# *Staphylococcus aureus* Community-Acquired Pneumonia During the 2006 to 2007 Influenza Season

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The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

**Study objective:** *Staphylococcus aureus* is a cause of community-acquired pneumonia that can follow influenza infection. In response to a number of cases reported to public health authorities in early 2007, additional case reports were solicited nationwide to better define *S aureus* community-acquired pneumonia during the 2006 to 2007 influenza season.

**Methods:** Cases were defined as primary community-acquired pneumonia caused by *S aureus* occurring between November 1, 2006, and April 30, 2007. Case finding was conducted through an Emerging Infections Network survey and through contacts with state and local health departments.

**Results:** Overall, 51 cases were reported from 19 states; 37 (79%) of 47 with known susceptibilities involved infection with methicillin-resistant *S aureus* (MRSA). The median age of case patients was 16 years, and 44% had no known pertinent medical history. Twenty-two (47%) of 47 case patients with information about other illnesses were diagnosed with a concurrent or antecedent viral infection during their illness, and 11 of 33 (33%) who were tested had laboratory-confirmed influenza. Of the 37 patients with MRSA infection, 16 (43%) were empirically treated with antimicrobial agents recommended for MRSA community-acquired pneumonia. Twenty-four (51%) of 47 patients for whom final disposition was known died a median of 4 days after symptom onset.

**Conclusion:** *S aureus* continues to cause community-acquired pneumonia, with most reported cases caused by MRSA and many occurring with or after influenza. In this series, patients were often otherwise healthy young people and mortality rates were high. Further prospective investigation is warranted to clarify infection incidence, risk factors, and preventive measures. [Ann Emerg Med. 2009;53:358-365.]

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**SEE EDITORIAL, P. 366.**

## INTRODUCTION

### Background

*Staphylococcus aureus* community-acquired pneumonia is a well-recognized complication of influenza.[1-5] This entity has been associated with severe disease and high mortality rates.[1-3,6] Despite longstanding recognition of this condition, many questions remain, including the current role of methicillin-resistant *S aureus* (MRSA) and the proportion of *S aureus* community-acquired pneumonia cases that are not associated with laboratory-confirmed influenza. Both issues could have implications for selection of empiric antibiotic regimens for patients presenting with community-acquired pneumonia and for potential preventive measures such as influenza vaccination.

### Goals of This Investigation

In early 2007, federal and state public health officials began to receive a number of reports from state and local health

**Editor's Capsule Summary**

*What is already known on this topic*

*Staphylococcus aureus* has been associated with pneumonia after influenza but has not been a common cause of community-acquired pneumonia.

*What question this study addressed*

This series of 51 cases reported to the Centers for Disease Control and Prevention describes clinical features of community-acquired pneumonia caused by *S aureus*, including 79% with methicillin-resistant *S aureus* (MRSA).

*What this study adds to our knowledge*

Although reporting bias likely overrepresents severe cases, *S aureus* is now recognized as a possible cause of community-acquired pneumonia with high mortality, often in otherwise healthy young people with influenza.

*How this might change clinical practice*

Empiric therapy for *severe* community-acquired pneumonia should include activity against *S aureus*, including MRSA.

departments of severe *S aureus* community-acquired pneumonia. Many of these initial reports appeared to involve MRSA and were fatal.[7] These reports occurred in the context of an influenza season characterized by relatively low levels of influenza activity and few reports of influenza-related deaths.[8] This prompted an effort to better characterize the clinical findings, natural history, and outcomes of *S aureus* community-acquired pneumonia during the 2006 to 2007 influenza season with a nationwide case-finding effort. We report the epidemiologic and clinical characteristics and laboratory findings from, to our knowledge, the largest *S aureus* community-acquired pneumonia case series to date.

