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## ORIGINAL COMMUNICATIONS.

(Original Communications are received with the understanding  
that they are contributed exclusively to THE LARYNGOSCOPE.)

### STREPTOCOCCUS HEMOLYTICUS MASTOIDITIS.

DR. A. M. DUNLAP, Peking, China.

Early in November of last year, an epidemic of septic sore throats made its appearance in Peking, China, and a number of the larger centers within a day's journey by rail. Individuals attacked were usually prostrate for a day or two with evening temperatures ranging from  $101^{\circ}$  to  $102^{\circ}$ . Occasionally symptoms were so slight as to pass almost unnoticed. Throats were found to be acutely inflamed with usually a thin white pseudo membrane on the tonsil, the posterior pharyngeal wall or, not infrequently, the anterior pillar. Bacteriological examination demonstrated the streptococcus hemolyticus to be the predominating organism in all throat cultures. The epidemic probably would have attracted very little attention had there not been a great many cases of mastoiditis complicating the disease, from all of which the streptococcus hemolyticus was obtained in pure culture. This organism seemed to extend to the middle ear and mastoid cells with singular ease, but showed no inclination to invade the lower respiratory tract. While there was one case of meningitis following a mastoid complication and two cases of septicemia, one following mastoid disease and one probably following a mild throat infection, there was no diagnosed case of lung complication.

The primary object of this paper is to report the mastoid cases of the epidemic and in so doing to emphasize the fact that the invasion of mastoid cells by the streptococcus hemolyticus produces

a mastoiditis which is characteristic and should be recognized as such in order to insure proper operative and, what is perhaps quite as important, post-operative treatment. Bacon<sup>1</sup> and Whiting<sup>2</sup> have reported cases of mastoiditis caused by the streptococcus mucosus capsulatus, which resemble in many respects those of this series. They do not describe, however, the post-operative course of their cases in detail so that it is impossible to make a satisfactory comparison. It is probable that while there are many points of similarity, there are certain characteristic differences which make it possible to separate them clinically. The cases which we have had this winter, with type one and type two sub-group pneumococci as the causative agents, have given many of the same pre-operative symptoms as the streptococcus cases, but their post-operative course has been entirely different. A study of the cases as reported would seem to justify us in grouping acute mastoiditis according to the causative organism. Further research will make possible the combining of certain groups and the emphasizing of others.

The cases of mastoiditis described below, therefore, belong to a distinct group and the disease should be known as *streptococcus hemolyticus mastoiditis*. The writer is of the opinion that this disease is as much an entity as some of the older types of conjunctivitis, such as gonorrheal ophthalmia and trachoma, or as the different types of cerebral spinal meningitis. It is to be hoped that the work already started in various centers in the study of the bacteria of acute ear infections may help to make us more accurate in the diagnosis of acute mastoiditis, and also that future text-book writers may separate the general subject of acute mastoiditis into the different types or groups which are becoming more clearly established. To this end, it is not too much to ask that it become the practice of all otologists to examine carefully the bacteria of the discharges from all cases of acute otitis media and mastoid wounds. By so doing, not only will our special knowledge be increased, but as individuals, we shall understand why, in some cases, the middle ear fails to become dry within the classical six to ten-day period; why we lose a certain number of cases with meningitis when the mastoid wound is well on the road to recovery; when we may safely employ Dr. Hammond's<sup>3</sup> method of closure, and many other things which will help in the proper conduct and post-operative care of our patients.

Pure cultures of the streptococcus hemolyticus were obtained in all the cases of this series from swabs taken from the mastoid cavities, either at operation or within forty-eight hours after operation.

Ser. No.	Strain No.	SOURCE	Gram Strain	Blood Agar Plate	Growth in Bouillon	Loefflers Blood Serum	Gelatine
1.	X-3	Middle Ear	Positive	Hemolysis	Sedimenting	Minute, grayish colonies. No liquefaction	No liquefaction
2.	2329	Mastoid	"	"	Diffusely	Minute, grayish colonies. No liquefaction	"
3.	2309	Mastoid	"	"	Sedimenting	Very fine, white colonies. No liquefaction	"
4.	2334	Mastoid	"	"	"	Minute, grayish colonies. No liquefaction	"
5.	2118	Mastoid	"	"	"	White, small colonies. No liquefaction	"
6.	2190	Mastoid	"	"	Uniform	Minute, grayish colonies. No liquefaction	"
7.	2191	Mastoid	"	"	"	Minute, grayish colonies. No liquefaction	"
8.	2187-A	Mastoid	"	"	Sedimenting	Minute, white colonies. No liquefaction	"
9.	2187-B	Mastoid	"	"	"	Minute, grayish colonies. No liquefaction	"
10.	2231	Throat	"	"	Sedimenting on 2nd day	White, small colonies. No liquefaction	"
11.	2378	Mastoid	"	"	Diffusely	Minute, grayish colonies. No liquefaction	"
12.	X-4	Mastoid	"	"	Sedimenting	Minute, grayish colonies. No liquefaction	"
13.	2347	Throat	"	"	"	Minute, grayish colonies. No liquefaction	"
14.	2348-A	Middle Ear	"	"	"	White, small colonies. No liquefaction	"
15.	2348-B	Middle Ear	"	"	Diffusely	Minute, grayish colonies. No liquefaction	"
16.	2394	Mastoid	"	"	Sedimenting	Minute, grayish colonies. No liquefaction	"
17.	2381	Mastoid	"	"	"	Minute, grayish colonies. No liquefaction	"

\* ‡ indicates acid. — no acid.

lers l Serum	Gelatine	Litmus Milk	Soluble in Bile	Dext- rose	Lac- tose	Sac- cha- rose	Mal- tose	Man- nitol	Dext- rine	Inuline	Salicine	Hemolysis in 2 hrs. at 37° with horse blood. Brown's 4 Technic	Limiting Hydrogen 5 on concentration in Dextrose Broth after 68 hrs. at 37° C.	CLASSIFICATION			
te, grayish ies. No action	No lique- faction	Acid in 3 days	—	†*	†	†	†	—	—	—	†	† † † †	PII	5.2	Streptococcus	Pyogenes,	Human Type
te, grayish ies. No action	"	Acid in 3 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
fine, white ies. No action	"	Acid in 5 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.0	"	"	" "
te, grayish ies. No action	"	Acid in 4 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.0	"	"	" "
, small es. No action	"	Acid in 4 days	—	†	†	†	†	—	†	—	†	† † † †	"	5.4	"	"	" "
te, grayish es. No action	"	Acid in 3 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
te, grayish ies. No action	"	Acid in 3 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.0	"	"	" "
te, white ies. No action	"	Acid in 4 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
te, grayish es. No action	"	Acid in 3 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
, small es. No action	"	Acid in 5 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
e, grayish es. No action	"	Acid in 5 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
e, grayish es. No action	"	Acid in 3 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
e, grayish es. No action	"	Acid in 4 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
, small es. No action	"	Acid in 5 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
e, grayish es. No action	"	Acid in 5 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
e, grayish es. No action	"	Acid in 3 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
e, grayish es. No action	"	Acid in 4 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
, small es. No action	"	Acid in 5 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
e, grayish es. No action	"	Acid in 5 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "
e, grayish es. No action	"	Acid in 3 days	—	†	†	†	†	—	—	—	†	† † † †	"	4.8	"	"	" "
e, grayish es. No action	"	Acid in 3 days	—	†	†	†	†	—	—	—	†	† † † †	"	5.2	"	"	" "

The writer is indebted to Dr. Johannes Bauer of the Department of Pathology, for the detailed study given below of seventeen strains taken at random from throats, middle ears and mastoids during the height of the epidemic.

The epidemic character of the septic sore throats, the clinical similarity of all mastoid complications and the result of this bacteriological study would seem to justify the conclusion that we have been dealing with a single type of the streptococcus pyogenes. According to the work of Avery, Dochez and Lancefield,<sup>6</sup> there are at least four types of the streptococcus pyogenes. Because of its inability to ferment mannite, the organism of this epidemic belongs, in all probability, to their Type S3, Type S23 or Type S84. Nichols<sup>7</sup> gives the sugar reactions of one hundred strains of hemolytic streptococci, all of which fermented dextrin. In this study, with the exception of Strain Number 2118, none fermented dextrin, from which we might conclude that his strains belonged to a different type or types than the one predominating here.

