Staphylococcic Pneumonia in Infants
Under the Age of Six Months*

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During the past decade, staphylococcic infection has become a frequent cause of suppurative pneumonia in infants requiring hospitalization. Involvement of the lungs by this infection is seen during the first year, particularly in the first six months of life, more frequently than in later years, and carries a high mortality in the young patients.

The emergence of antibiotic-resistant strains of staphylococci has created problems in the management of this illness and perhaps placed more importance on early diagnosis and surgical management of its complications.

The purpose of this paper is to review the radiologic and clinical features of staphylococcic pneumonia and emphasize the importance of surgical treatment as seen in 11 consecutive infants under the age of six months, who were admitted to the American University Hospital of Beirut during the last nine years. Attention is placed in this report on the available means to reduce the morbidity and mortality of this disease.

Material

Ten infants had the diagnosis of staphylococcic pneumonia made on the basis of radiologic appearance of a pneumonic infiltrate and recovery of coagulase positive Staphylococcus aureus in cultures of the blood and/or the pleural fluid. The devel-

<table>
<thead>
<tr>
<th>No.</th>
<th>Date</th>
<th>Age (in months)</th>
<th>Weight (in Kg.)</th>
<th>Radiological Findings</th>
<th>Frequency of Chest Drainage</th>
<th>Period of Hospitalization (in days)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Nov. 1955</td>
<td>4½</td>
<td>7.08</td>
<td>Pyothorax (right)</td>
<td>Repeated needle</td>
<td>49</td>
<td>L</td>
</tr>
<tr>
<td>2.</td>
<td>July 1956</td>
<td>5</td>
<td>3.82</td>
<td>Upper lobe pneumonia (right)</td>
<td>Repeated needle</td>
<td>10</td>
<td>D</td>
</tr>
<tr>
<td>3.</td>
<td>July 1960</td>
<td>1</td>
<td>4.0</td>
<td>Large pneumatocele lower lobe (right)</td>
<td>Tube 2x</td>
<td>30</td>
<td>L</td>
</tr>
<tr>
<td>4.</td>
<td>Jan. 1961</td>
<td>6</td>
<td>7.9</td>
<td></td>
<td>Tube 2x</td>
<td>35</td>
<td>L</td>
</tr>
<tr>
<td>5.</td>
<td>Feb. 1961</td>
<td>4 days (cough at age of 26 days)</td>
<td>2.21</td>
<td>Massive pneumonia (right) (Fig. 1)</td>
<td>Tube 1x</td>
<td>54</td>
<td>L</td>
</tr>
<tr>
<td>6.</td>
<td>July 1961</td>
<td>40 days</td>
<td>3.42</td>
<td>Pyothorax (right)</td>
<td>Tube 1x</td>
<td>24</td>
<td>L</td>
</tr>
<tr>
<td>7.</td>
<td>Sept. 1961</td>
<td>2</td>
<td>3.7</td>
<td>Pyopneumothorax and pneumatoceles (right)</td>
<td>Tube 2x</td>
<td>33</td>
<td>L</td>
</tr>
<tr>
<td>8.</td>
<td>Feb. 1962</td>
<td>2</td>
<td>3.3</td>
<td>Pyothorax and pneumatoceles (left)</td>
<td>Tube 1x</td>
<td>11</td>
<td>L</td>
</tr>
<tr>
<td>9.</td>
<td>Dec. 1962</td>
<td>6</td>
<td>4.95</td>
<td>Pneumatoceles and pyopneumothorax (right) (Fig. 4)</td>
<td>Tube 2x</td>
<td>56</td>
<td>L</td>
</tr>
<tr>
<td>10.</td>
<td>Sept. 1963</td>
<td>3</td>
<td>5.3</td>
<td>Multiple pneumatoceles (left)</td>
<td>Tube 1x</td>
<td>12</td>
<td>L</td>
</tr>
<tr>
<td>11.</td>
<td>Sept. 1963</td>
<td>6</td>
<td>8.1</td>
<td>Pyothorax (left) (Fig. 2)</td>
<td>Tube 1x</td>
<td>28</td>
<td>L</td>
</tr>
</tbody>
</table>

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opment of pneumatoceles and pleural exudate led to the diagnosis of staphylococccic pneumonia in the eleventh infant although no growth of organisms was obtained by culture of the pleural fluid and no blood culture was done. A positive culture for staphylococci was obtained from the throat, but was not considered significant for diagnosis.

All patients were admitted to the hospital between January 1, 1955 and December 31, 1963 (Table 1). Nine were hospitalized during the last four years. Eight contracted the infection between September and February and three were seen during the month of July. There were eight boys and three girls. Six were under the age of three months. The youngest, who was admitted at the age of four days because of prematurity, developed signs of pneumonia three weeks after admission to the hospital.

