A SEPTIC SORE THROAT EPIDEMIC IN CORTLAND AND HOMER, N.Y.*

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I. HISTORICAL.

Since 1875 outbreaks of sore throat have been reported in England. A number of large epidemics have been officially investigated there, in all of which the symptoms of the disease have been characteristic and the relationship to the milk supply either suspected or confirmed.

Swithinbank and Newman[1] state that "in all probability these outbreaks are comparatively common, but, as the condition is not notifiable, it is seldom that a record is obtained of the cases occurring. We think it is safe to assume that a year never goes by in which there are not outbreaks of sore throat or tonsillitis due to milk or cream. The usual symptoms are congestion of the tonsils and mucous membrane of the throat, with sometimes ulceration, enlargement of the cervical glands, and some pyrexia and general malaise." The authors suggest some relation between scarlet fever and this disease, but believe they are not identical. They tabulate 9 typical outbreaks. Among these they mention an outbreak at Dover in 1884, affecting 205 persons, all of whom obtained milk from one dairy farm. The chief symptoms were local inflammations of the throat and enlargement of the lymphatic glands of the neck. In 1890 they mention an outbreak at Craigmore affecting 80 persons. As secondary to the sore throat, a number of cases of erysipelas developed. The incubation of the disease was 3 or 4 days. They record an outbreak in April and May, 1900, at North Hackney, which included 151 cases, 138 of which were supplied with milk from one dairy. The symptoms included tonsillitis, swelling of the cervical lymphatic glands, rise of temperature—in some cases to 105° F.—and great prostration. Secondary to the sore throat, in 1 case septicemia developed, followed by pneumonia and death; in 2 cases, acute nephritis. The authors state that there was a marked tendency for multiple cases to occur in families. Another outbreak mentioned by these authors occurred at Bedford, in June, 1902, including 42 cases. In every case milk was obtained from the same dairy. The health officer reporting this outbreak states: "I think that every case of septic sore throat should be notifiable. The difficulties of tracing an outbreak like this to its origin in the dairy can only be successfully carried out by a sanitary expert with the aid of a skilled bacteriologist." He also states: "Milk which was boiled did not produce the disease, but cream, which could not be boiled, produced the disease." In many of these sore-throat outbreaks the investigators found dairy cows suffering from mastitis, and they reported this inflammation of the udder as the probable cause. The bacteria most commonly found in the throats and udders were streptococci.

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[1] *Bacteriology of Milk*, New York, 1903, p. 352.

In the United States this disease has attracted much attention in the last 3 years owing to 3 extensive outbreaks.

The first of these, reported by Winslow,[1] occurred in Boston, Massachusetts, in the winter of 1910–11. The total number of cases collected was 1,043. The epidemic lasted over a period of about 2 weeks in Boston, Brookline, and Cambridge. About 70 per cent of the cases were supplied by one dairy. In the statistics reporting these outbreaks Winslow concludes that the milk from this dairy was the means of transmission of the disease, but that it was infected by human beings and not by dairy cows. Altho there were no acute cases among dairy employees the author states: "A carrier case presumably infected the milk."

In December, 1911, and January, 1912, an extensive outbreak occurred in Chicago. In the report by Capps and Miller[2] the authors estimate that over 10,000 persons were victims of the outbreak, the majority of whom were taking milk from the same dairy. They state that an epidemic of mastitis occurred among the cows supplying milk to this dairy during the winter months. Dr. D. J. Davis,[3] of Chicago, reports, concerning the examinations of the milk, that they found a streptococcus identical in morphology, in culture, and in pathogenicity with a culture obtained from a human case of tonsillitis and arthritis. E. C. Rosenow[4] reports further studies of this streptococcus and other streptococci from milk. The author is not positive in his conclusions, however, for he states: "The fact that milk so modifies streptococci is an additional indication of the important part it may play in epidemic sore throat. It is not possible to determine whether the streptococci in such epidemics are of exclusively bovine or human origin; they may be both. Milk drawn in a sterile way from normal cows may contain virulent streptococci and pneumococci; hence, "certified milk," while surely less contaminated than ordinary milk, may contain pathogenic bacteria, and the advisability of pasteurization even in this case should be considered, especially during the season when sore throat is common."