## MATERIALS AND METHODS

Cases were defined as community-acquired pneumonia diagnosed between November 1, 2006, and April 30, 2007, in a person who as an outpatient or within 48 hours of admission had (1) *S aureus* isolated (or a positive immunohistochemical test for *S aureus*) from pleural fluid, blood, or lung tissue; or (2) *S aureus* isolated from sputum, tracheal aspirate, or a bronchoscopy specimen, without another previously identified bacterial pathogen from a sterile site. "Community-acquired" was defined as onset in the community in a person not residing in a nursing home and with no known hospitalizations in the preceding 72 hours. Pneumonia was defined as clinical evidence of pulmonary infection with evidence of pneumonia on at least 1 chest radiograph. Cases of secondary pneumonia (eg, pulmonary seeding from primary bacteremia) were excluded.

Cases were ascertained in 3 ways. First, several unsolicited case reports were made directly to the Centers for Disease Control and Prevention (CDC) in early 2007. Second, an Infectious Disease Society of America Emerging Infections Network survey on *S aureus* community-acquired pneumonia was distributed to 1,083 adult and pediatric infectious disease specialists in March 2007, requesting case reports from participants who had cared for a patient with *S aureus* community-acquired pneumonia. Third, an April 2007 Morbidity and Mortality Weekly Report highlighting several unsolicited *S aureus* community-acquired pneumonia cases from Georgia and Louisiana requested additional case reports from health care providers and state and local health departments.[7]

### Data Collection and Processing

A standardized data collection instrument was developed by the CDC and distributed to local providers and public health officials for completion. The instrument included basic demographics, medical history, culture results, symptoms, viral/influenza history, influenza vaccination, clinical/laboratory findings, hospitalization information, pre- and postculture antibiotics, and outcome. Risk factors for MRSA included (within the previous year) surgery, dialysis, hospitalization (including birth admission), residence in long-term care, or presence of an invasive device (eg, central line). Comorbidities were defined as any underlying medical condition.

Persons offering to submit case report forms were asked to send available *S aureus* isolates to the CDC for characterization. Isolates received were confirmed as *S aureus* with the Staphaurex latex agglutination test (Remel, Lenexa, KS), catalase, and tube coagulase. Antimicrobial susceptibility testing was performed on a standard panel of antimicrobial agents with the reference broth microdilution method. Molecular testing for genes encoding Panton-Valentin leukocidin and toxic shock syndrome toxin-1 was performed by real-time multiplex polymerase chain reaction assays with previously described primers.[9] All isolates also underwent pulsed-field gel electrophoresis with *Sma*I-digested chromosomal DNA; patterns were analyzed by Bionumerics software (Applied Maths, Austin, TX) with dice coefficients as previously described.[10]

### Outcome Measures and Primary Data Analysis

Most analysis was descriptive. Logistic regression was used to measure the effect of a low WBC count and laboratory-confirmed influenza on mortality; small sample size prevented including additional variables in the model. All statistical analyses were performed with Stata 9.0 (StataCorp, College Station, TX).

The activities involved in this investigation constituted a public health response to a disease outbreak; as such, the study was not subject to approval by a CDC institutional review board.

## RESULTS

Sixty-three patients were reported; 51 from 19 states met our case definition. Those not meeting the case definition included patients with secondary pneumonia, with onset outside our period, and with onset in a health care facility. Forty-four patients had positive culture results for *S aureus*, 4 patients had a positive *S aureus* immunohistochemistry result at autopsy and pathology consistent with necrotizing pneumonia, and 3 patients had both. Among the 47 patients with a positive culture result for *S aureus*, 28 (60%) had positive respiratory culture results, 18 (38%) had positive blood culture results, 11 (23%) had positive pleural fluid culture results, and 4 (9%) had positive culture results for postmortem lung tissue or fluid. Thirty-seven (73%) patients were infected with MRSA, 10 (20%) were infected with methicillin-susceptible *S aureus*, and susceptibility results were not available for the 4 (8%) identified by immunohistochemistry.

