Studies of Staphylococcal Infections in the Hospital del Torax
Medical, Surgical and Bacteriologic Aspects

HÉCTOR ORREGO-PUELMA, M.D., F.C.C.P.,* OSCAR BOTTESELLE PAHUL, M.D.,**
JULIO GAJARDO HENRIQUEZ, M.D.† AND JORGE OLIVARES CORONA, M.D.‡

Santiago, Chile

IN THE PRESENT REPORT, WE SHALL point out our experience in regard to Staphylococcal infections in patients treated at a 300-bed hospital for thoracic pathology. One-third of the beds are assigned to the surgical service and the rest to the medical service, where they are equally divided between tuberculous and nontuberculous patients.

The adequate and almost methodical bacteriologic control carried out in our patients since 1954 constitutes one of the most important bases for our experience.

Through the different bacteriologic data obtained and published before, it can be observed in Table 1 that the presence of hemolytic Staphylococcus aureus in any of the groups is not lower than 20 per cent, reaching 100 per cent in the group of patients who died from acute post-influenzal thoracic syndromes.

In order to have a general view of the actual problem, we reviewed 2,320 hospital records between March, 1961, and August, 1962. Of these, 1,431 were on medical wards and were divided as follows: 920 patients without tuberculosis and the rest, 511, with tuberculosis; 889 patients were from the surgical ward with a total of 934 surgical procedures. We investigated all of them for hemolytic Staphylococcus aureus in any pathologic material.

Of the total of 920 patients without tuberculosis admitted to the medical ward during the period mentioned above, 37 presented hemolytic Staphylococcus aureus at some time, with an incidence of 4.01 per cent; while in the 521 patients with

<table>
<thead>
<tr>
<th>Table 1</th>
<th>No. of Cases</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1954</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic Bronchitis:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacterial strains isolated</td>
<td>274</td>
<td></td>
</tr>
<tr>
<td>Pathogenic strains of Staphylococcus</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Strains of hemolytic Staphylococcus aureus from the total</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Patients infected with hemolytic Staphylococcus aureus</td>
<td>11.61</td>
<td>25.2</td>
</tr>
<tr>
<td>1957</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epidemic of Influenza</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of hemolytic Staphylococcus aureus in chronic pulmonary patients (100 cases before influenza)</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Frequency of hemolytic Staphylococcus aureus in 115 cases with complicated bronchopulmonary process following influenza</td>
<td>52.17</td>
<td></td>
</tr>
<tr>
<td>Frequency of isolation of hemolytic Staphylococcus aureus at necropsy of 14 fatal cases with acute pleuropulmonary involvement</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>1957—January to August, 1959</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Empyema</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cases admitted to the surgical ward</td>
<td>1,236</td>
<td></td>
</tr>
<tr>
<td>Total empyemas</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Frequency of empyemas in the above cases</td>
<td>13</td>
<td>2.9</td>
</tr>
<tr>
<td>Emphyemas of staphylococcal etiology</td>
<td>36.1</td>
<td></td>
</tr>
<tr>
<td>Emphyema of staphylococcal etiology</td>
<td>36.1</td>
<td></td>
</tr>
<tr>
<td>1962</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control of nasopharyngeal carriers</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Presence of hemolytic Staphylococcus aureus</td>
<td>33.6</td>
<td></td>
</tr>
<tr>
<td>1962</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control of the respiratory microbial flora among hospital personnel (468 cases) for hemolytic Staphylococcus aureus</td>
<td>25.8</td>
<td></td>
</tr>
</tbody>
</table>
tuberculosis hospitalized during the same period, we found only 12 cases, with an incidence of 2.03 per cent.

In the surgical cases, when possible, the search was carried out with the utmost promptness. It was methodically performed with sputum specimens or aspirated bronchial secretions, in the immediate postoperative period, in almost 100 per cent of the distal segment of the surgical specimen in cases of resection, and in all wound secretions, intra- or extra-pleural exudates, and with pus obtained by drainage of abscesses, etc. This permitted the isolation of 89 strains of hemolytic \textit{Staphylococcus aureus}, of which 44 were from sputum, 22 from wound secretions, 14 from pleural exudates and the rest from bronchial segments and abscesses, etc.

From these 89 strains, only 43 (48.3 per cent), were accompanied by a clinical picture, which was assumed to be caused by hemolytic \textit{Staphylococcus aureus}. Its distribution can be observed in Table 2.

In our judgment, it is important to point out that through the investigation performed either with sputum specimens or with aspirated bronchial secretions during the preoperative period, of 43 carriers of hemolytic \textit{Staphylococcus aureus}, 21 later developed a pus-producing complication attributable to the same germ.

