Present Status of Antibiotic Resistant Staphylococci in Seoul

Jung Koo Youn and Joon Lew

Department of Microbiology, Yonsei University
College of Medicine

It has been recognized that antibiotic resistant organisms have been gradually increasing in incidence since 1944, when Rantz and Kirby first reported Staphylococci resistant to penicillin. The factors responsible for this increasing incidence are considered mainly to be due to the inappropriate use of antibiotic substances in many fields of medicine, for example, their use as a prophylaxis against possible secondary infection, as treatment for febrile disease of unknown etiology, and also their use without previous testing for antibiotic susceptibility. In Korea, another factor can also be that ordinary people can purchase and use antibiotics legally without prescription.

The pathogenic Staphylococci are essentially parasitic and are commonly found on the skin and mucous membranes and are sometimes found in the environment, for example, in dust, in the air or articles of daily use. These organisms are responsible for a number of pathological conditions, chiefly suppurative in nature. It also generally accepted that Staphylococci have the most consistently developed prompt resistance to each of the antibiotics, while other species of bacteria have demonstrated resistance only to some of the antibiotics. As a consequence, strains completely resistant to all antibiotics available at the present time may appear, and infections due to such strains pose the most serious clinical problems of treatment. The problems regarding the appearance and wide dissemination of antibiotic resistant Staphylococci, especially in hospital infections due to this species, have been seriously discussed by many workers. It can easily be understood why in most hospitals, because antibiotics are used extensively, prevalent staphylococci are resistant to the common antibacterial drugs and why a large proportion of the hospital population carry antibiotic-resistant Staphylococci in the nasopharynx.

The incidence of antibiotic resistant Staphylococci and the occurrence of hospital infections caused by resistant strains have been reported, and they appear to be very high. Barbar, in 1948, reported that the incidence of penicillin-resistant Staphylococci was 14.1% in 1946, 38.8% in 1947 and 59.0% in 1948. According to the Laliberte’s report, in 1959, 3 to 10% of the patients had been infected by antibiotic-resistant Staphylococci during their hospitalization. Howe also reported that hospital wound infections in thoracic surgery was 2% in 1949 and 10.9% in 1952.

This study was undertaken for the purpose of evaluating the present status of pathogenic Staphylococci in Korea, with respect to the resistance of 280 strains currently being isolated to seven different antibiotics now widely used. The subjects dealt with in this report are chiefly, a) the incidence of antibiotic-resistant Staphylococci isolated from various sources, b) the relation of biological properties, previous antibiotic exposure and anatomical source to the incidence of antibiotic-resistant strains, c) a comparative survey of antibiotic-resistant Staphylococci isolated from medical personnel, from the environment of Severance Hospital and from healthy people and environments in Seoul City not associated with hospitals.
MATERIALS AND METHODS

Two hundred and eighty strains of Staphylococci were collected in Seoul City from the following sources: (a) Active lesions, (b) Throat and nasal swabs from medical personnel in Severance Hospital, such as doctors, nurses, technicians and other employees, and from patients who had been at least one week in the wards of the hospital without having pyogenic infection, (c) Throat and nasal swabs from healthy people who had not been associated with a hospital environment, (d) The air in Severance Hospital, such as in wards, operating rooms, recovery and delivery rooms, doctors' offices and nurses' stations, (e) The air in dormitories of schools and orphanages, churches and theatres in the city. The strains collected from sources (b) and (d) were referred to as hospital strains, and those from sources (c) and (e) as city strains.

To isolate pathogenic Staphylococci from active lesions and from throat and nasal swabs, thioglycolate broth and blood agar were used for culture at 37°C for 24 hours; to isolate from the air 7.5% salt agar plates were exposed to the air for 30 minutes. The biological characteristics of each strain were investigated testing for the production of coagulase, hemolysis and pigment formation.

The antibiotics used were penicillin, dihydrostreptomycin, chlorotetracycline, oxytetracycline, chloramphenicol, erythromycin and sigmamycin (Table 1). Susceptibility tests to these antibiotics were performed by the Kolmer paper disc method. Antibiotic resistance was recorded whenever there was a complete absence of a zone of inhibition surrounding a test disc on a plate on which organisms had been inoculated by the pour method and incubated at 37°C for 24 hours.