### Characteristics of Study Subjects

Characteristics of the patients with *S aureus* community-acquired pneumonia are shown in Table 1; the age distribution is shown in the Figure. Two patients had a history of MRSA skin disease, occurring 11 and 20 weeks before the onset of their pneumonia. Two additional patients had a history of skin or soft tissue infections of unknown origin before onset of their pneumonia. Although not specifically included on the case report form, 4 patients were noted in the comments section to have had contact with persons with skin and soft tissue infections before onset of the pneumonia. One case patient's wife had a recent MRSA abscess, the mother of another had recurrent boils, one had a close friend with a "staph abscess," and one had a brother and a sister with recurrent soft tissue abscesses. MRSA risk factors were found in 42% of patients who developed MRSA pneumonia; hospitalization within the past year was the most commonly identified risk factor (25%) (Table 1).

Information on influenza vaccination was available for 25 case patients; 11 of 25 patients had an indication for influenza vaccination according to their age or presence of comorbidities, and 6 of 11 (55%) had been vaccinated. No others were vaccinated.

Twenty-two (47%) of the 47 patients with information on concurrent diagnoses were diagnosed with a concurrent or antecedent acute viral infection. Thirty-three case patients were tested for influenza virus and 11 (33%) had a positive test result (7 for influenza A, 2 for influenza B, and 2 for both). Testing for influenza was performed primarily by a rapid antigen test (41%), viral culture (24%), or immunohistochemical stain for influenza A and B at autopsy (21%). Data were not collected on other respiratory viruses.

Fever was the most common clinical finding reported, occurring in 78% of patients. Cough was reported in 65% of case patients, and shortness of breath was reported in 55%. All other symptoms were reported in less than half of case patients and included chest pain (31%), sore throat (31%), fatigue (27%), chills (25%), hemoptysis (16%), and diarrhea (14%).

**Table 1.** Demographic characteristics of *S aureus* pneumonia case patients.

| Characteristic | No. (%) or Median (Range) |
|---|---|
| **Age, y (n=51)** | |
| Median age (range) | 16 (<1,81) |
| Percentage <18 y | 26 (51) |
| Percentage >64 y | 2 (4) |
| Female sex (n=51) | 30 (59) |
| **Race (n=48)** | |
| White | 39 (81) |
| Black | 7 (15) |
| Received influenza vaccination (n=25) | 6 (24) |
| Diagnosed with concurrent or preceding viral illness (n=47) | 22 (47) |
| Positive influenza testing (n=33) | 11 (33) |
| ≤18 y (n=20) | 8 (40) |
| >18 y (n=13) | 3 (23) |
| Underlying comorbidities* (n=48) | 27 (56) |
| Smoker | 6 (13) |
| Chronic obstructive pulmonary disease | 5 (10) |
| Asthma | 4 (8) |
| Intravenous drug use | 2 (4) |
| Attention deficit hyperactivity disorder | 2 (4) |
| History of pneumonia | 2 (4) |
| Prescribed antibiotics in previous 3 mo (n=45) | 10 (22) |
| Hospitalization (including birth) (n=44) | 13 (30) |
| Previous skin condition (n=47) | 7 (15) |
| Eczema | 2 (4) |
| Atopic dermatitis | 1 (2) |
| Previous skin infection (non-MRSA) | 2 (4) |
| Previous skin infections with MRSA | 2 (4) |
| MRSA risk factors present†¶ (n=31) | 13 (42) |
| History of MRSA ever† (n=30) | 4 (13) |
| Hospitalization (including birth)† (n=36) | 9 (25) |
| Dialysis† (n=36) | 0 |
| Resident of long-term care facility† (n=36) | 0 |
| Surgery† (n=36) | 1 (3) |
| Indwelling device† (n=36) | 0 |

*Only comorbidities found in more than 1 patient listed.
†Includes only those with documented MRSA.
¶MRSA risk factors include history of MRSA colonization or infection, overnight stay in health care facility (hospital or long-term care facility) in past year, dialysis in the past year, surgery in past year, or presence of indwelling device in last year.