In Baltimore an epidemic occurred in 1912 during the months of February and March. This was reported by several authors, the most extensive report being made by Frost and Stokes and Hachtel.[5] A total of 602 cases was reported, the majority of which occurred from February 1 to March 20, 1912. The symptoms included sudden onset with chill, irregular fever, inflammation of tonsils, enlargement of cervical glands, and unusual prostration. Of these cases 65 per cent were supplied with milk from one dairy. This dairy supplied only 3.3 per cent of the milk sold in Baltimore. There were 28 deaths following the sore-throat attacks due to secondary infection, which included 13 cases of peritonitis, 7 cases of septicemia, 1 case of appendicitis, 2 cases of erysipelas, and 4 cases of pneumonia. The milk was pasteurized by the flash method. The author states: "Either the pathogenic germs were introduced into the milk by some infected person who had had to handle the milk, or were derived from the udders of some of the cows which produced it." The latter is believed to be the more probable hypothesis, altho no evidence could be obtained of the epidemic among the cows, and the veterinary examination of the cows through March and April failed to discover any cows with mastitis.

[1] *Jour. Infect. Dis.*, 1912, 10, p. 73.
[2] *Jour. Am. Med. Assn.*, 1912, 58, p. 1111; *ibid.*, p. 1848.
[3] *Ibid.*, p. 1852.
[4] *Jour. Infect. Dis.*, 1912, 11, p. 338.
[5] *Pub. Health Report 47, U.S. Public Health Service*, 1912, 27, p. 1889.

Stokes and Hachtel recovered pneumococci from the milk, showing that the flash system of pasteurization was inefficient. In the raw milk shipped to Dairy 1, they isolated a streptococcus of the epidemicus type. Several gargety cows were found among the dairy herd. The authors state: "We feel reasonably sure that the infection was caused by streptococci of the epidemicus type from cases of mastitis among the herds supplying this dairy."

In February, 1912, there was a sudden increase in the acute infections noted in Boston, almost a year later than the great Baltimore outbreak previously described. In this outbreak, which was investigated and reported by Coues,[1] 227 cases were reported. Forty-eight and five-tenths per cent were found to be taking milk from one dairy. Examination of the employees in the plant of this dairy showed that 16 men had remarkably reddened throats. A visit to the dairy farm from which the milk was obtained showed 10 farm hands with reddened throats. The milk was not pasteurized. The author concludes: "The occurrence of so many cases of milk pharyngitis . . . . in dairymen . . . . and the presence of streptococci in so many of their throats is of great interest. . . . . It seems fair to state from clinical examination of 77 cases that there is a condition which might be termed dairymen's or milk handlers' pharyngitis, incident to the long hours of constant work on wet floors often covered with ice and milk. . . . . It would seem as if direct, or nearly direct, hand contact with the milk is impossible to avoid in some stage of the preparation."

From a survey of the outbreaks outlined above it is obvious that, with the exception of those reported from Boston, there is a tendency on the part of all observers to conclude that the source of infection in septic sore throat is to be found in the inflamed udder of the dairy cow and is due to the streptococcus which is discharged from the inflamed udder into the milk, through which it is transferred to the throats of milk consumers, but that such conclusions are based on circumstantial evidence and that positive and direct evidence is lacking.

II. CORTLAND-HOMER OUTBREAK.

During the months of February and March, and the first three weeks of April, 1913, while there were a few scattered cases of sore throat among the inhabitants of the city of Cortland and the village of Homer, New York, no unusual conditions were noted. In the last week of April, however, the physicians in both these communities were alarmed by the sudden increase in the number of their patients complaining of sore throat. Within 3 days the cases multiplied rapidly into a widespread epidemic of sore throat. The disease manifested itself by redness and swelling—a raw beefsteak appearance—of the fauces, a rise in temperature,

[1] *Am. Jour. Pub. Health*, 1912, 2, p. 419.

enlargement of the lymphatic glands of the neck, and, in some cases, great prostration.

