors reported a significantly reduced prevalence of stethoscopes being contaminated with MRSA after they were disinfected with UV-C device (4/45, 9% vs 17/45, 38%, p<0.01) and a small reduction in the mean number of colonies for those stethoscopes which were still contaminated.

Finally, one study237 described an outbreak investigation involving MRSA and MSSA strains. Using the data from clinical isolates, environmental sampling and patient records, together with WGS analysis which help to identify the clusters, authors were able to trace the outbreak to contaminated anaesthesia equipment, which following disinfection of an operating room and equipment, was not a source of further cases.

**Recommendation**

**13.1** Clean and decontaminate shared pieces of equipment used in the delivery of patient care after each use, with products recommended by the manufacturer.

**13.2** When using the equipment that is shared between patients:

* Use products recommended by the manufacturer.
* Decontaminate the equipment between patients using a generally available method.

**13.3** Educate all healthcare workers about the importance of maintaining a clean and safe care environment for patients. Every healthcare worker needs to know their specific responsibilities for cleaning and decontaminating the clinical environment and the equipment used in patient care.

**13.4** Introduce policies for staff, patients, and visitors to clean their hands before and after the use of shared equipment.

## 8.14 What information do patients and relatives require in relation to screening, suppression and management to minimise anxiety and improve the patient experience? What information do patient’s, families and primary/ home care professionals need when a patient is discharged home?

Opinion polls have demonstrated that the fear of developing MRSA is the single greatest concern of people who need to go into hospital for treatment. MRSA has received considerable media coverage, which has helped to shape public awareness. Unfortunately, most of the reporting has been negative and alarmist, so patients due for hospital admission are often anxious about the risk of MRSA infection. Much of the anxiety that patients with MRSA feel stems from the fact that they are not fully or appropriately informed. Lay people do not appear to access credible sources of information, or, if they do access them, are unable to understand their messages. Organisations that provide patient-focused information about MRSA are generic in scope, so that obtaining specific information may take time and effort to locate.

There was moderate evidence from a retrospective matched cohort study,238 one retrospective case control study239, one survey,240 and five qualitative studies,441-245 all undertaken in North America, which investigated the quality of care and other adverse outcomes potentially associated with isolation for MRSA colonisation or infection. One survey, which evaluated the use of CP in patients with MRSA,240 indicated that patients who were subject to isolation for MRSA were as satisfied with their care as patients who were not isolated. However, the authors reported that, in this hospital, an infection preventionist made frequent visits to patients placed on CP so that they would be reassured. In a retrospective case control study239 in a tertiary care setting, the authors reported that non-isolated patients had a slightly shorter hospital stay 6.0 vs 7.0 days but that isolated patients received significantly fewer bedside visits (p=0.01) and showed a tendency toward more preventable complications (p=0.06). Isolated patients had less documented care and less bedside visits from medical staff, which could hamper the therapeutic relationship. In a retrospective matched cohort study238 to examine the effect of isolation precautions on hospital related outcomes and the cost of care, the authors reported no significant differences in 30-day ED visits, formal complaints, or inpatient mortality rates between the cohorts. Similar to patients with respiratory illness, patients isolated for MRSA stayed 30% longer (LOS [length of stay], 11.9 days vs. 9.1 days; 95%CI: 1.22, 1.39), were hospitalised 13% longer than expected, (LOS/ELOS, 1.3 vs. 1.2; 95 % CI: 1.07, 1.20), and had 43% higher costs of care (direct cost, CAD $11,009 vs. CAD $7670; 95 % CI: 1.33, 1.54) compared to matched controls.

Five qualitative studies included findings that related to the patient experience of isolation.241-245 The studies suggested that patients had a poor understanding of the reason for their isolation and were confused about the need and variation in the use of protective equipment (gloves, aprons, gowns). This confusion led to feelings of anger and frustration toward healthcare staff and the health-care institution. Isolation in a side room was perceived to have both positive and negative aspects; positives were greater freedom from routine, greater privacy and solitude, and the perception that visitors were given greater freedom. The negative characteristics were a lack of attention from nursing staff and feeling lonely and stigmatised. Isolation also indicated to some the severity (or not) of the condition.

**Recommendation**

**14.1** Make patients aware of the reasons for MRSA screening and decolonisation.

**14.2** Inform patients of their screening result as soon as it is available.

**14. 3** For patients who are identified as MRSA positive, provide consistent and appropriate information about

* The difference between colonisation and infection
* The microorganism
* How MRSA is acquired and transmitted
* How MRSA is treated
* The reasons for contact precautions or isolation.

**14.4** On discharge provide consistent and appropriate information about

* The risks to household members, friends, and family.
* The implications for future health and health care.
* Persons who need to be notified about their MRSA colonisation status.
* Decolonisation regimen instructions if applicable.

**14.5** Provide information in a format and language that the patient and their family is able to understand.

**Good Practice Point**

**GPP 14. 1** Use patient leaflets provided in the supplementary materials of this guideline.

**GPP 14. 2** Inform patients about the possibility of re-colonisation and the importance of changing linen, towels, and clothes daily.

## 8.15 What needs to be considered by healthcare professionals when a person who is colonised or infected with MRSA dies?

MRSA colonisation or infection in a deceased person is not a risk but can cause concern amongst funeral directors with some even refusing to take the body. There is negligible risk to mortuary staff or funeral directors provided that standard IPC precautions are employed. An approach to address this problem should include staff training and education. IPC guidelines for funeral directors do exist for many hospital trusts but there is inconsistency in the contents of such guidelines as well as in their implementation. Consistent guidance on what needs to be considered by healthcare professionals when a person who is colonised or infected with MRSA dies, would facilitate the deceased’s family obtaining funeral services and protect the involved personnel to minimize the risks of transmission of MRSA. Our previous MRSA guidelines recommended that the IPC precautions for handling deceased patients should be the same as those used in life.

No evidence was found from the studies published since 2004 meeting the inclusion criteria for the study design, which investigated the handling of deceased patients who were colonised or infected with MRSA.

**Recommendation**

**15.1** Follow national guidance for managing infection risks when handling the deceased.

# Further research

**Research recommendations:**

**RR 1.1** Studies showing cost-effectiveness and practicality of performing targeted vs universal screening.

**RR 1.2** Validation studies for targeting tools.

**RR 3.1** Further studies assessing the clinical and cost effectiveness of molecular diagnostic methods.

**RR 3.2** Studies that describe the real-life, clinically relevant TAT (e.g., the time between when the patient should be screened, and the test results are available to clinician).

**RR 4.1** Well-described reports discussing staff implicated in outbreaks.

**RR 6.1** Rigorous comparative studies assessing the effectiveness of alternatives to mupirocin and chlorhexidine.

**RR 7.1** Studies which show whether environmental sampling and feedback to cleaning staff has a potential in reducing MRSA transmission.

**RR 8.1** Studies that assess the effectiveness of antimicrobial surfaces and touch-free devices on the environmental contamination with MRSA as well as MRSA transmission.

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