Trends and Antibiotic Susceptibility Patterns of Methicillin-Resistant and Methicillin-Sensitive Staphylococcus aureus in an Outpatient Dermatology Facility

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Objectives: To determine whether the relative proportions of methicillin-resistant Staphylococcus aureus (MRSA) and methicillin-sensitive S aureus (MSSA) were changing or stable in an outpatient dermatology clinic and to examine the antibiotic susceptibility profiles of S aureus isolates.

Design: Retrospective observational data were collected from skin culture isolates annually between January 1, 2005, and December 31, 2010, and monthly during the 6-month period of January 1, 2011, to June 30, 2011.

Setting: The University of Miami Hospital outpatient dermatology clinic.

Participants: A total of 387 S aureus isolates were analyzed between January 1, 2005, and June 30, 2011, from adult and pediatric patients.

Main Outcome Measures: The relative proportions of MRSA and MSSA skin culture isolates were measured, along with antibiotic sensitivity profiles.

Results: The overall relative proportion of MRSA was 35.7%. The overall relative proportion of MSSA was 64.3%. During the last 6 months of the study, the relative proportion of MRSA was 33.3%, while the relative proportion of MSSA was 66.7%. The relative proportion of MRSA from January 1, 2008, through December 31, 2010, was significantly higher than the relative proportion from January 1, 2005, through December 31, 2007 (45.3% vs 28.3%, P=.001). MRSA became more sensitive to ciprofloxacin, while MSSA became more resistant to ciprofloxacin, clindamycin, gentamicin sulfate, and trimethoprim-sulfamethoxazole.

Conclusions: The relative proportion of MRSA in the S aureus isolates increased by 17.0% during the last 3 years of our study. Despite this increase, MRSA became more sensitive to ciprofloxacin, while MSSA demonstrated increased antibiotic resistance to ciprofloxacin, clindamycin, gentamicin, and trimethoprim-sulfamethoxazole.


Staphylococcus aureus is the most common cause of skin and soft-tissue infections in the United States and has been since the late 1970s, prior to which Streptococcus pyogenes caused the majority of these infections. Methicillin-sensitive S aureus (MSSA) and methicillin-resistant S aureus (MRSA) are the 2 major subtypes of S aureus, with methicillin resistance defined as an oxacillin sodium minimum inhibitory concentration of at least 4 μg/mL. According to the Centers for Disease Control and Prevention, a MRSA infection is designated as community associated (CA) if it develops in an individual without a history of MRSA isolation or if a positive culture is obtained in the outpatient setting or within 48 hours of hospitalization. In distinction to CA-MRSA, health care–associated MRSA is a strain isolated from a patient within 48 hours of hospitalization who has risk factors for a resistant infection, including dialysis, previous colonization, surgery during the past year, a permanent medical device or catheter, or hospital, hospice, or nursing home admission.

In 1980, almost 2 decades after health care–associated MRSA was initially observed, the first case of a CA-MRSA infection was reported in the United States. Before 1987, MRSA isolation from outpatient dermatology clinic patients had not been reported. MRSA accounts for more than 50% of CA S aureus infections in many US centers. The reported prevalence and rise of CA-MRSA skin infec-
PREVALENCE AND RELATIVE PROPORTIONS OF MRSA AND MSSA

A total of 387 Staphylococcus aureus isolates were analyzed between January 1, 2005, and June 30, 2011. Of these total isolates during this period, the overall relative proportion of MRSA was 35.7%, and the overall relative proportion of MSSA was 64.3% (Figure 1). During the last 6 months of the study, the relative proportion of MRSA was 33.3%, while the relative proportion of MSSA was 66.7%. The relative proportion of MRSA from January 1, 2005, through December 31, 2010, was significantly higher than the relative proportion from January 1, 2005, through December 31, 2007 (43.3% vs 28.3%, P=0.001). The relative proportion of MRSA in the S aureus isolates increased by 17.0% during the last 3 years of our study compared with the previous 3 years.

