Intrafamilial Contagion in Chronic Sino-Respiratory Infections*

SAMUEL J. PRIGAL, M.D., F.A.C.P.
New York, New York

The problem of chronic sino-respiratory infections which includes sinusitis, bronchitis, bronchiectasis and infective asthma is of great magnitude. Although these illnesses do not immediately endanger the life of the patient they seriously affect the health of many individuals. It is estimated that approximately 2,000,000 people in this country suffer from chronic bronchitis and 1,250,000 from sinusitis. With asthma due to infection included, approximately 3,000,000 to 4,000,000 are sufferers of chronic broncho-pulmonary disease. Bronchitis alone is responsible for the largest average absenteeism in industry and exceeds the common cold in terms of time lost from productive work.

For the past eight years the author has concerned himself with the problem of infection in the respiratory tract, in view of the frequency of these infections in allergic patients. At first, attention was paid to the use of antibiotics in combating infection; preferably this was administered in aerosol form to achieve maximum concentration within the respiratory tract, although secondary absorption and systemic action could be demonstrated with penicillin and streptomycin. A method of administering long-lasting aerosols, utilizing open and closed methods of treatment, and a tent and closed chamber (bathroom) for treatments of infants and children, was developed. Subsequently, to achieve more specific therapy with the antibiotics, bacteriologic methods were introduced which included the use of cultures, and the performance of in vitro inhibition tests. This unquestionably improved the results of the treatment. Nevertheless, it soon became apparent that the problem was not the control of specific incidents of infection but how to prevent the recurrence of infection, since this seemed to be inevitable in most patients. At times it was noted that despite adequate therapy with specifically-selected antibiotics, cultures taken revealed the presence of the offending organisms in the respiratory tract. This was particularly true for the hemolytic staphylococcus and some strains of streptococci. In others it was noted that these organisms were apparently eliminated as a result of therapy, only to be isolated again with a recurring infection. Then again, when several members of a family were treated simultaneously, and cultures were taken from them, it was frequently noted that there was a commonality of potentially pathogenic organisms. Attention was, therefore, focused on contagion as an important

---

*This is the 5th of a series on a Bacteriologic and Epidemiologic approach to the Treatment of Sino-respiratory Infections.
The bacteriologic studies were performed by The Biological Laboratories, Brooklyn, New York.
From the Department of Medicine (Allergy), New York Medical College Flower-5th Avenue Hospital, New York City.
factor in maintaining chronic sino-respiratory infection within the family group.\textsuperscript{5,6} The possible existence of a carrier state within the family, and the search for foci of dissemination of respiratory infection was then pursued, and is the subject of this communication.

Our investigation of the carrier state within the family was first reported in observations which covered 43 persons in 17 family units, from whom cultures were taken 68 times and 159 organisms isolated. The data revealed the possibility of the existence of a family source of contagion in 10 of the 17 families in which only selected members were studied. This preliminary data was subsequently fortified by a more thorough investigation of 28 additional families (comprising 63 individuals) in 17 of which evidence was encountered of contagion and a carrier state.\textsuperscript{6} This series was more representative of the family, and consisted of instances in which families of four or five members were investigated regardless of clinical status. In the families studied completely, 11 out of 12 showed evidence strongly suggestive of contagion whereas in the incomplete family group only six out of 10 showed such possible relationship. In some of the families three to four out of five members had identical organisms presumably pathogenic. This not only included a single organism but at times even two or three organisms, with most of the members of the family exhibiting disease-producing organisms, although illness was not apparent, except for the patient. Altogether 39 families were studied, of which 27 showed bacteriologic evidence suggesting the existence of a carrier state. It should be emphasized that not all members of a family were investigated. Were the investigation to have included every member of the family, it would seem that the incidence of a carrier state might have been higher. The data obtained from the observations of these families is recorded in Table I.

The opportunity to study intrafamilial contagion within a large family group, comprising seven family units, was subsequently presented to the author. This occurred during the examination of a dentist, who had been subject at different times to frequent colds, sinusitis, tonsillitis, asthma and infections about the eyes. A review of the family history revealed that his mother had been subject to asthma and bronchitis; that his brothers and sisters were subject periodically to frequent episodes of sino-respiratory disease, and that likewise most of their children were similarly afflicted. It was, therefore, arranged to make a study of the seven brothers and sisters, their spouses and their children. The study, made in December

