Incidence of MRSA surgical-site infection in MRSA carriers in an orthopaedic trauma unit

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We examined the incidence of infection with methicillin-resistant Staphylococcus aureus (MRSA) in patients admitted to the Leicester Royal Infirmary Trauma Unit between January 2004 and June 2006. The influence of MRSA status at the time of their admission was examined, together with age, gender and diagnosis, using multi-variant analysis. Of 2473 patients, 79 (3.2%) were MRSA carriers at the time of admission and 2394 (96.8%) were MRSA-negative. Those carrying MRSA at the time of admission were more likely to develop surgical site infection with MRSA (7 of 79 patients, 8.8%) than non-MRSA carriers (54 of 2394 patients, 2.2%, \( p < 0.001 \)). Further analysis showed that hip fracture and increasing age were also risk factors with a linear increase in relative risk of 1.8% per year.

MRSA carriage at admission, age and the pathology are all associated with an increased rate of developing MRSA wound infection. Identification of such risk factors at admission helps to target health-care resources, such as the use of glycopeptide antibiotics at induction and the ‘building-in’ of increased vigilance for wound infection pre-operatively.

The incidence of methicillin-resistant Staphylococcus aureus (MRSA) in hospitals is increasing world-wide, and despite their increased vigilance this includes orthopaedic units. The risk of death from MRSA bacteraemia is twice that from methicillin-sensitive Staph. aureus bacteraemia. Infections of implants in orthopaedic practice are difficult to treat, and when caused by MRSA, the outcome is particularly poor with higher rates of complications and a higher economic cost.

The incidence of MRSA carriage in the nose, axilla or groin in in-patient admissions in general hospitals has been reported to be between 0.18% and 7.2%. In these patients, the risk of developing a clinical MRSA infection has been documented to be up to 30%. In orthopaedic units the incidence of MRSA carriage at the time of admission is about 5.3%. However, the risk of subsequently developing MRSA surgical-site infection (SSI) in this group has not been investigated previously.

Our aim in this retrospective study was to quantify the impact of MRSA carriage on acquiring MRSA SSI in trauma patients admitted to our orthopaedic unit.

Patients and Methods
The Leicester Royal Infirmary has an acute trauma admission unit. Since January 2004 all patients admitted to the unit are screened on admission and treated as MRSA carriers until proven otherwise, and are swabbed at weekly intervals. The swabs are cultured on Baird-Parker medium (Oxoid Ltd, Basingstoke, United Kingdom) which provides results within 24 hours. All patients are treated as positive and given topical antimicrobials until their MRSA status is known. Confirmed MRSA carriers receive continued prophylaxis with teicoplanin (400 mg intravenously) at the time of surgery and are barrier nursed.

Between January 2004 and June 2006 we analysed all adult trauma admissions (16 years and older). Only patients admitted to the trauma wards who were screened at least once for MRSA were included in our study. For each patient we determined their MRSA status at admission and subsequently during their inpatient stay. The MRSA status was subdivided into the following categories based on the microbiological growth and the site of swab taken.

1) SSI. In this group were patients who grew MRSA from wound swabs from the surgical site or from deep-cavity tissue cultures. The microbiological diagnosis of SSI was based on the growth of bacteria from wound swabs or fluid from surgical wounds. Swabs were taken when there was clinical suspicion of wound infection.
2) Other infection. This group contained patients who grew MRSA from blood, urine, sputum or other non-surgical site culture.

3) MRSA carriers. In this group were patients who grew MRSA from pooled swabs from the nose, axilla and groin or from pressure sores.

**Statistical analysis.** Univariate and stepwise logistical regression was performed to assess risk factors for developing MRSA SSI. Risk factors analysed were MRSA status on admission, age and gender. Because patients with fractures of the neck of the femur appeared to be at high risk of developing MRSA infection, this diagnosis was also analysed.

As well as the development of wound infection, the length of stay and mortality at 12 months were also analysed as outcome measures. SPSS version 14 software (SPSS Inc., Chicago, Illinois) was used with \( p \leq 0.05 \) being taken as significant.

### Results

Between January 2004 and June 2006, 6536 patients were admitted to the trauma wards. A considerable proportion of these was either children or short-stay patients (< 24 hours) who were discharged on the same day before MRSA screening was available. Therefore only 2473 patients were screened for MRSA and included in our study. The mean age of all patients admitted was 65 years (16 to 105) and the male:female ratio was 1:1.38. Of the 2473 patients, 754 (30.5%) had a fracture of the neck of the femur and 1719 (69.5%) had other disorders.

**MRSA status on admission.** Analysis of the admission screening swab revealed that 2394 patients (96.8%) were MRSA-negative and 79 (3.2%) were MRSA carriers (Fig. 1). Compared with MRSA-negative patients, the carriers were significantly older (mean age 63 vs 79 years, \( t \)-test \( p < 0.001 \)) and more likely to be female (1:1.3 vs 1:2.1, chi-squared test, \( p < 0.001 \)).

**Risk factors for developing MRSA SSI.** Of the 2473 patients, 61 acquired MRSA SSI as an in-patient. The MRSA carriers were significantly more likely to develop MRSA SSI (7 of 79 patients, 8.8%) of MRSA carriers compared with 54/2394 (2.3%) of MRSA-negative patients (chi-squared test, \( p < 0.001 \)). This difference was confirmed on multivariate analysis, which showed that the odds ratio for developing MRSA SSI among MRSA carriers was 2.5 (\( p = 0.015 \)). A further 29 patients who were not screened grew MRSA from a surgical site and were not included in the study. We made an analysis of the 29 patients in the carrier and non-carrier group and in either case the MRSA carriers were still significantly more likely to have MRSA surgical site infection. This is summarised in Tables I and II below.