ANTIBIOTIC SENSITIVITY PROFILES

MRSA and MSSA Antibiotic Sensitivity From January 1, 2005, Through December 31, 2010

For the period January 1, 2005, through December 31, 2010, the antibiotic sensitivity profile of MRSA is summarized in Table 1. Additional results comparing the earlier years with the later years are shown in Figure 2. For the period January 1, 2005, through December 31, 2010, the antibiotic sensitivity profile of MSSA is summarized in Table 2. Additional results comparing the earlier years with the later years are shown in Figure 3.

Trend Data for MRSA and MSSA From January 1, 2005, Through December 31, 2010

For January 1, 2005, through December 31, 2007, and for January 1, 2008, through December 31, 2010, the trend data for MRSA are summarized in Table 3. For the same periods, the trend data for MSSA are summarized in Table 4.

Antibiotic Sensitivity for MRSA and MSSA During the Last 6 Months of the Study

Antibiotic sensitivity data during the last 6 months of the study are given for MRSA in Table 1. These data for MSSA are given in Table 2.
Consistent with national data, the relative proportion of MRSA in this outpatient dermatology clinic in Miami has risen. For 3 years (2008-2010), the proportion of MRSA rose by 17.0% compared with the prior 3 years (2005-2007). The overall proportion of MRSA in our study was 35.7%. In another outpatient dermatology office, 21% of 135 cultures were MRSA. The proportion of MRSA in our study is not only higher than that among many other studies but also is increasing. These findings are similar to, albeit less dramatic than, the results of a large-scale retrospective study that analyzed trends in MRSA isolates and the prevalence in the United States using the Surveillance Network database (Eurofins Medinet) and the National Hospitalization Discharge Survey from 1998 to 2007. Among 1,711,991 S aureus isolates from patients seen in ambulatory settings in that study, the unadjusted MRSA annual prevalence increased by 79.5% from 1998 to 2007. These findings were corroborated by the results of a recent study from an outpatient dermatology clinic in Germany during the same period, which may suggest that the incidence of MRSA is increasing in multiple and geographically diverse regions.

Despite reports of an increase in MRSA skin isolates, other observations suggest that MRSA may not be rising in incidence as rapidly as once thought. In a North Carolina tertiary outpatient pediatric dermatology clinic, S aureus was recently recovered from 143 cultures, and 27.3% of those were MRSA, which was slightly decreased compared with S aureus cultures between 2005 and 2007, in which the proportion was 32.0%. Another study analyzing 240 cultures of S aureus from outpatient dermatology clinics noted a significant decrease in MRSA between 2005 and 2009, from 32.0% to 27.3%. Despite the decrease in the proportion of MRSA reported by Diamantis et al, they documented a rise in resistance to penicillin, methicillin sodium, erythromycin, clindamycin, and trimethoprim-sulfamethoxazole but not to vancomycin and gentamicin.

In addition to the rise in proportion of MRSA in our outpatient dermatology clinic, we observed a notable trend that MSSA is becoming more resistant to many antibiotics. Comparing the antibiogram results from 2008 to 2010 with those from 2005 to 2007, it was found that

![Table 1. Methicillin-Resistant Staphylococcus aureus (MRSA) Antibiotic Sensitivity Profiles From 2005 to 2011](https://archderm.jamanetwork.com/)

**Table 1. Methicillin-Resistant Staphylococcus aureus (MRSA) Antibiotic Sensitivity Profiles From 2005 to 2011**

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciprofloxacin</td>
<td>8.0</td>
<td>38.1</td>
<td>20.0</td>
<td>30.7</td>
<td>100.0</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>60.0</td>
<td>71.4</td>
<td>40.0</td>
<td>61.5</td>
<td>67.6</td>
<td>63.6</td>
<td>70.0</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>12.0</td>
<td>23.8</td>
<td>0.0</td>
<td>0.0</td>
<td>8.1</td>
<td>13.6</td>
<td>30.0</td>
</tr>
<tr>
<td>Gentamicin sulfate</td>
<td>92.0</td>
<td>90.4</td>
<td>70.0</td>
<td>76.9</td>
<td>81.1</td>
<td>86.4</td>
<td>100.0</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>16.0</td>
<td>33.0</td>
<td>NR</td>
<td>NR</td>
<td>29.7</td>
<td>36.4</td>
<td>40.0</td>
</tr>
<tr>
<td>Rifampin</td>
<td>96.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>88.0</td>
<td>76.2</td>
<td>70.0</td>
<td>69.2</td>
<td>86.5</td>
<td>81.8</td>
<td>90.0</td>
</tr>
<tr>
<td>Trimethoprim-sulfamethoxazole</td>
<td>96.0</td>
<td>100.0</td>
<td>80.0</td>
<td>84.6</td>
<td>89.2</td>
<td>81.8</td>
<td>90.0</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Linezolid</td>
<td>. . . . . .</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total No. b</td>
<td>25</td>
<td>21</td>
<td>10</td>
<td>13</td>
<td>37</td>
<td>22</td>
<td>10</td>
</tr>
</tbody>
</table>