\begin{table}
\centering
\caption{Bacteriologic Evidence of Contagion in Families with Sino-Respiratory Infection}
\begin{tabular}{|c|c|c|c|c|c|c|c|}
\hline
Series & No. of Families & Complete & Incomplete & No. of Patients & No. of Cultures & No. of Isolates & Possible Contagion \\
\hline
1) 1949 & 17 & 6 & 11 & 43 & 68 & 159 & 10 \\
\hline
2) 1950 & 22 & 12 & 10 & 63 & 73 & 144 & 17 \\
\hline
TOTAL & 39 & 18 & 21 & 106 & 141 & 303 & 27 \\
\hline
\end{tabular}
\end{table}
1951, included a questionnaire concerning the frequency of sino-respiratory infections, such as the occurrence of frequent colds (more than two a year), tonsilitis, sinusitis, pneumonia, bronchopneumonia, bronchitis, infective asthma and infections in and about the eye. Simultaneously, pharyngeal cultures were taken from the 25 members of the families who made themselves available at that time for the investigation. The data obtained of the L. family is presented in Charts I and II. Thus, it is noted that 15 members of the family were subject to more than the average of two colds per year; that 13 of them had a history of repeated tonsilitis, and that 14 of them had tonsillectomies; seven were subject to bouts of sinusitis;

---

**BACTERIOLOGIC AND EPIDEMIOLOGIC INVESTIGATION OF THE "L" FAMILY**

CHART I: Genealogy of the "L" family. The infection is traceable by history to the mother. Five of her children suffered from one or more varieties of sino-respiratory infections. In contrast, their respective spouses were subject to fewer respiratory episodes. Their children, however, continue to show an abnormal incidence of sino-respiratory infections. The frequent occurrence of the hemolytic staphylococcus indicates these infections to be a familial disease similar to tuberculosis due to contagion within the household.

---

**BACTERIOLOGIC AND EPIDEMIOLOGIC INVESTIGATION OF THE "L" FAMILY**

**BACTERIOLOGICAL SURVEY**

<table>
<thead>
<tr>
<th>&quot;L&quot; Family</th>
<th>&quot;Normal&quot; Non-Related Families</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Families</td>
<td>7</td>
</tr>
<tr>
<td>Total No. of Individuals</td>
<td>25</td>
</tr>
<tr>
<td>No. of Hemolytic Staph (Pharynx)</td>
<td>15</td>
</tr>
<tr>
<td>No. of Hemolytic Staph (Pharynx)</td>
<td>10</td>
</tr>
<tr>
<td>No. of Organisms Cultured</td>
<td>65</td>
</tr>
</tbody>
</table>

"L" family investigated Dec. 1951
"Normal" control families August 1951.

CHART II: A comparative bacteriologic study of the seven branches of the "L" family and 15 unrelated "normal" families without history of frequent sino-respiratory and related infections. The incidence of hemolytic staphylococci in the "L" families as cultured from the pharynx is approximately four times that seen in the "normal" families.
five had pneumonia or broncho pneumonia; two bronchitis; seven asthma associated with infection, and six with infections in and about the eye.

The history of repeated infection implying contagion was confirmed by the bacteriological studies. The hemolytic staphylococcus was cultured from the pharynx in 15 of the 25 individuals studied (an incidence of 60 per cent), and the hemolytic streptococcus occurred nine times (36 per cent). In order to validate these observations as well as the data obtained in the study of the unrelated families, as previously described, a study was undertaken of “normal” families without any history of chronic sino-respiratory infections in any member of the family. This study comprised 15 families, 48 individuals, from whom pharyngeal cultures were taken and 160 isolates obtained. In this group the hemolytic staphylococcus occurred only eight times (an incidence of 16.6 per cent) and the hemolytic streptococcus occurred 16 times (37 per cent), the latter being the same frequency as in the “sick” families. This would indicate that although members of “normal” families tend to harbor proportionately more organisms in their pharynx, these are relatively innocuous, and that the relative percentage of probable pathogens was considerably less in the so-called “normal” group as compared with families in whom there is the presence of chronic sino-respiratory disease. Congnizance is taken of the role of “host resistance” factors when pathogens are present without obvious disease.

In searching further for possible sources of infection or reinfection within the family groups it was noted that there was an unusual occurrence in these people of low-grade infections about the eye such as styes, conjunctivitis and/or blepharitis. A study was, therefore, undertaken of patients suffering from chronic sino-respiratory disease associated with blepharoconjunctivitis and related conditions. This study reported in detail elsewhere, is summarized here. Of 25 patients investigated, ranging in age from one to 63 years, 23 showed concommittant respiratory and eye infections. The remaining two were subject to sino-respiratory disease without infections about the eye; they were, however, intimately exposed to one other member of the family suffering from blepharoconjunctivitis; eight of the 25 individuals displayed blepharoconjunctivitis simultaneously with another member of the family. Six times this involved a mother-patient relationship, since the intimate relationship between mother and child was probably more conducive to the spread of the infection.