As further clinical evidence that we were in all probability dealing with a single type of the streptococcus hemolyticus in epidemic form, it should be stated that with the exception of two cases, there was no previous illness which might have acted as a predisposing cause. Adenoids and tonsils played no part as starting points for secondary invasions since four patients of this series and many others infected during the epidemic had had them removed. Regarding the presence of the streptococcus hemolyticus in the army, Blake<sup>8</sup> writes as follows:

"The epidemic character of the hemolytic streptococcus infection that has occurred in the army should be quite obvious to everyone, yet it is often disregarded in discussions upon the relation of streptococcus carriers to secondary streptococcus infections. \* \* \* That streptococcus bronchopneumonia has occurred in the form of epidemics rather than as an endemic disease, such as pneumococcus lobar pneumonia, is clearly brought out by the fact that during the winter of 1917-18, it occurred extensively in certain camps, particularly those in the South, while many of the northern and far western camps were almost entirely free from it."

It is not unlikely that a number of the epidemics in the army started from carriers possessing pathogenic strains. These were passed directly from individual to individual or through some medium, such as milk, as was found to be the case in the Boston epidemic. Milk cannot be considered as the source of infection in Peking, as the Chinese do not drink it, and practically all foreign-

ers either boil or pasteurize it before using. While the source of infection was not determined, it is highly probable that individual contacts were responsible for the spread of the disease.

For the purpose of this report, fifteen cases have been selected, which comprise practically all of the foreign cases treated during the epidemic. Five of these patients had double mastoids, so that the total number of infections reported is twenty. A departure from the ordinary method of reporting cases has been made in order to admit of greater facility of comparison for those who wish to study them in detail.

#### RECORD OF CASES.

Sex, age and past history.

Case No. 1. Female, age 6. Well-nourished child who had had no previous diseases and no ear trouble. Adenoids and tonsils have not been removed.

Case No. 2. Female, age 54. Elderly woman in fair health. Had scarlet fever and typhoid as a child. Was in fair health until five years ago, when she met with an accident, receiving nose injury. Since that time has had nasal obstruction, which has seemed to increase since coming to China, one year ago. No previous ear trouble. Adenoids and tonsils have not been removed.

Case No. 3. Male, age 10. Well-nourished boy with no history of ordinary children's diseases. Has had no previous ear trouble. Two years ago, tonsils and adenoids removed.

Case No. 4. Male, age 4. Well-nourished boy, who, aside from influenza prior to present illness, has been in good health. Has been free from ordinary children's diseases. Has had no previous ear trouble. Tonsils and adenoids have not been removed.

Case No. 5. Male, age 6. Under-nourished boy who has had frequent illnesses since coming to China, two and a half years ago. One year ago, adenoids and tonsils were removed. Child has had retracted ear drums and difficulty in hearing.

Case No. 6. Male, age 5. Well-nourished boy, who aside from occasional attacks of bronchitis, has been free from the ordinary children's diseases. Has had no ear trouble. Adenoids and tonsils have not been removed.

Case No. 7. Male, age 3. Boy only fairly well developed; nourishment slightly under normal, who, except for German measles one year ago, has been in good condition. Has had no previous ear trouble. Adenoids and tonsils have not been removed.

Case No. 8. Male, age 22. Young man of rather uncertain health. Frail from early youth. Treated from time to time for extremely

high blood pressure. Had scarlet fever when seven years of age. Has had no previous ear trouble. Adenoids and tonsils have not been removed.

Case No. 9. Female, age 8. Child in good health. Has had bronchitis a number of times. No history of ordinary children's diseases. Two years ago, had otitis media, which ran a very short course. Adenoids and tonsils have been removed.

Case No. 10. Female, age 6. Child in fair health. Has had practically all diseases of childhood, including influenza. Has had no ear trouble. Adenoids and tonsils were removed one year ago.

Case No. 11. Male, age 18 months. Child in only fair health. Has had occasional attacks of bronchitis with one definite attack of bronchial pneumonia, which lasted for ten days. Has had tonsillitis. Both ears have given trouble since early winter and both had to be opened. Both were in good condition before present illness began. Adenoids and tonsils have not been removed.

Case No. 12. Female, age 26. Young woman in good health, who has had all the diseases of childhood, with one attack of otitis media. Tonsils removed two years ago. Small remnant remains on the right side.

Case No. 13. Female, age 8. Child in fair health, who has had diphtheria and scarlet fever. Has had no previous ear history. Tonsils and adenoids have not been removed.

Case No. 14. Male, age 13. Boy in good health. Has had German measles, mumps and acute tonsillitis. Has had no previous ear trouble. Tonsils and adenoids have not been removed.

Case No. 15. Female, age 25. Young woman in good health, who had practically none of the ordinary children's diseases, but subject to repeated attacks of tonsillitis. Tonsils and adenoids have not been removed.

#### PRESENT ILLNESS.

Case No. 1. Ten days before entering the hospital, child complained of sore throat, at which time her temperature ranged between 102° and 104°. Three days after the onset of the sore throat, she complained of pain in the right ear. The following day the ear drum burst, the discharge becoming very profuse, straw colored and of a watery consistency. The left ear was somewhat inflamed, but not bulging.

A swab was sent to the laboratory for bacteriological examination.

Case No. 2. Two weeks before entering the hospital, patient complained of severe distress in the nose. Some medicine was given for the purpose of clearing it. She thinks that in forcing the

medicine through her nose, she blew something into her left ear, for almost immediately the ear began to ache, and continued to be very painful until three days before entering the hospital, when the ear drum was opened. Following incision, there was a profuse discharge which gradually decreased, although the temperature remained somewhat elevated.

A swab was sent to the laboratory for bacteriological examination.

Case No. 3. Three days before entering the hospital, patient complained of a slight sore throat and pain in the right ear. The hearing was impaired and there was a very slight rise in temperature. One day before entering the hospital, the ear drum ruptured and a great deal of straw colored fluid escaped. The ear drum was incised to admit of better drainage.

A swab was sent to the laboratory for bacteriological examination.

Case No. 4. Two weeks before entering the hospital, child had an attack of influenza, after which the temperature subsided until the sixth day before entrance, when there was a slight daily elevation. Two days later, child complained of pain in the right ear. During all this time the leukocyte count ranged between 19,000 and 21,000. Next day, the right ear drum membrane was incised, since which time there has been a profuse watery discharge.

A swab was sent to the laboratory for bacteriological examination.

Case No. 5. Two weeks before entering the hospital, the child had what was supposed to have been German measles. For the past eight days, temperature had been running up to 101° and 102° every afternoon, but there have been no symptoms to account for it. Child has not complained of pain in the ear. Examination showed both ear drums to be bulging and, after incision, there was profuse watery discharge from both sides.

A swab was sent to the laboratory for bacteriological examination.

Case No. 6. One week before entering the hospital, child had sore throat which lasted for two days with slight elevation of temperature. At that time, he complained of a slight irritation in both ears, but it was not enough to cause his parents' concern. He was brought for treatment because of deafness. Both ear drums were bulging and, on incision, only a very small amount of thick mucus was obtained. During the night, however, both ears began running very profusely a watery discharge.

A swab was sent to the laboratory for bacteriological examination.

Case No. 7. One week before entering the hospital, patient complained of pain in the right ear, which, after being opened, discharged very freely. While the throat was red at the time of examination, there was no history of a sore throat.



A swab was sent to the laboratory for bacteriological examination.

Case No. 8. Four weeks before entering the hospital, following a slight sore throat, patient complained of pain in his right ear. The ear drum was opened by the doctor in the station, and there was a fair amount of drainage; the mastoid, however, became very painful, but after a time, improved. There continued, however, a sense of uneasiness, so the patient came to Peking for examination. The ear drum was found to be bulging and, after incision, a rather thick mucus discharge was obtained, which continued for a few hours, but later became rather thin and profuse.

A swab was sent to the laboratory for bacteriological examination.

Case No. 9. One week before entering the hospital, child complained of pain in her left ear. The mother does not think she had a sore throat at the time. Having had a previous experience with ear disease, she reported at once and the ear drum was opened within an hour and a half after the pain began. Almost immediately there was a profuse, straw-colored discharge. There had been no elevation of temperature, and there continued to be none until just before admission to the hospital.

A swab was sent to the laboratory for bacteriological examination.

Case No. 10. About ten days before entering the hospital, patient complained of a sore throat, but upon examination, it appeared to be fairly normal. There was a slight flushing of the lateral walls of the pharynx. Seven days before admission, she suddenly developed pain in the left ear, which on incision, discharged very freely.