Laboratory findings from the day of the first positive *S aureus* culture are shown in Table 2. Although the median WBC count was normal, 39% of case patients had a low (<4,000/mm3) WBC count and 41% had a high (>10,000/mm$^3$) WBC count. Median WBC count was stratified by a number of variables and was lower in case patients with a positive test for influenza and in those with a fatal outcome (Table 3).

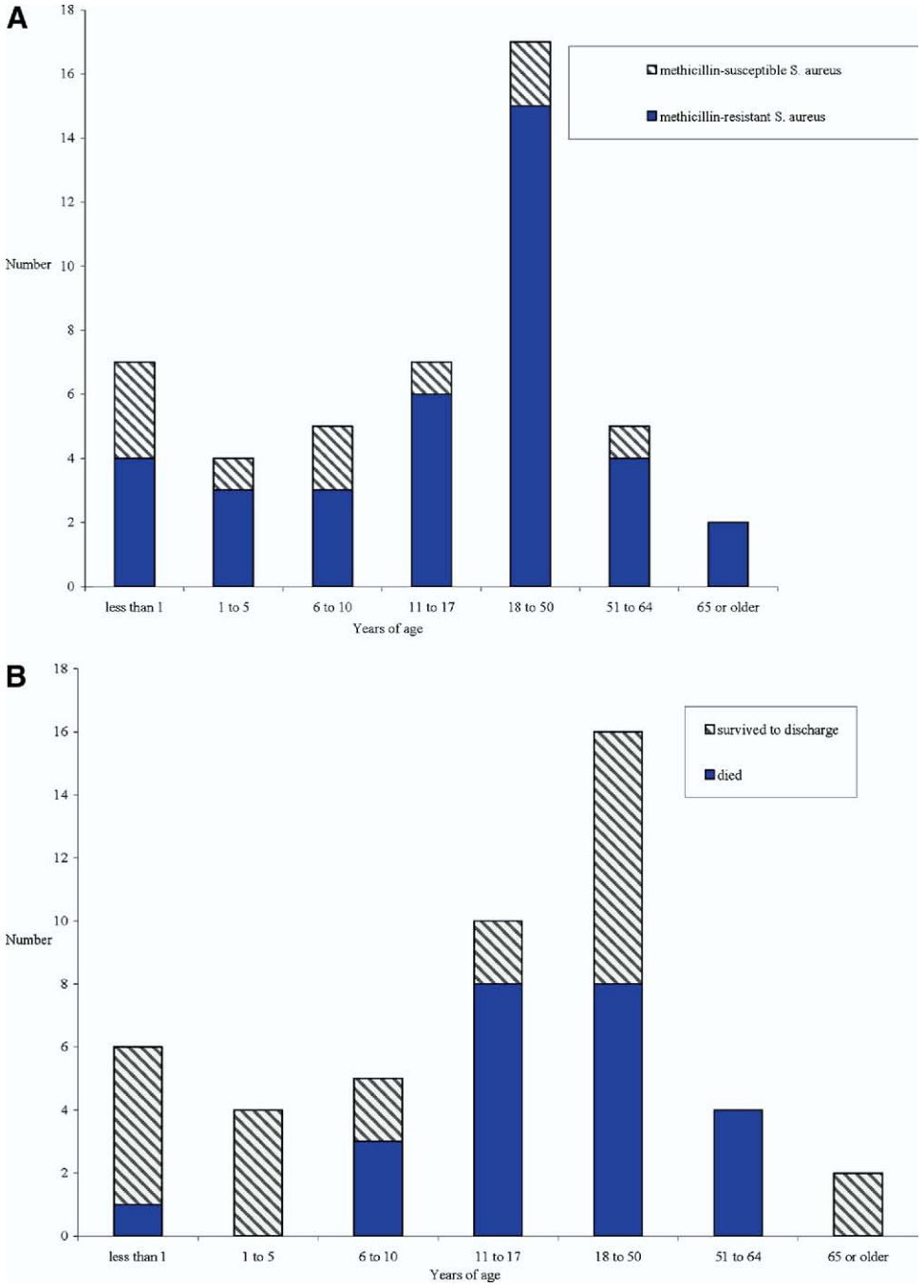


**Figure.** Number of patients with methicillin-resistant and methicillin-sensitive *S aureus* (*A*), and patient outcomes (*B*), stratified by age category.

