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

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1 Joint Healthcare Infection Society (HIS)
2 and Infection Prevention Society (IPS)
3 guidelines for the prevention and
4 control of meticillin-resistant
5 *Staphylococcus aureus* (MRSA) in
6 healthcare facilities.
7

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41 **Authors' contribution:**

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

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47 *"NICE has accredited the process used by the Healthcare Infection Society to produce: Joint*
48 *Healthcare Infection Society (HIS) and Infection Prevention Society (IPS) guidelines for the*
49 *prevention and control of meticillin-resistant Staphylococcus aureus (MRSA) in healthcare*
50 *facilities." The NICE accreditation of HIS methodology is valid for five years from March 2020.*

51 *More information on accreditation can be viewed at <http://www.nice.org.uk/about/what-we->*

52 *[do/accreditation](http://www.nice.org.uk/about/what-we-do/accreditation)"*

53

54 **1. Executive summary**

55 Meticillin-resistant *Staphylococcus aureus* (MRSA) infections remain a serious cause of
56 healthcare-associated infection (HCAI) in many countries. MRSA is easily spread by multiple
57 routes and can persist in the environment for long periods. In health and care settings,
58 transmission via staff hands remains the most important route for patient MRSA acquisition.
59 Infection prevention and control (IPC) measures and control of the use of antimicrobials are
60 effective in reducing prevalence of MRSA. There have been many publications related to
61 MRSA since the last guideline was published in 2006 and this update contains further
62 measures that are clinically effective for preventing transmission when used by healthcare
63 workers.

64 Methods for systematic review were in accordance with National Institute for Health and Care
65 Excellence (NICE) approved methodology and critical appraisal followed Scottish
66 Intercollegiate Guidelines Network (SIGN) and other standard checklists. Articles published
67 between 2004 and February 2021 were included. Questions for review were derived from a
68 stakeholder meeting, which included patient representatives in accordance with the
69 Population Intervention Comparison Outcome (PICO) framework. Recommendations are
70 made in the following areas: screening, management of colonised healthcare staff,
71 environmental screening and cleaning/disinfection, surveillance, IPC precautions (including
72 isolation and movement of patients and equipment), and patient information.

73 **Table 1:** Summary of the changes to the recommendations from previous guidelines

74 Please see the separate document

75 **2. Lay summary**

76 'MRSA' stands for meticillin-resistant *Staphylococcus aureus*, which is a type of bacteria
77 that can cause infection. Infection with MRSA mainly occurs in people who are already ill
78 and can occur wherever care is given. This can be in hospital or in the community such
79 as in residential or nursing care homes or in your own home. Treating MRSA is difficult
80 because the bugs are resistant to some types of antibiotics (penicillins) that would often
81 be used to fight *Staphylococcus aureus*. This means these types of antibiotics will not
82 work for MRSA infections.

83 The good news is that the number of MRSA infections in the UK has fallen since 2008,
84 but it does still remain a problem. This guideline is intended to help doctors and other
85 health and social care staff to try and prevent patients from getting MRSA and becoming
86 ill. It may also be of use to patients who already have MRSA, those who care for them
87 (relatives, care staff, etc.) and the general public, by helping them to understand which
88 things work and which do not work to prevent MRSA in hospitals and other care
89 settings.

90 The guideline contains an explanation, scientific evidence, and a glossary of terms to
91 make it easy to read and use (Supplementary Materials A).

92 **3. Introduction**

93 Infections due to meticillin-resistant *Staphylococcus aureus* (MRSA, also referred to as
94 methicillin-resistant *Staphylococcus aureus*) have decreased significantly in the UK and
95 elsewhere but they continue to cause significant morbidity and mortality. Hence, infection
96 prevention and control (IPC) measures remain essential.

97 There has been significant progress in recent years in managing MRSA in healthcare settings.
98 Despite these advances the control of MRSA remains demanding, and should be based on the
99 best available evidence to ensure the appropriate use of healthcare resources. This document
100 is an update of the previously published recommendations for the IPC of MRSA in healthcare
101 facilities.

102 A Joint Working Party of the Healthcare Infection Society (HIS) and the Infection Prevention
103 Society (IPS) has updated the previous guidelines and has prepared the following
104 recommendations to provide advice on the procedures and precautions needed to prevent
105 the spread of MRSA. This includes recommendations on patient and staff screening, patient
106 management, testing strategies, decolonisation, reduction of environmental contamination,
107 surveillance and feedback to minimise transmission and drive system improvement, and the
108 information needs of patients and healthcare professionals.

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

116

117 **4. Guideline Development Team**

118

119 **4.1 Acknowledgements**

120 APRW was supported, in part, by the National Institute for Health Research University College
121 London Hospitals Biomedical Research Centre. AD was supported by Public Health England
122 (soon to become UK Health Security Agency, UKHSA).

123 **4.2 Source of funding**

124 There was no external funding for this work.

125 **4.3 Disclosure of potential conflicts of interest**

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

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

129 JRP received consultancy fee from Imperial College London.

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

131 LB received consultancy fee from a commercial organisation.

132 All declarations of interest are available in Supplementary Materials B.

133

134 **4.4 Relationship of authors with sponsor**

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

138 **4.5 Responsibility for guidelines**

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

141 **5. Working Party Report**

142 Date of publication: XXX (published online XXX).

143 **5.1 What is the Working Party Report?**

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

148 **5.2 Why do we need a Working Party Report for this topic?**

149 The previous guidelines relating to this topic were published in 2006. MRSA is still an
150 important healthcare-associated pathogen which can be controlled effectively by evidence-
151 based IPC and quality improvement methods. There have been many publications on the
152 subject since 2006 and new technologies have emerged. The effect of these studies on
153 recommended practice needs to be reviewed.

154 **5.3 What is the purpose of the Working Party Report's recommendations?**

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

158 **5.4 What is the scope of the guidelines?**

159 The main scope of the guidelines is to provide advice for the optimal provision of an effective
160 and safe healthcare service while reducing the risk of MRSA transmission in healthcare
161 settings. The guidelines are suitable for patients of all age groups. These guidelines were
162 largely developed with hospitals in mind but may be useful in other settings where MRSA is a
163 concern, for example long-stay units. The guidelines' main focus was the prevention of
164 transmission to patients, thus pre- and perioperative care was not included. Antibiotic
165 stewardship and treatment are covered in a separate publication.²

166 **5.5 What is the evidence for these guidelines?**

167 Topics for these guidelines were derived from stakeholder meetings including patient
168 representatives and were designed in accordance with the Population Intervention
169 Comparison Outcomes (PICO) framework (Appendix 1). To prepare these recommendations,
170 the Working Party collectively reviewed relevant evidence from peer-reviewed journals
171 subject to validated appraisal. Methods, which were in accordance with NICE methodology
172 for developing guidelines, are described fully below.

173 **5.6 Who developed these guidelines?**

174 The Working Party included infectious diseases/microbiology clinicians, IPC experts,
175 systematic reviewers, and two lay member representatives.

176 **5.7 Who are these guidelines for?**

177 Any healthcare practitioner may use these guidelines and adapt them for their use. It is
178 anticipated that users will include clinical staff and, in particular, IPC teams. These guidelines
179 aim to provide recommendations for all health and care settings and to include available
180 evidence for all settings where MRSA is a concern. However, the available reported studies
181 were predominantly conducted in hospital settings. The Working Party believes that while
182 many sections of these guidelines are particularly relevant to hospitals, some evidence and
183 recommendations can be extrapolated to other health and social care settings (e.g. the
184 sections on environment and equipment decontamination, use of personal protective
185 equipment (PPE), transfer of patients and patient information).

186 **5.8 How are the guidelines structured?**

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

189 **5.9 How frequently are the guidelines reviewed and updated?**

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

192 **5.10 Aim**

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

196 **6. Implementation of these guidelines**

197 **6.1 How can these guidelines be used to improve clinical effectiveness?**

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

203 **6.2 How much will it cost to implement these guidelines?**

204 Provided that existing practice follows current recommendations, it is not expected that
205 significant additional costs would be generated by the recommendations in this document.
206 However, failure to follow best practice, for example by not screening in a population with
207 high prevalence, the hospital should expect to incur higher costs due to MRSA infections.

208 **6.3 Summary of audit measures**

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

215 Compliance with screening protocol.

216 Compliance with decolonisation regimens.

217 Compliance with prescribed isolation precautions.

218 Cleaning/disinfection standards.

219 Antimicrobial Stewardship (please refer to recent MRSA treatment guidelines²).

220 Emergence of resistance, especially to mupirocin and chlorhexidine (CHG), if used
221 extensively.

222 IPC practices, e.g. hand hygiene, aseptic technique.

223 Compliance with informing the receiving ward/unit/care home and the ambulance/
224 transport service that patient is colonised/infected with MRSA.

225

226 **6.4 Supplementary tools**

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

229

230 **7. Methodology**

231 **7.1 Evidence appraisal**

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

236 **7.2 Data sources and search strategy**

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

244 **7.3 Study eligibility and selection criteria**

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

258 **7.4 Data extraction and quality assessment**

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

266 Controlled trials (Randomised Controlled Trials (RCT) and non-Randomised Controlled
267 Trials (n-RCT)): SIGN Methodology Checklist 2: Controlled Trials.

268 Cohort studies: SIGN Methodology Checklist 3: Cohort Studies.

269 Interrupted time series (ITS): Cochrane Effective Practice and Organisation of Care
270 (EPOC) Risk of bias for interrupted time series studies.
271 Case-controlled studies: SIGN Methodology Checklist 4: Case-control studies.
272 Controlled before/after (CBA) studies: EPOC Risk of Bias (RoB) Tool (for studies with a
273 control group).
274 Uncontrolled before/after (UBA) studies: Joanna Briggs Institute (JBI) Critical Appraisal
275 Checklist for Quasi-Experimental Studies (non-randomized experimental studies).
276 Diagnostic accuracy studies (DAS): SIGN Methodology Checklist 5: Studies of
277 Diagnostic Accuracy

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

281 Data were extracted by one reviewer and checked/corrected by another. For each question
282 cluster the data from the included studies were extracted to create the tables of study
283 description, data extraction and summary of findings tables (Appendix 4). The list of the
284 studies rejected at full text stage with a reason for this decision, is included in the excluded
285 study tables. Due to limited evidence, most of the data were described narratively. Where
286 meta-analysis was possible, this was conducted in Review Manager 5.3 software for
287 systematic reviews. This software only allows the entry for dichotomous data; it was not
288 suitable for meta-analysis for decolonisation where a range of different decolonisation
289 therapies were used. For this, the analyses were calculated manually, with sample proportion
290 and confidence intervals [CI95%] obtained using the Wilson score interval
291 (epitools.ausvet.com.au). For the therapies which showed a significant benefit, the risk ratios
292 were calculated using MedCalc software (medcalc.net).

293 **7.5 Rating of evidence and recommendations**

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

298 When writing recommendations, the Working Party considered the following:

299 Who should act on these recommendations?

300 What are the potential harms and benefits of the intervention and any unintended
301 consequences?

302 What is the efficacy and the effectiveness of each intervention?

303 Is it possible to stop another intervention because it has been superseded by the new
304 recommendation?

305 What is the potential effect on health inequalities?

306 What is the cost-effectiveness of the intervention, including staff resources other
307 economic concerns?

308 Can the recommended interventions be feasibly put into practice?

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

311 'offer', 'measure', 'advise', 'refer', 'use' or similar wording was used if the Working
312 Party believed that most practitioners/commissioners/service users would choose an
313 intervention if they were presented with the same evidence: this usually means that
314 the benefits outweigh harms, and that the intervention is cost-effective. This reflects
315 a strong recommendation for the intervention. If there is a legal duty, or if not
316 following a recommendation may have serious consequences, the word 'must' was
317 used.

318 'do not offer' or similar wording was used if the Working Party believed that harms
319 outweigh the benefits or if an intervention is not likely to be cost-effective. This
320 reflects a strong recommendation against the intervention. If there is a legal duty, or
321 if not following a recommendation may have serious consequences, the words 'must
322 not' were used.

323 'consider' was used if the Working Party believed that the evidence did not support a
324 strong recommendation, but that the intervention may be beneficial in some
325 circumstances. This reflected a conditional recommendation for the intervention.

326 The 'do not offer, unless...' recommendation was made if the Working Party believed
327 that the evidence did not support the strong recommendation, and that the
328 intervention was likely not to be beneficial, but could be used in some circumstances,
329 for instance if no other options were available. This reflected a conditional
330 recommendation against the intervention.

331

332 **7.6 Consultation process**

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

339 **8. Rationale for recommendations**

340 **8.1 What is the clinical and cost-effectiveness of universal versus targeted** 341 **screening in minimising the transmission of MRSA?**

342 While in certain instances screening is implemented for every patient entering the healthcare
343 unit, it is not in the current UK NICE guidelines for healthcare facilities to implement universal
344 screening. Screening is completed largely for some pre-operative patients or other high-risk

345 patients, such as those entering the intensive care unit (ICU). Despite this, there is
346 disagreement in the literature about the clinical effectiveness of targeted screening in
347 preventing the transmission of MRSA. Moreover, there is a debate about the cost-
348 effectiveness of universal screening. The effectiveness of universal versus targeted screening
349 was not assessed in previous MRSA guidelines,¹ although the recommendation endorsed the
350 use of a targeted approach.