A swab was sent to the laboratory for bacteriological examination.

Case No. 11. Child had been having ear trouble most of the winter, but one ear drum had completely healed while the other was on the point of closing. There was practically no discharge. The father became ill with what was supposed to be influenza and almost immediately the child had a similar attack. Ten days before entering the hospital, the left ear began running again with a very thin but profuse discharge. The temperature became elevated daily to 101° to 102°, with a leukocyte count of 19,900.

A swab was sent to the laboratory for bacteriological examination.

Case No. 12. One week before entering the hospital, patient had a severe coryza for two days and a slight sore throat. Two days before admission, she had pain in her right ear, which became rapidly very severe, not only in the ear, but in the mastoid process. Her doctor used warm irrigations, but the condition rapidly grew worse until yesterday morning, when the ear drum burst, giving a very profuse watery discharge. Since that time, she has

been somewhat more comfortable, but still has considerable pain in the mastoid.

Case No. 13. Following an attack of sore throat three weeks before entering the hospital, the child complained of pain in the right ear. The doctor-in-charge at the station advised the use of poultices, which succeeded in increasing the pressure to the point of rupture of the ear drum, after which there was a profuse discharge. At the same time there was a great deal of pain behind the ear, to which poultices were again applied. Five days before admission a swelling appeared behind the ear, which has steadily increased.

Case No. 14. Three days before entering the hospital, following a slight sore throat, patient complained of pain in the right ear. Within twenty-four hours the ear drum was opened and a profuse watery discharge was obtained. The blood count at this time was 12,000.

A swab was sent to the laboratory for bacteriological examination.

Case No. 15. A week before entering the hospital, patient had an attack of sore throat, which was somewhat more severe than a number of previous attacks recurring through the winter. The middle ear became painful and twenty-four hours before admission, the ear drum was opened, since which time there has been a profuse discharge. The temperature remained normal.

A swab was sent to the laboratory for bacteriological examination.

#### SYMPTOMS ON ADMISSION TO THE HOSPITAL.

Case No. 1. Admitted December 6, 1920. Patient complained of slight sore throat. Had no pain in middle ear or mastoid, and no pain on pressure. Had been comfortable since incision of ear drum.

Case No. 2. Admitted December 4, 1920. Patient felt a great deal of uneasiness about the head, but had no pain, either in middle ear or mastoid processes, with but slight tenderness at tip on pressure.

Case No. 3. Admitted December 11, 1920. Had fair amount of pain in right ear, which was relieved on opening of ear drum. Had no pain on firm pressure of the mastoid tip.

Case No. 4. Admitted December 17, 1920. Patient had been perfectly comfortable since opening of ear drum at his home. No subjective pain in or about the ear. No pain on firm pressure of mastoid tip.

Case No. 5. Admitted January 15, 1921. Since opening of ear drums hearing had improved on both sides. No subjective pain, either in the middle ear or in mastoid processes, and but only slight pain on firm pressure of right mastoid tip.

Case No. 6. Admitted January 19, 1921. Since opening ear drums, hearing had greatly improved. No subjective pain, either in middle ear or mastoid processes. Firm pressure over mastoid tips failed to elicit pain.

Case No. 7. Admitted March 12, 1921. Since opening ear drum, no pain in or about the ear. No tenderness on firm pressure over mastoid tip.

Case No. 8. Admitted February 21, 1921. In spite of a certain amount of uneasiness in head, which could not be localized on right side, there was no definite pain referable to ear. Firm pressure over mastoid tip failed to elicit any pain.

Case No. 9. Admitted March 11, 1921. No pain in or about ear since opening of drum. Child showed certain amount of uneasiness, but pressure over mastoid tip produced no pain.

Case No. 10. Admitted April 15, 1921. Since opening of ear drum, patient had been perfectly comfortable. No subjective pain, either in middle ear or in mastoid process. Slight pain on pressure over mastoid tip.

Case No. 11. Admitted April 18, 1921. Child was considerably run down from his recent illness, but on the whole, seemed fairly comfortable. No pain could be elicited upon firm pressure of mastoid tip.

Case No. 12. Admitted April 21, 1921. Patient admitted with great deal of pain, both in middle ear and in mastoid process. Just before operation, middle ear began discharging profusely and pain lessened perceptibly; pain and tenderness in mastoid, however, continued to be severe.

Case No. 13. Admitted May 17, 1921. Patient complained of much pain and uneasiness about the ear, with considerable pain on pressure over the mastoid processes.

Case No. 14. Admitted May 25, 1921. Since opening of middle ear, pain in and around ear had disappeared. Slight pain on pressure of mastoid tip.

Case No. 15. Admitted June 1, 1921. Since opening of ear drum, pain had completely disappeared. Firm pressure over mastoid tip failed to elicit pain.

#### PHYSICAL FINDINGS ON ADMISSION TO HOSPITAL.

##### *Objective Examination of the Ears.*

Case No. 1. Right ear drum opened and draining freely. Slight flushing of Shrapnell's membrane, but no drooping of canal wall. No swelling or edema behind auricle. Profuse straw-colored discharge.

Case No. 2. Rather large incision in left ear drum with extremely red edges. Remainder of ear drum not congested, with exception of Shrapnell's membrane. No sagging of canal wall. No swelling nor edema behind ear. Profuse straw-colored discharge.

Case No. 3. All landmarks of right ear drum lost, and drum showing presence of severe inflammatory process. No sagging of canal wall. No swelling nor edema behind ear. Profuse straw-colored discharge.

Case No. 4. Right ear discharging profusely. Ear drum congested, but not greatly inflamed. No sagging of canal wall. No swelling nor edema behind ear.

Case No. 5. Both middle ears had profuse straw-colored discharge. Neither drum greatly inflamed. No sagging of canal wall. No swelling nor edema behind either ear.

Case No. 6. Profuse straw-colored discharge coming from both middle ears. Ear drums not greatly inflamed. No sagging of canal wall. No swelling nor edema behind the auricles.

Case No. 7. Profuse straw-colored discharge coming from left ear. Drum showed certain amount of flushing, but no evidence of severe inflammation. No sagging of canal wall. No swelling nor edema behind ear.

Case No. 8. Profuse muco-purulent discharge coming from right middle ear. Practically no redness of ear drum except about incision. No sagging of canal wall and no swelling nor edema behind ear.

Case No. 9. Profuse straw-colored discharge coming from left ear. Considerable inflammatory reaction around both drum incisions and Shrapnell's membrane, but no sagging of canal wall. No swelling nor edema behind ear.

Case No. 10. Profuse straw-colored discharge coming from left ear. Considerable redness throughout entire drum membrane, but no sagging of canal wall. No swelling nor edema behind ear.

Case No. 11. Profuse muco-purulent discharge coming from left ear. All landmarks of drum lost. Drum showed evidence of severe inflammatory process, but no sagging of canal walls. No swelling nor edema behind ear.

Case No. 12. Straw-colored discharge coming from middle ear. Ear drum had ruptured, but place indistinguishable. Both anterior and posterior canal walls sagging. No swelling nor edema behind the ear.

Case No. 13. Profuse muco-purulent discharge from right middle ear coming through large perforation in lower posterior quad-

rant. Slight sagging of posterior canal walls. Swelling behind the ear which fluctuated.

Case No. 14. Profuse straw-colored discharge coming from right ear. Drum showed evidence of severe inflammatory process. No sagging of canal walls. No swelling nor edema behind the auricle.

Case No. 15. Profuse straw-colored discharge from right middle ear. Fair amount of inflammation about the drum-incision and in Shrapnell's membrane, but no sagging of canal walls. No swelling nor edema behind ear.

#### BACTERIOLOGICAL FINDINGS OF SWAB FROM CANAL.

Case No. 1. Staphylococcus and diplococcus.

Case No. 2. Staphylococcus and diplococcus.

Case No. 3. Practically pure culture, streptococcus hemolyticus.

Case No. 4. Pure culture, streptococcus hemolyticus.

Case No. 5. Streptococcus hemolyticus from the left middle ear. No growth on the plate after twenty-four hours incubation from swab of right ear.

Case No. 6. Culture from right canal positive for streptococcus hemolyticus. Culture from left ear positive for streptococcus hemolyticus.

Case No. 7. Culture positive for streptococcus hemolyticus, and Gram negative diplococcus.

Case No. 8. Positive for staphylococcus albus.

Case No. 9. Positive for staphylococcus albus.