The city of Cortland has a population of 12,000 and the village of Homer, a population of 2,700. They are 2 miles distant from each other. As soon as the outbreak was recognized, a special meeting of the Cortland County Medical Society was called and a committee appointed to study the epidemic. The health officers of Cortland and Homer also began an official investigation of the outbreaks in these communities. By the first week in May there were several hundred persons in these two communities who were suffering from the disease, altho only a few cases had been officially reported to those studying the outbreak. The milk supply of one dairy soon fell under suspicion, and Doctor Ball, the health officer, took prompt action by making an inspection of the dairy, isolating from the main herd two cows showing physical signs of udder inflammation, and ordering that their milk be no longer used. This milk dealer was ordered to suspend the delivery of all milk from his dairy until the completion of the investigation, and a supply of pasteurized milk was secured for him from a large pasteurizing station located in the neighborhood.

On May 7, an offer made by Doctor North to act as a special investigator was accepted by the committee of the Cortland County Medical Society and by the health officers of the two communities. Every facility was furnished by the local physicians and health officers for a complete study.

At a special meeting of the Boards of Health of Cortland and of Homer, regulations were passed declaring septic sore throat to be a contagious disease, reportable and quarantinable, and statements were published in the local papers urging citizens to avoid contact with those suffering from the contagion.

1. ORGANIZATION OF INVESTIGATION.

The investigation was greatly facilitated by the ready co-operation which was secured from the following bodies:

1. Public Health Committee of the Cortland County Medical Society.
2. Boards of Health of Cortland and Homer.
3. New York Milk Committee.
4. Hoagland Laboratory, Brooklyn.
5. DeLaval Separator Company.
6. New York Dairy Demonstration Company.

Through these agencies it was possible to organize thoroughly all branches of the investigation at once, and to carry on several parallel lines of work at the same time. The work fell into the following divisions:

a) *Reporting of cases.*—Printed blanks were prepared having spaces for residence, name, age, sex, type of disease, date of onset, date of first visit, number of adults in the family, number of children, milk dealer, and remarks. These blanks were distributed to all of the physicians in Cortland and Homer, and they were asked to record in this regular manner all of the cases occurring in their practice, and to report same promptly to the director of the investigation. Twenty-seven physicians in the city of Cortland and 5 in the village of Homer made reports in the manner indicated.

b) *Detailed investigation of cases.*—Two statisticians were furnished by the New York Milk Committee who made a house to house canvass both in Cortland and Homer, calling on physicians and patients to check up and confirm details regarding each report in order that the same might be complete.

c) *Cultures taken.*—Doctors Benjamin White and Oswald T. Avery at the Hoagland Laboratory in Brooklyn made bacteriological examinations of cultures, taken from sore throats and from the sore udders of dairy cows.

d) *Dairy inspections.*—Early in the investigation, it became evident that a much larger number of cases were the patrons of one milk dealer than his proportion of the milk trade would warrant. Inspection was made of his own dairy and of another dairy from which he occasionally purchased a small quantity of milk. Physical examinations were made of dairy cows by the local veterinarian.

e) *Sediment tests of cows' milk.*—A new form of centrifuge called the Clarifier was furnished by the DeLaval Separator Company, with an expert operator, and proved of the highest value in the examination of cows' milk for inflammatory products. The apparatus was installed in the dairy barn of the dairyman under suspicion, and the milk of each dairy cow was examined by this means. From those cows in which the presence of inflammatory products was obvious, cultures were sent to the laboratory for bacteriological examination.

f) *Pasteurization of milk.*—The New York Dairy Demonstration Company in Homer consented to carry out the washing and sterilizing of all milk utensils of the suspected dairyman and furnish him with pasteurized milk for his retail trade during the progress of the investigation. All of his own milk supply was taken out of the market and disposed of for manufacturing purposes.

g) *Inquiries in other towns.*—To determine whether the outbreak was strictly local in character or not, inquiries were carried out in nearby towns and villages.

h) *Tabulation of results.*—As fast as the detailed reports of cases were completed, the results were tabulated at the central office by the director of the investigation, the entire local work occupying a period of about one week.