Table 1. Antibiotics Used for Sensitivity Tests

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Abbreviation</th>
<th>Manufacturer</th>
<th>Lot No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dihydrostreptomycin</td>
<td>SM</td>
<td>Merck and Co., Rahway N.J., U.S.A.</td>
<td>01B 3330</td>
</tr>
<tr>
<td>Chlorotetracycline (Aureomycin)</td>
<td>A</td>
<td>American Cyanamid Co., Lederle Laboratories Division, New York N.Y., U.S.A.</td>
<td>4683-244</td>
</tr>
<tr>
<td>Oxytetracycline (Terramycin)</td>
<td>T</td>
<td>Chas Pfizer and Co., New York N.Y., U.S.A.</td>
<td>81509</td>
</tr>
<tr>
<td>Chloramphenicol</td>
<td>C</td>
<td>Parke Davis and Co., Detroit Mich., U.S.A.</td>
<td>238866</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>E</td>
<td>Eli Lilly and Co., Indianapolis, U.S.A.</td>
<td>6945-73079</td>
</tr>
<tr>
<td>Tetrazycline-Oleandomycin</td>
<td>S (Sigmamycin)</td>
<td>Chas Pfizer and Co., New York N.Y., U.S.A.</td>
<td>93529</td>
</tr>
</tbody>
</table>

RESULTS

1). Incidence of resistant strains to seven antibiotics (Table 2)

It is seen that the antibiotic to which the strains exhibited the highest incidence of resistance was penicillin. This incidence was 81.4% and was followed in the order of decreasing incidence by dihydrostreptomycin (57.1%), oxytetracycline (42.5%), chlorotetracycline (33.3%), chloramphenicol (29.6%), sigmamycin (23.9%) and erythromycin (21.1%). Resistance to erythromycin, sigmamycin and chloramphenicol was less frequent than with the other antibiotics.

Table 2. Incidence of Strains Resistant to Seven Antibiotics

<table>
<thead>
<tr>
<th>Antibiotics</th>
<th>Unit or µg per ml</th>
<th>Strains (60)</th>
<th>Hospital Strains (140)</th>
<th>City Strains (50)</th>
<th>Total (260)</th>
<th>Coagulase Positive Strains (%)</th>
<th>Coagulase Negative Strains (%)</th>
<th>Total (260)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillin</td>
<td>50</td>
<td>60</td>
<td>92.3</td>
<td>111</td>
<td>973</td>
<td>85.4%</td>
<td>100%</td>
<td>228</td>
</tr>
<tr>
<td>Dihydro-streptomycin</td>
<td>500</td>
<td>37</td>
<td>56.8</td>
<td>94</td>
<td>150</td>
<td>34.5%</td>
<td>150%</td>
<td>160</td>
</tr>
<tr>
<td>Oxytetracycline (Terramycin)</td>
<td>500</td>
<td>30</td>
<td>46.2</td>
<td>73</td>
<td>112</td>
<td>43.0%</td>
<td>7%</td>
<td>119</td>
</tr>
</tbody>
</table>
- 32 - JUNG KOO YOUN AND JOON LEW

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>#</th>
<th>%1</th>
<th>%2</th>
<th>%3</th>
<th>%4</th>
<th>%5</th>
<th>%6</th>
<th>%7</th>
<th>%8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorotetracycline (Aureomycin)</td>
<td>500</td>
<td>31</td>
<td>47.7</td>
<td>50</td>
<td>35.7</td>
<td>4</td>
<td>7.2</td>
<td>85</td>
<td>31.7</td>
</tr>
<tr>
<td>Chloramphenicol</td>
<td>700</td>
<td>7</td>
<td>10.8</td>
<td>52</td>
<td>37.1</td>
<td>16</td>
<td>29.0</td>
<td>75</td>
<td>28.8</td>
</tr>
<tr>
<td>Sigmamycin</td>
<td>500</td>
<td>15</td>
<td>23.1</td>
<td>51</td>
<td>30.4</td>
<td>0</td>
<td>0</td>
<td>66</td>
<td>25.3</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>500</td>
<td>5</td>
<td>7.7</td>
<td>53</td>
<td>37.8</td>
<td>0</td>
<td>0</td>
<td>58</td>
<td>22.3</td>
</tr>
</tbody>
</table>

#: Number of Strains %: Incidences of Resistant Strains, μG: Microgram.