351 There was weak evidence of no benefit from one ITS³ which investigated the incidence of
352 MRSA acquisition in all patients, excluding new-borns, admitted to hospital with the use of
353 universal screening (n=61,782) as compared to targeted screening (n=76,273). The study
354 found no significant difference in the incidence of MRSA acquisition in patients screened
355 universally (47.5/100,000) as compared to those when a targeted approach was in use
356 (41.8/100,000; p=0.923).

357 There was weak evidence of no benefit from one ITS study³ and one CBA study⁴ which
358 investigated the incidence of MRSA infection in patients admitted to hospital with the use of
359 universal screening as compared to targeted screening. One study³ of all patients, excluding
360 new-borns, admitted to hospital found no significant difference in the incidence of MRSA
361 bloodstream infection (BSI) in patients screened universally (1.8/1000pd (patient days)
362 n=61,782), as compared to those when a targeted approach was in use (2.1/1000pd
363 n=76,273; p value not reported). Another study⁴ of adult patients admitted to hospital for at
364 least 24 hours with universal screening (n=61,782) compared to targeted screening
365 (n=76,273) found that the rate of healthcare-associated MRSA infection (HCAI-MRSA) did not
366 fall significantly (0.27% before versus 0.15% after the switch to universal screening), while the
367 rate in the control hospital remained the same throughout the study period (0.10%, p=0.34).

368 There was weak evidence of no benefit from one CBA study⁴ which investigated the cost
369 saving from a reduced incidence of healthcare-associated MRSA acquisition per each
370 additional dollar spent on screening in adult patients admitted to hospital for at least 24 hours
371 with the use of universal screening (n=3255) as compared to targeted screening (n=2037).
372 The study found lower cost savings when screening patients universally (USD 0.50 saved) as
373 compared to those when targeted approach was in use (USD 1.00 saved).

374 The Working Party considered the evidence and concluded that the universal screening
375 strategy had no benefit over targeted screening. The clinical experience of the Working Party
376 suggests that universal screening may be easier and more time-effective for staff as it
377 removes the need to perform additional assessments to determine whether patients require
378 such screening. When a targeted approach is used, careful consideration is needed to
379 establish which patients should be considered at risk and that local risk factors are taken into
380 account. The Working Party concluded that for screening to be effective, it needs to be linked
381 to a specific action that either attempts to eradicate or suppress the MRSA in the patients
382 (decolonisation) or minimises contact with MRSA colonised patients (isolation).

383 **Recommendations**

384 **1.1** Targeted or universal patient MRSA screening must be performed and must be linked to
385 a specific point of action such as decolonisation or isolation (or both).

386 **1.2** Use at least a targeted approach but consider using universal screening as appropriate
387 depending on local facilities.

388 **1.3** If a targeted approach is used, define risk factors for MRSA carriage as appropriate for
389 your area.

390 **Good Practice points**

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

394

395 **8.2 What is the clinical and cost-effectiveness of repeat screening people who** 396 **screen negative/positive on pre-admission/admission to prevent the transmission** 397 **of MRSA?**

398 If patients screen negative at admission, repeat screening can identify whether they acquired
399 MRSA during their stay, so that appropriate actions can be taken. On the other hand, for those
400 who screen positive, repeat screening can show whether an MRSA patient was successfully
401 decolonised. It is currently unclear whether repeat MRSA screening is clinically and cost-
402 effective and how the repeat screening should be performed. Effectiveness of repeat
403 screening was not assessed in previous MRSA guidelines¹ and no recommendation was
404 endorsed for its use.

405 No evidence was found from the studies published since 2004, which met the inclusion
406 criteria for the study design, and which assessed the benefit of repeat screening for people
407 who screened negative or positive on pre-admission/admission screening to prevent the
408 transmission of MRSA.

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

412 **Recommendations**

413 **2.1** Do not perform repeat MRSA screening for patients who screen positive at admission
414 unless the patient undergoes decolonisation therapy.

415 **2.2** If the patient undergoes decolonisation therapy, consider repeat MRSA screening two to
416 three days following the therapy, to determine whether decolonisation was successful or not.
417 Do not delay a surgical procedure if the patient still tests positive.

418 **2.3** Do not perform repeat MRSA screening routinely.

419 **2.4** Consider re-screening patients who previously screened negative if there is a significant
420 MRSA exposure risk (e.g. contact with a confirmed MRSA case) or where there is a locally-
421 assessed risk of late acquisition.

422

423 **8.3 What is the clinical and cost-effectiveness of rapid molecular diagnostics versus**
424 **culture in screening to prevent the transmission of MRSA in hospital and non-acute**
425 **care settings?**

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

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

453 There was strong evidence of no benefit from the meta-analysis of three RCTs and one n-
454 RCT^{33,71,75,76} which investigated the incidence of MRSA colonisation when using PCR screening
455 (n=16,773) versus culture (n=17,754). The results of meta-analysis showed that the incidence
456 of colonisation did not decrease significantly in the PCR group (n=268, 1.51%) when compared

457 to culture (n=324, 1.94%, OR=0.86 [CI95% 0.73-1.01]). These results are consistent with the
458 results of studies which reported colonisation per 1000pd or 1000pd at risk, with one RCT⁷⁵
459 reporting significantly lower incidence in the PCR group (2.86 versus 4.10/1000pd, p=0.002)
460 while four other studies reported non-significant differences (0.39 versus 0.35/1000pd,
461 p=0.39,⁷⁷ 4.4. versus 4.9/1000pd at risk, p=0.27,³³ 2.57 versus 2.83/1000pd at risk, p=0.66,⁷⁶
462 4.60 versus 5.39/1000pd at risk p value not reported⁷¹).

463 There was moderate evidence of no benefit from two RCTs^{33,76} which investigated the
464 incidence of MRSA infection when using PCR screening versus culture. One study³³ found no
465 difference in MRSA BSI in the group of patients where PCR was used (1/3553, 0.03%)
466 compared to patients where culture was used (2/3335, 0.06%, p value not reported) and no
467 difference in MRSA wound (included but not limited to surgical wound) infection (21/3335,
468 0.6% in PCR versus 22/3553, 0.7% in culture, p=0.77). Another study⁷⁶ found no significant
469 difference in a rate of infection/1000pd in patients with PCR (5/1063, 4.06/1000pd) versus
470 culture (2/1121, 1.57/1000pd, p=0.281).

471 There was strong evidence of benefit from 14 studies,^{10,15,27,33,38,42,45,53,59,62,71,75-77} which
472 investigated the TAT of PCR and culture. There was a high degree of heterogeneity as to how
473 TAT was reported across these studies, but they consistently showed significantly decreased
474 TAT for PCR samples. The studies showed that the time from patient admission to results
475 being available for PCR was under 24 hours^{33,71,76} and just over 24 hours for admission until
476 isolation,^{62,76} while results for culture using the same TAT were 40.4 hours or longer.^{33,62,71,76}
477 When TAT was defined as the time from the collection of the screening sample until results
478 were available, it showed that these results could be available in less than two hours³⁸ and
479 are typically available in under 24 hours for PCR.^{27,59,75} The results of culture were available
480 after 28 hours at the earliest⁵⁹ and sometimes took more than two days.^{27,38,75} The studies
481 which assessed TAT as the arrival of samples at the laboratory to results being
482 available^{15,27,42,45,53,62} reported the shortest time for PCR at 1.8 hours and the average time as
483 eight hours, while the shortest time for culture was 24 hours and the average time longer
484 than 40 hours.

485 There was strong evidence of no benefit from eight studies^{10,15,33,56,62,76-78} investigating the
486 cost of PCR versus culture. One UK study¹⁵ reported that the cost of one screen is
487 approximately 2.5 times more when using PCR than culture (£4.29 versus £1.71, total cost
488 £14,328.60 versus £5711.40 for a total sample of 3340). Another study¹⁰ estimated this cost
489 to be higher: USD 6.71 and USD 7.52 (approx. £5.17 and £5.79) for culture (negative and
490 positive result, respectively) and USD 25.50 (approx. £19.60) for PCR. This study, besides the
491 cost of materials necessary for screening, considered the cost of staff required to process the
492 samples (1.5-2min for culture and 5-9min for PCR per sample). Other studies reported 4-5
493 times higher screening costs compared to culture, although it is not possible to determine
494 what was included in the estimation of the costs.^{56,78} Two studies did not report data on the
495 cost of culture but reported that screening with PCR required an additional €4.961 (approx.

496 £4.27)⁷⁶ and €56.22/€69.62 (approx. £48.45/£59.99)⁶² depending on the assay. Three studies
497 reported^{33,62,78} a potential cost saving when screening with PCR. One of these studies⁷⁸ of 232
498 participants reported that while the PCR screening cost itself was higher (additional
499 CHF104,328.00, approx. £80,332.56 for universal screening and CHF11,988.00 approx.
500 £9,230.76 for targeted screening), there is potential for reducing the costs of pre-emptive
501 isolation by CHF38,528.00, approx. £29,666.56. Hence, while the net cost of universal
502 isolation was still higher (CHF91,509.00, approx. £70,461.93), the targeted screening reduced
503 the net costs by CHF14,186.00 (approx. £10,923.22). Another study,⁶² using targeted
504 screening reported a reduction in the daily cost of isolation as €95.77 (approx. £73.74) and
505 €125.43 (approx. £96.58) when using two PCR screening methods compared to culture. One
506 study,³³ which used a universal screening approach reported that PCR screening reduced the
507 number of inappropriately used isolation days from 399 to 277. While the authors did not
508 report the cost analysis, they suggested that there was a potential to counterbalance the cost
509 of PCR screening with the benefit from reducing the number of isolation days. Last study⁷⁷
510 reported that the total cost of screening with PCR was more expensive (CAN 3,656.92, approx.
511 £2,281.92) than culture methods (CAN 2,937.06, approx. £1,832.73), although they did not
512 report any information on how this cost was estimated.

513 Further evidence came from UBA studies, three of which reported a decrease in the incidence
514 of MRSA acquisition when PCR screening was introduced,⁷⁹⁻⁸¹ and four of which reported a
515 decrease in reducing TAT.^{11,79,81-83}

516 There was strong evidence from a total of 45 studies,<sup>5,7-11,13,14,16,17,19,22-24,27,29-32,35,37-41,43,45,47-
517 51,53,57,58-61,62,64,65,67,69,72,73,78,84</sup> which reported the occurrence of PCR inhibition rates. This is
518 important because sometimes these can be mistaken for negative results. Overall, the
519 inhibition rate was 2.98% [CI95% 2.80-3.17], although one study⁷³ which used a Point-of-Care
520 Testing device, reported the inhibition rates as high as 8.1%.

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

525 **Recommendation**

526 **3.1** Use either PCR or traditional culture methods for MRSA screening as you consider
527 appropriate depending on the local laboratory facilities.

528 **Good practice point**

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

532

533 8.4 What is the clinical and cost-effectiveness of screening staff to prevent the
534 transmission of MRSA?

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

545 No evidence was found in studies published since 2004 which met the inclusion criteria for
546 the study design, and which assessed the benefit of performing staff screening on any patient-
547 related outcomes.

548 There was weak evidence from one UBA study⁸⁵ which assessed the benefit of performing
549 staff screening on the prevalence of staff MRSA carriage. The authors reported that a total of
550 27/566 (4.77%) of the staff were colonised with MRSA at their first screening, while 14/445
551 (3.15%) of staff were colonised at least once at subsequent screenings. While it is not possible
552 to directly compare the before/after prevalence (some staff were screened more than once
553 at subsequent screenings), the authors reported that 9/201 (4.48%) staff were colonised in
554 2005 and the prevalence from 2006-2008 was 12/207 (5.80%), 11/237 (4.64%) and 7/186
555 (3.76%) respectively. This suggests that overall, the prevalence did not change. The authors
556 reported that for the staff who were screened more than once (n=221) and were given the
557 decolonisation treatment following the positive screen, the colonisation rate dropped for this
558 group from 5.88% to 2.71% (p=0.55) and the odds ratio of being colonised at second screen
559 was 0.45 (CI95% not reported) compared to the first screen. It is not possible to determine
560 whether the staff were subsequently recolonised at the follow-up screenings.

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

565 Recommendations

566 **4.1 Do not routinely screen staff for MRSA.**

567 **4.2** Consider screening staff for MRSA if there is an epidemiological reason for suspecting a
568 staff member as a source of MRSA, e.g. if transmission continues on a unit despite active
569 control measures, if epidemiological aspects of an outbreak are unusual, or if they suggest
570 persistent MRSA carriage by staff.

571 **Good practice points**

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

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

578 **GPP 4.3** If possible, involve the Occupational Health Team in the process of staff screening
579 and management.

