The Value of Bacteriological Studies in Pneumonia Occurring in Age Group 15-60

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The purpose of this study was to evaluate the routine need for bacteriological studies as a guide to therapy and prognosis of patients with pneumonia in a selected age group. Bacteriological studies in pneumonia may be of value for diagnosis, treatment, prognosis, and epidemiology. The clinician is interested in bacteriological studies primarily because they may serve as a guide to treatment. Although the literature contains relatively little statistical evidence, it is entirely logical to expect that the type of antibiotic treatment could be determined from bacteriological studies. For this reason, the opinion is generally held that the type of antibiotic treatment should depend upon the results of appropriate bacteriological investigation. The positive correlation between results of bacteriological studies and the subsequent response to therapy is evident to everyone treating pneumonia. However, it does not necessarily follow that bacteriological studies are essential to the satisfactory treatment of all patients with pneumonia.

Several factors need to be considered when investigating this subject. The chief means of bacteriological examination in pneumonia are by blood culture, throat smear and culture, and sputum smear and culture. Except for an occasional contaminant which is usually recognizable as such, a positive blood culture is a reliable indication of the cause of infection. Unfortunately the blood culture is usually sterile, and even when positive, one or more days are required before the organism can be cultured and identified. Specimens obtained from the throat always contain the normal inhabitants which are seldom pathogenic. It is not rare to find that the causative organism in a case of pneumonia is not reported on either smear or culture from the throat. On rare occasion the causative agent may not even be found in sputum specimens. It may be that a carefully collected and promptly examined sputum specimen is more desirable than the usual routine method; however, this is not a common practice. Sometimes it is impossible for the patient to produce a satisfactory sample of sputum. Since it is a frequent experience to obtain a mixture of organisms without a predominant pathogen, it is often difficult to interpret the results of cultures, and sometimes they may even be misleading. When in vitro antibiotic sensitivity tests are used as a guide to therapy, some degree of success may be expected, but exceptions are not rare. Two days are routinely required after collecting the specimen before the results of in vitro antibiotic sensitivity tests are available. Treatment of the patient can not be delayed for this length of time. Thus it is apparent that be-

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cause of occasional inherent inadequacies and the necessary time delay, the final results of bacteriological studies can not be expected to serve as a satisfactory routine guide to therapy. A simple and rapid method of classifying cases of pneumonia for the purpose of initial treatment is needed.

It is not always easy to determine the bacteriological cause of a case of pneumonia. However, in a series of 2500 cases reported by Dowling it was considered that the pneumococcus was the causative organism in 98 per cent of all cases of primary bacterial pneumonia. The Streptococcus hemolyticus, Staphylococcus aureus, Streptococcus viridans, Friedlander's bacillus, Hemophilus influenza, and other organisms are considered to be causative in the small remaining group of bacterial pneumonias. Particularly in the younger age group a number of different viruses are responsible for a small but significant proportion of all pneumonias. Essentially all pneumococci are highly sensitive to penicillin and most other organisms causing bacterial pneumonia are also penicillin sensitive. Although the controversy over the efficacy of antibiotics in viral pneumonias continues, there appears to be no drug which produces a favorable response with reasonable uniformity.

**Method of Study**

All cases with pneumonia in the age group 15-60 years admitted to The Rochester General Hospital from 1948 through 1953 were reviewed. This represented 52.4 per cent of all adult patients with pneumonia admitted during this period. It was decided to include all pneumonias, regardless of etiology, because of the difficulty in making a definite differentiation between bacterial and viral pneumonia in many cases. The material includes both private and ward patients and is considered to represent a good cross-section of the hospital population of this area. The upper age limit of 60 years was selected because of the ever increasing frequency of the manifestations of degenerative diseases beyond that age. With advancing age it would be expected that the virulence of the infecting organism would play a relatively less important role in prognosis. Whereas the factor of host resistance which is difficult to evaluate would play an increasingly important role. The years 1948 through 1953 were selected because of the availability of multiple antimicrobial agents during this period.

All patients were classified as to the presence or absence of coexistnet diseases as follows: (1) major coexistent disease (greater severity than the pneumonia), (2) intermediate coexistent disease (severity equal to the pneumonia), (3) minor coexistent disease (severity less than the pneumonia), and (4) no coexistent disease. Although this classification is arbitrary, it serves a useful purpose as will be discussed later. Cases with major coexistent diseases included conditions such as advanced malignancy, severe congestive heart failure, recent myocardial infarction, uremia, diabetic acidosis, and often represented terminal pneumonia. The intermediate coexistent diseases included such conditions as advanced heart disease with no more than mild congestive failure, poorly controlled
diabetes, cirrhosis of the liver of no more than moderate severity, and most congenital chest deformities.