2). Relation of biological characteristics to the incidence of resistant strains (Figure 1, 2, & 3) As to their biological characteristics, 280 strains of Staphylococci were tested for their production

![Graph 1](attachment:image1.png)

Fig. 1. Comparison of antibiotic resistances between coagulase-positive strains and coagulase-negative strains of Staphylococci

![Graph 2](attachment:image2.png)

Fig. 2. Comparison of antibiotic resistances between hemolytic strains and non-hemolytic strains of Staphylococci.
of coagulase and for their hemolytic activities and pigment formation. Findings showed 290 coagulase-positive strains and 20 coagulase-negative strains, 216 hemolytic strains and 64 non-hemolytic strains, and 235 aureus strains and 45 albus strains. Comparing their resistance to their biological characteristics, these results, as a whole, revealed that coagulase-positive, hemolytic and aureus strains were generally more resistant to the antibiotics than were coagulase-negative, non-hemolytic and albus strains.

![Bar chart](chart1.png)

**Fig. 3.** Comparison of antibiotic resistances between aureus strains and albus strains of Staphylococci.

3) Relation of previous antibiotic exposure to the incidence of resistant strains (Figure 4)

Of 65 strains collected from clinically active lesions, 25 strains (exposed group) were isolated from the patients who had previously received two or more kinds of antibiotics for at least two

![Bar chart](chart2.png)

**Fig. 4.** Comparison of antibiotic resistances between antibiotic-exposed strains and non-exposed strains of Staphylococci.
weeks, and 24 strains (non-exposed group) were from patients in the hospital; mostly infants and newborn babies, who had never been exposed to any antibiotic substance. A comparison of the incidence of resistant strains in each group was made in Figure 4. It shows that the incidence of resistant strains in the exposed group is generally higher than in the non-exposed group, except with dihydrostreptomycin and chloramphenicol where the incidences in the former is rather lower than in the latter. However, it must be noted that the strains of non-exposed group also show a considerably high incidence of resistance to the antibiotics.

4. Relation of anatomical sources to the incidence of resistant strains

The 65 coagulase-positive strains of Staphylococci from clinically active lesions were collected from seven sources: skin, respiratory tract, middle ear, bone, conjunctiva, exudates from the pleural cavity, peritoneal cavity and pericardium, and others, depending on where the infection was located. The results showed no close correlation between the anatomical source of the strains and their antibiotic resistance.

5. Common resistance (Figure 5, Table 3)

Common resistance has been defined as resistance which an organism exhibits to two or more kinds of antibiotics regardless of previous exposure. The incidence of common resistance in the 260 strains of coagulase-positive Staphylococci to the seven antibiotics is listed under eight groups and is presented in Figure 5. Common resistance to penicillin-streptomycin was found in 134 strains, or 51.4% and to aureomycin-terramycin in 78 strains, or 30.0%. In those groups matched with chloramphenicol, erythromycin and sulfamycin, common resistance occurred less frequently. The number of strains that exhibit common resistance to all seven kinds of antibiotics was 24 or 9.2% of the total.

The strains with common resistance to each group of antibiotics were analysed as to their distribution in active lesions between hospital sources and city sources. Of 134 strains with common resistance to penicillin-streptomycin, 80 strains were hospital strains, and 17 strains were city strains. No strain that exhibited common resistance to chloramphenicol-aureomycin-terramycin and to all the seven kinds of antibiotics was found from city sources. This fact would indicate that the common resistant strains of Staphylococci were mostly distributed among hospital personnel and in hospital environment.
Table 3. Distribution of Common-Resistant Strains

<table>
<thead>
<tr>
<th>Sources of Strains</th>
<th>Strains of Active Lesions</th>
<th>Hospital Strains</th>
<th>City Strains</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#</td>
<td>%</td>
<td>#</td>
<td>%</td>
</tr>
<tr>
<td>P — SM</td>
<td>37</td>
<td>27.6</td>
<td>80</td>
<td>59.7</td>
</tr>
<tr>
<td>A — T</td>
<td>27</td>
<td>34.6</td>
<td>47</td>
<td>56.3</td>
</tr>
<tr>
<td>P — SM — T</td>
<td>25</td>
<td>36.6</td>
<td>61</td>
<td>64.9</td>
</tr>
<tr>
<td>P — SM — A</td>
<td>20</td>
<td>36.6</td>
<td>42</td>
<td>59.2</td>
</tr>
<tr>
<td>C — A — T</td>
<td>6</td>
<td>21.4</td>
<td>22</td>
<td>78.1</td>
</tr>
<tr>
<td>P — SM — C</td>
<td>7</td>
<td>17.9</td>
<td>30</td>
<td>76.9</td>
</tr>
<tr>
<td>P — SM — A — T</td>
<td>24</td>
<td>34.8</td>
<td>42</td>
<td>60.9</td>
</tr>
<tr>
<td>P — SM — A — T — C</td>
<td>3</td>
<td>12.5</td>
<td>21</td>
<td>87.5</td>
</tr>
</tbody>
</table>