580

581 **8.5 What approaches to the management of healthcare staff who are colonised**
582 **with MRSA are most practical and effective at minimising the risk to patients?**

583 If a member of staff tests positive for MRSA, the hospital is required to comply with
584 appropriate governance to ensure that the risk of acquisition, and potentially infection, is
585 minimised among the patients. This includes sending staff home, reducing their interaction
586 with patients or treatment with topical antimicrobials. The cost-effectiveness and clinical
587 benefit of these management strategies have not been established. Effectiveness of
588 managing staff who screen positive for MRSA was not assessed in previous MRSA guidelines,¹
589 although the Working Party recommended developing local protocols which assess the
590 individual staff member's risk of transmission to patients when agreeing their continuation or
591 return to work. It was recommended that only staff members with colonised or infected hand
592 lesions should be off work while receiving courses of decolonisation therapy, but this decision
593 should be based on local risk assessments. To aid staffing resources, it was recommended to
594 temporarily re-allocate staff carriers to low-risk tasks or to non-patient contact activities. The
595 management of staff with nasal carriage was not included in previous guidelines.

596 No evidence was found in the studies published since 2004 which met the inclusion criteria
597 for the study design and, which assessed the management of staff who tested positive for
598 MRSA carriage.

599 The Working Party considered previous recommendations from MRSA guidelines and,
600 together with the clinical experience of the members, suggested that staff who are identified

601 as MRSA positive may need a course of decolonisation therapy and sometimes may need to
602 be excluded from clinical areas.

603 **Recommendations**

604 **5.1** Consider excluding staff from work, reducing their interaction with patients, or offering
605 decolonisation therapy as deemed appropriate.

606 **5.2** Consider investigating the risk factors for staff MRSA carriage. Investigate staff members
607 with persistent carriage in a multi-disciplinary setting to determine any associated factors.

608 **Good practice points**

609 **GPP 5.1** For staff members with nasal carriage only: offer decolonisation therapy, exclusion is
610 not required. For staff with infected lesion/skin rash: offer decolonisation therapy AND carry
611 out a risk assessment to consider re-deploying them to low-risk areas or excluding them from
612 work.

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

618

619 **8.6 What is the evidence that topical decolonisation therapy is clinically and cost- 620 effective in minimising the transmission or eradication of MRSA? What is the 621 evidence that the selected strategy for topical decolonisation results in resistance?**

622 The most common topical decolonisation therapy offered to patients and staff is CHG and
623 mupirocin, either as combination or alone. There is some disagreement in the literature over
624 the clinical effectiveness of topical decolonisation in preventing MRSA colonisation or its
625 eradication. It is generally acknowledged that complete eradication is not always possible,
626 but a temporary suppression may be sufficient in some circumstances (e.g. prior to surgery).
627 Moreover, there are risks that overuse of topical decolonisation therapies leads to resistance.
628 This has led some healthcare facilities to implement other interventions such as putting
629 patients in single rooms to prevent transmission to others. There is a need to understand
630 clearly the clinical and cost-effectiveness as well as antimicrobial resistance risks of different
631 decolonisation (defined here as a therapy which aims to eradicate or temporarily suppress
632 the MRSA growth) therapies compared to the best standard of care, including those from no
633 decolonisation therapy. Previous MRSA guidelines¹ recommended prophylactic use of
634 mupirocin in conjunction with CHG for patients undergoing some operative procedures. This

635 was also recommended in outbreak situations. Throat decolonisation with systemic therapy
636 was recommended only on the advice of the consultant microbiologist and was
637 recommended in conjunction with nasal and skin decolonisation therapy with mupirocin and
638 CHG. Skin decolonisation was recommended for pre-operative patients who were found
639 positive for the carriage of MRSA. Skin decolonisation with 4% CHG wash, 7.5% povidone-
640 iodine (PVP) or 2% triclosan was recommended.

641 ***Chlorhexidine (CHG)***

642 There was strong evidence of benefit from twelve RCTs,⁸⁶⁻⁹⁸ four controlled trials,⁹⁹⁻¹⁰² eleven
643 ITS studies,¹⁰³⁻¹¹³ two retrospective cohort studies^{114,115} and one CBA study¹¹⁶ which
644 investigated the effectiveness of CHG washing on the prevalence of MRSA colonisation,
645 incidence of MRSA acquisition, incidence of MRSA infection and the eradication of MRSA. The
646 results of the meta-analyses showed that decolonisation therapy with CHG, either alone or in
647 combination with another agent (PVP, polysporin or mupirocin), was consistently better than
648 the comparison group (either no decolonisation or placebo) for all outcomes, except for
649 incidence of MRSA acquisition when CHG was used alone. When CHG was used alone, the
650 prevalence of MRSA was 2.1% in CHG group versus 25.5% in control group ($p < 0.001$), the
651 incidence of MRSA acquisition was 3.55% versus 3.04% ($p < 0.0001$), the incidence of MRSA
652 acquisition/1000pd was 2.35 versus 3.10, $p = 0.0051$, incidence of infection was 1.11% versus
653 1.49%, $p = 0.0361$ and the incidence of infection per 1000pd was 0.22 versus 0.46, $p < 0.0001$.
654 When CHG was used alone or in combination with another therapy (PVP or mupirocin), the
655 prevalence of MRSA was 5.3% versus 25.5%, $p < 0.0001$, the incidence of MRSA acquisition was
656 1.57% versus 3.04%, $p < 0.0001$, the incidence of acquisition per 1000pd was 0.89 versus 3.10,
657 the incidence of infection was 1.11% versus 1.49%, $p = 0.0361$, the incidence of infection per
658 1000pd was 0.08 versus 0.46, $p < 0.0001$ and the rate of MRSA eradication was 60.5% versus
659 34.5%, $p < 0.0001$, thus showing that CHG performs better when used in combination with
660 nasal decolonisation therapy. The results remained significant when stratified by different
661 types of setting (e.g. surgical, ICU, general ward) or when using a selective (only for MRSA
662 positive patients) or universal (blanket) approaches, although there was large heterogeneity
663 in the reported results between the individual studies. Additional evidence from the studies
664 which provided data not compatible for entry into metanalysis, did not show a significant
665 benefit of using CHG. One small ITS,¹¹² which used nasal mupirocin and 4% CHG wipes for
666 patients colonised with MRSA in neonatal ICU did not report a significant decrease in the
667 incidence of MRSA acquisition in the intervention period in comparison to pre-intervention
668 (2.00 versus 2.38 events/1000pd, IRR=1.85 (incidence rate ratio) [CI95% 0.80–1.73], $p = \text{NR}$).
669 An RCT⁹⁸ conducted in adult ICU patients with a treatment group receiving a daily 4% CHG
670 wash and a control group receiving a daily soap and water wash reported no significant
671 decrease in the incidence of HCAI-MRSA (2/226, 0.9% or 1.08/1000pd versus 6/223, 2.7% or
672 3.80/1000pd, RR=0.33, [CI95% 0.07-1.61], $p = 0.1704$). Considering the small sample sizes,
673 these two studies were likely underpowered, resulting in type I error. Further evidence came
674 from eighteen UBA studies¹¹⁷⁻¹³⁴ which used CHG either in combination or alone. These other

675 studies showed heterogenous results with 11 studies reporting a benefit^{118,120-124,128,130-132,134}
676 and seven reporting no significant change.^{117,119,125-127,129,133}

677 There was inconsistent evidence from two RCTs^{86,95} which assessed the effectiveness of CHG
678 mouth rinse on the presence of MRSA in the oral cavity in patients admitted to ICUs. One
679 study reported no effect of CHG on the presence of MRSA in dental plaque,⁸⁶ while another
680 found a significantly lower prevalence of MRSA in both dental plaque (15.2 versus 37.3%,
681 $p=0.006$) and oral mucosa (18.6 versus 39.7%, $p=0.011$).⁹⁵ The difference may be explained
682 by the differences in CHG concentrations with 0.2% and 2% used, respectively. A small study
683 assessing the effectiveness of CHG on the incidence of MRSA acquisition in patients with a
684 peritoneal catheter found a benefit, although the sample size was too small to show a
685 significant effect.⁹⁶

686 There was strong evidence from the meta-analysis of five studies^{97,102,105,108,132} and one
687 narratively-described cross-sectional study¹³⁵ which investigated resistance to CHG. Meta-
688 analysis showed a high proportion of isolates which were resistant to CHG in the group of
689 patients with CHG bathing, although the rates were still high (27.7%) in the comparison group
690 where CHG was not used. The use of CHG significantly increased the incidence of resistant
691 isolates (OR=2.79 [CI95% 1.81-4.26], $p<0.0001$). There were not enough data to establish
692 whether a universal approach to decolonisation carried a higher risk of developing resistance.
693 One cross-sectional study,¹³⁵ which evaluated MRSA isolates obtained from the patients for
694 resistance patterns, reported that those patients who were exposed to CHG were more likely
695 to carry MRSA isolates with disinfectant resistance genes *qacA/B* and *qacC* than those who
696 were not exposed (70.0% versus 43.4%, AOR=7.80 [CI95% 3.25-18.71], $p<0.001$ and AOR=0.18
697 [CI95% 0.04-0.94], $p=0.04$ respectively). Additionally, authors reported that a higher
698 proportion of isolates obtained from patients previously exposed to CHG had a reduced
699 susceptibility to CHG (minimum inhibitory concentration (MIC) levels ≥ 4 mg/L) than the
700 isolates from patients with no exposure history AOR=3.15, [CI95% 1.14-8.74], $p=0.03$.

701 There was moderate evidence from fourteen studies,^{86,88-94,96,97,99,100,102,109,121} which reported
702 adverse events associated with the use of CHG. These included rash,^{91,94,100} burning
703 sensation,^{92,97} itching,^{92,94,97,100,109} redness,^{92,109} dryness,⁹² irritation,⁹⁷ fissures⁹⁷ and other
704 not-specified skin reactions.⁹⁰ Three studies reported allergy to CHG^{88/89,96,102} and two
705 reported discontinuation of CHG due to adverse events.^{97,100} Another three studies reported
706 adverse events, but did not specify what they were.^{86,93,99} Despite the many studies reporting
707 adverse events, meta-analysis showed that the overall rate of occurrence was low (0.15%)
708 and not significantly different than the rate reported for studies which did not use skin
709 decolonisation therapy or used a placebo (0.12%, OR=1.30 [CI95% 0.97-1.76], $p=0.0811$). The
710 use of oral CHG was associated with a higher risk of adverse events (24% versus 0% in
711 comparison group, OR=85.07 [CI95% 5.08-1424.00], $p=0.0020$) including burning sensation,
712 unpleasant taste, dryness of the mouth and tenderness. These results are based on one

713 study⁹² which reported the side effects when 2% CHG was used. Another study⁸⁶ which used
714 0.2% CHG reported no adverse events.

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

717 **Mupirocin**

718 There was strong evidence of benefit from the meta-analyses of ten RCTs,^{88/89,91-94,96,136-139}
719 two control trials,^{140,141} three ITS,^{104,105,111} and two retrospective cohort studies,^{115,142} which
720 investigated the effectiveness of nasal mupirocin on the prevalence of MRSA colonisation,
721 incidence of MRSA acquisition, incidence of MRSA infection and eradication of MRSA. The
722 results of the meta-analyses showed that mupirocin was not effective when used alone but
723 was effective when used in combination with a skin decolonisation agent (e.g. CHG, triclosan
724 or octenidine). When mupirocin was used alone, the prevalence of MRSA was 21.1% in the
725 mupirocin group versus 25.5% in the control group ($p=0.1636$), the incidence of infection was
726 2.54% versus 1.49%, $p=0.1100$, and the eradication rate was 60.5% versus 34.5%, $p<0.0001$.
727 When mupirocin was used alone or in combination with another therapy, the prevalence of
728 MRSA was 15.5% versus 25.5%, $p=0.0001$, the incidence of MRSA acquisition was 1.12%
729 versus 3.04%, $p<0.0001$, the incidence of acquisition per 1000pd was 0.62 versus 3.10,
730 $p<0.0001$, the incidence of infection was 0.20% versus 1.49%, $p<0.001$, the incidence of
731 infection per 1000pd was 0.02 versus 0.46, $p<0.0001$ and the rate of MRSA eradication was
732 63.2% versus 34.5%, $p<0.0001$. The two studies included a follow-up period (one month or
733 longer) after successful decolonisation and reported that in a large proportion of patients,
734 MRSA was redetected at follow-up.^{93,97} Both studies used mupirocin in combination with
735 CHG, but this finding needs to be considered as a possible outcome for other protocols such
736 as mupirocin alone or in combination with other agents. There was additional evidence from
737 one small ITS,¹¹² which used nasal mupirocin and 4% CHG wipes for patients colonised with
738 MRSA in a neonatal ICU and did not report a significant decrease in the incidence of MRSA
739 acquisition in the intervention period in comparison to pre-intervention (2.00 versus 2.38
740 events/1000pd, IRR=1.85 [CI95% 0.80–1.73], $p=NR$). This study had a small sample size; thus,
741 it was likely to be underpowered and at risk of type I error. Further evidence was obtained
742 from thirteen UBA studies,^{119,121,122,123,124,126,130-132,134,143-146} which found similar results.
743 Introduction of mupirocin itself was beneficial in one study¹⁴⁴ and not significantly reduced in
744 another.¹⁴⁵ Application of mupirocin in combination with a skin decolonisation agent was
745 beneficial in eight studies^{122,123,124,130-132,134,143} while three studies^{119,126,146} reported no
746 significant benefit.