The patients who died were included in the general analysis but were also reviewed separately with particular reference to: (1) presence of coexistent disease, (2) duration of hospitalization, and (3) bacteriological studies performed.

Next, all surviving patients were classified according to their response to therapy. The response was considered "good" if either or both of the following criteria were met: (1) less than 10 days hospitalization, and (2) only one antibiotic used during the period of hospitalization. All not meeting this requirement were classified as having a "poor" response.

Extensive data were collected upon detailed analysis of that portion of the "poor" response group having minor or no coexistent diseases. This might be called the "unanticipated poor response" group. Particular attention was paid to the results of any bacteriological studies performed in relation to the antibiotic therapy used. It was hoped that reasons for the poor response could be determined. Finally, in each of these cases an opinion was formed as to whether the bacteriological studies were of value as a guide to therapy.

Results

A total of 625 patients 15 to 60 years of age with pneumonia were admitted to The Rochester General Hospital during the six year period 1948 through 1953. There were 31 individuals in the age group 15 to 20 years, 101 from 20 to 30 years, 104 from 30 to 40 years, 157 from 40 to 50 years, and 232 from 50 to 60 years.

The mortality rate for this group was 8.5 per cent (53 patients) compared to an overall mortality rate of 14.7 per cent in all adults with pneumonia from this hospital during the same period. Table I indicates that the majority of this mortality group had major coexistent diseases and only two had no coexistent disease. It is noteworthy that both of these patients died within two hours after admission and did not receive treatment prior to admission. Of the 12 hospitalized less than 24 hours, six were for even less than 12 hours. However, the majority were hospitalized for more than four days. Reasons for obtaining bacteriological studies in only 23 cases will be brought out under discussion.

| TABLE I |
| PNEUMONIA DEATHS IN AGE GROUP 15-60 FROM 1948-1953 INCLUSIVE |
| (Total Deaths—53) |

<table>
<thead>
<tr>
<th>1. Coexistent Diseases</th>
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<tr>
<td>A. Major</td>
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<tr>
<td>B. Intermediate</td>
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<tr>
<td>C. Minor or none</td>
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<td>40</td>
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<th>2. Duration of Hospitalization</th>
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<tr>
<td>A. Less than 24 hours</td>
</tr>
<tr>
<td>B. One to four days</td>
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<tr>
<td>C. More than four days</td>
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<td>12</td>
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<th>3. Bacteriological Studies</th>
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Table II presents the response to therapy in relation to the presence of coexistent diseases. Combining those who died with those who had a poor response, it is found that in the group with major coexistent diseases 72 per cent had an unsatisfactory response compared with 29 per cent in the intermediate coexistent disease group and 17 per cent in the minor or no coexistent disease group. The incidence of maximum response (less than 10 days hospitalization plus only one antibiotic) is found to increase significantly as the severity of the coexistent diseases decreases. The prognosis is therefore related to the presence of coexistent disease.

| TABLE II |
| RELATIONSHIP OF COEXISTENT DISEASES TO RESPONSE TO THERAPY OF PATIENTS WITH PNEUMONIA IN THE AGE GROUP 15-60 (625 Patients) |

**I. Major (92)** 15 per cent  
A. Dead (40) 43 per cent  
B. Living (52) 57 per cent  
   1. Good Response (26) 50  
      a. Both (b+c) (1) 1  
      b. Less than 10d. Hosp. only (2) 8  
      c. Single antibiotic only (23) 88  
   2. Poor Response (26) 50

**II. Intermediate** 31 per cent  
A. Dead (11) 6 per cent  
B. Living (182) 94 per cent  
   1. Good Response (137) 75  
      a. Both (b+c) (59) 43  
      b. Less than 10d. Hosp. only (11) 8  
      c. Single antibiotic only (67) 49  
   2. Poor Response (45) 25

**III. Minor or None (340)** 54 per cent  
A. Dead (2) 0.6 per cent  
B. Living (338) 99.4 per cent  
   1. Good Response (282) 83  
      a. Both (b+c) (165) 59  
      b. Less than 10d. Hosp. only (57) 20  
      c. Single antibiotic only (60) 21  
   2. Poor Response (56) 17