# : Number of Strains, % : Incidence of Resistant Strains.

P : Penicillin, SM: Dikydo streptomycin,
T : Terracycl, A : Aureomycin, C : Chloramphenicol.
S : Sigmanycin, E : Erythromycin.

The difference in percentages of the incidence seems to be significant, and it indicates that coagulase-positive Staphylococci were more widely distributed among hospitals. The incidence of antibiotic resistance of these strains was analyzed as shown in Table 3, from which it is seen that hospital strains exhibit a higher incidence of resistance to most antibiotics than do city strains, particularly the strains that are resistant to erythromycin and sigmanycin, which could not be isolated from city sources, but mostly hospital sources in active lesions. It is readily recognized that antibiotic-

### Table 4. Incidence of Coagulase-Positive Staphylococci from Hospital and City Sources

<table>
<thead>
<tr>
<th>Sources of Specimens</th>
<th>Numbers of Specimen</th>
<th>Number of Strains (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persons</td>
<td>138</td>
<td>56 (40.5)</td>
</tr>
<tr>
<td>Throat</td>
<td>128</td>
<td>50 (39.1)</td>
</tr>
<tr>
<td>Air of Environment</td>
<td>95</td>
<td>34 (35.7)</td>
</tr>
<tr>
<td>Total</td>
<td>361</td>
<td>140 (38.8)</td>
</tr>
<tr>
<td>City</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persons</td>
<td>90</td>
<td>23 (25.6)</td>
</tr>
<tr>
<td>Throat</td>
<td>92</td>
<td>30 (32.6)</td>
</tr>
<tr>
<td>Air of Environment</td>
<td>40</td>
<td>2 (5.6)</td>
</tr>
<tr>
<td>Total</td>
<td>226</td>
<td>55 (24.8)</td>
</tr>
</tbody>
</table>

Fig 6. Comparison of antibiotic resistances between hospital strains and city strains of Staphylococci.
resistant staphylococci are more widely distributed among hospital personnel and in hospital environments than they are among those outside of hospitals.

**DISCUSSION**

The author performed sensitivity tests on 280 strains of Staphylococci isolated from various sources to determine their response to various antibiotics widely used in Korea and compared the incidence of resistance of each strain to each of the antibiotics. The results showed that the organisms exhibited, in general, higher resistance to penicillin, dihydrostreptomycin and oxytetracycline, and lower resistance to erythromycin, sigamycin and chloramphenicol. These findings are generally in accord with those of Borchardt (1959), Griffith (1959) and others, suggesting that the tested organisms were more resistant in vitro to the older and more-used antibiotics than they were to the newer or less used agents. As an exception to this generalization, Finland (1953), Suter (1959), Borchardt (1959), and Griffith (1959) noted that the incidence of strains resistant to chloramphenicol was relatively low when compared to other longer-used antibiotics such as the tetracyclines. They made no explanation of this difference but it may be so in Korea because chloramphenicol has been used in Korea chiefly for enteric infections and rarely for Staphylococcal infections.

From a study of the relationship between the biological properties of Staphylococci and the occurrence of antibiotic resistance, it was found that coagulase-positive, aureus and hemolytic strains were more resistant to most antibiotics than coagulase-negative, albus and non-hemolytic strains. According to the 1954-1955 report of the U.S. 496th Medical General Laboratory in Tokyo, Japan, which compared the incidence of resistance of hemolytic and non-hemolytic strains of Staphylococci to penicillin, chlorotetracycline, oxytetracycline, dihydrostreptomycin and chloramphenicol, the incidence of resistance of hemolytic strains was higher without exception, and this coincides with the author's results. There is no doubt bacteriologically, that pathogenic staphylococci mean coagulase-positive strains, but pathogenic biological properties other than coagulase production can include also aureus pigmentation and hemolysis. This therefore means that Staphylococci with the biological properties of pathogenic strains have a higher incidence of resistance than do non-pathogenic strains. Bondi & Dietz reported similar findings in 1945 and as the reason proposed that pathogenic staphylococci secrete an enzyme which either neutralizes or destroys the action of antibiotics. As an example, they maintained that penicillin-resistant Staphylococci secrete such an enzyme, penicillinase, and most of the Staphylococci which secrete penicillinase are coagulase-positive strains.