747 There was strong evidence of no relationship between mupirocin use and resistance from
748 eight studies.^{92,93,97,105,132,138,141,147} Meta-analysis showed that the prevalence was slightly
749 higher in the group where mupirocin alone was used as compared to the no mupirocin group

750 (13.27% versus 11.18%), although the difference was not significant (OR=1.21 [CI95% 0.64-
751 2.29]).

752 There was moderate evidence from 12 studies,^{88/89,92-94,111,126,131,137,139,142} which reported
753 adverse events associated with the use of mupirocin. The studies reported discomfort,^{88/89}
754 burning sensation,⁹² itching,⁹² dryness,⁹² rhinorrhoea,⁹⁴ nasal irritation,⁹⁴ nose bleeds,¹³⁹
755 headaches,⁹⁴ congestion,⁹⁴ cough,⁹⁴ pharyngeal pain⁹⁴ and unspecified adverse
756 events.^{92,93,111,126,131,137,138,142} Two studies reported that treatment had to be discontinued due
757 to adverse events associated with mupirocin use in some patients^{94,138} and one study
758 reported that 38% of the patients considered the treatment to be unpleasant, regardless of
759 whether they experienced adverse events.⁹⁴ The results of meta-analysis showed that the use
760 of mupirocin was associated with an over-six-times higher risk of experiencing adverse events
761 when compared to a group that used no decolonisation or placebo (RR=6.44 [CI95% 4.85-
762 8.54], p<0.0001). When comparing to nasal placebo only, the incidence of adverse events with
763 mupirocin was significantly lower (RR=0.30 [CI95% 0.16-0.57], p=0.0002).

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

766 ***Octenidine***

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

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

786 There was weak evidence of resistance from one cross-sectional study,¹³⁵ which evaluated
787 MRSA isolates obtained from patients. The study reported that those patients who were
788 exposed to octenidine were more likely to carry MRSA isolates with disinfectant resistance
789 genes *qacA/B* than those who were not exposed (AOR=11.79, [CI95% 5.14-27.04], p<0.001)
790 but not more likely to carry the isolates with the *qacC* genes (AOR=0.55 [CI95% 0.23-1.31],
791 p=0.18). The authors reported that a higher proportion of isolates obtained from patients
792 previously exposed to octenidine had reduced susceptibility to octenidine (MIC levels \geq
793 mg/L) than the isolates from patients with no exposure history AOR=0.27, [0.08-0.95], p<0.01.

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

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

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

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

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

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

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

823 ***Other decolonisation therapies***

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

839 The Working Party considered the evidence and concluded that high quality studies support
840 the use of CHG and mupirocin, either used alone or in combination. Octenidine may be used
841 as an alternative when CHG is not feasible. The effectiveness of alternative agents, including
842 octenidine, PVP and triclosan needs to be adequately assessed. Concern remains about
843 resistance associated with the use of CHG and mupirocin. Whilst the meta-analysis for
844 mupirocin did not show that the risk of resistance increased with mupirocin use, the Working
845 Party concluded that this most likely reflected the ecology of changing MRSA strains and not
846 the evidence that the resistance is not resultant from the excessive use.

847 **Recommendations**

848 **6.1** Use mupirocin for nasal decolonisation, either selectively (i.e., for those who are
849 colonised) or universally (i.e., for all high-risk patients).

850 **6.2** Use chlorhexidine, either selectively or universally, for body decolonisation to reduce
851 MRSA carriage.

852 **6.3** Consider alternatives (e.g. octenidine) where mupirocin and chlorhexidine are not
853 feasible.

854 **6.4** Monitor the emergence of resistance, especially to mupirocin and chlorhexidine, if used
855 extensively.

856 **Good Practice Points**

857 **GPP 6.1** Follow manufacturers' guidance when using decolonisation products.

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

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

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

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

866 **GPP 6.6** Make healthcare workers and patients aware that decolonisation therapy does not
867 necessarily result in complete eradication but that achieving temporary suppression is
868 sufficient in many circumstances.

869

870 **8.7 What is the clinical and cost-effectiveness of environmental screening/sampling**
871 **in minimising the transmission of MRSA?**

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

880 No evidence was found in the studies published since 2004 which met the inclusion criteria
881 for the study design, and which assessed the benefit of environmental screening/sampling on
882 the prevalence of MRSA colonisation or the incidence of MRSA acquisition.

883 There was weak evidence from one stepped wedge trial¹⁵⁵ which assessed the effectiveness
884 of the cleaning/disinfection bundle on the rates of BSI in hospitals with ICUs. The bundle
885 consisted of training and providing advice on the use of cleaning/disinfection agents and the
886 feedback to staff after cleaning and disinfection. The study reported a beneficial improvement
887 in overall cleanness, but no effects on MRSA BSI (n=22, 0.17/10,000pd versus n=66,
888 0.19/10,000pd, p=0.7674). Further evidence came from one UBA study¹⁵⁶ which reported an

889 intervention where the environmental services staff received training, following which audits
890 were periodically conducted. General cleanness was assessed using adenosine triphosphate
891 (ATP) bioluminescence assay and results were fed back to the staff. The authors reported that
892 no changes were observed in the incidence of MRSA acquisition in the pre- and post-
893 intervention periods (n= 171 acquisitions versus=178 respectively, p value not reported).

894 No evidence was found in the studies published since 2004 which met the inclusion criteria for the
895 study design, and which assessed the cost-effectiveness of environmental screening/sampling.

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

900 **Recommendations**

901 **7.1** Do not screen/sample the environment routinely.

902 **7.2** Consider using environmental screening/sampling as part of targeted investigation of an
903 outbreak.

904

905 **8.8 What are the most effective cleaning/disinfection agents and technologies for** 906 **reducing environmental contamination in the near patient environment and** 907 **minimising transmission of MRSA?**

908 There is evidence supporting the role of cleaning and disinfection in hospitals as an important
909 intervention in the control of MRSA. Unfortunately, it often constitutes part of an overall IPC
910 package in response to an outbreak and its importance as a stand-alone activity remains
911 undetermined. There are a variety of cleaning and disinfection agents and technologies
912 available for reducing environmental contamination but guidance regarding the best
913 approaches is limited and the policies vary considerably between hospitals. Disinfection
914 agents include alcohols (e.g. isopropyl, ethyl alcohol, methylated spirit), quaternary
915 ammonium compounds (QAC) (e.g. alkyl dimethyl benzyl ammonium chloride, alkyl dimethyl
916 ethyl benzyl, ammonium chloride), phenolics (e.g. benzyl-4-chlorophenol, amyphenol,
917 phenyl phenol) and sodium hypochlorite (e.g. sodium dichloroisocyanurate). It is not known
918 which agents are efficient for decontamination (decontamination relates to a process where
919 microbial contamination is removed to render the environment or an item safe; please see
920 the glossary). Previous guidelines recommended that cleaning regimens and products should
921 be in accordance with local policy, and that they should include products able to remove
922 organic material.¹ Additionally, new approaches have been proposed, including room
923 decontamination with ultraviolet (UV) irradiation or hydrogen peroxide vapour (HPV) systems
924 or the use of antimicrobial surfaces, but their effectiveness in preventing MRSA acquisition
925 and infection was not discussed by the previous guidelines.¹

926 There was moderate evidence for benefit from two controlled trials^{157,158} and one ITS¹⁵⁹ which
927 investigated the effectiveness of HPV on hospital cleanness. All studies reported that using
928 HPV in addition to the standard cleaning and disinfection regimen (i.e., what was used in the
929 hospital before an intervention was introduced) resulted in a significantly lower number of
930 sites contaminated with MRSA. One study¹⁵⁷ in particular showed that the terminal cleaning
931 (this term is used to describe a process of thorough cleaning and disinfection; please refer to
932 glossary in Supplementary Materials file) with standard sanitiser (details not reported)
933 resulted in 66.1% of sites still being contaminated with MRSA as opposed to 1.2% when HPV
934 was added to post-manual cleaning and disinfection (OR=0.02 [CI95% 0.00-0.13], p<0.0001).
935 Another trial¹⁵⁸ which assessed the number of rooms contaminated with MRSA found a lower
936 rate of contamination in rooms where HPV was used in conjunction with manual cleaning and
937 disinfection with QAC, concentration not reported), although the difference was not
938 significant (2.02% versus 3.80%, OR=0.53 [CI95% 0.21-1.31], p=0.1708) compared to the
939 rooms terminally cleaned with QAC only. The last study¹⁵⁹ showed a significantly lower
940 proportion of sites contaminated with MRSA (6.2% versus 7.2%, OR=0.86 [CI95% 0.79-0.94],
941 p=0.0008). This translated to a significant reduction of MRSA acquisition (186 versus 334
942 cases, p<0.0001) and a small, non-significant decrease in MRSA BSI (0.11 versus 0.16
943 cases/1000pd, p=0.58). Further evidence came from one UBA study¹⁶⁰ which reported that
944 significantly fewer sites were contaminated with MRSA following the use of HPV when
945 compared to a standard cleaning/disinfection with QAC (concentration not reported) and
946 0.5% sodium hypochlorite (0.06% versus 2.14%, OR=0.03 [CI95% 0.01-0.11], p<0.0001).

947 There was inconsistent evidence of the benefit from one RCT,¹⁶¹⁻¹⁶³ one controlled trial,¹⁶⁴
948 one ITS¹⁶⁵ and two CBA studies^{166,167} which assessed the effectiveness of UV devices on the
949 colony counts and the reduction of MRSA contamination^{163,164} and MRSA acquisition
950 rates.^{161,162,165-167} One RCT, which was described in three separate articles¹⁶¹⁻¹⁶³ reported that
951 MRSA acquisition and infection rates were not affected using UV-C light devices. This was
952 regardless of whether the outcomes were assessed on the whole hospital population¹⁶²
953 (n=259, 0.31% in QAC + UV-C light arm, n=242, 0.29% hypochlorite + UV-C arm versus n=204,
954 0.27% in QAC arm) or just patients in rooms previously occupied by MRSA carriers¹⁶¹ (n=54,
955 1.6% in QAC + UV-C light arm, n=89, 2.3% hypochlorite + UV-C arm versus n=73, 2.1% in QAC
956 arm). These studies showed that UV-C light may be used as a part of an IPC strategy due to
957 their benefits in controlling bacteria other than MRSA. The authors collected environmental
958 samples and published the data in a separate article.¹⁶³ The mean number of colony forming
959 units (cfu) in rooms and bathrooms was 8.52 in the QAC group, 4.34 in hypochlorite group
960 and 0.11 and 0.85 for QAC and hypochlorite with UV-C groups, respectively (significance not
961 reported). Another controlled trial¹⁶⁴ reported that the colony counts and the reduction of
962 MRSA contamination from baseline did not improve following the introduction of the UV-C
963 light system (99.4% versus 91.1% hypochlorite (1:10) alone). This study reported a high
964 variation in colony counts in the manual cleaning/disinfection arm, which was attributed to
965 inconsistencies in cleaning and disinfection by the personnel. Two low-quality CBA

966 studies^{166,167} conducted in ICUs and one ITS¹⁶⁵ showed the benefit of adding pulsed-xenon UV
967 (PX-UV) device to standard cleaning and disinfection with either QAC (concentration not
968 reported),¹⁶⁶ hypochlorite (concentration not reported),¹⁶⁷ or standard cleaning and
969 disinfection (details not reported).¹⁶⁵ The first CBA study¹⁶⁶ reported that the incidence of
970 MRSA acquisition in the intervention ICUs decreased from 3.56 to 2.21 events per 1000pd
971 (IRR=0.556 [CI95% 0.309–0.999], p=0.0497) following the use of PX-UV device, while it
972 significantly increased from 0.33 to 0.38 events per 1000pd (IRR=10.967 [CI95% 7.061–
973 17.033], p<0.0001) in other hospital wards. The second study¹⁶⁷ reported a decrease from
974 14.02 to 9.5 MRSA acquisitions per 10,000pd (IRR=0.71 [CI95% 0.57-0.88], p<0.002) in the
975 intervention ICUs using a PX-UV device, while reporting that the neighbouring high care units
976 and the general wards did not experience a decrease in MRSA acquisitions (IRR=0.85 [CI95%
977 0.65-1.12], p=0.283 and IRR=1.14 [CI95% 0.62-2.12], p=0.663 respectively). Finally, one ITS¹⁶⁵
978 reported a benefit of adding a UV-C device to standard cleaning and disinfection (not
979 described) in general acute wards. The device resulted in the incidence of HCAI-MRSA
980 decreasing from 0.7% (91/12,747 or 1.42/1000pd) to 0.5% (61/13,177, RR=0.65 [CI95% 0.47-
981 0.70], p=0.0087 or 0.98/1000pd), which in ITS analysis corresponded to a 30.79% reduction,
982 p=0.02. The authors reported annual savings of USD 1,219,878 (approx. £889,474) mostly due
983 to a decreased length of stay (LOS). Further evidence came from two UBA studies which used
984 UV-C devices and found no effect on MRSA colonisation¹⁶⁸ or infection.¹⁶⁹

985 There was weak evidence of no benefit from one controlled study with crossover¹⁷⁰ and
986 RCT¹⁷¹ which assessed the effectiveness of adding copper fittings to high-touch surfaces to
987 prevent MRSA transmission. One study¹⁷¹ reported no difference in the incidence of MRSA
988 infections in patients admitted to isolation rooms with copper surfaces (2/36) as compared
989 to standard surfaces (3/34, OR=0.63 [CI95% 0.10-.4.00], p=0.6240). Another study¹⁷⁰ reported
990 that adding copper fixtures did not result in a decrease in the number of sites being
991 contaminated with MRSA (2.3% versus 3.7% for the sites without copper, OR=0.621, [CI95%
992 0.306-1.262], p=0.217). Both studies concluded that copper surfaces can be used as a part of
993 an IPC strategy due to their benefits in controlling bacteria other than MRSA.