Abbreviation: NR, not reported.

a Six-month data for 2011.

b Total number of MRSA isolates tested for each year from 2005 to 2010.

![Figure 2. Methicillin-resistant Staphylococcus aureus antibiotic sensitivity from 2005 to 2007 compared with 2008 to 2010. * Denotes statistically significant difference in antibiotic sensitivity between 2005 to 2007 and 2008 to 2010.](https://archderm.jamanetwork.com/)
MSSA in the later period is significantly more resistant to ciprofloxacin, clindamycin, gentamicin, and trimethoprim-sulfamethoxazole. Comparing the same data for MRSA, the later period shows a statistically significant decrease in resistance to ciprofloxacin. It is possible that the increasing resistance of MSSA to these antibiotics is due to their popular use as empirical antibiotics, especially for MRSA, which can also convert to MSSA in vivo; furthermore, genetic recombination may be contributing to the increasing resistance that was observed because staphylococcal cassette chromosomes can be un-

Table 2. Methicillin-Sensitive Staphylococcus aureus (MSSA) Antibiotic Sensitivity Profiles From 2005 to 2011

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciprofloxacin</td>
<td>93.4</td>
<td>87.5</td>
<td>84.2</td>
<td>78.8</td>
<td>0.0</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>96.7</td>
<td>100.0</td>
<td>78.9</td>
<td>75.8</td>
<td>77.4</td>
<td>56.5</td>
<td>90.0</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>64.8</td>
<td>59.4</td>
<td>73.7</td>
<td>54.5</td>
<td>64.5</td>
<td>39.1</td>
<td>65.0</td>
</tr>
<tr>
<td>Gentamicin sulfate</td>
<td>97.8</td>
<td>100.0</td>
<td>89.5</td>
<td>84.8</td>
<td>83.8</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Levofloxacin</td>
<td>94.5</td>
<td>87.5</td>
<td>NR</td>
<td>100.0</td>
<td>77.4</td>
<td>82.6</td>
<td>95.0</td>
</tr>
<tr>
<td>Rifampin</td>
<td>100.0</td>
<td>93.8</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>90.1</td>
<td>81.3</td>
<td>94.7</td>
<td>87.9</td>
<td>87.1</td>
<td>78.3</td>
<td>90.0</td>
</tr>
<tr>
<td>Trimethoprim-sulfamethoxazole</td>
<td>97.8</td>
<td>100.0</td>
<td>94.7</td>
<td>87.9</td>
<td>83.9</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Lincosamid</td>
<td>NR</td>
<td>NR</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total No. b</td>
<td>91</td>
<td>32</td>
<td>19</td>
<td>33</td>
<td>31</td>
<td>23</td>
<td>20</td>
</tr>
</tbody>
</table>

Abbreviation: NR, not reported.

a Six-month data for 2011.

b Total number of MSSA isolates tested for each year from 2005 to 2010.