Case No. 10. Positive for streptococcus hemolyticus.

Case No. 11. Positive for streptococcus hemolyticus.

Case No. 12. No culture made from external canal before operation.

Case No. 13. No culture made from external canal before operation.

Case No. 14. Culture from external canal gave no growth.

Case No. 15. Culture from external canal positive for streptococcus hemolyticus.

#### X-RAY FINDINGS.

The X-ray findings noted below are the result of stereoscopic examinations made by Dr. Paul C. Hodges.

Case No. 1. December 9, 1920. Left mastoid, pneumatic in type and clear. Some evidence of sclerosis, probably the result of a very old process. Right, mastoiditis involving all of the cells. Transverse sinus normally placed. There are some cells along the squamopetrosal junction just above the mandibular articulation which are also involved.

(A second mastoid operation was performed on this patient and, for the sake of convenience and comparison, the X-ray report of December 18, is inserted in this place. It will be noted that the left mastoid was demonstrated to have become involved.)

December 18, 1920. Left mastoid, cells completely involved. There is a dark area seen through the transverse sinus, which may be the beginning of an epidural abscess; this latter at best doubtful from X-ray standpoint. (As will be noted below, "dark area" was necrotic area over sinus.)

Case No. 2. Three X-ray reports are given, taken at intervals, as there was considerable doubt as to the desirability of operating on this patient. The drainage from the middle ear ceased and, aside from slight uneasiness on the part of the patient, she seemed to be making a recovery. These reports cover, therefore, a period of observations and indicate in part our reasons for operating.

December 3, 1920. Left mastoid, chronic mastoiditis with sclerosis of part of the cells. Right mastoid, possibly normal; more probably the site of a chronic infection with the production of cholesteatoma.

December 7, 1920. Left mastoid, the upper cells seem to be undergoing sclerosis, but those of the tip probably contain pus. There are no normal air-filled cells. The transverse sinus is seen something over half an inch posterior to the auditory canal.

Right mastoid shows signs of an old sclerosis and possibly the formation of cholesteatoma, but many of the cells, particularly in the tip, contain air. If there had been an infection on the right side, it is now entirely quiescent.

December 16, 1920. Right mastoid. Cells almost completely filled except in tip with the formation of at least one and probably several cholesteatoma. The condition strikes me as very chronic with partial sclerosis. Mastoiditis, left, involving all of the cells. I believe that operation on the left side at this time would demonstrate pus or granulation tissue.

Case No. 3. December 14, 1920. Mastoiditis, right. All of the cells involved. Left mastoid, pneumatic in type and clear.

Case No. 4. December 18, 1920. Left mastoid, pneumatic in type and apparently clear. It seems to me possible that the cells may be slightly clouded, but X-rayically it would be dangerous to say that they were not normal. Right mastoid, the two rows of cells along the petrous portion just above the auditory canal are frankly involved. Those of the body of the process and the tip are X-rayically clear.

Diagnosis: Very early mastoiditis, right.

Case No. 5. January 17, 1921. Mastoids: Right, diploic in type; all of the cells involved. The lateral sinus comes moderately far forward, its anterior portion underlying the antrum. Left, diploic in type; all of the cells involved. The transverse sinus even farther forward than on the right, so that the antrum is seen to overlies almost the centre of the lumen.

Diagnosis: Findings indicate sub-acute mastoiditis on both sides.

Case No. 6. March 12, 1921. Mastoiditis on both sides, particularly the left.

Case No. 7. March 12, 1921. Mastoiditis, as reported yesterday. Right mastoid, small pneumatic cell type. Cells clear. Left mastoid, apparently of the same type, but cells completely involved. Mastoiditis.

Case No. 8. February 21, 1921. Right mastoid, large cells, pneumatic in type, with wide distribution of cells from the mandibular articulation forward far back into the occipital region. Mastoiditis involving almost all of the cells. Left mastoid, similar in type to right, but normal.

Case No. 9. March 11, 1921. Right mastoid, pneumatic in type and clear. Left mastoid, mastoiditis involving all the cells, particularly those in the tip.

Case No. 10. April 15, 1921. Right mastoid, clear. Left mastoid, all cells obscured.

Case No. 11. April 19, 1921. Right mastoid, mastoiditis, involving all of the cells, probably with destruction of the cell walls. Left, beginning mastoiditis.

Case No. 12. April 21, 1921. Left mastoid, all cells clear. Right mastoid, pneumatic in type, with all cells obscured.

Case No. 13. May 17, 1921. Left mastoid, cells clear. Right mastoid, all cells obscured.

Case No. 14. May 25, 1921. Left mastoid, pneumatic in type and clear. Right mastoid, pneumatic in type, but all the cells, particularly those near the tip, are involved with an acute mastoiditis. The process is at a very early stage and the cells still contains some air, but the soft fleecy shadows in the cells are pathognomonic of early mastoiditis.

(Inasmuch as temperature continued, a further examination was made of the left mastoid, as indicated in the following reports on May 28.)

May 28, 1921. Examination on May 26, day after operation on the right mastoid, shows most of the cells on the right side cleared out, but with some small ones persisting, especially in the upper part. A sharp metallic shadow is seen, probably caused by the

iodoform dressing. Note also, three metallic skin clips. Left mastoid, two or three of the large tip cells show very slight evidence of involvement today which was not noticeable yesterday. Evidence not sufficient to warrant operation unless clinical symptoms persist, but mastoid should be watched. Chest, slight increase of hilus shadows, left at the level of the eighth rib, posterior, and right one interspace lower. The findings are quite common, even in children of this age. They probably have no clinical significance, but might account for abnormal clinical signs. No evidence of pneumonia. Note: stereoscopic pair not available because patient moved during second exposure.

Case No. 15. June 2, 1921. Right mastoid, mastoiditis involving all of the cells. Left mastoid, of the moderately pneumatic type, probably beginning cells involvement.

#### TEMPERATURE AND LEUKOCYTE COUNT ON ADMISSION.

- Case No. 1. Temperature, 37.4 C.; leukocyte count, 21,100.
- Case No. 2. Temperature, 38.4 C.; leukocyte count, 11,020.
- Case No. 3. Temperature, 37.6 C.; leukocyte count, 11,620.
- Case No. 4. Temperature, 37. C.; leukocyte count, 15,550.
- Case No. 5. Temperature, 36.8 C.; leukocyte count, 13,750.
- Case No. 6. Temperature, 37.2 C.; leukocyte count, 14,250.
- Case No. 7. Temperature, 37. C.; leukocyte count, 13,500.
- Case No. 8. Temperature, 36.6 C.; leukocyte count, 9,450.
- Case No. 9. Temperature, 37. C.; leukocyte count, 11,940.
- Case No. 10. Temperature, 36.6 C.; leukocyte count, 13,300.
- Case No. 11. Temperature, 38.4 C.; leukocyte count, 19,900.
- Case No. 12. Temperature, 38.4 C.; leukocyte count, 20,000.
- Case No. 13. Temperature, 37. C.; leukocyte count, not taken.
- Case No. 14. Temperature, 38.9 C.; leukocyte count, 12,000.
- Case No. 15. Temperature, 36.8 C.; leukocyte count, 14,000.

#### FINDINGS AT OPERATION.

Case No. 1. December 9, 1920. Simple mastoid operation performed. External table of bone covering mastoid cells found in good condition. Mastoid cells partly destroyed and containing considerable free pus under pressure. Many cells contained small freshly made granular masses, which bled easily when curetted. Dura and sinus not exposed. Wound drained with iodoform gauze.

Swab from mastoid wound taken at time of operation gave a pure culture of streptococcus hemolyticus.

Case No. 2. December 16, 1920. Simple mastoid operation performed. External table of bone covering mastoid cells found to be slightly discolored, but intact. Mastoid cells completely destroyed and filled with pus and granulations. Sinus not exposed, but large



area of dura just over the tegmen antri uncovered in removal of necrotic bone. Wound drained with iodoform gauze.

Swab from wound at time of operation produced no growth at end of thirty-six hours, but second taken from wound forty-eight hours after operation gave pure culture of streptococcus hemolyticus.

Case No. 3. December 13, 1920. Simple mastoid operation performed. External table found to be normal, while cells which were pneumatic in type and very slightly destroyed, were found to be filled with pus and newly formed granular masses which bled easily when curetted. Sinus and dura not exposed. Wound drained with iodoform gauze.

Swab taken from wound at time of operation gave pure culture of streptococcus hemolyticus.

