# Susceptibility Patterns of Staphylococcus in a Family Practice Population

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Nasal swabs were obtained from 408 patients seen in a family practice office in an attempt to identify Staphylococcus aureus carriers. Isolated strains were tested for sensitivity to 11 antibiotics. Study participants were interviewed to obtain the following data: age, history of recent hospitalization and/or recent antibiotic use, number of household members, and occupation, if employed in a health-care facility.

S aureus was isolated from 109 nasal swabs. This represents a 26.7 percent carrier rate. Only 25.7 percent of the isolates were sensitive to penicillin G and ampicillin. No statistically significant association was found between the patient variables and either the carrier rate or the sensitivity of the S aureus isolates to penicillin. The sensitivity testing demonstrated that 94.5 percent of the isolates were sensitive to tetracycline and erythromycin. Ninety-nine to 100 percent of the isolates were sensitive to all other antibiotics tested.

The authors conclude that penicillin G should not be used in the treatment of S aureus infections. Erythromycin, due to demonstrated sensitivity and reasonable cost, is recommended for mild to moderate infections.

Bacterial skin infections, such as furunculosis or cellulitis, are frequently encountered in primary care. The pathogen commonly associated with these infections is Staphylococcus aureus. Oral antibiotics are often the preferred treatment. In many cases the severity of infection may not warrant the laboratory cost of a bacterial culture and sensitivity test. Antibiotic therapy is most often empirically selected based on expected efficacy against S aureus, potential for side effects, and cost. Penicillin V has been a popularly chosen antibiotic for years. It must be noted that in the treatment of susceptible S aureus there is no antibiotic more effective, better tolerated, or less expensive than penicillin V.

"Susceptible" is the key word, however, since the incidence of resistant "hospital" strains of staphylococcal organisms is very extensive. It is commonly recognized that there is a difference in the sensitivity pattern of these organisms isolated from hospital vs non-hospital sources. The resistance of "community" strains of S aureus has historically been low. In 1949, Martin and Whitehead[1] noted 18 percent resistance of penicillin in coagulase-positive staphylococci isolated from the nares of healthy adults. Weinstein[2] states, "It is estimated that over 90 percent of staphylococcal infections due to hospital strains and from 15 to 20 percent of those involving mi-

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**Table 1. Antibiotic Susceptibility of 109 S aureus Isolates**

| Antibiotic | % Sensitive |
|---|---|
| Ampicillin | 25.7 |
| Cephalexin | 99.1 |
| Cephalothin | 99.1 |
| Chloramphenicol | 100 |
| Clindamycin | 99.1 |
| Erythromycin | 94.5 |
| Oxacillin | 99.1 |
| Penicillin G | 25.7 |
| Sulfamethoxazole/trimethoprim | 99.1 |
| Sulfathiazole | 99.1 |
| Tetracycline HCl | 94.5 |

croorganisms present outside a hospital environment are presently resistant to therapy with penicillin G." This viewpoint tends to support the choice of penicillin V in the treatment of S aureus infections in the primary care setting. Recent data, however, demonstrate a much higher frequency of penicillin-resistant S aureus isolated from community sources.

Ross et al[3] demonstrated that 84 percent of 95 street strains of S aureus isolated from various infections were resistant to penicillin G. An additional 145 strains were obtained from nare swabs of healthy elementary school children. Sixty-eight percent were resistant to penicillin. Holloway and Clark[4] studied 100 strains of S aureus obtained from community-based patients, and only 22 percent were sensitive to penicillin. These data challenge the use of a penicillinase-sensitive penicillin in potential staphylococcal infections.

The purpose of this study was to determine if the pattern of resistance reported by these two eastern, urban centers would be repeated in a typical, midwestern family practice population. The study also examined the influence of certain patient variables on the carriage rate of staphylococci and the sensitivity pattern of S aureus isolates.

## Methodology

The staphylococcal organisms tested in this study were obtained by nasal swabs of patients from a family practice population. It has been shown that organisms isolated from the nares of S aureus carriers are representative of those isolated from clinical infections.[5] Patients were selected consecutively from the daily roster of the Family Medical Center, Davenport, Iowa. No patients were repeated in the study. Each participant was interviewed to obtain the following information: age, last course of antibiotic taken, number of household members, last hospitalization, and occupation of any participant working in a health-care facility.