2. CASES REPORTED.

The cases reported by the physicians of Cortland and by the physicians of Homer were tabulated. Because of the obviously large percentage of cases occurring among the customers of one

dairy, which will be called Dairy X, the number of cases occurring among the patrons of this dairy were separated from those occurring among the patrons of all other dairies. Since the outbreak occurred simultaneously in the communities of Cortland and Homer, and in both of these a considerable number of cases was found among

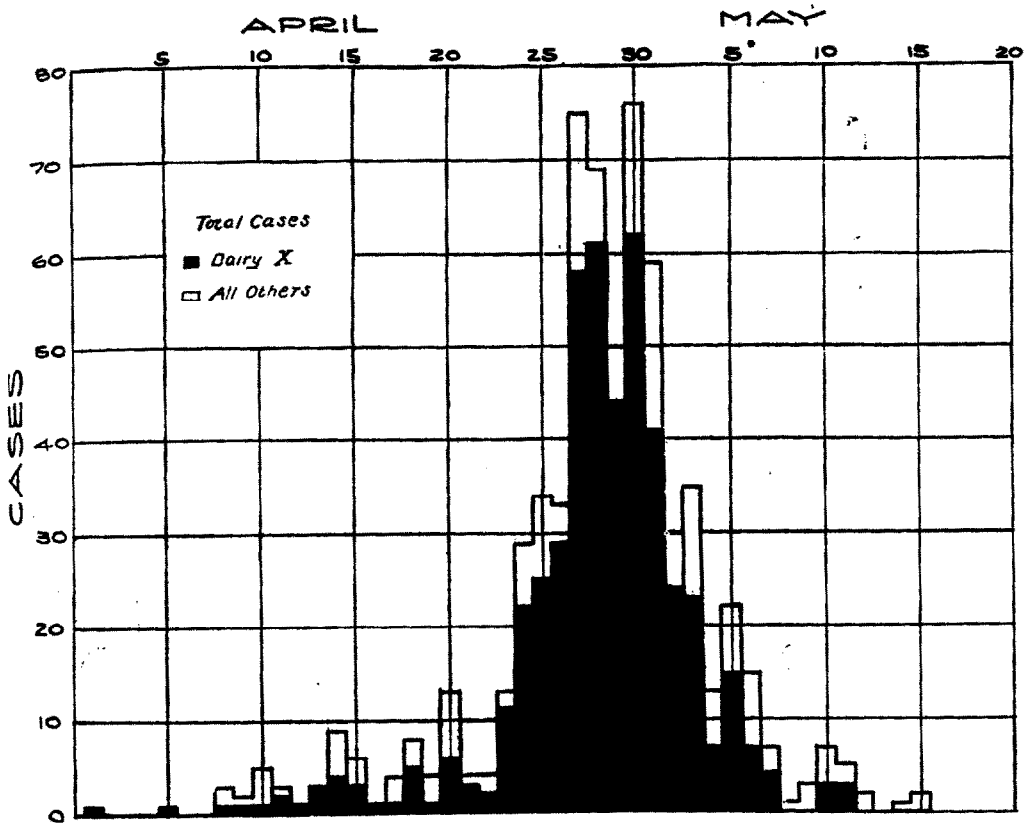

CHART 1.

the patrons of Dairy X, the figures for both Cortland and Homer are combined in Table 1, in order to secure a comprehensive idea of the entire outbreak.

The rise and fall of the cases in Cortland and Homer and of the cases found among the patrons of Dairy X is shown graphically in Chart 1. From this chart it appears that the epidemic

TABLE 1.