Detailed study was made of the 56 cases with minor or no coexistent diseases but who had poor response. Thirty-six were males and 20 females. The age distribution was not remarkably different from the overall group. Thirty were hospitalized from 10 to 15 days and only four more than 30 days. The white blood count was in the normal range in 13 cases, 10,000—15,000 in 23, and above 15,000 in 20. Cold agglutinins were present in four of the 12 tested. Of the four cases with cold agglutinins, none had white blood counts above 15,000 but only one was normal. Pneumococci were cultured from the sputum in three of these cases and no definite pathogen in the fourth. Chest x-ray film showed unilateral involvement of less than one-third of a lung field in 23, unilateral but greater than one-third of a lung field in 12, and bilateral in 21. Seventeen throat cultures were done in 17 cases. Sputum was examined 95 times in 43 cases. Sixty-two blood cultures were made in 31.
The blood culture was sterile in all but three. Pneumococcus was the organism found in each of the positive blood cultures. The course of the illness was not remarkable in two of them but the third developed empyema and broncho-cutaneous fistula. Nine of the 56 had no bacteriological studies and five had only blood cultures which were sterile. Of the 41 patients in which a stained smear (sputum or throat) was examined, Gram positive cocci were found in 40 and Gram negative bacilli in 26. On culture Friedlander's Bacillus was found in two but was not the predominant organism in either. Staphylococcus aureus was cultured in five but in none was it a pure culture. Pseudomonas was repeatedly obtained in pure culture from one patient. Fungi were found in nine. *In vitro* antibiotic sensitivity tests were performed on 23 occasions in 14 cases. Etiology of the pneumonia was considered to be probably bacterial in 27, indefinite in 26, and probably viral in three. There were three cases of empyema and one of lung abscess but no other serious complications were recorded. The initial antibiotic (single or combined) treatment consisted of penicillin in 48 cases, aureomycin 20, sulfonamides seven, terramycin four, streptomycin three, and chloramphenicol two. The only other antibiotic used at any time was erythromycin. Twenty-four of the 56 patients remained afebrile after the fifth hospital day. In two of the 56 bacteriological studies suggested that the initially used antibiotic was not the drug of choice. However, in no case was there a satisfactory clinical response after change to the antibiotic indicated by *in vitro* sensitivity tests. Thirty-three of the 56 had one or both of the following: (1) less than 15 days hospitalization or (2) no change in the initially ordered antibiotic therapy. It was concluded that bacteriological studies in this poor response group were of no value as a guide to treatment or prognosis in 37. In five the studies were of doubtful value, and in none were they of probable or definite value. No bacteriological studies (except negative blood cultures in five patients) were performed in the remaining 14 cases.

**Discussion**

An attempt has been made to evaluate a problem which does not readily lend itself to statistical analysis. However, criteria were established which can be defined with relative ease. Opinions were then formulated on the results of this analysis of the data.

This study shows that bacteriological work as done at present in this hospital is of no definite value in determining the type of antibiotic treatment to be used in patients with pneumonia in the age group 15 to 60 years.

Bacteriological studies were done in over three-fourths of this series. There were several reasons for not obtaining them in the remaining cases; however, it is safe to assume that studies were more likely to be ordered in the more seriously ill patients. In the mortality group the chief reasons for the low incidence of bacteriological studies were the obviously fatal prognosis in many cases plus the fact that some of the pneumonias were not diagnosed until autopsy.

Several cases diagnosed on admission as having pneumonia were subsequently found to have tuberculosis. This group was purposely excluded
because special diagnostic techniques are required. Unfortunately tuberculosis will seldom be suspected from routine smears and cultures. All questionable cases should have the special tuberculosis studies. Furthermore, all pulmonary infections should be followed closely by x-ray film until there is complete resolution or until the lesion becomes stable.

The rarity of penicillin resistant organisms in this series needs emphasis. Friedlander's bacillus was found in only two of the poor response group, and probably in neither of these was it the primary pathogen. There has been no case of Friedlander's pneumonia at any age reported at autopsy from this hospital during the six year period of this study. The case in which pseudomonas was the only organism cultured survived even though the organism was resistant by in vitro testing to all of the then available antibiotics.

Table II indicates the importance of coexistent diseases as a factor in prognosis. It is felt that this factor is of considerably greater importance than the virulence of the organism responsible for the pneumonia. In fact, in those without significant coexistent disease, and therefore with presumably normal host resistance, the only fatalities were two patients who did not receive treatment until moribund.

A classification of pneumonias occurring in the 15-60 age group based on the severity of coexistent diseases is proposed in Table III. It was rare that the presence of a coexistent disease was not recognized after the initial examination of the patient. In the poor and guarded prognostic groups bacteriological studies may be performed, but it should be realized that even here the results are not likely to be of value as a guide to therapy. In the good prognostic group there appears to be no reason to expect that bacteriological studies would yield information of value for treatment or prognosis. The possibility of a case in the good prognostic group yielding definitely significant positive bacteriological findings indicating that a drug other than penicillin is the drug of choice can not be denied. However, the rarity of this situation is evident. Of the 56 who had "poor" response to treatment as previously defined, only five gave evidence that the bacteriological studies were of even possible (doubtful) value as a guide to treatment. These five represent 1.5 per cent of the good prognostic group in this series. If a patient in the good prognostic group does not respond to penicillin within 48 hours, it then