994 There was weak evidence of benefit from one RCT of acceptable quality¹⁷² and low-quality
995 controlled trial¹⁷³ which assessed the effectiveness of antimicrobial curtains. The RCT¹⁷²
996 compared the MRSA contamination (no patient outcomes) of standard curtains and
997 antimicrobial curtains impregnated with halamine (BioSmart®) with or without hypochlorite
998 spray twice weekly. The authors described that halamine curtains can be 're-charged' with
999 hypochlorite, during which process amine polymers impregnated into the fabric are able to
1000 bind the chlorine ions, which in turn provide an antimicrobial benefit. The study reported no
1001 decrease in the number of curtains contaminated with MRSA when comparing the halamine
1002 and standard curtains (7/14, 50% versus 7/13, 53.8%, not significant). There was no decrease
1003 when comparing the standard curtains to curtains pre-sprayed in halamine with the
1004 hypochlorite group (7/13, 53.8% versus 6/14 (42.9%, not significant). The number of
1005 contaminated curtains after spraying reduced from six (42.9%) to one (7.1%, significance not

1006 reported). Another study, which was a low-quality controlled trial¹⁷³ compared two different
1007 types of antimicrobial curtain (impregnated with either silver, or QAC combined with
1008 polyorganosiloxane) to a standard curtain. There was a significant decrease in the number of
1009 curtains contaminated when comparing curtains impregnated with QAC and
1010 polyorganosiloxane (3/580, 0.5%) and a standard curtain (204/507 (40.2%), RR=0.02 [CI95%
1011 0.00-0.04], p<0.0001, a difference of 39.7% [CI95% 34.8–44.0%], but no decrease in the
1012 number of curtains contaminated with MRSA when comparing silver impregnated (137/267,
1013 51.3%) and the standard curtain (204/507 (40.2%), RR=1.28 [CI95% 1.09-1.49], p=0.0025.

1014 There was weak evidence from one UBA study¹⁷⁴ assessing the effectiveness of titanium
1015 dioxide-based photocatalyst reactive to visible light, which was painted to the walls and high-
1016 touch surfaces in medical ICU rooms. The authors reported a significant decrease in the
1017 number of MRSA acquisitions by patients (4/280, 1.4% or 2.57/1000pd) from the pre-
1018 intervention period (15/341, 4.4% or 9.30/1000pd, p=0.01; IRR=0.26 [CI95% 0.06–0.81]).

1019 There was inconsistent evidence of benefit reported by one RCT^{161/162}, three controlled
1020 trials¹⁷⁵⁻¹⁷⁷ and two ITS^{178,179} studies investigating different types of cleaning and disinfection
1021 agents. One ITS,¹⁷⁸ which replaced hypochloric acid (concentration 1000ppm) with chlorine
1022 dioxide (concentration 275 ppm) reported a significant change in MRSA acquisition per 100
1023 bed days/month at 12 months from the start of the intervention. Another ITS¹⁷⁹ reported that
1024 switching from cleaning with detergent wipes followed by alcohol wipes (details on
1025 ingredients and concentration not reported) to one wipe system (containing <0.5%
1026 benzalkonium chloride, <0.5% didecyl dimethyl ammonium chloride and <0.10%
1027 polyhexamethylene biguanide) in a general hospital setting, resulted in the reduction of the
1028 incidence of MRSA acquisition from 26.8 per 100,000pd to 9.4 per 100,000pd (p<0.0001). The
1029 authors reported that there was no significant difference in the incidence of MRSA BSI
1030 between the pre- and post-intervention periods (1.8 and 0.2 per 100,000pd respectively, p
1031 value not reported). One controlled trial¹⁷⁶ reported beneficial effects of 10% bleach (not
1032 specified, presumably hypochlorite) compared to Biomist® (QAC in 58.6% alcohol), with the
1033 proportion of sites contaminated with MRSA in Biomist® group reported as 5/23 (21.7%),
1034 while there were no contaminated sites in the bleach group (0/40, 0%, p=0.0007). Other
1035 controlled trials did not report any difference in cleaning and disinfection or clinical outcomes
1036 when using a disinfectant with QAC (0.25% QAC, referred to as ammonium arm) versus bleach
1037 arm (1:10 hypochlorite wipes),^{161/162} or QAC (concentration not reported) versus 0.5%
1038 hydrogen peroxide wipes¹⁷⁵ or when comparing QAC (concentration not reported), 10%
1039 hypochlorite, hydrogen peroxide with peracetic acid (concentration not reported) or standard
1040 detergent (i.e., what was previously used in practice, details not reported) to each other.¹⁷⁷
1041 Further evidence came from two UBA studies. One study¹⁸⁰ reported no change in
1042 environmental contamination after switching from standard detergent (details not reported)
1043 to sodium hypochlorite with 1000ppm chlorine (13.2% versus 10.1%, OR=1.31 [CI95%0.70-
1044 2.46], p=0.4021). Another study¹⁸¹ used JUC® spray, a polymeric surfactant containing QAC
1045 (concentration not reported), which was sprayed on the surfaces following the cleaning. The

1046 study found that none of the bed units (0/18, 0.0%) were contaminated with MRSA following
1047 the treatment. This was in contrast to 4/18 (22.2%) of sites cleaned with hypochlorite,
1048 concentration not reported (OR=0.11 [CI95% 0.01-2.21], p=0.1501). The study was too small
1049 to draw inferences, but authors concluded that JUC® spray may be beneficial in controlling
1050 staphylococcal load for up to four hours following its application.

1051 No evidence was found in the studies published since 2004 which met the inclusion criteria for the
1052 study design, and which investigated the cost-effectiveness of different cleaning and
1053 disinfection agents or hands-free devices.

1054 The Working Party considered the data above and, together with clinical experience of the
1055 Working Party members, concluded that there is no evidence that antimicrobial surfaces can
1056 control MRSA. Some new technologies can be used as a part of wider IPC strategy to eliminate
1057 the inconsistencies associated with manual cleaning and disinfection, while HPV/UV-C/PX-UV
1058 may be beneficial as a part of terminal cleaning. The Working Party considered that the
1059 disinfection agents have similar efficacy against MRSA.

1060 **Recommendations**

1061 **8.1** Continue using currently utilised products approved for use in healthcare.

1062 **8.2** Consider hydrogen peroxide vapour (HPV) or ultraviolet (UV-C, PX-UV) devices as an
1063 adjunct to terminal cleaning as a part of a wider IPC strategy.

1064

1065 **8.9 What is the evidence that local surveillance and feedback to staff is effective in** 1066 **minimising the transmission of MRSA?**

1067 Surveillance plays two roles with respect to IPC: it allows detection of infected/colonised
1068 individuals necessary for their removal from the general population, and it allows
1069 quantification of control success. Many hospitals have introduced surveillance systems to
1070 monitor MRSA cases. This surveillance can be used to assess the infection risk of people in
1071 hospital and inform the response. Since the last guidelines were published, mandatory
1072 national surveillance of MRSA cases has been set up in many countries, with hospitals being
1073 required to report infections to public health bodies (for example, in England, acute trusts are
1074 required to report all cases of BSI). This not only allows monitoring on a hospital level, but
1075 also allows the hospitals to compare their data to other facilities and to the national average.

1076 There was moderate evidence from one RCT¹⁸² and two ITS^{183,184} studies which assessed the
1077 effectiveness of hospital surveillance on the incidence of MRSA BSI or MRSA acquisition.

1078 One study,¹⁸² which recruited three units in participating hospitals and randomly assigned
1079 one unit into each intervention, used statistical process control charts (SPC) to monitor and
1080 feedback the MRSA acquisition rates to the staff on participating units. The authors reported

1081 a decrease in the average MRSA acquisition rates in the units which used either SPC charts
1082 alone or SPC charts with Pareto charts, which promoted IPC improvements on the units in
1083 comparison to the wards which did not use the charts. For the SPC group, the authors
1084 reported that the MRSA rate was stable during the baseline period with a possible increase in
1085 acquisition as observed from the last six points on the chart before the intervention was
1086 introduced. A monthly average of 48 cases was observed during the baseline period, which
1087 fell to 30 cases per month post-intervention. For SPC + Pareto charts, continuous post-
1088 intervention improvements were observed with the average MRSA acquisition reduced from
1089 50 to 26 cases per month. Lastly, the control arm experienced a slight pre-intervention
1090 reduction and a more significant post-intervention reduction from an average of 49 cases to
1091 36 per month. This decrease was not sustained, and in the last six out of seven points shown
1092 on SPC charts, an increase in the number of MRSA acquisitions was observed. One ITS¹⁸³
1093 showed a marked reduction in BSI in ICU as well as other hospital patients even though the
1094 surveillance was limited to ICU only. The authors did not report a p value, but the prevalence
1095 rate was 1.6/1000pd in ICU and 0.6/1000pd in hospital. These rates are substantially lower
1096 than those predicted by ITS analysis which would have been 4.1/1000pd and 1.4/1000pd,
1097 respectively, if surveillance was not in place. The authors did not report any information about
1098 the interventions which were introduced following the surveillance. The last ITS study,¹⁸⁴
1099 which used SPC charts to feed the data back to staff to drive the improvement across the
1100 hospital, reported that the incidence of MRSA acquisition across the hospital decreased from
1101 3.0 [CI95% 2.8-3.2] to 1.7 [CI95% 1.6-1.8] events per 100 patient admissions ($p < 0.001$). The
1102 decrease was also observed in ICUs (9.3 [CI95% 7.5-11.2] versus 6.7 [CI95% 5.2-8.5], $p = 0.047$).
1103 The authors reported that a significant decrease was observed in hospital MRSA BSI (0.45
1104 [CI95% 0.38-0.52] pre-intervention versus 0.27 [CI95% 0.24-0.32] per 100 patient admissions,
1105 $p = 0.02$ post-intervention) as well as in ICU central line-associated MRSA BSI (CLABSI) (2.0
1106 [CI95% 1.3-3.0] versus 1.1 [CI95% 0.7-1.7] per 100 device days, $p = 0.018$ for pre- and post-
1107 intervention respectively).

1108 Further evidence of the benefit came from a total of eight UBA studies.¹⁸⁵⁻¹⁹² Two of these
1109 studies reported a decreased prevalence of MRSA colonised patients in their hospitals.^{186,187}
1110 One study,¹⁸⁵ which reported a very low baseline prevalence of MRSA demonstrated that five
1111 years after the start of a mandatory surveillance of MRSA BSI cases, the prevalence of MRSA
1112 did not decrease significantly in their hospital (4.3% versus 12.2%, $p = 0.317$) when comparing
1113 all MRSA isolates. A significant change was observed when only non-BSI isolates were
1114 included (3.5% versus 8.6%, $p < 0.001$). While the rate of MRSA BSI remained unchanged
1115 throughout the five years (data not reported, $p = 0.555$), the rate of non-BSI isolates decreased
1116 each quarter by 0.47-1.61 cases/1000 patient episodes, which was significant ($p = 0.007$). The
1117 authors concluded that since the rate of MRSA BSI was very low in their setting, surveillance
1118 of non-BSI cases may be more beneficial. Furthermore, of the UBA studies which reported
1119 incidence of MRSA infection, four reported that the incidence of MRSA BSI declined following
1120 the introduction of surveillance,^{187,190-192} two reported no benefit^{185,189} and, one reported the
1121 benefit on some but not all units in the hospital.¹⁸⁸

1122 The Working Party considered the evidence from the included studies and together with the
1123 evidence from previous guidelines and the clinical experience of the Working Party members,
1124 concluded that hospital surveillance must remain a component of any strategy to prevent and
1125 control MRSA infections.