A single, anterior nare swab was obtained from each participant and cultured on mannitol salt agar. S aureus organisms were identified by physical appearance of the colony, a positive catalase test, and a positive slide-coagulase test. Antibiotic sensitivity testing was performed using the Kirby-Bauer disk diffusion technique.[6] Results were reported as sensitive (S), resistant (R), or intermediate (I). For the purposes of this study, the intermediate sensitivity and resistant categories were combined for analysis.

Association between the patient variables and the staphylococcal carrier rate and the sensitivity of isolates to penicillin was tested using the Chi-square test.

## Results

A total of 109 S aureus isolates were obtained from 408 nasal swab cultures, representing a 26.7 percent carrier rate.

The results of the antibiotic sensitivity testing are shown in Table 1. Only 25.7 percent of the isolates were sensitive to penicillin G and ampicillin. Tetracycline HCl and erythromycin demonstrated activity against 94.5 percent of the isolates. The sensitivity rate to all other antibiotics was 99 to 100 percent.

In an attempt to determine if any subpopulations would yield a high percentage of S aureus strains sensitive to penicillin, the sensitivity results and patient variables were examined. The results of this analysis are shown in Tables 2 through 6. Although no statistically significant association was found at the 0.05 level between any patient variable and the carrier rate or the sensitivity of

**Table 2. S aureus Carrier Rate and Penicillin Sensitivity of S aureus by Age of Participant**

| Age (years) | n | S aureus Carriers* (%) | % Isolates Sensitive to Penicillin* |
|---|---|---|---|
| Not reported | 7 | 0(0) | 0 |
| 1-5 | 36 | 13(36.1) | 7.7 |
| 6-10 | 26 | 12(46.2) | 16.7 |
| 11-18 | 44 | 13(29.5) | 46.2 |
| 19-25 | 58 | 13(22.4) | 23.1 |
| 26-35 | 107 | 30(28.0) | 33.3 |
| 36-45 | 44 | 12(27.3) | 16.7 |
| 46-55 | 26 | 7(26.9) | 14.3 |
| 56-65 | 18 | 2(11.1) | 50.0 |
| 66-99 | 42 | 7(16.7) | 28.6 |

* Chi-square NS

the isolates to penicillin, the high incidence of penicillin-resistant S aureus was underscored.

The pediatric population is of interest in this study. The younger age groups, one to five and six to ten years old, had the highest carrier rates of all groups (Table 2). A higher carrier rate in children than adults has been demonstrated previously.[7] The sensitivity rates of S aureus isolates in these same groups were very low (Table 2).

Analysis of the data demonstrated the carrier rate among those living in households of seven members or more was higher than any other group (Table 3). Thirteen of 14 (93 percent) isolates from this group were resistant to penicillin (Table 3).

Hospitalization in the year prior to the study did not affect the carrier rate or the sensitivity of the isolates to penicillin (Table 4). There were six S aureus isolates from the group with a history of antibiotic use in the month prior to the study. All were resistant to penicillin (Table 5). Four of five isolates from those working in a health-care facility were resistant to penicillin (Table 6). The samples in these instances were too small to reach statistical significance.

## Discussion

The resistance of hospital strains of S aureus to penicillin is well recognized. The resistance of community strains of S aureus to penicillin is becoming increasingly evident. Several studies have now documented penicillin resistance in 60 percent or more of S aureus strains tested.[3,4,8-10]

The results of this study indicate that a minority of community strains of S aureus isolated in the sampled family practice population were sensitive to penicillin. This indicates that penicillin V should not be used routinely in the treatment of suspected community-acquired staphylococcal infections.

Analysis of the results failed to demonstrate any subpopulation in which the use of penicillin could

**Table 3. S aureus Carrier Rate and Penicillin Sensitivity of S aureus by Number in Household**

| Number in Household | n | S aureus Carriers* (%) | % Isolates Sensitive to Penicillin* |
|---|---|---|---|
| 1 or 2 | 114 | 22(19.3) | 36.4 |
| 3 | 83 | 25(30.2) | 16.0 |
| 4 | 91 | 25(27.5) | 28.0 |
| 5 or 6 | 82 | 22(26.8) | 36.4 |
| 7 or more | 37 | 14(37.8) | 7.1 |

* Chi-square NS

**Table 4. S aureus Carrier Rate and Penicillin Sensitivity of S aureus in Patients Hospitalized During Previous Year**

| Hospitalization in Previous Year | n | S aureus Carriers* (%) | % Isolates Sensitive to Penicillin* |
|---|---|---|---|
| Yes | 56 | 14(25) | 14.3 |
| No | 352 | 95(27) | 27.4 |

* Chi-square NS

be recommended. No subpopulation with greater than four isolates had a sensitivity rate to penicillin exceeding 50 percent.