The sensitivity of the staphylococccic strains to antibiotics was tested in vitro by the disc method. Eighty per cent of the strains were resistant to penicillin, 20 per cent to streptomycin and erythromycin, and 10 per cent to tetracycline and nocomycin. No resistance to chloramphenicol was found. The bacteriophage patterns of the bacteria were not investigated.

Neutrophilic leukocytosis was present in all survivors. A relative lymphocytosis was noted in the patient who succumbed.

All patients received various antibiotics two days to four weeks before hospitalization for symptoms of respiratory infection. The most common presenting symptoms were cough, respiratory distress, mild cyanosis and fever (39° to 40°C.). Gastrointestinal symptoms dominated the clinical picture in two cases. Three infants were afebrile on admission to the hospital. Congestive heart failure was encountered in one patient during the course of the illness. Signs of pericardial effusion developed in the infant who expired.

The radiologic findings on admission were variable (Table 1). The right lung was involved in seven patients and the left in four. There were no cases admitted with bilateral lung involvement. Two patients presented with pneumonic consolidation (Fig. 1), three with pyothorax (Fig. 2), two with pneumatoceles and four with pyopneumothorax and pneumatoceles (Figs. 3 and 4).

The course of the illness was characterized by development of pneumatoceles with or without pyopneumothorax in all patients. When absent on admission, pneumatoceles became manifest three to nine days later, and pyopneumothorax three to 16 days later. Pleural thickening and pneumatoceles were slow to disappear (Fig. 4). On discharge from the hospital, four patients had marked pleural thickening, three of whom also had evidence of pneumatoceles. The pleural thickening in another five patients was minimal and consistently accompanied by pneumatoceles. The shortest time for complete radiologic clearing of the lungs was one month after the initiation of treatment (Fig. 1).

Surgical chest drainage was instituted in all patients. Repeated needle aspiration of the chest fluid was used in two cases. Catheter drainage was resorted to in all other nine patients and had to be repeated more than once in four. Catheter drainage was used in seven instances for tension pneumothorax or pneumatocele, in two instances for extensive empyema, and in four instances for pyopneumothorax. Four patients needed chest drainage on the first day of admission because of severe respiratory distress, and seven had their chests drained during the first five days of hospitalization.

One of the 11 patients expired. This infant, who was five months old, was admitted with marasmus and had an abscess of the back for four days before admission. His empyema, which was present on admission, was treated with repeated needle aspiration and a combination of penicillin, streptomycin and chloramphenicol. The baby developed signs of pericardial effusion on the fifth day and died on the tenth hospital day. No necropsy permit was granted.
Figure 1: (Patient 5)—A. Chest roentgenogram taken on admission shows pneumonia involving the right upper and middle lobes. B. Film taken three days later shows evidence of a right pyopneumothorax with mediastinal shift to the left. C. Film one month later shows normal lungs.
**Table 2**

<table>
<thead>
<tr>
<th>Source of Data</th>
<th>Year</th>
<th>Cases Above the Age of Six Months</th>
<th>Cases Below the Age of Six Months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>Mortality Per Cent</td>
</tr>
<tr>
<td>Bloomer et al.¹</td>
<td>1955</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Wallman et al.²</td>
<td>1955</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Hendren et al.³</td>
<td>1958</td>
<td>32</td>
<td>3</td>
</tr>
<tr>
<td>Pryles⁴⁸</td>
<td>1958</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Isbister¹⁰</td>
<td>1959</td>
<td>9</td>
<td>33</td>
</tr>
<tr>
<td>Morris¹⁸</td>
<td>1959</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Oliver et al.¹⁸</td>
<td>1959</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Sabiston et al.¹¹</td>
<td>1959</td>
<td>22**</td>
<td>9</td>
</tr>
<tr>
<td>Present series</td>
<td></td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

(*): All patients were below the age of four months. (**): All patients were above the age of three months. (†): All patients were below the age of three months.

The period of hospitalization in the ten surviving patients ranged from ten to 56 days (average 31 days).

All patients received two or more antibiotics for at least three weeks after admission to the hospital. In seven of our 11 patients, penicillin and streptomycin were started on admission and then replaced by the appropriate antibiotics as soon as the diagnosis was made and the sensitivity studies were available. The other antibiotics used were erythromycin in nine patients, chloramphenicol in eight, tetracycline in six, sodium dimethoxyphenyl penicillin (Staphcillin) in three and novobiocin in one. One antibiotic was continued until all signs of activity of the disease disappeared. Enzymatic debridement of the empyema space with streptodornase-streptokinase (Varidase) was used in one case. Local instillation of antimicrobials into the pleural cavity was not employed. Roentgenograms of the chest were repeated at intervals of one or two weeks or sooner depending on the clinical status of the patient. Patients with pneumatoceles were kept in the hospital as long as there was radiologic evidence of increase in the size of the cyst.