1126 **Recommendation**

1127 **9.1** Undertake surveillance routinely as part of the hospital's infection prevention and control
1128 strategy and to comply with mandatory national requirements.

1129

1130 **8.10 What is the evidence that local and/or national surveillance for MRSA is** 1131 **effective in driving service/ system improvement?**

1132 Beyond the hospital-wide surveillance system further extensive surveillance of MRSA cases
1133 may be performed at unit level. Previous MRSA guidelines concluded that surveillance must
1134 be undertaken routinely as part of the hospital's IPC programme and that it must be a
1135 recognised element of the clinical governance process. Thus, there should be clear
1136 arrangements identifying those responsible for acting on the results in individual hospital
1137 directorates. This question was not assessed in our previous MRSA guidelines and no
1138 recommendation was made.

1139 No evidence was found in the studies published since 2004 which met the inclusion criteria
1140 for the study design, and which assessed the effectiveness of local versus national surveillance
1141 for MRSA in driving service or system improvement.

1142 Other sources of evidence were considered. One excluded study,¹⁹³ which did not meet the
1143 criteria for this review, reviewed the data of the mandatory surveillance of MRSA in England.
1144 Since 2001 when mandatory surveillance was introduced, all acute trusts reported the data
1145 quarterly. This data was publicly published, and the feedback was given to the trusts.
1146 Additionally, the trusts were given a target to reduce their MRSA BSI rates by 50% by 2008
1147 and all trusts not meeting their trajectories were audited. The overall rate of BSI in England
1148 decreased by 56% between 2004 and 2008 and further decreased by 50% from 2008 to 2011,
1149 reaching 1.8 cases per 100,000pd. The authors reported that mandatory surveillance and
1150 feedback from the surveillance drove the implementation of interventions which ultimately
1151 contributed to reduced incidence of MRSA BSI.

1152 Data on MRSA BSI surveillance for England, Scotland, Wales and Northern Ireland as well as
1153 all European Union countries are available (<https://www.gov.uk/government/statistics/mrsa-BSI-annual-data>;
1154 <https://ecdc.europa.eu/en/antimicrobial-resistance/surveillance-and-disease-data/report>).
1155

1156 The Working Party considered the evidence from the above study, and together with the
1157 evidence from previous guidelines and the clinical experience of the Working Party members,
1158 concluded that recommendation cannot be made based on current knowledge.

1159 **Recommendation**

1160 **10.1** No recommendation

1161 **Good Practice Point**

1162 **GPP 10.1** Consider using local surveillance of MRSA acquisition (colonisation and infection) as
1163 a component of local strategies to prevent and control MRSA and to drive improvement
1164 where needed.

1165

1166 **8.11 To what extent are contact precautions effective in minimising the**
1167 **transmission of MRSA? To what extent does the isolation or cohorting of patients**
1168 **minimise the transmission of MRSA and what are the costs?**

1169 *Staphylococcus aureus* is a commensal organism of human skin occupying body sites such as
1170 nose, axilla, and groin. Patients with MRSA are commonly colonised at these body sites and
1171 the organism may contaminate their immediate environment.¹⁹⁴ Transmission of MRSA in
1172 healthcare settings occurs when *Staphylococcus aureus* is acquired on the hands of staff and
1173 then transferred to other patients, surfaces or equipment.¹⁹⁵ Hand hygiene with either soap
1174 and water or alcohol hand rub removes microorganisms including MRSA from hands, and
1175 interrupts transmission.¹⁹⁶ Standard precautions¹⁹⁷ and recommendations from the WHO
1176 Hand Hygiene guidelines¹⁹⁶ require that staff wash their hands before and after direct contact
1177 with the patient and their immediate environment, and any susceptible site on the patient.
1178 Standard precautions are therefore essential to prevent transmission of MRSA to other
1179 patients and protect susceptible sites on the patient from infection.¹⁹⁶

1180 The previous MRSA guidelines¹ found consistent weaknesses in studies reporting the use of
1181 screening and isolation interventions for the prevention of MRSA because many reports
1182 describe the simultaneous implementation of multiple interventions, making it difficult to
1183 draw clear conclusions about the effect of any intervention independently. They concluded
1184 that there was some acceptable evidence that screening and isolation of patients contribute
1185 to reductions in MRSA outbreak and endemic situations. The recommendations in the
1186 previous guidelines were therefore that 'a standard approach to isolation precautions should
1187 be adopted in accordance with the general principles of IPC, rather than introducing specific
1188 guidance for the management of MRSA that may lead to differing standards.' The guidelines
1189 recommended that patients were managed in accordance with the type of setting, the
1190 resources available locally (e.g. numbers of isolation rooms), and the risk that they pose to
1191 others or that is posed to them.

1192 Since then, the US guideline for isolation precautions has been published¹⁹⁸ which
1193 recommended the use of CP for the management of patients with some multidrug-resistant
1194 organisms (MDRO), although not specifically MRSA. This guidance recommends that, to
1195 contain pathogens, staff don PPE on room entry and discard it on exit, and more specifically
1196 that gloves and gowns should be worn when touching patients' intact skin or surfaces in close
1197 proximity to the patient. The recommendations are based on a theoretical rationale rather
1198 than epidemiological evidence that the use of PPE in this way prevents transmission of
1199 MDRO.¹⁹⁸ These guidelines recommended that room cleaning and disinfection is prioritised
1200 for patients on CP. The use of CP for the management of patients with MDRO is now
1201 widespread but in the UK setting plastic aprons are used in place of gowns. Evidence for the
1202 efficacy of CP in reducing transmission of MRSA is uncertain as there are limited acceptable
1203 studies that compare CP versus the absence of CP independently.

1204 There was inconsistent evidence from two cluster RCT^{199,200} and three ITS²⁰¹⁻²⁰³ studies which
1205 investigated the effectiveness of CP on MRSA acquisition and infection. One study,¹⁹⁹ which
1206 used active surveillance combined with CP for MRSA positive patients and universal gloving
1207 until patients were confirmed as MRSA negative, reported no significant difference in the
1208 incidence of new MRSA acquisitions. This study used CP in both groups, with one arm
1209 extending the application of CP (universal gloving) to a broader set of potential carriers in
1210 combination with enhanced surveillance and screening. Another study²⁰⁰ compared universal
1211 gloving for all patient contacts with CP (gloves/gowns) for patients known to be MRSA
1212 positive. Universal gloving was associated with a significant decrease in new MRSA
1213 acquisitions (-2.98 risk difference between intervention and control group; p=0.46) but the
1214 effect of CP versus no CP was not tested. One ITS²⁰¹ found no difference in MRSA acquisition
1215 in MRSA colonised or infected patients placed in a single room or nurse cohorted patients as
1216 compared to patients with no single room or cohorting. Standard precautions were used with
1217 all patients, but this included elements of CP (aprons for all patient contact, gloves for all
1218 devices and washing patients). Another ITS²⁰² found a 60% reduction in MRSA acquisition
1219 associated with rapid screening, CP and isolation, compared to no isolation and standard
1220 precautions (adjusted HR=0.39, [CI95% 0.24-0.62]; p<0.001; segmented regression change in
1221 slope p<0.001). This study was sensitive to bias as a stricter screening method was used during
1222 the intervention period, the separate effect of single room and CP were not distinguished,
1223 and the study was conducted in an ICU where MRSA was endemic, and decolonisation was
1224 not a routine practice. One very low-quality ITS²⁰³ in an acute hospital found a decrease in
1225 MRSA device-associated infection rates associated with discontinuing CP for known MRSA
1226 positives, but other practice changes were introduced at the same time.

1227 There was moderate evidence of a negative effect of CP on the patient experience and mental
1228 wellbeing from five qualitative studies.²⁰⁴⁻²⁰⁷ These studies focused specifically on the impact
1229 of isolation for MRSA colonisation or infection. These studies concluded that isolation had an
1230 impact on patient experience and resulted in increased anxiety and low mood.²⁰³⁻²⁰⁷
1231 Additionally, in a study of 57 Dutch MRSA colonised patients,²⁰⁸ it was reported that a

1232 substantial proportion of MRSA carriers reported stigma due to MRSA, and stigma was
1233 associated with poor mental health. These studies were all small scale, in different
1234 populations and for varying durations of isolation. They reported mixed findings but
1235 suggested that isolation should be of as short a duration as possible to avoid anxiety and
1236 potential depression.

1237 No evidence was found from the studies published since 2004 meeting the inclusion criteria
1238 for the study design, which assessed the cost-effectiveness of CP.

1239 Additional evidence was obtained from national guidelines¹⁹⁷ and seven UBA studies^{154,209-214}
1240 which attempted to discontinue CP in hospitals (including ICU and general wards). In one of
1241 these studies a nurse cohorting area was associated with a significant decrease in MRSA
1242 transmission.²⁰⁹ Another study²¹⁰ found no effect of including gowns as part of CP on risk of
1243 MRSA transmission. The remaining studies^{154,211-214} found no difference in the rate of MRSA
1244 acquisition associated with discontinuation of CP for known MRSA patients.

1245 The Working Party considered the evidence from the included studies together with the
1246 evidence from previous guidelines and the clinical experience of the Working Party members,
1247 and concluded that the decision to isolate or cohort patients colonised with MRSA should be
1248 based on risk assessment and patient experience. Currently there is little evidence that CP are
1249 necessary, but the Working Party acknowledged that they are widely used in health and care
1250 settings and that some facilities may decide to continue with this practice.

1251

1252 **Recommendations**

1253 **11.1** Use standard infection prevention and control precautions in the care of all patients to
1254 minimise the risk of MRSA transmission.

1255 **11.2** For patients known to be colonised/infected with MRSA, consider using contact
1256 precautions for direct contact with the patient or their immediate environment. If contact
1257 precautions are used, gloves and aprons must be changed between care procedures and hand
1258 hygiene must be performed after glove removal.

1259 **11.3** Consider placing patients colonised or infected with MRSA in a single room. The decision
1260 to use a single room should be based on a risk assessment that considers the risk of
1261 transmission associated with the patient's condition and the extent of colonisation or
1262 infection (e.g. sputum, exfoliating skin condition, large open wounds) and the risk of
1263 transmission to other patients in the specific care setting e.g. in burns units.

1264 **11.4** Where isolation is deemed necessary, isolate patients for the shortest possible time to
1265 minimise feelings of stigma, loneliness, and low mood.

1266 **11.5** Provide clear information to patients about the need for the use of protective equipment
1267 to reduce feelings of stigma.

1268 **11.6** Be consistent in the use of protective equipment to ensure that patients have confidence
1269 in the decision to place them in isolation.

1270

1271 **Good Practice Points**

1272 **GPP 11.1** Advise visitors about the need and available facilities for hand hygiene.

1273 **GPP 11.2** Where applicable, advise visitors about the use gloves and aprons.

1274 **GPP 11.3** When considering the need to isolate a patient with MRSA in a single room, other
1275 demands on single-room use may take priority and alternative strategies such as nurse
1276 cohorting may be appropriate.

1277 **GPP 11.4** If isolation or cohorting of MRSA patients is not possible, use decolonisation therapy
1278 to temporarily suppress MRSA and prevent transmission to other patients.

1279 **GPP 11.5** Prioritise room cleaning and disinfection for MRSA patients placed in isolation or on
1280 contact precautions.

1281

1282

1283 **8.12 What is the evidence that the transfer of patients who are colonised or** 1284 **infected with MRSA between wards/ other care settings contributes to the** 1285 **transmission of MRSA?**

1286 Patients who are colonised or infected with MRSA have the potential to transmit MRSA to
1287 other patients in the same clinical area. Frequent movement of patients within a single
1288 healthcare setting or movement between related healthcare settings has the potential to
1289 increase the transmission of MRSA within the healthcare population and between different
1290 care settings such as a hospice or residential home. The evidence is currently lacking in
1291 establishing the effect of intra- and inter- hospital transfers of patients with MRSA on the rate
1292 of new acquisition of MRSA. Evidence for the impact that transferring patients between
1293 different units has on the transmission of MRSA can be derived from studies that have used
1294 genotyping of isolates to track the transmission of MRSA between patients. In this way,
1295 epidemiological links can be established to provide evidence for the extent to which the
1296 transfer of patients within and between healthcare facilities contributes to the transmission
1297 of infection. Previous MRSA guidelines recommended that patient transfers should be kept
1298 to a minimum.