Case No. 4. December 17, 1920. Simple mastoid operation performed. Mastoid bone showed numerous small bleeding points. Cortex dark, but no places of actual necrosis. On opening, mastoid cells found to be pneumatic in type and completely filled with pus and considerable streptococcal membrane. No dura or sinus exposed. Wound drained with iodoform gauze.

Swab taken from mastoid wound at time of operation gave pure culture of streptococcus hemolyticus.

Case No. 5. January 15, 1921. Simple mastoid operation performed on both sides. Right cortex normal. Mastoid filled with pus and necrotic bone. Cells almost completely destroyed. Dura exposed in middle fossa, but sinus not exposed. Wound drained with iodoform gauze.

Left mastoid, cortex normal. Cavity contained much necrotic bone and free granulations with very little free pus. No dura or sinus exposed. Wound closed with iodoform gauze.

Swab from right mastoid wound at time of operation gave pure culture of streptococcus hemolyticus.

Swab from left mastoid wound at time of operation gave pure culture of streptococcus hemolyticus.

Case No. 6. January 19, 1921. Simple mastoid operation performed on both sides. Right, cortex soft and slightly necrotic. Cells filled with stringy mucus and pus and somewhat destroyed. No dura or sinus exposed. Wound drained with iodoform gauze.

Left side, cortex normal. Cells filled with stringy mucus and pus and partly destroyed.

Swabs taken from both mastoid wounds at time of operation negative for streptococcus hemolyticus, but found to be positive three days after the operation.

Case No. 7. March 12, 1921. Simple mastoid operation performed on left ear. External table of bone covering mastoid cells normal. Cells intact, but containing pus and granulations. No dura or sinus exposed. Wound drained with iodoform gauze.

Swab taken from left mastoid at time of operation gave pure culture of streptococcus hemolyticus.

Case No. 8. February 21, 1921. Simple mastoid operation performed on right ear. Cortex intact, **but discolored**. On opening, mastoid cells found to be pneumatic in type and completely filled with a muco-purulent discharge. Little granular tissue inside the cells and only slight discoloration of the larger tip cells. No sinus or dura exposed. Cavity drained with iodoform gauze.

Swab taken three days after operation gave pure culture of streptococcus hemolyticus.

Case No. 9. March 11, 1921. Simple mastoid operation performed on left ear. Table of bone covering mastoid cells found to be normal. Mastoid cells when exposed showed necrosis and were filled with pus and granulations. No dura or sinus exposed. Cavity drained with iodoform gauze.

Culture made from the mastoid cavity at time of operation showed no growth after forty-eight hours, but two days after operation, a swab taken from wound gave pure culture of streptococcus hemolyticus.

Case No. 10. April 15, 1921. Simple mastoid operation performed. External table of bone found to be normal. Mastoid cells were filled with granulations and pus. No dura or sinus exposed. Wound drained with iodoform gauze.

Swab taken from wound at time of operation gave pure culture of streptococcus hemolyticus.

Case No. 11. April 18, 1921. Simple mastoid operation performed on left ear. External table of bone somewhat discolored and showed numerous bleeding points. Mastoid cells partially broken down and filled with granulations and pus. No dura or sinus exposed. Wound drained with iodoform gauze.

Swab taken from wound at time of operation gave a pure culture of streptococcus hemolyticus.

Case No. 12. April 21, 1921. Simple mastoid operation performed on right ear. External table of bone markedly discolored with many bleeding points. Mastoid cells pneumatic in type, partially destroyed, completely filled with pus and granulations. Cavity drained with insertion of two small rubber tubes in addition to gauze strips above and below.

Swab taken from wound at time of operation gave pure culture of streptococcus hemolyticus.

Case No. 13. May 17, 1921. Simple mastoid operation performed on right ear. On opening the skin, a large amount of pus escaped. Mastoid was perforated high up over the antrum. The external table of bone was necrotic. Mastoid cells were found to be almost completely broken down and to contain pus and granulations. No sinus, but a small area of dura was exposed. Wound was packed with iodoform gauze and left wide open.

Swab taken from wound at time of operation gave pure culture for streptococcus hemolyticus.

Case No. 14. May 15, 1921. Simple mastoid operation performed on right ear. External table of bone found to be normal. Exposure of cells showed them to be pneumatic in type; partially broken down and filled with pus and granulations. No sinus or dura exposed. Wound drained by insertion of small rubber tubes with gauze strips above and below.

Swab taken from mastoid wound at time of operation gave pure culture of streptococcus hemolyticus.

Case No. 15. June 1, 1921. Simple mastoid operation performed on right ear. External table of bone normal with the exception of a small area over the lateral sinus, which proved to be a broken down cell which had almost perforated the external table. Mastoid cells found to be pneumatic in type and only partially broken down, but completely filled with granulations and pus. No sinus or dura exposed. The wound was drained with two small rubber tubes with gauze strips above and below.

Swab taken from wound at time of operation gave pure culture of streptococcus hemolyticus.

In the above table, the maximum temperature for each day is placed above and the leukocyte count below, for those days on which it was taken.

Case No. 1 continued to run a normal temperature until the eighth day after the first operation, when it rose to 39 and a second mastoid operation was performed. This will be reported below.

Case No. 10 returned home with a leukocytosis of 16,050 and continued to run a slight temperature with elevation of the leukocyte count for another ten days. It is just possible that a mild pyelitis accounted in part for the continuation of temperature and leukocytosis.

#### OPERATION OF A SECOND MASTOID ON THREE OF THE CASES.

Case No. 1.—On the twelfth day after entering the hospital, the temperature suddenly became elevated to 39 with a leukocyte count

Chart No. 2. MAXIMUM TEMPERATURE AND LEUKOCYTE COUNT IMMEDIATELY FOLLOWING OPERATION

Days After Operation	1	2	3	4	5	6	7	8	9	10	11	12
Case 1	37.8	37.6	37.2	37.4								
Case 2	14,050	18,900	13,370	10,850	37.2							
Case 3	37.4	37.8	37.8	38.4								
Case 4	37.4	37.8	37.4	37.	37.8	38.	37.8					
Case 5	40.4	39.4	37.8	37.4	37.4	37.	7,550					
Case 6	27,225	18,050	11,250	9,700								
Case 7	37.4	37.8	37.6	37.								
Case 8	11,750	37.4	37.2	37.	37.2	37.8	37.4					
Case 9	37.8	37.4	16,200	13,850		10,520						
Case 10	38.2	37.	37.									
Case 11	13,500	37.	37.2									
Case 12	9,450	37.2	37.									
Case 13	38.6	37.4	37.									
Case 14	38.4	37.1	37.2	37.2	36.8	37.8	37.4					
Case 15	18,900	16,990	17,400			16,050						
Case 16	39.4	38.8	39.2	38.2	39.	39.4	40.	37.4	38.4	37.4	37.2	37.
Case 17	17,500	22,400	22,400	18,850		24,400	20,420	19,050		17,150	13,300	
Case 18	38.4	38.4	38.	37.8	37.2							
Case 19	13,900	10,580	37.	37.4	37.							
Case 20	38.8	37.4										
Case 21	38.8	40.	39.9	39.6	40.	(First Operation)						
Case 22	12,000	13,900		21,000								
1st Operation												
Case 23	39.	38.6	38.2	38.	38.	39.	39.	38.8	38.2	38.2	37.4	37.4
Case 24	18,750	17,700	12,250	12,150	12,250	11,090	15,500	13,650	9,950			8,625
2nd Operation												
Case 25	37.6	37.8	37.6	37.6	37.4	37.2	37.					
Case 26	14,400	15,425	12,250	10,500		11,150						