Ampicillin demonstrated results identical to penicillin G. This would be predictable based on its susceptibility to penicillinase. All remaining antibiotics tested demonstrated in vitro efficacy against greater than 94 percent of the S aureus isolates. The preferred alternative antibiotics to penicillin V would be a penicillinase-resistant penicillin (oxacillin, cloxacillin, or dicloxacillin) and erythromycin.

Each of the other antibiotics tested has certain disadvantages which discourage its use. The high costs of cephalexin and clindamycin are shown in Table 7.[11] The potential for serious side effects with clindamycin and chloramphenicol is well documented.[12] The indications for sulfamethoxazole/trimethoprim (Bactrim and Septra) are limited primarily to urinary tract infections. Tetracyclines and sulfonamides are frequently ineffective against streptococci.[13,14] This is an important consideration because streptococci, along with S aureus, constitute the most frequently isolated pathogens from skin infections. Without the benefit of culture, an antibiotic effective against both organisms is desirable.

The choice of the most appropriate agent for the treatment of staphylococcal infections must be made with knowledge of the specific clinical situa-

**Table 5. S aureus Carrier Rate and Penicillin Sensitivity of S aureus in Patients with a History of Antibiotic Use in Previous Month**

| Antibiotics in Month Prior to Study | n | S aureus Carriers* (%) | % Isolates Sensitive to Penicillin* |
|---|---|---|---|
| Yes | 36 | 6(16.7) | 0 |
| No | 372 | 103(27.7) | 27.2 |

* Chi-square NS

**Table 6. S aureus Carrier Rate and Penicillin Sensitivity of S aureus in Patients Working in a Health-Care Facility**

| Occupation in Health-Care Facility | n | S aureus Carriers* (%) | % Isolates Sensitive to Penicillin* |
|---|---|---|---|
| Yes | 20 | 5(25.0) | 20 |
| No | 388 | 104(26.8) | 26 |

* Chi-square NS

tion. The authors conclude that erythromycin be considered the drug of choice in the majority of mild to moderate skin and soft tissue infections. Erythromycin is effective, well tolerated, and less expensive than the penicillinase-resistant penicillins. The penicillinase-resistant penicillins remain the treatment of choice when the clinical situation warrants the additional expense.

## Summary

The results of this study emphasize the relatively high resistance of community-acquired S aureus to penicillin G. Alternatives with demonstrated efficacy include: cephalosporins, clindamycin, erythromycin, and a penicillinase-resistant penicillin. The authors suggest that penicillin G no longer be used in the treatment of skin and soft tissue infections without documented sensitive strains. Erythromycin, due to demonstrated sensitivity and reasonable cost, is recommended as the most appropriate drug of choice.

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**Table 7. Cost to Pharmacist for Ten-day Course of Various Antibiotics—Average Wholesale Price 1978[11]***

| Antibiotic | Dosage | Cost |
|---|---|---|
| cephalexin | | |
| Keflex | 250 mg q.i.d. | $12.21 |
| clindamycin | | |
| Cleocin | 150 mg q.i.d. | $15.00 |
| cloxacillin | | |
| Tegopen | 250 mg q.i.d. | $10.90 |
| dicloxacillin | | |
| Dynapen | 125 mg q.i.d. | $7.99 |
| Dynapen | 250 mg q.i.d. | $14.32 |
| erythromycin | | |
| E Mycin (base) | 250 mg q.i.d. | $7.08 |
| SK-Erythromycin (stearate) | 250 mg q.i.d. | $3.64 |
| Parke-Davis Generic, stearate | 250 mg q.i.d. | $4.63 |
| oxacillin | | |
| Bactocill | 500 mg q.i.d. | $15.84 |
| Prostaphlin | 500 mg q.i.d. | $16.20 |

* Based on information originally published in Drug Topics Redbook, 1978. With permission from Medical Economics Company, a division of Litton Industries, Oradell, NJ.

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