1299 There was moderate evidence from two cross-sectional surveys^{215,216} one prospective cohort
1300 study²¹⁷ and one surveillance study²¹⁸ which investigated the effect of patient transfer on
1301 MRSA transmission. One study²¹⁵ using whole genome sequencing (WGS) to investigate the
1302 origins of 685 MRSA isolates identified in a 13-month period from a total of 610 patients in a
1303 single healthcare network comprising of three hospitals, outpatients and community settings,
1304 found that 41% (248/610) of MRSA patients were linked in a total to 90 transmission clusters
1305 (defined as at least two patients), most of which (68%, 61/90) involved multiple settings. Of
1306 these clusters, 42 (38%) involved different settings within one hospital and 30% (n=27)
1307 involved more than one hospital. One transmission cluster involved 32 patients between all
1308 three. Complex patterns of frequent hospital stays resulted in 81% (26/32) of the MRSA
1309 patients who were identified having had multiple contacts with one another during ward stays
1310 at any hospital but no outpatient contact, and had shared a GP (general practitioner) or
1311 residential area, suggesting that MRSA was transmitted on the wards and spread to other
1312 settings as a result of transfers. Another study²¹⁶ used a social network approach by analysing
1313 Hospital Episode Statistics (HES) data in England from April 2006 to March 2007 to determine
1314 how movements between healthcare institutions, which were derived from patient
1315 admissions, affected the incidence of BSI. The MRSA incidence rate for a hospital (adjusted
1316 for cluster-specific mean MRSA BSI rates) was found to be contingent on the number of
1317 patients it shared with other hospitals within its cluster. The incidence of MRSA BSI increased
1318 as the interconnectedness of the hospitals surveyed increased, with strongly connected
1319 hospitals in large clusters found to have significantly higher MRSA BSI rates than less
1320 connected hospitals. Another study²¹⁷ obtained genotypes and matched the MRSA screening
1321 results from admission and discharge from all patients previously admitted to 36 general
1322 specialty wards at two Scottish hospitals. The prevalence of MRSA in discharge screens was
1323 2.9% [CI95% 2.43-3.34] and in the set of 2724 patients with paired screens, the odds ratio of
1324 acquiring MRSA was 2.64 for patients who stayed on four or more wards compared to those
1325 who stayed in three or less. In the last study,²¹⁸ surveillance cultures were obtained from 584
1326 residents admitted to nursing facilities within one healthcare network, representing
1327 approximately half of the residents who were admitted to these facilities during the study
1328 period. Surveillance cultures were obtained at admission together with data on healthcare
1329 contact and antimicrobial use. WGS was performed and the analysis focused on isolates which
1330 appeared genetically similar. The gene flow in these facilities was estimated based on single
1331 nucleotide variants using Wright's F statistic. A total of 89/117 (76%) MRSA isolates belonged
1332 to ST5 or closely related isolates. The authors observed a positive correlation between patient
1333 sharing between hospitals and nursing facilities and concluded that the burden of antibiotic
1334 resistant organisms (including MRSA) was endemic in their healthcare network and driven by
1335 patient sharing in these institutions.

1336 There was moderate evidence from five epidemiological investigations of outbreaks,²¹⁹⁻²²³
1337 which assessed the effect of patient transfers on transmission of MRSA. These studies
1338 involved specific outbreak clones, which facilitated investigation of transmission events, and

1339 provided data on the role of hospital transfers. One study²²² reported an outbreak of an
1340 unusual New York/Japan epidemic MRSA clone in Western Australia in 22 patients and two
1341 healthcare workers who acquired the MRSA. Transfers between another acute hospital (n=3
1342 patients), a community hospital (n=4 patients) and regional care facility (n=3 patients)
1343 illustrated how patients acted as vectors and contributed to the transmission of infection.
1344 Another study²¹⁹ reported transmission of four new cases of a Panton-Valentine leucocidin
1345 (PVL) MRSA strain from a patient transferred from another hospital, while another study²²⁰
1346 identified MRSA transmission to 13 patients and nine healthcare workers from patients
1347 transferred from another hospital. One outbreak investigation²²³ identified that transfer of
1348 patients between neonatal and paediatric ICU was a key factor in the transmission of MRSA
1349 with a total of 13 patients in paediatric ICU and 14 patients in neonatal ICU acquiring the same
1350 MRSA strain. In another outbreak investigation,²²¹ a total of 16 cases of MRSA transmission
1351 occurred from a baby, which was transferred from another hospital.

1352 There was moderate evidence from eleven risk factor studies²²⁴⁻²³⁴ which investigated the risk
1353 of MRSA acquisition related to transfers between healthcare settings. The studies found that
1354 admissions from other acute settings^{224,225,227,229} and long-term settings²²⁴⁻²²⁹ were significant
1355 risk factors for detection of MRSA on admission. In a logistic regression model analysis of
1356 81,000 admissions to acute care in Scotland,²³¹ admission 'not from home' was a significant
1357 risk factor for MRSA colonisation on admission (OR=3.025 [CI95% 2.685-3.407] and the risk of
1358 colonisation increased with the frequency of previous admissions (four or more previous
1359 admissions OR=2.484 [CI95% 2.111-2.923]. Although there was a higher incidence of MRSA
1360 acquisition for patients who stayed in more wards, this was not statistically significant
1361 (OR=1.91 [CI95% 0.97-3.98], p=0.061). Another multivariate analysis of 12,072 admissions
1362 (399 with MRSA) to a university hospital in Switzerland²²⁶ found patients who were admitted
1363 as an inter-hospital transfer had an odds ratio of 2.4 [CI95% 1.3-4.4] for MRSA carriage.
1364 Another Swiss study²³³ of 1621 patients admitted to a geriatric unit, identified an increased
1365 risk of MRSA on admission screening associated with intra-hospital transfer (adjusted OR=2.5;
1366 [CI95%1.2–5.3] p=0.02) and hospitalisation within the last 2 years (adjusted OR=2.7 [CI95%
1367 1.1–6.0], p=0.03) and in a small case-control study of 187 admissions to surgical wards of a
1368 limited resource hospital in Indonesia, transfer from another hospital was associated with an
1369 increased risk of MRSA carriage (OR=7.7 [CI95% 1.2-9.1]).²³² One case-control study,²³⁴ which
1370 investigated risk factors for MRSA acquisition in a neonatal ICU identified bed transfer as a
1371 potential risk factor, but this was insignificant in the multivariate analysis (43/67, 64% versus
1372 103/201 (51%), OR=1.83 [CI95% 0.97–3.49], p=0.06).

1373 Further cross-sectional studies investigated prevalence and reasons for MRSA acquisition.
1374 These studies reported higher prevalence of MRSA in patients previously exposed to another
1375 ward,²³⁵ another hospital,²³⁶ or a long-term facility.²³⁷ Another cross-sectional study²³⁸
1376 compared the incidence of MRSA acquisition for the patients who stayed in two, three or four
1377 and more wards to the patients who were in one ward during their hospital stay. When the
1378 groups of multiple wards were combined, there was a higher incidence of MRSA acquisition

1379 than for patients who stayed in one ward, although this was not significant (OR=1.91 [CI95%
1380 0.97-3.98], p=0.061). When the groups were compared separately, the risk increased with the
1381 number of wards the patients stayed in, although this was still not significant. Lastly, one case-
1382 control study²³⁹ which investigated the incidence of MRSA infection reported no increased
1383 risk in patients transferred to another hospital when compared to those who remained in one
1384 hospital throughout their stay.

1385 The Working Party considered the above evidence and the recommendations from previous
1386 guidelines and concluded that evidence suggests that patient transfers contribute to
1387 transmission of MRSA.

1388 **Recommendations**

1389 **12.1** Do not transfer patients between wards, units, hospitals, or other clinical settings unless
1390 it is clinically necessary.

1391 **12.2** Inform the receiving ward/unit/care home and the ambulance/transport service that the
1392 patient is colonised/infected with MRSA.

1393

1394 **Good Practice Point**

1395 **GPP 12.1** MRSA colonisation is not a barrier to discharging patients to another health care
1396 setting, their home or residential care.

1397

1398 **8.13 What role does shared equipment have in the transmission of MRSA and how** 1399 **should shared equipment be decontaminated?**

1400 One of the risks for transmitting MRSA to patients within healthcare premises or long-term
1401 care facilities is the use of improperly cleaned and disinfected medical equipment. When
1402 equipment is shared and not cleaned in between patient use, transmission of organisms such
1403 as MRSA can occur. Examples of equipment that may be shared between patients include
1404 venepuncture tourniquets, stethoscopes, ultrasound transducers, thermometers, blood
1405 pressure cuffs, dermatoscopes, pulse oximeters, hoists, hand-held devices, and keyboards.
1406 Such equipment needs to be decontaminated after each patient use. Decontamination is the
1407 use of physical or chemical means (e.g. alcohol/detergent wipes/sprays, chlorine tablets) to
1408 remove, inactivate or destroy pathogens on an item to prevent transmission of infectious
1409 agents and render the item safe for use on other patients. Previous MRSA guidelines
1410 recommended that patient shared equipment should either be suitable for decontamination
1411 or should be single-patient use and discarded as clinical waste after use.

1412 There was weak evidence of potential risk of MRSA transmission from eight studies²³⁹⁻²⁴⁶
1413 which evaluated microbial contamination of shared equipment. One experiment²³⁹ involved

1414 the contamination of stethoscope diaphragms with a known inoculum of MRSA. These were
1415 then a) pressed directly onto selective agar and b) onto a pig skin surface and then selective
1416 agar. The number of MRSA transferred directly to the agar was approximately 2 Log_{10} , with 1
1417 to 1.5 Log_{10} fewer transferred by indirect transfer. Following simulated auscultation on 57
1418 patients colonised with MRSA, stethoscopes were pressed onto selective agar and the same
1419 procedure was conducted with a sterile gloved hand for comparison. The stethoscope was
1420 less likely to transfer MRSA from the patients' skin to agar than gloved hands (11/57 (19%)
1421 versus 15/57 (26%); $p=0.05$), with a mean of 5.9 (+/-8.6) versus 14.3 (+/-11.4) ($p=0.01$)
1422 acquired and transferred by stethoscopes compared to gloved hands. Wiping the diaphragm
1423 with 70% isopropyl alcohol, 70% ethanol, or sterile water, removed 100%, 100% and 94% of
1424 the MRSA respectively. Although this study provides evidence that MRSA are potentially
1425 transferred by stethoscopes, the number of organisms transferred is lower than would be
1426 transferred on hands. A 10-second wipe with alcohol removed all MRSA from the stethoscope
1427 and even wiping with water removed over 90% of the contamination. A similar study²⁴⁵ tested
1428 a stethoscope disinfection UV device in comparison to wiping the diaphragm with 70% alcohol
1429 during examinations of MRSA patients (six skin locations around heart and abdomen for 5-
1430 sec contact each). The authors reported that 17/45 (38%) of stethoscopes were contaminated
1431 with MRSA, and that after using the UV device, the number reduced to four (9%) ($p<0.01$).
1432 The mean number of colonies fell from 4.00 to 0.08 colony forming units (cfu, $p=0.45$). In the
1433 70% isopropyl alcohol pad group, a total of 7/20 (35%) stethoscopes were initially
1434 contaminated and cleaning with the pad removed microorganisms from all (0.0%) ($p<0.01$).
1435 The sample size was too small to make any inferences between the UV and the alcohol group.

1436 Another study²⁴⁰ cultured the handles of 300 wall-mounted and portable digital
1437 thermometers in an acute and long-term care hospital; 8% were contaminated with one or
1438 more pathogens, although only 1% of these pathogens were MRSA. To test the risk of cross-
1439 contamination from contaminated thermometer handles, six handles on digital
1440 thermometers in portable units were inoculated with a DNA marker (generated from a mosaic
1441 virus) and an additional fluorescent marker was applied to assess if the thermometer handles
1442 were cleaned. The handles were checked at day one and two (acute setting) and 14 (long-
1443 term care setting) to assess if the fluorescent marker had been removed. High-touch surfaces
1444 (e.g. bed rails, call buttons), other portable equipment and ward areas (e.g. nursing stations)
1445 and patient hands (acute setting) were sampled for the presence of the DNA marker on day
1446 one and two 2 (acute) and day 14 (long-term care). In the long-term care area, the DNA
1447 marker was detected on high-touch surfaces in 21% of 14 rooms sampled and 80% (4/5) of
1448 shared portable equipment not previously inoculated with the marker. In the acute setting,
1449 the marker was detected in 33% (2/6) of rooms and on the hands of one (2) of six patients. None
1450 of the fluorescent markers were removed by day two (acute setting) or 14 (long-term care
1451 setting). This study provides evidence that reusable patient equipment does become
1452 contaminated with pathogens, although the frequency of contamination with MRSA was very
1453 low. If thermometer handles are contaminated, the model suggested there was a risk of

1454 transfer to both the patient and other sites in the care environment. Although not possible to
1455 generalise, in the study sites, this shared equipment did not appear to be cleaned.

