Comparison of methicillin-resistant *Staphylococcus aureus* (MRSA) carriage rate in the general population with the health-worker population

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Abstract

The emergence of antibiotic resistance in bacteria is becoming a widespread problem and a major health issue. Methicillin resistant *Staphylococcus aureus* (MRSA) is becoming increasingly frequent in hospitals. In this study, we compared the carriage rate of MRSA in 100 health workers at North Shore Hospital with the carriage rate of MRSA in the general population (100 staff members and students of Auckland University of Technology) and found a prevalence of MRSA in the health workers of 4%, but none in the general population group. The implication of MRSA carriage in health workers is discussed.

**Key words:** *Staphylococcus aureus*, MRSA, methicillin, prevalence, health workers


Introduction

*Staphylococcus aureus* is a virulent bacterium that can cause serious infections including skin and soft tissue infections, wound infection, bacteremia, pneumonia, and endocarditis (1). It is an organism that is renowned for its potential to acquire resistance to antimicrobial agents. In 1961 there were reports from the United Kingdom of *S. aureus* that had acquired resistance to methicillin (methicillin-resistant *S. aureus*) (2). The clinical significance of oxacillin-resistant (methicillin-resistant) *S. aureus* is heightened by the fact that these isolates are usually resistant to other anti-staphylococcal agents such as lindamycin, erythromycin, tetracycline, and sometimes trimethoprim/sulphamethoxazole, with the exception of vancomycin (4). Although oxacillin-resistant staphylococci appear susceptible in vitro to other β-lactam agents, (such as the cephalosporins) these are clinically ineffective. Therefore, all oxacillin-resistant staphylococci are reported as resistant to all β-lactam agents, including cephalosporins, β-lactam/β-lactamase inhibitor combinations, and imipenem (2).

Currently nearly 90% of *S. aureus* isolates are penicillin-resistant. Methicillin and other semi-synthetic penicillins were successful in treating penicillin-resistant *S. aureus* until the 1980s, when methicillin resistance emerged (3). Methicillin is no longer commercially available, and in many laboratories testing for methicillin resistance has been replaced by oxacillin and/or cefoxitin. Cefoxitin gives clearer endpoints because it is a better inducer of the mecA gene (2). The genetic basis of methicillin resistance in MRSA is the acquisition of *mecA* gene, that renders MRSA resistant to all β-lactam antibiotics (2,3).

The origins of the major MRSA strains are still poorly understood. It has been proposed that all MRSA were descended from a single ancestral *S. aureus* strain that acquired *mecA*, but more recent studies show that some MRSA are very divergent, implying that *mecA* has been transferred between *S. aureus* families (2,4).

In the past three decades, MRSA has become widespread in many hospitals (2) and *S. aureus* (including MRSA) is commonly found in two main carriage sites, the nose (20%) and the perineum (3%). The skin, including the hands, can be transiently contaminated (5). The major form of spread is hand borne transmission (2).

Hospital infection control staff need to limit the spread of MRSA for several reasons. There have recently been reports of strains of MRSA that have intermediate resistance to vancomycin. This is an important concern since the already limited treatment options for serious MRSA infections may become more limited due to the increase in resistance to vancomycin. Limiting the transmission of MRSA might reduce the potential for these strains to spread (6).

Another concern is the simultaneous spread of MRSA and vancomycin-resistant enterococci (VRE), possibly resulting in the transfer of the vancomycin-resistance gene from VRE to MRSA, rendering MRSA fully resistant to vancomycin. The first such isolate was detected in the United States in 2002 (7). The cost of treating an MRSA infection is another concern because vancomycin, the antibiotic most commonly used to treat MRSA infection is expensive.

Epidemiological studies have shown that since the mid 1990s, the incidence of MRSA has been increasing in New Zealand (6). In 2006 the incidence of MRSA amongst hospital patients and staff was approximately 0.17% (10). Amongst *S. aureus* isolates in N.Z, 7% were resistant to oxacillin/methicillin in 2005.

There are four main strains of MRSA, each of which has distinguishing characteristics (11). In New Zealand, different strains of MRSA can become epidemic in different geographical regions (10). EMRSA -15 is predominately isolated in hospitals, whereas WSPP is found more frequently in the community.