In the postoperative period, of the 40 surgical cases that developed a septic complication due to Staphylococcus, two died; both from sudden hemoptysis, subsequent to rupture of an important blood vessel involved by the co-existing serious supplicative process.

Recovery was accomplished in the rest of the patients due to measures such as: appropriate treatment, mechanical elimination of pus, and proper selection of one or more antimicrobial drugs, according to the findings of sensitivity tests performed \textit{in vitro}.

Nevertheless, we want to emphasize the fact that according to our experience the staphylococcal infection in patients with cardiorespiratory capacity frequently damaged, chronic suppurations, tuberculosis or cancer, presents particular seriousness.

The postoperative staphylococcal complication greatly extends the recovery period, an obstacle which can be overcome at high cost, due to the need for a prolonged treatment with high priced drugs and measures for isolation assumed to be essential.

The occasional outbreak of suppurating intrathoracic staphylococcal complications in the late postoperative period makes it necessary for the physician to carry out a thorough observation of this type patient, even after discharge from the hospital, with periodic check-up examinations for evidence of staphylococcal involvement.

Of the 920 patients without tuberculosis in the medical ward, 37 presented hemolytic \textit{Staphylococcus aureus}, and from the group of 521 tuberculous patients, there were only 12.

In our judgment, and without disregarding the frequent existence of serious primary staphylococcal pneumonopathy, there are factors which influence the pathogenesis of pulmonary staphylococcal infection.

(a) A background of hypo-ergic disease, especially viral. The influenza epidemic of
1957 supplies strong support of this judgment. Thus, we observed that hospitalized patients, especially those under antibiotic treatment, did not present any serious post-influenzal pathology.

At the same time, patients with this complication transferred to our hospital from other medical centers, in many instances yielded positive results for hemolytic *Staphylococcus aureus* in their pathologic specimens, a frequency which reached 100 per cent when the bacteriologic study was carried out at necropsy of the 14 fatal cases who died from broncho-pneumonopathy, which complicated the virus infection.

(b) The bacterial differentiation due to the intensive and indiscriminate use of antimicrobial drugs. This is a well known fact which in our case reveals special importance, since we are dealing with chronic bronchopulmonary cases who acquire repeated infections.

The infection within the hospital is a liability which our medical center, as many others, has had to experience due to a biologic phenomenon of microbial development which has come about through the years, conditioned by the use of antimicrobial drugs.

**CLINICAL PICTURE**

For our own purpose, we divided our 49 patients into two groups: Group I consisted of 26 patients with a clinical picture which leaves no doubt of its staphylococcal origin. From these cases, 21 were of bronchopulmonary type; 12 of them with serious implications of typical staphylococcal infection (bronchopneumonia, pulmonary abscess or pleural empyema), three of them were secondary (diffuse pneumonia, followed by anthrax, and two empyemas) and finally, five extra-pulmonary cases with abscess, furunculosis, etc.

Six cases presented diffuse bronchopneumonic features with rapid onset of fever and serious general manifestations including the respiratory system (one of them even required 24 hours of assisted respiration).

Through x-ray findings, we could observe diffuse infiltrates, sometimes changeable, and in four cases, check-valve cavities which, like pneumocele of children, also show sudden changes.

In only two cases did we find pleural complications with scarce purulent exudate, a fact which can be attributed to the massive treatment employed. These cases, in spite of the graveness, presented a satisfactory course.

In three other cases, the parenchymatous complication gave place to rapidly developing pulmonary abscess, and serious compromise of the general condition of the patients requiring pleural pneumotomy in one.

It is worthwhile to point out that in the more serious cases the difficulty in the differential diagnosis encountered during the first few days may lead to wrong prognosis. In our case, for instance, the presence of changeable findings on x-ray examination, high erythrocyte sedimentation rate, hyper-gammaglobulinemia, with low leukocyte count, led us to the diagnosis of collagenous disease. In another patient, it was the presence of significant continued eosinophilia without clinical or x-ray evidence of consolidation.

On many occasions, the late and consistent identification of hemolytic *Staphylococcus aureus* may delay etiologic diagnosis. This being so, we must always bear in mind the existence of old chronic pulmonary patients who may suffer from serious recurrence of their illness.

Included in this same group with chronic symptomatology, we found nine patients in whom hemolytic *Staphylococcus aureus* appears to be responsible for recurrent bronchial infections, with fever, variable purulent bronchorrhea, and with hemolytic *Staphylococcus aureus* being the only, or at least the predominant micro-organism.