1456 Four studies evaluated methods of decontamination of shared equipment to minimise the
1457 risk of transmission of MRSA. Two used UV light-based devices and one a hydrogen peroxide
1458 cabinet. All studies were laboratory-based experiments, and the findings are difficult to apply
1459 to a clinical setting. In one study,²⁴¹ an UV-C cabinet designed to deliver large amounts of UV-
1460 C radiation for the disinfection of individual pieces of clinical equipment up to approximately
1461 1m³ in size, was evaluated against known pathogens. Eight items were tested (blood pressure
1462 gauge and cuff, patient call button, infusion pump, tympanic thermometer, oximeter base
1463 unit, keyboard, TV remote control). They were inoculated at nine sample points with a known
1464 concentration of test organisms (including a clinical MRSA isolate) and exposed to UV-C for
1465 two 30-second doses of 1590 L/m². Additional tests were conducted using bovine serum
1466 albumen to represent soiling with organic matter and performance was compared with
1467 wiping with an antimicrobial wipe. The cabinet cycle consistently reduced the number of
1468 organisms by at least 4.7 Log₁₀ or below 10 cfu on 80% of sample sites but contamination
1469 persisted on other sites. The authors reported that efficacy was not affected by organic soil
1470 and that a thorough cleaning (4 strokes) with a wipe achieved similar Log₁₀ reductions as the
1471 cabinet for some items. The authors concluded the cabinet could provide a means of rapidly
1472 decontaminating patient-related equipment but that these laboratory-based findings might
1473 not be replicated in use. Another study²⁴² involved testing the efficacy of a portable, hand-
1474 held UV irradiation device (Sterilray) designed to be held over surfaces while emitting UV-C
1475 radiation. In the laboratory, a known concentration of MRSA was inoculated onto a plastic
1476 surface and at 100mJ/cm² the UV device reduced MRSA cfu by 5.4 Log₁₀. A range of surfaces
1477 in 27 rooms where a patient was MRSA positive (call light, bedside table, telephone, bed rail)
1478 were tested, by culturing before and after the use of the UV-device. A total of 106 sites were
1479 cultured and the number positive after use of the device was reduced from 46% to 27%
1480 (p=0.007). The less effective reduction associated with in-use items may reflect the effect of
1481 organic contamination on the efficacy of the method.

1482 The efficacy of a cabinet that uses 35% hydrogen peroxide mist to disinfect ultrasound
1483 transducers in an automated seven-minute cycle was evaluated in simulated use tests in the
1484 laboratory.²⁴³ Standardised carrier tests included MRSA inoculated onto a hard plastic surface
1485 in combination with organic challenge (5% v/v horse serum). The process successfully
1486 eliminated MRSA from 20 carriers. In another study,²⁴⁴ decontamination of ultrasonographic
1487 probes inoculated with a known concentration of MRSA was evaluated using a three-step
1488 decontamination process (1. cleaning with a dry towel, 2. saline moistened towel, 3. QAC
1489 germicidal wipe) or by germicidal wipe alone. In surveillance cultures from probes used in the
1490 emergency department taken prior to the experiment, only one of 164 cultures recovered
1491 MRSA and only 1.2% of the probes were contaminated by clinically significant pathogens. In
1492 the 3-step decontamination process, MRSA was not eliminated after wiping with the towel

1493 but the germicidal wipe in both the 3-step and single step process, eliminated 100% and 90%
1494 of MRSA, respectively.

1495 Finally, one study²⁴⁶ described an outbreak investigation involving MRSA and meticillin-
1496 sensitive *Staphylococcus aureus* (MSSA) strains. Using the data from clinical isolates,
1497 environmental sampling and patient records, together with WGS analysis which helped to
1498 identify the clusters, the authors were able to trace the outbreak to contaminated
1499 anaesthesia equipment, which following disinfection of an operating room and equipment,
1500 was not a source of further cases.

1501 **Recommendations**

1502 **13.1** Clean and disinfect shared pieces of equipment used in the delivery of patient care after
1503 each use, utilising products as specified in a local protocol.

1504 **Good Practice Points**

1505 **GPP 13.1** Make all healthcare workers aware of the importance of maintaining a clean and
1506 safe care environment for patients. Every healthcare worker needs to know their specific
1507 responsibilities for cleaning and decontaminating the clinical environment and the equipment
1508 used in patient care.

1509 **GPP 13.2** Introduce policies for staff, patients, and visitors to clean their hands before and
1510 after they use the shared equipment.

1511

1512 **8.14 What information do patients and relatives require in relation to screening, 1513 decolonisation and management to minimise anxiety and improve the patient 1514 experience? What information do patient's, families and primary/ home care 1515 professionals need when a patient is discharged home?**

1516 Opinion polls have demonstrated that the fear of developing MRSA is the single greatest
1517 concern of people who need to go into hospital for treatment. MRSA has received
1518 considerable media coverage, which has helped to shape public awareness. Unfortunately,
1519 most of the reporting has been negative and alarmist, so patients due for hospital admission
1520 are often anxious about the risk of MRSA infection. Much of the anxiety that patients with
1521 MRSA feel stems from the fact that they are not fully or appropriately informed. Lay people
1522 do not appear to access credible sources of information, or, if they do access them, are unable
1523 to understand their messages. Organisations that provide patient-focused information about
1524 MRSA are generic in scope, so that specific information may take time and effort to locate.

1525 There was moderate evidence from a retrospective matched cohort study,²⁴⁷ one
1526 retrospective case-control study,²⁴⁸ one survey,²⁴⁹ and five qualitative studies,²⁵⁰⁻²⁵⁴ all
1527 undertaken in North America, which investigated the quality of care and other adverse

1528 outcomes potentially associated with isolation for MRSA colonisation or infection. One
 1529 survey, which evaluated the use of CP in patients with MRSA,²⁴⁹ indicated that patients who
 1530 were subject to isolation for MRSA were as satisfied with their care as patients who were not
 1531 isolated. The authors reported that, in this hospital, an infection preventionist made frequent
 1532 visits to patients placed on CP so that they would be reassured. In a retrospective case control
 1533 study²⁴⁸ in a tertiary care setting, the authors reported that non-isolated patients had a
 1534 slightly shorter hospital stay of 6.0 versus 7.0 days but isolated patients received significantly
 1535 fewer bedside visits ($p=0.01$) and showed a tendency toward more preventable complications
 1536 ($p=0.06$). Isolated patients had less documented care and less bedside visits from medical
 1537 staff, which could hamper the therapeutic relationship. In a retrospective matched cohort
 1538 study²⁴⁷ to examine the effect of isolation precautions on hospital related outcomes and the
 1539 cost of care, the authors reported no significant differences in 30-day emergency department
 1540 visits, formal complaints, or inpatient mortality rates between the cohorts. Similar to patients
 1541 with respiratory illness, patients isolated for MRSA stayed 30% longer (LOS 11.9 days versus
 1542 9.1 days [CI95%: 1.22-1.39]), were hospitalised 13% longer than expected, (LOS/ELOS
 1543 [estimated LOS], 1.3 versus. 1.2; [CI95%: 1.07-1.20]) and had 43% higher costs of care (direct
 1544 cost, CAD 11,009 versus. CAD 7670 [CI95% 1.33-1.54]) compared to matched controls.

1545 Five qualitative studies included findings that related to the patient experience of isolation.²⁵⁰⁻
 1546 ²⁵⁴ The studies suggested that patients had a poor understanding of the reason for their
 1547 isolation and were confused about the need and variation in the use of protective equipment
 1548 (gloves, aprons, gowns). This confusion led to feelings of anger and frustration toward
 1549 healthcare staff and the healthcare institution. Isolation in a side room was perceived to have
 1550 both positive and negative aspects; positives were greater freedom from routine, greater
 1551 privacy and solitude, and the perception that visitors were given greater freedom. The
 1552 negative characteristics were a lack of attention from staff and feeling lonely and stigmatised.
 1553 Isolation also indicated to some the severity (or not) of the condition.

1554 **Recommendations**

1555 **14.1** Make patients aware of the reasons for MRSA screening and decolonisation.

1556 **14.2** Inform patients of their screening result as soon as it is available.

1557 **14.3** For patients who are identified as MRSA positive, provide consistent and appropriate
 1558 information about:

1559 The difference between colonisation and infection

1560 The microorganism

1561 How MRSA is acquired and transmitted

1562 How MRSA is treated

1563 The reasons for contact precautions or isolation.

1564 **14.4** On discharge provide consistent and appropriate information about:

1565 The risks to household members, friends, and family.
1566 The implications for future health and health care.
1567 Persons who need to be notified about their MRSA colonisation status.
1568 If applicable, instructions on decolonisation regimen with the information that the
1569 results may not be permanent.

1570 **14.5** Provide information in a format and language that the patient and their family is able to
1571 understand.

1572 **Good Practice Points**

1573 **GPP 14.1** Use patient leaflets provided in the Supplementary Materials of this guideline.

1574 **GPP 14.2** Inform patients about the possibility of re-colonisation and the importance of
1575 changing linen, towels, and clothes daily.

1576

1577 **8.15 What needs to be considered by healthcare professionals when a person who** 1578 **is colonised or infected with MRSA dies?**

1579 MRSA colonisation or infection in a deceased person is not a risk, but can cause concern
1580 amongst funeral directors with some even refusing to take the body. There is negligible risk
1581 to mortuary staff or funeral directors provided that standard IPC precautions are employed.
1582 An approach to address this problem should include staff training and education. IPC
1583 guidelines for funeral directors do exist for many hospital trusts but there is inconsistency in
1584 the contents of such guidelines as well as in their implementation. Consistent guidance on
1585 what needs to be considered by healthcare professionals when a person who is colonised or
1586 infected with MRSA dies, would facilitate the deceased's family obtaining funeral services and
1587 protect the involved personnel to minimise the risks of transmission of MRSA. Our previous
1588 MRSA guidelines recommended that the IPC precautions for handling deceased patients
1589 should be the same as those used in life.

1590 No evidence was found in the studies published since 2004 which met the inclusion criteria for the
1591 study design, and which investigated the handling of deceased patients who were colonised or
1592 infected with MRSA.

1593 **Recommendation**

1594 **15.1** Follow national guidance for managing infection risks when handling the deceased.

1595 **9. Further research**

1596

1597 **Research recommendations:**

1598 **RR 1.1** Studies showing cost-effectiveness and practicality of performing targeted versus
1599 universal screening.

1600 **RR 1.2** Validation studies for targeted screening tools.

1601 **RR 3.1** Further studies assessing the clinical and cost-effectiveness of molecular diagnostic
1602 methods.

1603 **RR 3.2** Studies that describe the real-life, clinically relevant TAT (i.e., the time between when
1604 the patient should be screened, and when the test results are available to the clinician).

1605 **RR 4.1** Well-described reports discussing staff implicated in outbreaks.

1606 **RR 6.1** Rigorous comparative studies assessing the effectiveness of alternatives to mupirocin
1607 and chlorhexidine.

1608 **RR 7.1** Studies which show whether environmental sampling and feedback to cleaning staff
1609 has a role in reducing MRSA transmission.

1610 **RR 8.1** Studies that assess the effectiveness of antimicrobial surfaces and touch-free devices
1611 on the environmental contamination with MRSA as well as MRSA transmission.

1612 **General research recommendation** Studies conducted in health and social care settings other
1613 than the acute hospital sector.

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1618 **10. References**

1619

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2517

2518 **Abbreviations**

- 2519 AOR – adjusted odds ratio
- 2520 ATP – adenosine triphosphate
- 2521 BSI – bloodstream infection
- 2522 CBA – controlled before/after (study)
- 2523 cfu – colony forming units
- 2524 CHG – chlorhexidine gluconate
- 2525 CI – confidence intervals
- 2526 CLABSI – central line-associated bloodstream infection
- 2527 CP – contact precautions
- 2528 DAS – diagnostic accuracy study
- 2529 ELOS – estimated length of stay
- 2530 GP – general practitioner
- 2531 HCAI – healthcare-associated infection
- 2532 HES – Hospital Episode Statistics
- 2533 HPV – hydrogen peroxide vapour
- 2534 HR – hazard ratio
- 2535 ICU – intensive care unit
- 2536 IPC – infection prevention and control
- 2537 IRR – incidence rate ratio
- 2538 ITS – interrupted time series (study)
- 2539 LOS – length of stay
- 2540 MDRO – multidrug-resistant organism
- 2541 MIC – minimum inhibitory concentration
- 2542 MRSA – Meticilin-resistant *Staphylococcus aureus*
- 2543 MSSA – Meticilin-sensitive *Staphylococcus aureus*
- 2544 NICE – National Institute for Health and Care Excellence
- 2545 NR – not reported
- 2546 OR – odds ratio
- 2547 PCR – polymerase chain reaction
- 2548 pd – patient days

- 2549 PICO – Population-Intervention-Comparator-Outcome (framework)
- 2550 PPE – personal protective equipment
- 2551 PVL – Panton-Valentine leucocidin
- 2552 PVP – povidone-iodine
- 2553 PX-UV – pulsed-xenon ultraviolet
- 2554 QAC – quaternary ammonium compound
- 2555 RCT – randomised controlled trial (RCT)
- 2556 RR – risk ratio
- 2557 SIGN – Scottish Intercollegiate Guidelines Network
- 2558 SPC – statistical process control (chart)
- 2559 SSI – surgical site infections
- 2560 TAT – turnaround time
- 2561 UBA – uncontrolled before/after (study)
- 2562 UV-C – ultraviolet-C
- 2563 WGS – whole genome sequencing
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