Multivariate analysis also showed that increasing age was linearly associated with the development of MRSA SSI with the risk increasing by 1.8% for each increase in age of one year.

### Table I. Analysis of risk with missed patients (n = 29)

<table>
<thead>
<tr>
<th></th>
<th>MRSA* wound infection</th>
<th>No MRSA wound infection</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA carrier group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrier</td>
<td>36 (29 + 7)</td>
<td>108 (79 + 29)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Non carrier</td>
<td>54</td>
<td>2394</td>
<td></td>
</tr>
<tr>
<td>MRSA non-carrier group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrier</td>
<td>7</td>
<td>79</td>
<td>0.01619</td>
</tr>
<tr>
<td>Non carrier</td>
<td>83 (54 + 29)</td>
<td>2423 (2394 + 29)</td>
<td></td>
</tr>
</tbody>
</table>

* MRSA, methicillin-resistant Staphylococcus aureus

### Table II. Risk factors for developing methicillin-resistant staphylococcus aureus (MRSA) surgical site infection

<table>
<thead>
<tr>
<th></th>
<th>No MRSA wound infection (%)</th>
<th>MRSA wound infection (%)</th>
<th>( p )-value</th>
<th>Odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>2394/2473 (96.8)</td>
<td>61/2473 (2.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRSA carrier at admission</td>
<td>72 (3.0)</td>
<td>7 (11.5)</td>
<td>0.015</td>
<td>2.5</td>
</tr>
<tr>
<td>Hip fracture</td>
<td>727 (30.4)</td>
<td>27 (44.3)</td>
<td>0.098</td>
<td>1.4</td>
</tr>
<tr>
<td>Mean length of stay (days)</td>
<td>22 (19.8)</td>
<td>22 (36.0)</td>
<td>&lt; 0.001</td>
<td></td>
</tr>
<tr>
<td>12-month mortality</td>
<td>475 (19.8)</td>
<td>22 (36.0)</td>
<td>0.0016</td>
<td></td>
</tr>
</tbody>
</table>
Univariate analysis showed that patients admitted with a hip fracture were more likely to develop MRSA SSI (28 of 754 patients, 3.7% vs 34/1719, 1.98%), chi-squared test, \( p < 0.05 \). However, because such patients were more likely to be elderly and to be MRSA carriers at admission, this association was less strong on multivariate analysis (odds ratio 1.4, \( p = 0.098 \)).

**Consequences of MRSA infection.** Patients with MRSA SSI had a significantly longer hospital stay (mean 50 vs 22 days, \( t \)-test, \( p < 0.001 \)). The mortality at 12 months was also significantly higher in patients with MRSA SSI (22 of 61 patients (36.1%) vs 475/2412 (19.7%), chi-squared test, \( p < 0.01 \)).

**Discussion**

Our study has shown that elderly patients admitted who are carrying MRSA have a significantly higher risk of developing MRSA SSI. The reasons for this are probably that MRSA carriers are at risk of infecting themselves, have more co-morbidities and may have poorer host defences.

Similarly, patients with fracture of the neck of the femur are generally frail, bed-bound and require a high level of nursing care. The use of prophylactic antibiotics perioperatively may actually promote opportunistic infections.

Our study is the first to examine the influence of MRSA carriage on the development of MRSA SSI in trauma patients. Previous studies focusing on general hospital settings, intensive-care units and dermatological units have documented similar results.11,13-15 The impact of the carriage of MRSA on MRSA SSI has been shown indirectly in studies in which nasal mupirocin has been known to reduce the incidence of MRSA wound infections in patients undergoing implantation of prostheses or fixation of fractures.16

Our study provides important information both for patients and clinicians. MRSA carriers need to be aware that they have a 2.5 times higher risk than that of the normal population of developing post-operative MRSA SSI, and the consequences of such a complication are severe. This should be communicated to them when they are consented for surgery. Post-operatively, these patients should be closely monitored for signs of wound infection so that appropriate treatment can be started promptly.

Our study raises further questions which need investigating such as whether all operations should be delayed until the MRSA status is known. This is relatively easy to do in elective settings, but in emergency trauma units it is much harder. Unnecessary pre-operative delays have been noted to increase patient morbidity and delay discharge,17,18 and would only be beneficial if appropriate interventions on MRSA carriers subsequently prevented MRSA wound infections. There is no strong evidence that this can be done quickly in trauma settings. Simple measures such as the prophylactic use of antibiotics active against MRSA have been shown to reduce post-operative MRSA wound infections after percutaneous endoscopic gastrotomy insertion.19 This could be investigated in the acute trauma setting.

MRSA SSI is expensive to treat and is associated with higher mortality.6 Despite widespread awareness and preventive measures in place, infection is still occurring. The MRSA policy in Leicester Royal Infirmary applies to all new admissions and treats all new in-patients as carriers until proven otherwise. Measures and resources should be in place to ensure compliance. Innovative measures such as calculating the risk score for an admission may trigger off an earlier and more specific response and thereby help to prevent the development of MRSA SSI. This, along with improved staff and patient education, active screening of staff, eradication and ward closure,20 strict hand hygiene,21 and a search-and-destroy policy22 may help to reduce cross-contamination and the overall MRSA SSI burden.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

**References**