On comparing the incidence of resistant strains isolated from patients previously exposed to antibiotics and the incidence of those from patients not exposed to antibiotics, it was seen that the incidence of resistance was generally higher in those from patients previously exposed to antibiotics. It has been well established by many reports that in general, the more a pathogenic microorganism has been exposed to antibiotics, the higher the resistance to that antibiotic. Finland (1953) reported that when the resistance in 105 strains of Staphylococci from an antibiotic exposed group was compared with the resistance in 28 strains from a group not exposed to such antibiotics as penicillin, streptomycin, chloramphenicol and chlorotetracycline, the strains from the antibiotic-exposed group showed a higher incidence without exception. Forbes (1949) also reported similarly that the newer and less used an antibiotic is, the lower the incidence of resistance. But according to the author's results, as shown in Figure 4, the incidence of resistant strains in the group not exposed to antibiotics was relatively high too, and was even higher than in the antibiotic-exposed group, particularly so with dihydrostreptomycin and with chlorotetracycline. This indicates that there has been a considerably high occurrence of infections due to antibiotic-resistant strains in the hospital, because 18 out of 24 strains found in the group not exposed to antibiotics were isolated from infants under one
year of age and 6 out of these 16 strains were isolated from the nasopharynx of newborn babies born in the hospital.

The relationship between the anatomical source of strains isolated from clinically active lesions and their incidence of antibiotic resistance is a controversial question among many workers. For example, Sherris & Florey (1951) reported that penicillin-resistant strains were obtained primarily from superficial infections and were less often associated with signs of inflammation and suppuration whereas penicillin-sensitive strains were associated with acute or closed lesions and with deep-seated lesions which were either acute or chronic. Suter emphasized that microorganisms, in general, are more resistant when they have been isolated from organs in which chronic infections commonly occur than when they are isolated from organs, such as the ear, in which chronicity is rare. To inquire into such a relationship, the author have classified the strains according to their anatomical sources and studied their relationship with the incidence of resistant strains from each source, but they could find no such relationship. Finland (1953) also reported that he classified the specimens as to their anatomical sites and studied their relationship with the incidence of resistance, but found no such relationship.

The author have defined common resistance as the resistance which an organism exhibits to more than one kind of antibiotics regardless of previous exposures. It can be seen that there was a considerable number of strains with common resistance to two or more kinds of antibiotics. Cross resistance to chlortetracycline and oxytetracycline is generally recognized. Clough (1955) stated that because there is cross resistance among the tetracycline derivatives, if organisms acquire to one tetracycline, most of them develop resistance to other kinds of tetracyclines even though they were not exposed to the drugs previously. Common resistance to chlortetracycline and oxytetracycline was seen in 78 strains, and of these 73 strains, or 93.5%, were at the same time resistant to penicillin.

Finland (1953) reported that strains with common resistance to chlortetracycline and oxytetracycline were in most cases resistant to penicillin as well. To analyze this common resistance to chlortetracycline and oxytetracycline in more detail, 78 out of 83 strains, or 93.9%, that were resistant to chlortetracycline showed common resistance to oxytetracycline, while 79 out of 112 strains, or 70.5%, that were resistant to oxytetracycline showed common resistance to chlortetracycline. It was therefore evident that the incidence of common resistance to chlortetracycline-oxytetracycline was high. Strains with common resistance to chloramphenicol were few in number, and this is believed to be due to lowered incidence of resistance to that antibiotic as a whole. The high incidence of common resistance to penicillin-streptomycin is different from the cross resistance to chlortetracycline-oxytetracycline and is regarded as the result of the high incidence individually to penicillin and to streptomycin. When the common-resistant strains were classified as to their source, it was found that most of them were strains isolated from hospital sources. Not a single strain with common resistance to chloramphenicol-chlortetracycline oxytetracycline and to all the seven kinds of antibiotics was seen from city sources. This indicates that most of the common-resistant strains are distributed inside the hospital, which deals extensively with many kinds of antibiotics. It is easily presumed that most of the hospital infections are due to such common-resistant strains.