of 15,600. There was considerable edema behind the left ear and pain on pressure. The middle ear had been dry for four days, and, inasmuch as this ear drum had been opened when there was only slight congestion, it was assumed that there was little likelihood of the mastoid being infected. At the operation, however, it was found that the process had undoubtedly progressed from the time the middle ear was inflamed, as there was complete destruction of the mastoid cells with a large area of necrotic bone covering the lateral sinus. The surface of the sinus was gray but gave no other sign of being infected. There was also a large area of necrotic bone covering the dura. The first day after operation, the temperature was 38.8 with a leukocyte count of 17,170; second day 38.2, leukocyte count 13,700; third day 38.6, leukocyte count 11,800; fourth day 38.4, leukocyte count 10,250; fifth day 38.6, leukocyte count 10,350; sixth day 38.6; and on the seventh day 40.4 with a leukocyte count of 10,000. This sudden rise of temperature which continued for a number of days caused us some concern because of the appearance of the lateral sinus at the time of the second operation. The leukocyte count of 10,000 on the same day, however, gave us a certain amount of consolation even though the child did not seem to be resting well. On the eighth day after the operation, the temperature was 40.2; on the ninth, 39, leukocyte count 9,600; on the tenth 40.2; on the eleventh 40, leukocyte count 10,650. On the thirteenth day after the operation, a positive blood culture was obtained for streptococcus hemolyticus. In the absence of an increased leukocytosis, it was felt that the presence of the streptococcus in the blood was not the cause of the elevation in the temperature and a further search was made. On the evening of the same day, the blood smear showed a malarial parasite (autumnal type). There had been no history of malaria and inasmuch as we rarely have the autumnal type in North China, this was an unusual finding. Quinin was started immediately, but the child had difficulty in retaining it. Temperature on the fourteenth day after operation, 39.4; fifteenth day 38; sixteenth day 39; seventeenth day 37.6, leukocyte count 9,600; on the eighteenth day 37.4; nineteenth day 37.4; twentieth day 38.4; twenty-first day 39; twenty-second day 38.4, leukocyte count 10,200; twenty-third day 37.4; twenty-fourth day 38.2; twenty-fifth day 37.4. Thereafter the temperature remained below 37.

Case No. 7.—This child, as noted above, ran an even temperature after the first operation on the left ear for one week, when he came down with a mild case of measles. Three days after the onset of measles, the right ear became painful and had to be opened. Imme-

diately there was a very profuse straw colored discharge which continued until operation. The temperature did not go above 38 during this time, nor the leukocyte count above 9,000, probably due to the leukopenia, not unusual with measles. The operation was performed in the patient's home, so no detailed laboratory findings are recorded on the hospital record. A swab taken from the mastoid wound at the time of operation gave pure culture of streptococcus hemolyticus. After the second operation returned gradually to normal and remained so until a rather severe adenitis of the glands of the neck appeared three weeks after the operation. The temperature during this time ran between 39 and 40 for a period of one week, after which it dropped to normal.

Case No. 14—As noted above, this patient's temperature remained high after the operation on the right ear. The left ear drum had been opened the day after the first operation, and there was a slight amount of discharge but the temperature was not relieved. Further X-Ray examination (as will be noted above) showed some obstructing of the cells, which together with the clinical symptoms warranted an exploratory operation. The mastoid cells were found to be partially destroyed and filled with pus and granulations. The wound was drained by small rubber tubes with strips of gauze above and below.

Swab taken from the wound at time of this operation gave pure culture of streptococcus hemolyticus.

#### CULTURING OF WOUND DURING PROCESS OF HEALING.

At irregular intervals swabs were taken of the mastoid wounds to determine whether or not the streptococcus hemolyticus still prevailed. The writer regrets that this part of the study was not more systematic, but the heavy burden on the comparatively small staff in the laboratory made it impossible to make more frequent cultures. In this connection, the writer wishes to acknowledge Dr. Charles W. Young's assistance in placing the time of his assistants at our disposal for this work.

Case No. 1—On December 27, ten days after second operation, culture positive for streptococcus hemolyticus for right mastoid cavity, negative for left.

Case No. 2—On December 20, four days after the operation, and on January 3, eighteen days after operation, the culture was positive for streptococcus hemolyticus.

Case No. 3—On December 27, fifteen days after operation, and on January 4, twenty-three days after operation, culture positive for streptococcus hemolyticus.

Case No. 4. On January 3, seventeen days after operation culture positive for streptococcus hemolyticus.

Case No. 7. On March 29, four days after second operation on right mastoid, on April 2, seven days after operation, and on May 5, forty-one days after operation, right mastoid culture positive for streptococcus hemolyticus.

Case No. 8. On March 11, eighteen days after operation, and on May 24, thirty-one days after operation, culture from mastoid wound positive for streptococcus hemolyticus.

Case No. 11. On April 23, five days after operation, and April 30, twelve days after operation, culture from wound positive for streptococcus hemolyticus.

Case No. 12. On June 5, forty-four days after operation, culture positive for streptococcus hemolyticus.

#### POST OPERATIVE STAGES OF THE DISEASE.

Three typical post-operative stages were observed in all of these cases. They were most distinctive when the cells were drained within a few days of the onset of the disease. The first stage covered a period of from three to six days immediately following the operation. It was characterized by a profuse straw-colored discharge from the middle ear and mastoid cavity. The second stage covered a period of from one to four weeks. The thin discharge of the first stage changed with surprising rapidity into one of mucopurulent character with the mucus element predominating. The discharge was so profuse that frequently dressings had to be changed twice daily. The mucus discharge from the middle ear was especially distressing during this period. Granulations, which were only just beginning in the first stage, now became abundant. Instead of forming as solid masses with broad bases, they appeared as rather pendulous and flabby growths. It was not unusual to see polypoid masses of granulations escaping from a wound on removing the drains. The third stage covered a period of from two to ten weeks. It was characterized by a gradually lessening catarrhal mucus discharge. The granulations were less active and, in some cases, needed stimulation to bring about filling in of the cavities.

#### POST OPERATIVE STAGES OF DISEASE.

Case No. 1. Passed through ordinary stages as noted above. Child's resistance not high, so there was considerable retarding of the healing processes. Patient discharged thirty-seven days after second operation. Mastoids healed in one week after leaving the hospital.

Case No. 2. Passed through three stages noted above. Patient discharged thirty-five days after operation; mastoid wound healed within one week after leaving hospital.

Case No. 3. Passed through three stages as noted above. Pa-

tient discharged thirty-one days after operation; mastoid wound healed within one week after leaving hospital.

Case No. 4. Patient had a very severe first stage lasting for a week, with prolonged second and third stages, in the course of which a second mastoid was performed on the other ear. The second mastoid infected by pneumococcus, type two sub-group. Child's resistance extremely poor. After passing through second stage, there seemed to be no vitality within the wound to bring about a closure. Two months after operation, patient had severe cervical adenitis, probably as a result of extension from the tonsils which were in an inflamed state. Patient discharged thirty-six days after operation; mastoid healed at the end of five months after leaving hospital.

Case No. 5. Patient had extremely short first stage, probably due to mastoid inflammation of several days' standing before operation. Second stage rather prolonged. Considerable discharge from middle ear apparently continuing to reinfect the mastoid cavity. In this case, as in a number of others, the presence of the active process within the middle ear and the eustachian tube was probably the real reason for delayed healing. Discharge from middle ear insufficient to keep perforation open, resulting in the necessity for occasional incisions of the ear drum for relief from this accumulation. Mucus probably originated in middle ear or eustachian tube. In this particular case, the ear drums were opened as many as twelve times. Patient was discharged twenty days after operation; mastoids healed six weeks after leaving the hospital.

Case No. 6. Resembled Case No. 5 in almost every particular. Patient had been operated on after process had been going on for some time. Extremely short first stage. Prolonged second stage. Some accumulation of mucus within middle ear, necessitating frequent opening of ear drums. Patient discharged twenty-five days after operation and mastoid healed eight weeks after leaving hospital.

Case No. 7. Patient passed through typical stages following both mastoid operations, but had prolonged third stage, during which cervical glands became swollen on both sides. Second mastoid, on point of healing, became infected with Klebs Loeffler's bacillus, delaying healing for several weeks. This probably extended directly from the throat, as the child was found to be a carrier. Patient discharged to his home three days after operation on first mastoid, which healed four months after leaving the hospital.

Case No. 8. No evidence of first stage, due, probably, to the fact that patient came for operation some three weeks after onset of mastoiditis. As noted above, the mastoid cells were filled with mucus which continued to be very profuse during the entire month



of life after the operation. Just before death, however, there was a slight abatement of the discharge and a reduction in the activity of the granulations.

Case No. 9. Patient passed through typical stages. First and second stages fairly short. Third stage of healing somewhat prolonged, due, probably, to low resistance. Patient discharged eighteen days after operation; mastoid healed eight weeks after leaving the hospital.

Case No. 10. Patient passed through typical stages and was healing rapidly when she became ill with scarlet fever. Immediately there was a marked increase in the middle ear discharge and healing was delayed perhaps a month. Patient was discharged eleven days after operation; mastoid healed ten weeks after leaving the hospital.