Of the ten who were discharged as improved, radiologic and clinical follow-up

![Figure 2: Roentgenogram of chest taken on admission shows opacification of the left thoracic cavity representing a large empyema.](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21420/)
was possible in eight for periods ranging from three months to three and one half years. All eight are doing well and have complete clearing of their pulmonary findings.

**DISCUSSION**

In view of the high rate of recovery of *Staphylococcus aureus* from the nose and throat secretions of normal infants,6,18 other criteria for the diagnosis of staphylococcic pneumonia are necessary. The pleura is involved early in this disease and serves as a good source for bacteriologic confirmation of the infection. Positive pleural fluid cultures were obtained in ten of our 11 patients. In the absence of a pleural exudate, bacteriologic confirmation of the diagnosis may be obtained by lung puncture.4 Positive blood cultures for staphylococci have been found in 12 per cent to 25 per cent of patients with staphylococcic pneumonia.11,13,31 In our series, two blood cultures were done and one was positive for *Staphylococcus aureus*.

The appearance of pneumatoceles and empyema in infants under the age of six months with suppurative pneumonia virtually establishes the diagnosis.3,4,14 One of our cases was included in this study because of these findings despite no growth on pleural fluid culture. All patients developed pneumatoceles and empyema during the course of their illness.

The increase in frequency of the cases admitted to the hospital with staphylococcic pneumonia is apparently related to the growing resistance of these organisms to antibiotics.13 The pneumonia appears to

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**FIGURE 3:** (Patient 4)—A. (upper) Roentgenogram of chest taken on admission shows evidence of pneumatoceles and pneumothorax on the right with mediastinal shift to the left. B. (lower) film six months later shows normal lungs.

**FIGURE 4:** (Patient 9)—A. (upper) Roentgenogram of chest on admission shows large pneumatoceles and localized pneumothorax in the right lung with mediastinal shift to the left. B. (lower) Film taken seven weeks later shows residual pleural thickening and multiple smaller pneumatoceles.
have a higher incidence in the winter and spring months of the year. Infants, below the age of six months, account for about two thirds of the cases of staphylococccic pneumonia in the pediatric age group. Poor resistance to infection at this age has been offered as an explanation. The administration of pooled gammaglobulin (0.2 gm. per kg.) to infants with staphylococccic pneumonia was suggested by Sabiston et al.

The predominance of the disease in the right lung and its unilaterality in our patients conforms with other reports.

Empyema and pneumatoceles are frequent complications of staphylococccic pneumonia in infants. Pneumatoceles usually appear within one week after the onset of the illness and disappear in an average of six weeks. The rapidity with which changes in the radiologic findings of the chest occur is most characteristic of the early phases of this disease (Figs. 1 and 6). Vigilance in observation and, if necessary, daily radiologic examination are indicated during this early phase. Pneumatoceles require surgical intervention when they grow to be of a size to cause cardiorespiratory embarrassment by compression, or by rupture into the pleural space. Such an intervention was required in about half our patients. Staphylococccic lung abscesses in infants have usually resolved on conservative measures, and have rarely required pulmonary resection. Bronchopleural fistulae usually close spontaneously within one to four weeks after chest drainage.

Decortication is rarely indicated for fibrothorax following staphylococccic empyema. However, this may be resorted to if fibrothorax persists for more than three or four months since a thickened pleura of this duration represents a chronic empyema. In our experience, adequate intercostal tube drainage combined with prolonged antibiotic treatment have precluded the need for later pleural and/or lung resection.

Late sequelae of staphylococccic pneumonia are uncommon. Bronchiectasis has been found seven years after the subsidence of the infection by Hoffman in one of ten children who contracted the infection before the age of two years.

The mortality in staphylococccic pneumonia is highest in the infants below the age of six months (Table 2) and reaches as high incidence as 57 per cent. In 1943, Ladd and Swan found the incidence and mortality of staphylococccic empyema to be greatest in the first year of life and particularly in the first three months. They regarded age as the single most important factor in relation to mortality. This statement still holds true at the present time. We feel that the real mortality in this age group is even higher than reported on account of the great number of babies who die suddenly after a short period of respiratory infection and are found at necropsy to have staphylococccic pneumonia. Other factors which explain the high mortality in such patients are: prematurity, bilaterality of the pneumonia process, the presence of associated serious conditions (mucoviscidosis, hypogammaglobulinemia, malnutrition and widespread sepsis), delay in diagnosis and treatment and last, but not least, inadequate surgical drainage.