| TABLE III |
| CLASSIFICATION OF PNEUMONIA IN THE AGE GROUP 15-60 FOR PURPOSES OF PROGNOSIS AND AS A GUIDE TO TREATMENT |
| 1. Poor Prognosis—cases in which there is a coexistent disease of major proportions. Therapy is difficult and usually unsatisfactory. |
| 2. Guarded Prognosis—cases in which there is a coexistent disease of equal significance to the pneumonia. The less common organisms are probably more likely to be found. Response to therapy is unpredictable. |
| 3. Good Prognosis—cases in which there is no coexistent disease or one of minor significance. This group should include the majority of patients seen in private practice. Response to antibiotic therapy is uniformly good. Hospitalization and bacteriological studies are necessary only in the exceptional case. |
seems advisable to get bacteriological studies. Also it seems equally if not
more important to look further for a previously unrecognized coexistent
disease.

Although only 28 per cent of all adults with pneumonia in this hospital
fell into the good prognostic group, most patients with pneumonia are
no longer hospitalized. It is estimated that at least one-half of all pneu-
monia patients seen in private practice fall into the good prognostic group.

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manuscript.

SUMMARY AND CONCLUSIONS
1. In the age group 15-60, 625 cases with pneumonia admitted to The
Rochester General Hospital from 1948 through 1953 were reviewed.
2. Particular attention was paid to coexistent diseases and bacteri-
ological studies in relation to the course of the disease and the treatment
received.
3. With routine antibiotic therapy the course of the disease was de-
pendent more upon the presence of coexistent disease than upon the viru-
ulence of the causative organism.
4. In 340 cases of pneumonia without significant coexistent diseases,
bacteriological studies were of possible value as a guide to therapy in only
five and even these were doubtful.
5. In cases of pneumonia in the age group 15-60 without significant
coexistent disease, it is felt that routine bacteriological studies are
unnecessary.
6. A classification of pneumonias based on the presence of coexistent
disease is presented as a guide to treatment and prognosis. It is felt
that this will be generally more useful to the clinician than previous
classifications based on bacterial etiology.

RESUMEN Y CONCLUSIONES
1. Seiscientos veinticinco casos entre las edades de 15 a 60 años que
fueron admitidos con el diagnóstico de neumonía al Hospital General de
Rochester, son objeto de un estudio.
2. Se puso especial atención a las enfermedades coexistentes y a los
estudios bacteriológicos en relación con la evolución de la enfermedad y
el tratamiento recibido.
3. Con el tratamiento antibiótico de rutina la evolución de la enfermedad
dependió más de la presencia de enfermedad coexistente que de la viru-
lencia del germen causal.
4. En 340 casos de neumonía sin coexistencia de enfermedades signifi-
cantes, los estudios bacteriológicos fueron de valor como guía del trata-
miento sólo en cinco y aún esos fueron dudosos.
5. En casos de neumonía entre las edades de 15 a 60 sin enfermedades
coexistentes de significación se piensa que los exámenes bacteriológicos de
rutina son innecesarios.
6. Se presenta una clasificación de las neumonías basada en la presencia
de enfermedades coexistentes como guía del tratamiento y del prónóstico.
Se cree que esto será más útil al clínico que las clasificaciones anteriores basadas en la etiología bacteriológica.

RESUME
1. L'auteur passe en revue, dans un groupe d'individus âgés de 15 à 60 ans, 625 cas de pneumonies admis à l'Hôpital Général de Rochester, de 1948 à 1953.
3. Lorsqu'elle était traitée par les antibiotiques courants, l'évolution de la maladie fut plus influencée par l'existence d'affection surajoutée que par la virulence du microbe en cause.
4. Dans 340 cas de pneumonies sans maladies coexistantes nettes, les études bactériologiques eurent une certaines valeur pour guider le traitement dans cinq cas seulement et encor ceux-ci furent-ils douteux.
5. Pour les pneumonies du groupe de personnes âgés de 15 à 60 ans, et sans affection nette surajoutée, les études bactériologiques courantes se montrèrent inutiles.
6. L'auteur présente une classification des pneumonies basées sur la présence d'affections coexistantes pour établir le traitement et le pronostic. Celle-ci serait généralement plus utile au praticien que les classifications antérieures basées sur l'étiologie bactériologique.

ZUSAMMENFASSUNG UND SCHLUSSFOLGERUNG
2. Besondere Aufmerksamkeit wurde Begleitkrankheiten gewidmet wie bakteriologischen Untersuchungen in Bezug auf den Krankheitsverlauf und die durchgeführte Behandlung.

REFERENCE