It can be asserted without doubt, that *Staphylococcus* played a very important role in the serious relapse in chronic carriers of bronchopulmonary disease. This circumstance presents itself as one of the
most challenging problems the physician has to encounter in the treatment of these patients. The number of the latter is on the increase today due to better means at our disposal for prolonging their lives and applying therapy for the alleviation of their respiratory insufficiency. In this group, the selective and prolonged use of the antibiotics assured some improvement in their health, but only in half has it brought about sustained eradication of the causative micro-organism.

Group II. In this disease group of 23 patients, the presence of pathogenic Staphylococcus was not accompanied by clear manifestations, similar to group I. In 11 of these patients there existed parenchymal or bronchial disease, which rapidly responded to adequate therapy. The remaining 12 were asymptomatic without the clinical picture ascribed to the pathogen.

In spite of the seriousness of staphylococcal infection encountered in group I, no patient died due to the infection itself.

**Therapy**

We still continue to consider empyema and large staphylococcal pulmonary abscesses as “acute thorax” which requires as essential treatment the rapid elimination of pus besides an adequate antibiotic therapy. Nevertheless, the action of the antibiotic towards minimizing the quantity of the infection renders the exudate thinner. This permits us evacuation by means of thoracentesis, leaving surgical drainage as a second procedure, as long as this measure does not imply dangerous delay. Thus, in some cases with pleural involvement, we accomplished a cure with no important sequela, and without applying thoracotomy, which on the other hand, proved to be life saving in others.

**Antibiotics**

The fact that we could rely on certain antibiotics of well-known antistaphylococcal action, permitted us to carry out, in certain groups of patients, selected according to the degree of illness, a treatment which awarded helpful experience towards a better understanding of the antimicrobial action of these drugs.

Because of the great number of cases included in this study, we shall only mention the outstanding facts. During recent years, we have performed sensitivity tests in vitro as well as treatment of patients, with the following antimicrobial drugs: novobiocin, dimethoxy phenyl penicillin, triacetyl-oleandomycin, sigmamycin, rifomycin, and some new drugs derived from the tetracycline's basic nucleus.

Table 3 shows the demonstrative results obtained from our studies, in vitro, of 121 strains of hemolytic *Staphylococcus aureus*.
isolated from 468 pathologic specimens studied in the laboratory, with a total of 1,108 tests. According to our findings, the relationship of antimicrobial therapy and bacterial sensitivity can be summarized as follows: dimethoxy-phenyl penicillin, novobiocin, oleandomycin, erythromycin, chloramphenicol; combined therapy of tetracycline and oleandomycin, all kinds of tetracyclines, and finally, with very little antimicrobial action, streptomycin and penicillin G.

We have recently submitted for publication a short communication regarding the splendid results achieved in 12 cases of serious Staphylococcus infection treated with tri-acetylated oleandomycin.

In a more complete article, which includes 40 patients, 20 from the medical service and 20 from the surgical service, treated with novobiocin, we reported results obtained, especially in staphylococcal complications of the pleura, residual cavities or infected wounds. In surgical patients, the therapy was mostly local, with instillation into the cavity, or daily pleural irrigation over periods which frequently lasted for two weeks.

In patients from the medical ward, we instituted serial endobronchial instillations, as a local therapy for the existing pneumonitis or staphylococcal pulmonary abscesses.

The concentration of novobiocin, for endopleural use was of 5,000 micrograms per ml. in isotonic saline solution, and 1,000 or 2,000 micrograms per ml. in the case of endobronchial therapy. There were no signs of toxicity, and the results were highly satisfactory.

During these last two years, we have compiled valuable experience with the use of dimethoxy-phenyl-penicillin. Of the total number of strains analyzed, of unquestionable pathogenic action, we have not found resistant strains and the application of this particular drug at the clinic has always awarded good results.

The tabulation, which covers 40 cases treated up to now, has not yet been completed, but so far we are in a position to point out that we consider dimethoxy-phenyl penicillin as the antibiotic with pronounced efficacy. Since four months ago, we have included rifomycin in our clinical and bacteriologic investigation. Independent of its well known local action, especially as anti-tubercle bacillus agent, this drug presents in vitro an undoubted anti-staphylococcal action. Its application in the clinic, directed towards the treatment of localized suppurative process of staphylococcal etiology, has likewise furnished very favorable results.

**Summary**

1. In our judgment, the percentages of staphylococcal infection reported by the medical and surgical services of the Hospital del Tórax are of great importance, since they reveal more than 4 per cent of incidence.

2. The usual graveness of a typical staphylococcal clinical picture is another good reason to approach the problem seriously.

3. It seems pertinent to emphasize the risk which compromises the incorrect choice of antimicrobial agents in the genesis of staphylococcal infection.