Case No. 11. First stage extremely short. Child was progressing favorably during the normal second stage when she became ill with scarlet fever. Discharge from middle ear and mastoid immediately became very profuse and final healing delayed at least six weeks. Patient was discharged twelve days after operation and mastoid was healed four months after leaving the hospital.

Case No. 12. This patient had prolonged and severe first stage which lasted a week. Second stage normal. Third stage considerably prolonged. Granulation, which had been very profuse in the beginning, became quiescent and the wound refused to heal. Patient discharged twenty-two days after operation; mastoid healed by blood-clot method thirteen weeks after operation.

Case No. 13. Patient had no first stage, due, probably, to the fact that she was operated on at least four weeks after onset of disease. Second stage short; healing not retarded in any way. Patient discharged twelve days after operation; mastoid healed three weeks after leaving the hospital.

Case No. 14. Patient had a very short first stage for both ears. Second stage lasted four weeks, at the end of which time there was very rapid healing. Patient discharged twenty-six days after first operation; mastoid healed eight weeks after leaving the hospital.

Case No. 15. Patient passed through typical stages but with practically no discharge from middle ear beyond the sixth day, probably the only exception to the rule of a three weeks' discharge following operation. Patient discharged eight days after operation; mastoid healed nine weeks after leaving the hospital.

#### SUMMARY AND CONCLUSIONS.

*Streptococcus hemolyticus* mastoiditis is an acute inflammation of the mastoid cells from which the *streptococcus hemolyticus* is isolated in pure culture. Until further studies are made, it is fair to

assume that all groups of the streptococcus hemolyticus attack the mastoid cells in a characteristic manner.

#### ETIOLOGY.

The predisposing cause of practically all the cases reported here was an acute inflammation of the throat which, in many cases, was so slight as to pass almost unnoticed. The streptococcus hemolyticus was isolated in pure cultures from all mastoid wounds and in the absence of other demonstrable organisms may be considered to be the exciting cause of the disease.

#### PATHOLOGY.

The rapidity with which the mastoid cells may be destroyed is astounding. A number of mastoids of this series opened within three days after the middle ear symptoms began, showed partial or complete destruction of cells; and in one case, operated twenty-four hours after middle ear symptoms began, necrosis which stopped just short of perforation of the external table of bone. The mastoid process as a rule was filled with a bloody, serous discharge, with freely bleeding granulations in great abundance. In those cases operated upon within a few days of onset of disease, the partially destroyed cells were frequently found to be a third or half filled with a streptococcal membrane. In those cases where operation was delayed beyond the ten-day period, the bloody discharge had given way to a stringy mucus. This appearance of mucus was found to be characteristic, as will be noted under the post-operative course and treatment of the disease.

Dr. Alfred Kahn<sup>n</sup> has called our attention to the fact that there are clinical differences between mastoids infected with the streptococcus mucosus and hemolyticus and the pneumococcus. The "Apple Specking" which he describes in the case of streptococcus hemolyticus was not observed in this series of twenty mastoids, with the possible exception of two cases, probably because they were, almost without exception, given early operative treatment. In these two cases, an attempt was made to avoid operation and both mastoids had been involved at least two weeks before they were drained. In both cases, there were areas where the cells showed signs of healing and three or four foci in each, which gave every indication of being active processes. One such focus was immediately over the lateral sinus which, when curetted away, exposed the sinus.

*Symptoms.* With the exception of three cases, none had symptoms which could not have been explained by the acute otitis media. Case twelve had classical mastoid symptoms, probably due to the presence of a very large pneumatic mastoid. Cases one and thirteen both had pain and swelling, probably due to delayed operation.

With the exception of Case twelve, toxemia was not a symptom. Muecke and Grantham-Hill<sup>10</sup> have published a paper in "The Lancet" entitled "Symptomless Influenzal (Streptococcal) Mastoiditis," which undoubtedly describes an epidemic similar to the one in Peking.

*Diagnosis.* All writers agree as to the absence of definite signs pointing to mastoid disease in these cases. The rapidity with which sequelae appear in untreated cases, however, makes early diagnosis imperative. In this series, diagnosis was based on the profuse, serous discharge following incision of the ear drum membrane, the finding of the streptococcus hemolyticus in pure culture or as the predominating organism in the middle ear discharges, the moderate elevation of the leukocyte count and the obstruction of the cells as demonstrated by the X-Ray examination. In practically all cases, there was no elevation of temperature until after the cells were opened. The profuse discharge is perhaps the most remarkable sign of the disease. A large pad applied to the ear after incision of the drum becomes thoroughly saturated in a few hours. This discharge is always serous in the beginning and occasionally is tinged with blood.

It should be the practice of every otologist to examine bacteriologically all acute middle ear discharges. This is especially important when the streptococcus is suspected. Bacteriological examination of the discharge in all the above cases gave positive cultures in the great majority. In some, a pure culture was obtained, while in others, the streptococcus was found to be the predominating organism. Had repeated cultures been made of the cases in this series which gave negative results, it is fair to assume that sooner or later, a positive culture would have been obtained, inasmuch as all of them gave positive cultures after operation.

A leukocytosis ranging between 12,000 and 16,000 together with little or no rise in temperature has been characteristic. In a few cases, the count has been between 20,000 and 22,000 with again only a slight elevation in temperature. Case four presents the typical temperature and leukocyte picture. After opening the middle ear and until operation, the patient's temperature did not rise above normal, yet the leukocyte count was 15,550 on admission.

The X-Ray has been of great assistance in determining the degree of involvement. In practically all cases, it was possible for the Roentgenologist to describe fairly accurately the condition of the cells as found at operation. In two cases, the process was probably caught at too early a stage to show obstruction to the cells. Stereoscopic plates alone were used in making the diagnoses.

In only one case was there evidence of mastoid disease in the external auditory canal. Case twelve, which had a large pneumatic mastoid, showed the posterior canal wall completely collapsed.

*Complications.* Complications are to be expected early in the course of the disease if the mastoid cells are not opened. Lateral sinus thrombosis, brain abscess, septicemia and meningitis may appear before the surgeon has taken the patient's condition seriously. Early drainage of the mastoid reduces the danger from sinus thrombosis, septicemia and brain abscess, but to a less extent from meningitis. The only fatality in this series was from meningitis following a mastoid operation which had been drained adequately for one month. Whiting reports the case of a man who died of meningitis after the mastoid wound had completely healed. A bacteriological examination of the mastoid wounds of the above series demonstrated the fact that the streptococcus was present for days and weeks following operation. In the fatal case mentioned above, a pure culture was obtained from the mastoid wound at the onset of meningitis. The same organism caused the meningitis, though no portal of entrance to the meninges could be found in or about the ear at autopsy. Dr. Henry E. Meleney<sup>11</sup> is reporting on this case.

*Prognosis.* It is probable that a much higher percentage of these cases end fatally when the mastoid cells are not opened early. The writer attributes the absence of complications and fatalities, with the exception of the one case in this series, to prompt surgical treatment.

With the exception of possibly one case, hearing has returned to normal in all instances. This is remarkable to one who has witnessed the severity of the inflammation.

*Treatment.* Stoops<sup>12</sup> reporting on mastoiditis in Camp Pike, Arkansas, writes: "One otologist of splendid training and adequate experience became pessimistic as to the benefits of the mastoid operation and attempted to treat practically all the cases of streptococcic otitis by free paracentesis and the application of various medicaments to the external auditory canal. Some patients on whom the diagnosis of mastoiditis was certain apparently recovered and were discharged from the hospital, but so far as the writer is aware all these patients suffered a recurrence of the disease and were operated on later. However, the most noticeable result of this conservative method was an immediate and alarming increase of the cases of lateral sinus thrombosis, five cases developing the complication within a few weeks."

During the epidemic in Peking at least one foreigner and a number of Chinese refused operation and yet they recovered. At

least, they have every appearance of recovery at the end of six months. The writer would not go so far as to suggest with Stoops that all streptococcic mastoids come sooner or later to operation, but he would say that early operation and that alone can free the surgeon from grave responsibility and the constant worry of complications. If there were some means at our command by which we could determine which cases are progressing to the point of bone destruction, then it might be possible to be conservative and avoid operation in a certain number.