Adequate and prompt treatment will probably change the prognosis even in the young infants. A course of appropriate antibiotics extending over a minimum period of three to four weeks is recommended. Roundtree and Grigor prefer the combination of erythromycin and novobiocin for its effectiveness and minimum toxicity. We find that chloromycetin and erythromycin is another satisfactory combination unless sensitivity studies show resistance to those drugs. Sodium dimethoxy-phenyl penicillin (Staphcillin) which is not inactivated by staphylococccic penicillinase, should not be used indiscriminately, and should be restricted to newborn babies and, in older patients, to infections that are life-threatening, or resistant to other antibiotics. We do not think it necessary to continue the antibiotics until the pneumatoceles disappear. Yet, such patients are preferably kept...
under observation in the hospital until the cysts begin to shrink or remain stationary.

Needle aspirations of the pleural space in the presence of pneumothorax or empyema are inadequate and do not allow a rapid symphysis. Closed suction drainage of the chest is the procedure of choice in the presence of pneumothorax and/or empyema and may be resorted to more than once in the same patient. When the empyema is well encapsulated, an open thoracostomy with rib resection may be done. This was used in one of our 11 patients. Enzymatic debridement of the empyema space is not without risk; bronchopleural fistulae may open or subpleural abscesses rupture after the intrapleural instillation of streptokinase-streptodornase.

Conclusion

The physical signs of staphylococccic pneumonia in the young infant are often ill-defined. Occasionally, the respiratory symptoms are masked by gastrointestinal disturbances. Apyrexia is not uncommon. Pleuropulmonary complications are encountered in the majority of infants admitted to the hospital with staphylococccic pneumonia, may develop rapidly and result in respiratory and cardiac insufficiency, if not attended to by early and adequate surgical drainage. A course of appropriate antibiotics continued over a period of at least one month has been recommended to reduce the relapse rate. Such a combination of antibiotics and surgical drainage should cut down to a minimum the mortality and late compliance of this disease.

Summary

A review of 11 infants, under the age of six months, with staphylococccic pneumonia is presented. One of the 11 succumbed; eight of the remaining patients on whom follow-up examination was possible continue to do well. The other two were in good condition on discharge. All were treated with antibiotics and pleural drainage.

Resumen

Se presenta el estudio de 11 infantes de menos de seis meses que sufrieron neumonía estafilocócica. Uno de los 11 falleció. Ocho de los demás, en los que se pudo observar su evolución continúan bien. Los otros dos estaban en buenas condiciones al darse de alta. Todos fueron tratados con antibióticos y canalización pleural.

Zusammenfassung


References


22 Selye, G. P.: In discussion of Reference No. 22.


For reprints, please write Dr. Slim, American University Hospital, Beirut, Lebanon.

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**X-RAY PICTURE OF CALCIFICATIONS OF CORONARY ARTERIES**

In routine roentgenography of hearts removed from deceased patients aged 40 years and more, calcifications of coronary arteries were revealed in 72 cases of 100. In the x-ray picture, the author distinguishes nodular, striated and total forms of calcifications. Up to the age of 60 years, they are of importance as an objective sign confirming the clinical diagnosis of stenocardia; at this age, they are more marked and are encountered more frequently in the presence of stenocardia. Over the age of 60 years, calcifications are encountered with the same frequency also in instances without stenocardia. When assessing the degree of coronary calcifications, one should bear in mind the influence on the development of atherosclerosis of such general diseases as cancer, leukemia, pulmonary tuberculosis, diabetes, hypertension, etc.


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**GENERAL ANESTHESIA FOR BRONCHOSCOPY**

In 500 cases of bronchoscopy under general anesthesia in one private hospital, the authors encountered no death due to anesthesia. One case of myocardial infarction and two cases of cardiac arrest occurred; all patients are alive. The authors feel that general anesthesia should supplant local anesthesia for bronchoscopy, provided a well-coordinated and trained team carries out the procedure. This is not a technique to be used by the "occasional surgeon" or the anesthetist who gives only an occasional anesthetic for this procedure.

The advantages are absolute control of the patient; safety in having a thoracic surgery team at the table in the unusual event of a complication such as cardiac arrest; rapidity, ease and thoroughness of the examination in the totally relaxed patient, and last, but not least, acceptance of the examination by the patient, eliminating resistance to repeated endoscopic examination.


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**COLD AIR AND VENTILATORY FUNCTION**

The effect of abrupt exposure to cold air at 
\[-20^\circ\text{C} \] on the one-second forced expiratory volume of five normal and ten asthmatic subjects has been studied. There was no significant change in the normal subjects, but two asthmatic subjects were affected at once and showed a fall in FEV \(_1\), another two showed a later fall after return to normal room temperature. The authors consider that a history of sensitivity to cold in patients with respiratory disability should be taken seriously since this phenomenon can be confirmed objectively in experimental conditions.