Information on chest radiographs was available for 46 case patients. Forty-two (91%) of 46 initial chest radiograph results were abnormal; specific details were reported for 40 of the 42 abnormal initial chest radiographs. Of these, 13 (33%) had a single lobar infiltrate, 21 (53%) had a multilobar infiltrate, and 6 (15%) had an interstitial-type infiltrate. Pleural effusions were observed in radiographs from 12 (30%); cavitation, a finding described as suggestive of *S aureus*, was reported in initial chest radiographs from 3 patients (7%).[11]

All 10 patients with methicillin-susceptible *S aureus* were treated empirically with an antimicrobial agent likely to have activity against this organism. Of the patients with MRSA, 16 (43%) received empiric treatment with either vancomycin or linezolid, the currently recommended treatments for MRSA community-acquired pneumonia.[11] The median time from symptom onset to receipt of first antimicrobial agent was 3 days (range 0 to 22 days). Stratified by outcome, the median time from symptom onset to receipt of first antimicrobial agent was

**Table 2.** Laboratory findings for case patients.*

| Characteristic | Median | Range |
|---|---|---|
| WBC count, ×1,000/mm$^3$, n=41 | 7.1 | 0.43–38 |
| Percentage with leukocytosis, >10,000/mm$^3$ | 41% | |
| Percentage with leucopenia, <4,000/mm$^3$ | 39% | |
| Platelets, ×1,000/mm$^3$, n=38 | 192.5 | 19–981 |
| Hematocrit, %, n=35 | 36 | 22–46 |
| Creatinine, mg/dL, n=36 | 0.95 | 0.10–4.9 |
| Blood urea nitrogen, mg/dL, n=36 | 15 | 4–50 |
| Glucose, mg/dL, n=33 | 138 | 60–400 |
| Oxygen saturation, %, n=34 | 91 | 46–99 |
| pH, n=19 | 7.36 | 7.10–7.57 |
| Sodium, mmol/L, n=34 | 135 | 124–142 |

*Laboratory findings on day first positive *Staphylococcus aureus* culture result obtained.

**Table 3.** WBC count stratified by case patient characteristics.

| Category | Median WBC, 1,000/mm$^3$ | Interquartile Range, 1,000/mm$^3$ |
|---|---|---|
| **Age, y, n=41** | | |
| ≤18, n=20 | 8.1 | 2.0–23.7 |
| 19–50, n=15 | 4.7 | 2.6–16.5 |
| >50, n=6 | 8.9 | 2.3–25.8 |
| **Influenza test, n=27** | | |
| Positive, n=8 | 2 | 1.0–2.5 |
| Negative, n=19 | 9.1 | 2.3–25.3 |
| **Diagnosed with virus, n=40** | | |
| Yes, n=17 | 2.6 | 1.6–16.5 |
| No, n=23 | 9.4 | 3.5–21.2 |
| **Outcome, n=36** | | |
| Alive, n=21 | 16.5 | 7.1–22.0 |
| Dead, n=15 | 2.3 | 1.5–3.5 |

shorter for those who died (median 2 days; interquartile range 1 to 3 days) than those who lived (median 5 days, interquartile range 2 to 7 days). Antivirals were administered to 5 (11%) patients; all of these patients had laboratory-confirmed influenza, and all died.