The bacteriologic studies which included cultures taken simultaneously from the respiratory tract and from the eye or eyelid, revealed that 13 of 19 patients thus studied showed bacteriologic evidence indicating a commonality of organisms. An analysis of the organisms involved corroborated the findings previously noted within the family groups, in which it was indicated that the hemolytic staphylococcus was encountered in 10 of the 13 individuals in whom there was bacteriologic evidence of relationship between infections in and about the eye and the respiratory tract. This organism was encountered four times more frequently in the “L” families than in the “normal” families. This is not surprising since this organism
is widely distributed, not readily eradicated, frequently develops resistance to antibiotics, and does not readily stimulate sufficient immunity on the part of the host to eliminate it. Therefore, it is apt to produce a chronic infection in either (or both) respiratory and ocular organs.

Although the role of blepharitis and related eye infections has been stressed, it is undoubtedly not the only source of possible reinfection for the respiratory tract. Thus, one patient in addition to the respiratory tract infection, suffered as well from a chronic infection of both ears, and from whom was obtained similar organisms from the ears as well as from the pharynx. In two other patients identical organisms were cultured from chronic skin infections, and from infections in the respiratory tract. It would seem logical, therefore, once one is confronted with the problem of chronic sino-respiratory disease, particularly in children, to look for foci of infection elsewhere in the body (eyes, skin, ears), or from those in intimate contact with the patient, in order to remove sources of contagion.

Discussion

Many observations on the epidemiology of respiratory infections involving wards, nurseries, institutions and barracks, have been reported. This has been due to the fact that frequently the occurrence of respiratory infections in such large groups has been conspicuous and serious; and because of the availability of medical and technical help in these institutions, suitable for detecting carriers within such groups. In sharp contrast there have been no serious studies of the role of the carrier state, and the epidemiological aspects of sino-respiratory infection within the family group. The infections occurring within the family group are usually of the low-grade variety, rarely resulting in fatalities but frequently starting in early infancy when immunity is at its lowest, and burdening the patient with disability for many years, if not an entire lifetime. Nevertheless, this is an important public health problem second only in magnitude to tuberculosis.

Observations on the epidemiology of acute respiratory infections provide useful information as to the possible epidemiology of chronic sino-respiratory infections. Smiley and his collaborators have at various times reported on the epidemiology of pneumonia. In one instance, a large state hospital for the insane suffered an epidemic of pneumonia following a rather mild outbreak of influenza. More spectacular was the recounting by the same authors of the invasion of a specific pneumococcus (type 14) in a group of normal children in a nursery in which this virulent strain subsequently caused pneumonia in many infants and children, although it caused no apparent harm to the host (carrier), unless during the time of an acute upper respiratory infection, when pneumonia ensued. When these children from the nursery were transferred to a hospital ward they spread this pneumococcus (type 14) throughout the medical ward, infecting most of the children at one time or another. It was possible to anticipate the pneumonia since frequently the organisms were cultured in advance of the onset of the illness in those who were carrying the strain. The author
concluded that a virulent strain of pneumococcus may enter a community, permeate it and invade many individuals, and linger for a considerable time without causing any apparent harm, that is, until acute virus infections reduce the resistance of the carrier, thereby precipitating pneumonia.9

Studies involving the hemolytic streptococcus have been made by Loosli and his associates, in which the matter of contamination of the environment by the hemolytic streptococcus, and the spread of hemolytic streptococcal infection in army barracks, was observed.10 It was concluded from these studies that attention had to be paid to "secondary reservoirs" as possible sources for the spread of infection due to this organism. Cultures taken simultaneously from barrack personnel as well as from the "secondary reservoirs" (bedding, dusts, wearing apparel, etc.) revealed a definite correlation between the pharyngeal cultures and those of the reservoirs. In the barracks in which the majority of the positive bed, dust, and air cultures showed the same type of streptococcus, the same type was most prevalent in the positive nose and throat cultures of the barrack personnel. It was indicated from observations of epidemics of sore throats that this mode of spread, in addition to the many opportunities for direct contact with the contaminated environment, would seem to offer the most likely explanation for the observation that the barracks was the principal focus for the spread of respiratory tract infections due to streptococci among those studied.11 It will be, therefore, logical to study as well the role that the dust, the bedding and the air within the household play in disseminating sino-respiratory infections, particularly of the lowgrade variety.