An attempt was made in two cases of this series to give conservative treatment. Case one had a paracentesis of the left drum on the day the right mastoid was operated, thus relieving a middle ear condition of which the child had been conscious for not over four hours. The profuse discharge gradually subsided and the middle ear gave every sign of rapid recovery. Within ten days, marked tenderness of the mastoid indicated that while the discharge had practically disappeared, there was still an active process in the cells. At operation, a large area of necrosis was found over the lateral sinus and a blood culture taken several days later was positive for streptococcus hemolyticus. A second culture was negative. It is just possible that surgical interference in this case came in the nick of time to avoid a distressing complication. Case two was disinclined to operation because of her age and was allowed to wait inasmuch as the middle ear rather rapidly cleared up and the discharge practically ceased. Finally Shrapnell's membrane again became congested, although there was no increase in the discharge, and immediate operation was advised, with the result that the cells were found entirely destroyed with the tegmen antri completely necrosed. These cases cannot help impressing one with the insidious character of the disease and the need for early surgical intervention if grave complications are to be avoided.

It is interesting in this connection to note that the conclusions of the various men covering the infection of the mastoid with the streptococcus mucosus capsulatus might serve equally well for mastoids infected with the streptococcus hemolyticus. The conclusions of Whiting Bacon and J. Morrisett Smith can be summed up by the following quotations from Smith's<sup>13</sup> paper:

"The symptoms are very apt to be masked, even in the presence of an extensive destruction of the mastoid process.

"One of the chief dangers is that of not recognizing the presence of the infection.

"Practically all the cases come to operation.

"Prompt recognition with early and careful surgical intervention will result in a uniformly low mortality."

The operation should have for its objective not only the complete removal of all the cell but mucous membrane of the cells as well. The most troublesome feature in the post-operative treatment is an overabundance of mucus after the first few days, from the operated wound. The writer is of the opinion that while a certain amount of this comes from the middle ear and eustachian tube, by far the most important source is the mucous membrane of cells which has not been removed.

In the earlier operations of this series, the classical opening was left at the end of the mastoid incision, with a packing of gauze strips. In the later operations, the wound was left widely open and rubber tubing was used for drainage. No attempt was made to sterilize the open cavity.

*Post Operative Course and Treatment.* Examination of the above record of maximum temperatures and leukocyte counts following operation will show that not only a slight daily rise in temperature but also a gradual decline in the leukocytosis is the rule. Here is a picture which is entirely different from that of the so-called ordinary mastoid infection, where the temperature drops permanently to normal and the leukocytosis disappears.

As noted above in giving a detailed account of the different cases, there are three distinct stages in the process of healing, as indicated by the character of the discharges and activity of the granulations. Final healing has varied from five weeks to five months.

The proper post-operative care is of the utmost importance. The mortality may be increased through careless management of the wounds and hearing may be considerably impaired if the ear drum is not frequently inspected and drainage obtained as long as there is an accumulation of mucus within the tympanic cavity. While a systematic and exhaustive bacteriological study was not made of the wounds, sufficient cultures were secured to emphasize the fact that the streptococcus may be present for a considerable period following the operation. In two of the above cases, pure cultures of the streptococcus hemolyticus were obtained, one at the end of thirty-one days and one at the end of forty-four days. The presence of the infecting organism for so considerable a time makes the post-operative treatment an extremely important part of the management of the disease. There can be no feeling of security from complications such as meningitis until the wound is permanently healed.

All excepting the last five cases of this series had iodoform wicks inserted at the operation for the purpose of drainage. In practically every case, these were removed at the end of from twelve to twenty-four hours because of the excessive discharge. It was also found necessary for the majority to change the dressing twice daily. It became evident early in the treatment of these cases that we were closing the wounds at operation more than was wise as incisions had to be enlarged frequently to allow sufficient drainage. This was remedied by putting in only one suture and leaving the wound rather more widely open than seemed really necessary at the time. In the last five cases, small rubber tubes were inserted at the time of the operation and continued throughout the first and second stages. They admitted of very free drainage and the writer is of the opinion that the cases in which they were used improved most rapidly.

The classical time for the healing of the middle ear after the ordinary mastoid infection is given as from six to ten days. The accumulation and discharge of mucus from the middle ear of these patients varied so much that frequently perforations closed over night and the condition known as a dry middle ear was simulated. On inspection, the tympanic membranes were usually found to be bulging and, following paracentesis, the discharge continued for a variable period. In some cases, repeated incisions had to be made every few days until healing took place.

During the second stage in practically all the cases, the granulations were profuse and frequently interfered with drainage. At first these exuberant growths were snipped off with the scissors, but after concluding that a rise of temperature in one patient could be explained by these manipulations, this practice was discontinued, and fifty per cent silver nitrate was used for the cauterization. Whiting suggests that the granulations in cases of streptococcus mastoiditis should always be cauterized and never cut. One must assume following the cultural experiments noted above that the granulations are constantly bathed in a medium which is fairly well inoculated with a virulent organism and that nothing should be done to provide a portal of entrance to the blood stream or perivascular lymph spaces.

The writer has been at a loss to explain the inactivity of the granulations during the third stage. It may be the natural sequel of a severe inflammatory process. While in some of the cases, the cavities have been small enough with wound edges sufficiently approximated to employ Hammond's boric acid method of closure, others have presented large cavities which gave no signs of healing except-

ing as extremely unsightly post-aural depressions. Fifty per cent silver nitrate was used in an attempt to stimulate the granulations, but with very little success. All but one of these sluggish cases responded to what may be called the blood-clot and boric acid method. The margins of the wound were elevated and brought as near together as possible without the use of an anesthetic and the cavity was allowed to fill with blood obtained either from this manipulation or by curetting the inactive granulations. The incision and presenting clot were then covered with a generous amount of boric acid powder and the dressing applied. In one case, this treatment proved to be successful on the first attempt, but with the others, it had to be repeated three or more times. It should be understood that neither the Hammond nor the blood-clot boric acid method should be used as long as there are active streptococci in the wound. In the one case which failed to close after using the above methods, a general anesthetic was administered and the cavity curetted and closed following Blake's blood-clot method.

## BIBLIOGRAPHY.

1. BACON: "The Streptococcus Mucosus Capsulatus as a Cause of Mastoid Diseases." *Boston Medical and Surgical Journal*, Vol. CLXXV, No. 17.
2. WHIPING: "A Consideration of the Latent Stage and of the Period of Reinfection in Mastoiditis Due to Streptococcus Mucosus Capsulatus." *Surgery, Gynecology and Obstetrics*, Page 506, Vol. 30, No. 5.
3. HAMMOND: "Observations of the Healing Processes Following Mastoiditis." *Annals of Otolaryngology, Rhinology and Laryngology*, Page 586, Vol. XXIX, No. 3.
4. BROWN: "Cultural Differentiation of Beta Hemolytic Streptococci of Human and Bovine Origin." *Journal of Experimental Medicine*, Page 35, Vol. 31, 1920.
5. AVERY AND CULLEN: "Use of Final Hydrogen Concentration in Differentiation of Streptococcus Hemolyticus of Human and Bovine Types." *Journal of Experimental Medicine*, Page 215, Vol. 29, 1919.
6. AVERY, DOCHEZ AND LANCEFIELD: "Bacteriology of Streptococcus Hemolyticus." *Annals of Otolaryngology, Rhinology and Laryngology*, Page 350, Vol. 28, No. 2.
7. NICHOLS: "The Bacteriology of Throat Carriers of Streptococcus Hemolyticus." *Annals of Otolaryngology, Rhinology and Laryngology*, Page 344, Vol. 28, 1919.
8. BLAKE: "The Relation of Streptococcus Hemolyticus Carriers to Streptococcus Epidemics in the Army." *Annals of Otolaryngology, Rhinology and Laryngology*, Page 361, Vol. 28, No. 2.
9. KAHN: "Germ Life—The Mastoid Bone as a Living Medium." *THE LARYNGOSCOPE*, Page 434, Vol. XXX, No. 7.
10. MUECKE AND GRANTHAM-HILL: "Symptomless Influenzal (Streptococcal) Mastoiditis." *The Lancet*, Page 241, Vol. II, 1920.
11. MELENKY, H. E.: "Thrombosis of the Superior Petrosal Sinus and Meningitis Following Acute Mastoiditis." *THE LARYNGOSCOPE*, page 763, Vol. XXXII, No. 10.
12. STROOPS: "Mortality from Mastoiditis in U. S. A. Base Hospital at Camp Pike, Ark." *Annals of Otolaryngology, Rhinology and Laryngology*, Page 697, Vol. 29.
13. SMITH: "The Streptococcus Mucosus Capsulatus in the Mastoid." *Medical Record*, Page 18, Vol. 95, No. 1.