Forty-three (84%) case patients were admitted to the hospital (median length of stay, 9.5 days; range 0 to 51 days). Of the 8 case patients who were not admitted, all died either in the emergency department, in transport to another hospital, or at home. Thirty-four (79%) of the 43 hospitalized case patients were in the ICU for part of their hospitalization (median ICU stay 8 days; range 1 to 33 days), and 32 (74%) required the assistance of a ventilator (median time of ventilatory support, 5 days; range 1 to 21 days). Median length of stay was 16 days (interquartile range 2 to 19 days) for patients testing positive for influenza and 8.5 days (interquartile range 2.5 to 15.5 days) for patients testing negative.

Information on outcome was available for 47 case patients; of these, 24 (51%) died. The median time from symptoms onset to death was 4 days (range 1 to 33 days). Infection with influenza and a low WBC count were both associated with death in univariate analysis, and having a WBC of greater than 10,000 mm$^3$ appeared protective (Table 4). In multivariate analysis including low WBC count and infection with influenza, only low WBC count remained significantly associated with death.

Eighteen *S aureus* isolates (17 MRSA, 1 methicillin-susceptible *S aureus*) were received at the CDC. All but 1 contained genes for Panton-Valentin leukocidin toxin; none contained genes for toxic shock syndrome toxin-1. Pulsed-field gel electrophoresis revealed that 13 of the MRSA isolates had the pulsed-field pattern USA300-0114, the most common pulsed-field gel electrophoresis pattern observed among MRSA isolates causing disease in the community. Three isolates had other patterns within the USA300 pulsed-field type, and 1 (Panton-Valentin leukocidin-negative) had pulsed-field type USA100, a pulsed-field gel electrophoresis pattern often observed among MRSA isolates causing disease in hospitals. The one methicillin-susceptible *S aureus* isolate had a USA300 pulsed-field pattern and contained Panton-Valentin leukocidin genes.

Antimicrobial susceptibility test results from the local clinical laboratory or the CDC were available for 31 isolates (28 MRSA, 3 methicillin-susceptible *S aureus*). All isolates were susceptible to vancomycin, tetracycline, and trimethoprim-sulfamethoxazole. Two of 27 MRSA isolates tested were reported as susceptible to erythromycin; 10 of 20 MRSA isolates tested with levofloxacin were susceptible, and all 16 MRSA isolates tested with linezolid and daptomycin were susceptible to both.

## LIMITATIONS

This case series is subject to a number of limitations. First, reporting bias favoring the most severe cases is likely to have occurred; results from case series such as this may not be representative of the full spectrum of this disease. Second, case report forms were filled out retrospectively and could be subject to limitations in recall and information was not available for all patients. In addition, many of the patients had died, making the collection of data not commonly reported in the chart, such as preceding exposures and vaccination, difficult and possibly incomplete. Third, including patients with *S aureus* isolated only from sputum cultures might have decreased the specificity of our case definition and resulted in the inclusion of patients who were only colonized with *S aureus*; however, we believe this definition to be more in keeping with diagnostic methods used in clinical practice. Finally, it was difficult to collect information on concurrent or preceding influenza-like illnesses, because influenza and *S aureus* community-acquired pneumonia may present similarly. This combined with the relatively low sensitivity of influenza tests might have led to the misclassification of some who did in fact have influenza. In addition, we did not collect information on testing for other respiratory viruses.

## DISCUSSION

This series reinforces that *S aureus* community-acquired pneumonia occurs in young otherwise healthy people even