The aim of this study was to compare the carriage rate of MRSA in 100 health workers at North Shore Hospital with the carriage rate of MRSA in a general population of 100 staff members and students of the Auckland University of Technology.

Methods

Nasal swabs from 200 participants were collected, and inserted directly into 7% salt broth for 24 hr incubation at 37°C (12). After 24 hr the broths were sub-cultured onto mannitol salt agar (MSA, Fort Richards, USA) and examined after a further 24 hr and 48 hr for yellow colonies. Any yellow colonies on MSA plates had a DNA cascade chromosome *mec* (SCCmec), of which four forms have been described that differ in size and genetic composition.
Table 1. Interpretation of antibiotic sensitivities

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>mcg</th>
<th>Resistant</th>
<th>Intermediate</th>
<th>Sensitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillin</td>
<td>10U</td>
<td>282mm</td>
<td>≥29mm</td>
<td></td>
</tr>
<tr>
<td>Cefoxitin</td>
<td>30</td>
<td>19</td>
<td>≥20</td>
<td></td>
</tr>
<tr>
<td>Erythromycin</td>
<td>15</td>
<td>13</td>
<td>14-22</td>
<td>≥23</td>
</tr>
<tr>
<td>Cotrimoxazole</td>
<td>25</td>
<td>10</td>
<td>11-15</td>
<td>≥16</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>30</td>
<td>14</td>
<td>15-18</td>
<td>≥19</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>2</td>
<td>14</td>
<td>15-20</td>
<td>≥21</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>5</td>
<td>15</td>
<td>16-20</td>
<td>≥21</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>10</td>
<td>12</td>
<td>13-14</td>
<td>≥15</td>
</tr>
<tr>
<td>Fucidic acid</td>
<td>10</td>
<td>18</td>
<td>19-20</td>
<td>≥21</td>
</tr>
<tr>
<td>Rifampicin</td>
<td>5</td>
<td>16</td>
<td>17-19</td>
<td>≥20</td>
</tr>
<tr>
<td>Mupirocin</td>
<td>5</td>
<td>13</td>
<td>≥14</td>
<td></td>
</tr>
<tr>
<td>Vancomycin</td>
<td>30</td>
<td></td>
<td></td>
<td>15</td>
</tr>
</tbody>
</table>

Results

The main finding of our study was that the carriage rate of MRSA in health workers was 4% compared to 0% in the control population. The cohorts were well matched for age while there were more females than males in both groups. Average age of the health workers and control population were 42 yr and 40 yr respectively while there were 85 females in the health workers group and 64 females in the control group.

All four individuals in whom MRSA was isolated were nurses with more than 2 years of clinical experience. Three of the MRSA positive nurses were strain EMRSA-15 and one WSPP1. All four subjects showed resistance to cefoxitin and penicillin, three showed additional resistance to erythromycin, two additional resistance to ciprofloxacin and one additional resistance to clindamycin. One of the four nurses had previously isolated MRSA. Three of the four nurses were treated with the standard Waitemata DHB protocol and subsequently showed negative results for MRSA (Table 2).

Materials and Methods

MRSA screening

All MRSA positive isolates were confirmed by standard for identification and confirmation of MRSA isolates (13). Detection of the altered protein PBP2a using commercial MRSA screen slide latex agglutination kits is a highly specific and sensitive method. In this test, latex particles sensitized with a monoclonal antibody against cell wall PBP2a specifically react with methicillin-resistant staphylococci to cause agglutination. In this study, the latex agglutination, together with antibiotic sensitivity by disc diffusion was used. Various studies (5,11,14) have shown that cefoxitin is superior to oxacillin in the detection of MRSA, and cefoxitin was used in our study.

It is interesting to note that the first MRSA positive health worker was sensitive to ciprofloxacin as EMRSA-15 strains are often resistant to ciprofloxacin (11). The concern is that these health workers could transmit MRSA to vulnerable patients. Patients are at higher than normal risk of acquiring S. aureus infection particularly as the in-patient population tends to be older, sicker and weaker, making them more vulnerable to infection.