4. In view of actual therapeutic possibilities, the prognosis of the infection has fundamentally changed. This obliges the physician to make a correct diagnosis, based on the etiologic cause, and adequate understanding of the response of the pathogen to the antibiotics at hand.

5. All the resources aimed at improvement of sanitary environment should be perfected, with the addition of a rational and complete treatment of patients infected with pathogenic *Staphylococcus*.

6. A methodical, simple and didactic sanitary education should be aimed for and encouraged, especially for hospital personnel in daily charge of infected patients.

7. The administrative group in charge of combating staphylococcal infection with-
in the hospital should be efficient. This matter must be considered essential if we want to have a true picture concerning the magnitude of the problem. This will make possible the unification of criteria for prophylaxis and treatment.

Resumen
1. Los porcentajes de infecciones por estafilococos son importantes en los servicios médicos y quirúrgicos puesto que son mayores de 4 por ciento.
2. Otra razón para atender al problema es la gravedad del cuadro clínico de las infecciones tópicas por estafilococos.
3. Parece pertinente señalar el riesgo debido a la incorrecta selección de los antibióticos como importantes en la génesis de la infección por estafilococos.
4. En vista de las posibilidades actuales ha cambiado el pronóstico de modo fundamental. Esto obliga a diagnóstico correcto basado en la etiología y el conocimiento adecuado de la respuesta a los antibióticos.
5. Deben mejorarse todas las medidas sanitarias además de lo antes señalado.
6. Debe procurarse la educación sanitaria del personal del hospital que tiene a su cargo a los enfermos infectados.
7. El grupo administrativo en cargado de combatir la infección estafilocócica debe ser eficiente. Esto es esencial para apreciar la magnitud del problema así como para obtener la unificación del criterio para la profilaxis y para el tratamiento.

Resumé
1. Les pourcentages d'infections staphylocciques rapportées par les services médicaux et chirurgicaux de l'Hôpital du Thorax sont de grande importance puisqu'ils révèlent une fréquence de plus de 4%.
2. L'habituelle gravité du tableau clinique des staphylococcosies est une autre raison d'aborder le problème sérieusement.
3. Il semble pertinent de mettre l'accent sur le danger du choix incorrect des agents antimicrobiens dans la génèse de l'infection staphylococcique.
4. Dans l'optique des possibilités thérapeutiques actuelles, le pronostic de l'infection a fondamentalement changé. Ceci oblige le médecin à faire un diagnostic correct fondé sur l'etiology et sur la connaissance précise de la réponse du germe pathogène aux antibiotiques courants.
5. Toutes les ressources ayant pour but l'amélioration du milieu sanitaire devraient être améliorées par l'adjonction d'un traitement logique et complet des malades infectés par un staphylocoque pathogène.
6. Une éducation sanitaire méthodique, simple et didactique devrait être dirigée dans ce sens et particulièrement conseillée à l'égard du personnel hospitalier qui a la charge des malades infectés.
7. Le groupe administratif dont le rôle est d'enrayer l'infection staphyloccique dans l'hôpital devrait avoir une action efficace. Ce point devrait être considéré comme essentiel si nous voulons avoir un tableau véritable de l'amplitude du problème. Cela rendra possible l'unification des critères de prophylaxie et de traitement.

Zusammenfassung
1. Der Anteil an Staphylokokkeninfektionen, über die die internen und chirurgischen Abteilungen des Hospitals del Torax berichten, sind von großer Wichtigkeit, da sie mehr als 4% der Fälle aus machen.
2. Das für gewöhnlich ernste Krankheitsbild einer typischen Staphylokokkeninfektion ist ein weiterer Grund, das Problem ernsthaft zu analysieren.
3. Es scheint angebracht, das Risiko hervorzuheben, das man eingeht, bei einer unzweckmäßigen Auswahl der antimikrobiellen Medikamente im Zusammenhang mit der Genese der Staphylokokkeninfektion.
4. Im Hinblick auf die gegenwärtigen therapeutischen Möglichkeiten hat sich die Prognose der Infektion grundsätzlich gewandelt. Sie muß den Arzt veranlassen, eine sorgfältige Diagnose auf Grundlage der Ätiologie und des korrekten Verstehens der Reaktion des pathogenen Agens auf die zur Verfügung stehenden Antibiotika zu erstellen.
5. Alle auf eine Verbesserung der hygienischen Umweltbedingungen gerichteten Hilfen müssen in vollem Umfang zur Durchführung gelangen, zusätzlich einer verfünften und vollständigen Behandlung der mit pathogenen Staphylokokken infizierten Patienten.

For reprints, please write Dr. J. Olivares Corona, Hospital del Torax, J. M. Infante 717, Santiago, Chile.