was not directly measured by the diffusion disk test. Al-
genic infections among our population may be high; however, this
cin, suggesting that the prevalence of CA-MRSA with
addition, approximately 70% of CA-MRSA isolates for the
last 6 months of the study were resistant to erythromy-
table 2 for our
outpatient dermatology clinic, the best empirical antibi-
otic to cover both MRSA and MSSA is trimethoprim-
sulfamethoxazole or tetracycline. However, a caveat to
note is that when trimethoprim-sulfamethoxazole or tet-
racycline is empirically used to cover S aureus, an addi-
tional agent may be needed if infection by group A strep-
tococci is a possibility. Clindamycin or erythromycin may
be considered therapeutic options, but MRSA and MSSA
are not as sensitive to these 2 antibiotics; in fact, eryth-
romycin is a poor choice for MRSA. When a MRSA
isolate is erythromycin resistant but clindamycin sensi-
tive, it is important to perform a D-zone test to
detect the presence of erm genes before beginning therapy with
clindamycin. Depending on the geographic region, 25%
to 51% of CA-MRSA isolates tested are D-zone test posi-
tive, suggesting that clindamycin therapy would be in-
effective via a ribosomally mediated mechanism. In
addition, approximately 70% of CA-MRSA isolates for the
last 6 months of the study were resistant to erythromy-
cin, suggesting that the prevalence of CA-MRSA with
erm genes among our population may be high; however, this
was not directly measured by the diffusion disk test. Al-
though there is 0% resistance to linezolid, vancomy-
cin, and rifampin in an outpatient setting, these are un-
reasonable choices for antibiotic therapy because of their
administration route, cost, and availability.

A similar retrospective analysis was performed be-
tween June 1994 and May 1997 on pediatric skin infec-
tions from the same outpatient dermatology clinic in Mi-
ami. In that study, S aureus was isolated from 36% of
nares cultures (n = 118) and from 47% of skin cultures
(n = 131). Of 42 S aureus nares cultures, 79% were re-
sistant to penicillin, 26% to erythromycin, 5% to cloxa-
cillin and cephalothin sodium, and 2% to tetracycline.

Of 61 skin cultures with S aureus, 84% were resistant to
penicillin, 31% to erythromycin, 10% to cloxacillin and
cephalothin, and 8% to tetracycline. Although the study
did not analyze cultures based on MRSA or MSSA, a gen-
eral observation comparing these data with our data is
that S aureus is now more resistant to erythromycin and
tetracycline. Data suggest that antibiograms may im-
prove empirical therapy decision making by increasing
knowledge of local outpatient prevalence of antibiotic
resistance.

Our study has several limitations. The morphology of
cutaneous MRSA infection is variable, and common areas
for involvement include the legs, knees, thighs, feet, and
buttocks. This study did not measure the incidence or
morphology of MRSA-related and MSSA-related skin infec-
tions at these anatomic locations, and this measurement
would have been relevant to report. The study also
did not record the type of skin infection (eg, impetigo,
folliculitis, furunculosis, cellulitis, etc). Because this was
a retrospective study, we were also unable to look at the
genotypes. Regardless of which genotype was most preva-
lent in the Miami setting, the choice of the empirical an-
tibiotic would be unchanged. One variable that may have
affected the results is the fact that cultures were sent to
2 separate laboratories. A possibility exists that the labo-
ratories may have slightly different methods in measur-
ing sensitivities to antibiotics, which by itself should not
have grossly altered the sensitivities reported. The num-
er of cases sent to one of the laboratories was so small
that this probably did not significantly influence the re-

results. The antibiogram result for ciprofloxacin was not
reported in 2010 for MRSA and MSSA, which may have
affected the trend in antibiotic sensitivity. Unfortu-
nately, the exact age of most of the patients was un-
known because of database limitations of the laborato-
ries performing the sensitivity tests. The findings in this
population of dermatology clinic patients in Miami may
not be generalizable to other regions or clinical settings.
This study should be repeated with additional data within
the next few years to observe if the trend is the same or
is changing.

In conclusion, it is important for physicians to ob-
tain cultures of infected sites before administering an
antibiotic and to tailor therapy to antibiogram results as soon
as possible to appropriately treat a MRSA or MSSA in-
fec tion. Notably, in vitro susceptibility testing does not
necessarily predict in vivo efficacy of an antibiotic, and
physicians should alter therapy only if there is no clini-
cal improvement.

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and Schachner and Mr McLeod had full access to all
the data in the study and take responsibility for the integ-
rety of the data and the accuracy of the data analysis. Study
concept and design: Aber, Izakovic, and Schachner. Ac-

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Conflict of Interest Disclosures: None reported.

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REFERENCES