Discussion

This study, although small in size, found that 4% of health workers in the Waitemata DHB hospital carried MRSA, compared to none of the healthy volunteers in the wider Auckland community. Our figure of 4% is higher than the national reported incidence of 0.17% amongst hospital patients and staff (10), but compares with studies conducted on patient cohorts in the United Kingdom, where MRSA incidence ranged between 1.6% and 5.3% (15). However, our study is novel, because we compared carriage rate of MRSA in New Zealand health workers with the general community. We could not find any published studies with which to directly compare our results.

Discriminating or identifying a MRSA can be done in several ways. Detecting the presence of mecA gene using PCR is the gold standard for identification and confirmation of MRSA isolates (13). Detection of the altered protein PBP2a using commercially available MRSA screen slide latex agglutination kits is a highly specific and sensitive method. In this test, latex particles sensitized with a monoclonal antibody against cell wall PBP2a specifically react with methicillin-resistant staphylococci to cause agglutination. In this study, the latex agglutination, together with antibiotic sensitivity by disc diffusion was used. Various studies (5,11,14) have shown that cefoxitin is superior to oxacillin in the detection of MRSA, and cefoxitin was used in our study.

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Table 2. Characteristics of the MRSA positive nurses

<table>
<thead>
<tr>
<th>Age</th>
<th>Length of service in the hospital</th>
<th>Strain</th>
<th>Antibiotic resistance</th>
<th>Results after treatment for 5 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>4 years</td>
<td>EMRSA-15</td>
<td>cefoxitin, penicillin and erythromycin</td>
<td>Neg results for 3 swabs following treatment</td>
</tr>
<tr>
<td>30</td>
<td>2 years</td>
<td>EMRSA-15</td>
<td>cefoxitin, penicillin and erythromycin</td>
<td>Neg results for 1st &amp; 2nd swab and positive for 3rd swab</td>
</tr>
<tr>
<td>56</td>
<td>7 years</td>
<td>EMRSA-15</td>
<td>cefoxitin, penicillin and erythromycin</td>
<td>Neg results for 3 swabs following treatment</td>
</tr>
<tr>
<td>59</td>
<td>15 years</td>
<td>WSPP1</td>
<td>cefoxitin and penicillin</td>
<td>Not treated</td>
</tr>
</tbody>
</table>

Various strategies exist for controlling the spread of MRSA within healthcare settings. Preventative measures include laboratory surveillance and screening for MRSA (5), promoting careful hand washing with soap and water rather than the antibacterial gels in common use, gowning and gloving by staff and eradication of MRSA from colonized people (decolonization therapy). Most institutions use a combination of these strategies. Potential side effects associated with the use of eradication therapy include the development of further antibiotic resistance or the possibility of adverse reaction to the antibiotic. Although clinical trials of eradication therapy in colonized healthcare workers (healthy adults) exist, in practice healthcare workers are not always systematically screened for MRSA and offered eradication therapy (3). In contrast, many hospital patients are routinely screened and offered antibiotics or drugs if they are found to be colonized (5,9). Currently at WDHB all staff members have a pre-employment nasal swab to detect MRSA but no further screening if the staff member tests negative.

Patients admitted to the hospital will be screened if they are perceived to be at higher risk of MRSA carriage.
The results from this study suggest a small, but significant MRSA carriage in health workers that could be transmitted to vulnerable patients. This does raise the question whether all health workers should be screened at regular intervals for MRSA, as well as the usual pre employment screen.

Acknowledgments:
We would like to acknowledge the following:
Colin Swager, Team Leader Microbiology, North Shore Hospital; Joanne Morgan and all staff members of Microbiology, North Shore Hospital; Dr. Roger Whiting, Acting Head of School, AUT; Dr. Paul Henriques and Jim Clark, AUT; Dr. Jocelyn Peach, Director of Nursing & Midwifery, WDHB; Rachel Haggerty, Peter Pike and Andrea McLoid, previous managers, WDHB; Jane Sherard, Maori Advisor, WDHB; Pat Chainey and Dr. Tim Dare, Northern Regional Ethics Committee; Lorraine Neave and Dr. Wayne Miles, Knowledge Centre; Infectious control and occupational health nurses, WDHB; the Editor and two anonymous referees, NZ Journal of Medical Laboratory Science; and all the participants in AUT and WDHB.

References