Date	Total Cases	Dairy X	Other Dairies	Date	Total Cases	Dairy X	Other Dairies
April				April			
1	1	1	0	21	4	3	1
2				22	4	2	2
3				23	13	11	2
4				24	29	22	7
5	1	1		25	34	25	9
6				26	33	29	4
7				27	75	58	17
8	3	1	2	28	69	61	8
9	2	1	1	29	50	44	6
10	5	1	4	30	76	62	14
11	3	2	1	May			
12	2	1	1	1	59	41	18
13	3	3	0	2	30	24	6
14	9	4	5	3	35	23	12
15	6	3	3	4	13	7	6
16	1	1	0	5	22	15	7
17	4	1	3	6	15	7	8
18	8	5	3	7	7	4	3
19	4	1	3	8	1	0	1
20	13	6	7	9	3	0	3

extended over a period of about 20 days, beginning April 20 and ending May 10, and that its crest was reached about April 30.

The figures given show the number of persons living in houses to which the milk of Dairy X was delivered. All of these persons were not milk drinkers. The proportion of cases found in householders receiving milk from Dairy X was so great that it was thought to be unnecessary to make a detailed inquiry as to those persons who did or did not drink milk. For the same reason a tabulation of the number of persons who lived in the houses to which milk was delivered who did not become victims of the disease was not undertaken. The facts shown in Table 1, and their relation to the milk supply of Dairy X, are summarized in Table 2.

TABLE 2.

	Cortland	Homer	Totals
Population	12,000	2,700	14,700
Total cases	483	186	669
Dairy X	360	120	480
Other dairies	123	66	189
Milk dealers	14	5	19
Milk supply	4,200 qts.	700 qts.	4,900 qts.
Dairy X supply	300 "	50 "	350 "

From these summaries it appears that about 72 per cent of the cases were found among the patrons of Dairy X, while, on the other hand, Dairy X was delivering less than 7 per cent of the total milk

supply. This means, in short, that there were 10 times as many cases of septic sore throat among the patrons of Dairy X as that dairy would be entitled to, had the cases been evenly distributed among all milk dealers.

TABLE 3.

AGE DISTRIBUTION OF CASES.

Ages	Cortland	Homer	Ages	Cortland	Homer
0–5	41	8	30–40	93	31
5–10	42	10	40–50	61	24
10–20	76	29	50–60	36	19
20–30	91	24	60+	37	42

The age distribution of the cases is shown in Table 3. The occurrence of a larger number of cases between the ages of 20 and 40 than at other times of life corresponds to conditions found in other similar outbreaks.

Sex distribution was also recorded, showing that in Cortland there were 215 males and 268 females suffering from the disease. In Homer 71 males and 115 females were afflicted.

3. DEATHS.

There were 14 deaths in all reported by the local physicians as resulting from this epidemic. In each case death was due to complications. The date, age, and complication causing death have been separately tabulated in Table 4.

TABLE 4.

DEATHS.

Date	Age	Cause of Death
	CORTLAND	
May 3	50	Edema of larynx
" 4	51	Heart failure
" 5	69	Lobar pneumonia
" 11	39	Peritonitis
June 14	71	Erysipelas
	HOMER	
May 3	66	Peritonitis
" 3	60	"
" 4	62	"
" 5	70	Erysipelas
" 6	82	"
" 7	80	Pneumonia
" 8	72	Heart disease
" 11	78	Erysipelas
" 25	.....	Peritonitis

Of the 14 deaths, 5 were due to peritonitis, 4 to erysipelas, 2 to pneumonia, 2 to heart failure, and 1 to edema of the larynx.

In addition to the complications shown in the list of deaths, the physicians have reported that a considerable number of persons contracted rheumatism which manifested itself chiefly in the joints. In some cases the rheumatic symptoms were severe. There were also several cases of erysipelas, in addition to those resulting in death. Pleurisy and pericarditis have also been mentioned by some physicians as complications.