To know the possibility of hospital infections due to antibiotic-resistant staphylococci, the distribution of antibiotic-resistant strains both from hospital sources and from city sources have been investigated, and the following results were obtained: a) the incidence of coagulase-positive strains from hospital sources was considerably higher than that from city sources. Especially was it revealed that the longer a person resides in the hospital, the higher the incidence of the carrier state in the nasopharynx. b) comparing the hospital strains with the city strains in regard to their antibiotic resistance, the incidence of antibiotic resistance in the hospital was generally higher. These results
indicate that antibiotic-resistant Staphylococci were more widely distributed among hospital personnel and environments than among those unassociated with hospitals. It can easily be presumed that the rate of hospital infections due to these antibiotic-resistant Staphylococci will continue to increase because of the following evidence: hospital personnel harbor antibiotic-resistant Staphylococci in their nasopharynx to a high degree; most of the resistant strains isolated from patients not previously exposed to antibiotics were isolated from the nasopharynx of infants and newborn babies born at the hospital; and most of the common-resistant strains were distributed inside the hospital.

The problem of hospital infection caused by antibiotic-resistant Staphylococci has been regarded as a serious subject for a long time. In 1947, Barbara reported that penicillin-resistant Staphylococci in a hospital in England have gradually increased in incidence. Since then, Martine, Forbes, Howe, Laliberte and other workers have made similar reports. Recently, the prophylactic use of antibiotic substance has been condemned in many reports, because the complications caused by the emergence of antibiotic-resistant organisms are much more serious than the practical benefits to be gained by the prophylactic use of antibiotics.

Considering the various factors discussed heretofore, the following regulations are suggested to halt the emergence of antibiotic-resistant microorganisms and so to reduce hospital infection.

a. Adequate susceptibility tests must be performed before using antibiotics.

b. Even if proper antibiotics are employed, as determined by susceptibility tests, continuous treatment should be employed with a view to eradicating the causative microorganisms.

c. It is recommended, if possible, that the employment of antibiotics as a preventive measure be avoided.

d. Eliminating the causative organisms of hospital infections by thorough disinfection of all the hospital environment, especially the operating rooms, delivery room, and wards, etc. should be maintained by every possible means.

e. If one of the hospital personnel has a superficial pyogenic lesion, he should receive prompt treatment to avoid the spreading of the causative organisms.

**CONCLUSIONS**

1. Two hundred and eighty strains of Staphylococci isolated from various sources were investigated to determine their resistance to seven kinds of antibiotics, using the paper disc method. The incidence of resistant strains to penicillin was 81.4%, to dihydrostreptomycin 57.1%, and to oxytetracycline 42.5%. This was followed in decreasing order by 33.3% for chlorotetacycline, 29.6% for chloramphenicol, 23.9% for sigmamycin and 21.1% for erythromycin.

2. There was a lower incidence of strains resistant to chloramphenicol than of those resistant to chlorotetacycline and oxytetracyline.

3. Coagulase-positive strains, aureus strains and hemolytic strains of Staphylococci were more resistant to the antibiotics than were coagulase-negative, albus and non-hemolytic strains.

4. The incidence of antibiotic-resistant Staphylococci isolated from patients previously exposed to antibiotics was higher than from those patients not previously exposed to antibiotics.

5. Hospital infections due to antibiotic-resistant Staphylococci in the Severance Hospital were very frequent, because the incidence of resistant strains from patients not previously exposed to antibiotics was unusually high; one-fourth of the strains isolated from infants and newborn babies born in the hospital were resistant.

6. There was no close correlation between the anatomical source of the Staphylococci and their resistance to antibiotics.

7. The incidence of strains showing common resistance to penicillin-streptomycin was 51.4%, to penicillin-streptomycin-oxycycline 36.1%, and to chlorotetacycline-oxycycline 30.9%. In general, common resistance to chloramphenicol, erythromycin and sigmamycin were lower in incidence.

8. The strains of Staphylococci showing common
resistance to the antibiotics were distributed mostly among hospital personnel and in hospital environments.

9. The incidence of coagulase-positive Staphylococci from hospital sources was 38.8%, and from city sources that had not been associated with hospitals, 24.8%. This indicates that coagulase-positive Staphylococci are more widely distributed among hospital personnel and in hospital environments.

10. The incidence of antibiotic-resistant staphylococci from hospital sources was higher than that of antibiotic-resistant Staphylococci from city sources not associated with hospitals.

REFERENCES