**Table 4.** Characteristics of case patients by survival status.

| Characteristic | Case Patients Who Died N=24, No. (%) | Case Patients Who Survived, N=23, No. (%) | Relative Risk | 95% Confidence Interval |
|---|---|---|---|---|
| **Age, y** | | | | |
| <18 | 13 (48) | 14 (52) | | |
| 19–50 | 7 (50) | 7 (50) | | |
| >50 | 4 (67) | 2 (33) | | |
| **Sex** | | | 0.62 | 0.33–1.16 |
| Male | 8 (38) | 13 (62) | | |
| Female | 16 (62) | 10 (38) | | |
| **Influenza (test result positive)** | | | 2.02 | 1.20–3.40 |
| Yes | 10 (91) | 1 (9) | | |
| No | 9 (45) | 11 (55) | | |
| **Diagnosed with a virus** | | | 1.67 | 0.89–3.40 |
| Yes | 14 (64) | 8 (36) | | |
| No | 8 (38) | 13 (62) | | |
| **Medical history** | | | 1.45 | 0.75–2.68 |
| Comorbidities present | 11 (58) | 8 (42) | | |
| No comorbidities | 10 (40) | 15 (60) | | |
| ***S aureus*** in blood | | | 1.87 | 1.10–3.44 |
| Yes | 10 (67) | 5 (33) | | |
| No | 10 (36) | 18 (64) | | |
| **WBC count <4,000/mm$^3$** | | | 5.87 | 1.99–17.30 |
| Yes | 12 (80) | 3 (20) | | |
| No | 3 (14) | 19 (86) | | |
| **WBC count >10,000/mm$^3$** | | | 0.23 | 0.06–0.86 |
| Yes | 2 (13) | 13 (87) | | |
| No | 13 (59) | 9 (41) | | |
| **Platelet count <150,000/mm$^3$** | | | 1.56 | 0.67–3.63 |
| Yes | 5 (50) | 5 (50) | | |
| No | 8 (32) | 17 (68) | | |
| **Organism** | | | 1.21 | 0.53–2.80 |
| MRSA | 16 (48) | 17 (52) | | |
| Methicillin-susceptible *S aureus* | 4 (40) | 6 (60) | | |

during milder influenza seasons.[8] In addition, MRSA accounted for the majority of reported cases in this series, raising concern that this organism might be playing a greater role in community-acquired pneumonia than previously reported. However, only about half of patients with MRSA community-acquired pneumonia were treated with linezolid or vancomycin empirically, suggesting that MRSA was not initially suspected. Influenza virus infection was associated with a worse outcome, along with the presence of a low WBC count. The presence of preceding skin and soft tissue infections in the patients or patient contacts might serve as a diagnostic indicator for *S aureus* community-acquired pneumonia and requires further study.

This and previous reports demonstrate that *S aureus* community-acquired pneumonia occurs in otherwise healthy people.[1,3,4,6,13] In addition, the presence of comorbidities in patients with *S aureus* community-acquired pneumonia has been relatively consistent over time. Fisher et al,[3] in a series of cases from the 1940s and 1950s, found serious debilitating diseases in 11 of 21 *S aureus* community-acquired pneumonia patients, whereas our and other more recent series have similar proportions of patients with previous medical problems.[6,14] Influenza activity, however, might influence the type of patients who develop *S aureus* community-acquired pneumonia. Schwarzmann et al[15] found that only 43% of the patients presenting with *S aureus* pneumonia during the 1968 to 1969 influenza pandemic had comorbidities compared with 100% of *S aureus* community-acquired pneumonia patients presenting the year before.

Also notable is that a large proportion of *S aureus* community-acquired pneumonia cases reported in this series were due to MRSA. In a recent series reporting cases occurring from 1986 to 2005, the percentage of cases caused by MRSA was 12%; however, 15 (88%) of 17 reported cases were caused by MRSA in a series from the 2003 to 2004 season.[6,14] This is consistent with our finding that 79% of reported cases were attributed to MRSA.