The role of sneezing, coughing and talking in the dissemination of the hemolytic streptococcus was investigated by Hamburger and Robertson and found of minor importance.12 Of special interest and particularly germane to this discussion is the observation reported by Loosli, Smith, Cline and Nelson on the transmission of streptococcal infections in an infant ward, in which the skin acted as a disperser.13 The original source of the streptococcus (Group A—Type 33) was a six month old female infant with an infection of the skin superimposed on infantile eczema. She subsequently contaminated the ward and secondary infections occurred in other infants, as well as adults, resulting in infections in the throats, skin and wounds. It was believed that the mechanism involved spread of the infection from the skin disperser to the bedclothes, and then to the air and dust, thereby infecting infants, the attending personnel and visitors. More startling in its scope was the observation described by Colbeck14 concerning a particularly resistant strain of staphylococcus aureus which was responsible for an epidemic which was so extremely difficult to control, that several hospitals within a city had to be closed. The organism was subsequently observed in carriers among the hospital staff. These infected new-born infants whose nose and throat became an important reservoir for infection, and which was subsequently passed to the mother's breasts. A high incidence of boils and other pyogenic infections were then observed, in the families of these patients after their
return home from the hospital. The same organism was likewise implicated in the observations reported by Kugelas, in which post natal infection of the salivary glands was observed toward the end of the first week of life in infants. These infants were of low weight, delicate physically, and were overrun with staphylococcus aureus in the nasal pharynx. It was noted that the mother of each infant was afflicted with acne, folliculitis or furunculosis.

Finke in his excellent studies of respiratory infections confirms the epidemiologic role herein emphasized. Although no confirmatory bacteriologic studies were made his statistical studies are convincing. Of 224 children observed with primary pneumonia 67.9 per cent gave a history of recurrent croup, bronchitis, asthmatic bronchitis and related conditions. Of these patients 12.5 per cent had previous episodes of pneumonia. In another study of 176 children with bronchopulmonary infection there was a family history of bronchopulmonary infection in 86.2 per cent of the cases; in 72.4 per cent the onset of the infection dated to infancy, which belies the common notion that respiratory infections in children begin with schooling. Of particular interest were his studies, paralleling the observations herein recorded, of two types of families living in a single housing unit. In 64 families in which bronchopulmonary disease was in evidence in one or more members of the family, there were 166 children with a history of pneumonia in 22.3 per cent of them. In sharp contrast in 99 families without bronchopulmonary disease only 4.9 per cent of 269 children gave a history of pneumonia—one fourth the incidence.

Finke concludes from his studies that chronic bronchopulmonary disease is a public health problem since it is communicable and preventable. This conclusion is corroborated by the evidence presented in this communication.

An experimental approach to the problem of the epidemiology of respiratory infections was undertaken by Kruger and his associates at the Naval Research Medical Unit No. 1. Here an apparatus was developed in which air-borne infections were quantitatively produced and studied. Small laboratory animals were exposed to an aerosol of infectious material under controlled methods, and the spread of infection was determined. In a further study from this group radio-active air-borne bacteria were introduced into the apparatus so that these tagged organisms could be followed in the respiratory tract, and it was concluded that approximately 30 per cent of the tagged organisms were in the respiratory tract, while 70 per cent were ultimately found in the gastrointestinal tract.

The therapeutic approach in the face of repeated or chronic sinorespiratory infection, particularly in children, is therefore not only to treat the infection in the respiratory tract, with the proper antibiotics but also to search for and eradicate any "disseminators" in the skin, eye, etc. The search should be extended to other members of the family and hygienic measures instituted—particularly as to sharing of clothing, towels, handkerchiefs, etc., to prevent dissemination from one member of the family to the others. During an acute upper respiratory infection, or during an exacerbatim of a skin or eye infection special precautions, including
isolation should be instituted. The chronically ill patient must be protected from the carrier or carriers within the family.

Should these prophylactic measures fail, therapy with an autogenous vaccine may be useful in building the patient's immunity which is most desirable.

**SUMMARY**

1) Bacteriologic studies indicate that chronic sino-respiratory infections are contagious within the family group.

2) The hemolytic staphylococcus was frequently encountered in these studies.

3) Infections of the skin and eye in the patient and/or relative may act as a focus for infection and reinfection of the respiratory tract.

4) Public health measures for preventing the spread and recurrences of these illnesses are indicated in view of the great morbidity.

**RESUMEN**

1) Los estudios bacteriológicos indican que las infecciones sino-respiratorias, son contagiosas dentro del grupo familiar.

2) El estreptococo hemolítico, fue encontrado con frecuencia en estos estudios.

3) Las infecciones de la piel y del ojo en el enfermo y o en los parientes, puede actuar como foco de infección o de reinfección en el tracto respiratorio.

4) Están indicadas las medidas de salubridad pública para evitar la diseminación y las recurrencias de estas afecciones en vista de la gran morbimidad que tienen.

**RESUME**

1) Les études bactériologiques montrent que les infections chroniques sino-respiratoires sont contagieuses au sein du groupe familial.

2) Le staphylocoque hémolytique fut fréquemment trouvé dans ces recherches.

3) Les atteintes de la peau et de l'oeil chez le malade et (ou) ses parents peuvent agir comme foyer d'infection ou de réinfection de l'arbre respiratoire.

4) Des mesures de prophylaxie contre la dissémination et les récidives de ces affections sont indiquées.

**REFERENCES**


19 Finke, W.: "Public Health Aspects of and Prevention of Bronchopulmonary Disease."