The reason for this high proportion of MRSA is not completely clear, but clinicians might be more likely to report cases of MRSA community-acquired pneumonia. However, MRSA colonization appears to be becoming more common, including in healthy children,[16,17] as do other community-associated *S aureus* infections caused by MRSA, including skin infections.[9,18] A similar increase in the proportion of

community-acquired pneumonia caused by MRSA could be occurring. Notably, nearly all of the MRSA isolates collected were pulsed-field type USA300 and contained genes for Panton-Valentin leukocidin toxin, both characteristics of MRSA strains causing epidemic disease in the community. Community-associated MRSA infections might be difficult for clinicians to recognize because patients often lack risk factors associated with health care–associated MRSA infections.[6] This is supported by the fact that less than half the patients with MRSA were empirically treated with an antimicrobial agent recommended in current guidelines for MRSA community-acquired pneumonia.[11]

No clinical, radiographic, or laboratory findings clearly identify patients with *S aureus* pneumonia. Evaluating chest radiographs for cavitary infiltrates, a finding suggested by current guidelines as a potential indicator of *S aureus* community-acquired pneumonia, would have identified only 3 patients in this series.[11] Presence of any comorbidity and a history of hospitalizations were among the most common factors found in case patients, but both were found in only 56% and 30% of patients, respectively (Table 1). In addition, a history of *S aureus* skin and soft tissue infections might identify patients who are at higher risk for pneumonia. *S aureus* colonization may be common in children,[19] the same group in which *S aureus* community-acquired pneumonia was most often reported. Recently, both Hageman et al[6] and Gillet et al[14] reported a history of skin infections in some of their *S aureus* pneumonia case patients or their contacts. Additionally, Goslings et al[2] observed that a large number of patients with *S aureus* pneumonia during the 1957 to 1958 influenza pandemic had preceding staphylococcal skin lesions or family members with these lesions. In our series, 8 patients (16%) had antecedent skin infections or contact with someone who did. This finding, however, requires further evaluation to determine the extent of its association with *S aureus* community-acquired pneumonia.

Although *S aureus* has been commonly reported after influenza,[5,6,11] and some evidence has suggested that influenza might potentiate bacterial pneumonia,[20] only 33% of those tested were positive for influenza. This finding suggests that at least some *S aureus* community-acquired pneumonia is occurring in patients without preceding or concurrent influenza or in patients infected with noninfluenza respiratory viruses. However, influenza testing has limitations, including a relatively low sensitivity (70% to 75% for rapid tests in children and even lower sensitivity in adults), potentially leading to misclassification of some patients in this series.[21] The contribution of other respiratory viruses such as respiratory syncytial virus requires further study.

Although rapid progression has been reported, classically bacterial pneumonia after influenza has been described as a biphasic illness, with patients initially improving during 2 to 14 days before the onset of symptoms from the bacterial pneumonia.[12] Patients in this series, however, demonstrated a relatively rapid progression from symptom onset to pneumonia diagnosis, a median of 4 days overall and 3 days in patients with documented influenza infection. This would suggest that influenza and *S aureus* infections in this series were occurring concurrently rather than as a biphasic illness, with influenza infection distinctly preceding *S aureus* community-acquired pneumonia. This finding also requires further investigation.

In this series, a WBC count less than 4,000/mm$^3$ and infection with influenza were both associated with a greater likelihood of death. Gillet et al[14] also found a low WBC count to be a risk factor for death in their case series. Whether this is a marker of severe sepsis, influenza, or concurrent viral illness is not clear, especially in light of the poor sensitivity of current influenza tests and the known association between influenza and low WBC counts. The association between confirmed influenza infection and mortality is of particular interest because positive rapid tests for influenza have been associated with decreased antibiotic use and have been hailed by some as a way to decrease antibiotic use.[22] Although this might be true in those with influenza alone, clinicians should consider the possibility of concurrent bacterial pneumonia in influenza patients.

In summary, *S aureus* is a cause of community-acquired pneumonia in the winter months. It is associated with severe disease and is possibly more severe when occurring with influenza infection. Therefore, those at high risk for influenza and its complications should get an annual influenza vaccination.[23] Cases reported during the winter of 2006 to 2007 suggest a possible increase in disease caused by MRSA. Further work is required to identify possible risk factors for *S aureus* and MRSA among patients presenting with community-acquired pneumonia. Regardless, MRSA should remain in the differential diagnosis of severe community-acquired pneumonia occurring during the influenza season.

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