Inquiries were made in the communities located nearest to Cortland and Homer. These were the small villages of Preble, Scott, and McGraw, having populations of from 400 to 1,000, and located from 3 to 5 miles distant. The health officers of each of these villages stated that there were no cases of septic sore throat occurring in those places during the period of this outbreak. It is of further interest to note that no milk was supplied to these villages by Dairy X.

4. DAIRY INSPECTION.

Before the investigation was fully organized the health officer of Cortland, with a local veterinarian, had made physical examinations of the dairy cows in the herd of Dairy X and another dairy herd from which the proprietor of Dairy X occasionally purchased milk. As a result of this examination, Doctor Ball ordered two of the cows in the herd of Dairy X, showing external physical signs of inflammation, to be separated from the rest of the herd. Inspections of these two herds were again made and physical examinations of the dairy cows were duplicated by the local veterinarian, with the same result as in former examinations.

In the case of the other dairy, duplicate examinations failed to reveal any animals with udder inflammation. As later facts showed that the two cows having inflamed udders in the herd of Dairy X were undoubtedly responsible for the epidemic of septic sore throat, to the prompt action taken by Doctor Ball, the health officer of Cortland, must be credited the rapid decline in the number of new cases of sore throat which immediately followed.

For the first time in the history of the investigation of individual cows for the existence of udder inflammation, a new form of apparatus, the DeLaval milk clarifier, was used. The herd of Dairy X numbered 28 cows. The milk at the night's milking of all animals was examined by means of this apparatus. The machine was cleansed and sterilized between each operation by taking the apparatus entirely apart and washing and brushing all parts with a strong soda solution, after which they were rinsed in clean water. They were then plunged into a 1 per cent solution of chlorid of

FIG. 1.

lime, and afterward thoroughly rinsed in boiling water. This procedure was followed between the examination of each cow's milk. Two men were thus able to secure the sediment from the milk of about 9 cows at one milking, and it required three afternoons to secure sediment from every member of the herd.

In Fig. 1 are shown typical results of these examinations. The glass bottles are 2 ounces in capacity. The first 3 show the quantity of sediment obtained from the milk of 3 dairy cows which were apparently normal. The quantity of milk produced by these animals at the night's milking varied from 6 to 8 quarts each. The

last 2 bottles contain the sediment obtained by the clarifier from the milk of the 2 animals in which udder inflammation was suspected. In one case, the quantity of milk produced was 1 quart, and in the other, 1.5 quarts. The difference in the quantity of sediment secured from their milk as compared with sediment found in the milk of normal animals is too obvious to require comment.

In these examinations, the use of the clarifier made it possible to eliminate the existence of udder inflammation from other members of the dairy herd, and to confirm most emphatically the existence of udder inflammation in the 2 dairy cows under suspicion. The quantitative results alone furnished sufficient evidence for these purposes. There were, however, qualitative differences in the slime which were even more interesting, as shown by microscopic examinations.

5. MICROSCOPICAL EXAMINATIONS.

Smears were made on glass slides of all samples of slime as soon as they were obtained. Experience in examining milk sediments has shown that considerable change takes place in appearance, particularly of the tissue cells and bacteria, if sediments are kept for any length of time before examinations. The multiplication of bacteria alone is enormous. Degeneration of leukocytes and tissue cells is also very rapid. The best results are obtained, therefore, by making smears from samples which are as fresh as possible. In all of the sediments examined from this herd, there was shown, microscopically, no evidence of inflammatory conditions excepting in the cases of the 2 dairy cows already mentioned. The microscopical appearance of sediment from normal cows is shown in Fig. 2.

Here we observe a large number of cells, the majority of which are apparently of the same character. Many of these have multiple nuclei. It might be inferred that the cells were leukocytes or possibly pus cells. The more one studies sediments from milk the more must one hesitate, however, to call cells having multiple nuclei pus cells or even leukocytes. The cells shown in Fig. 2 are probably tissue cells, being epithelial cells shed in the normal process of lactation from the walls of the milk glands.

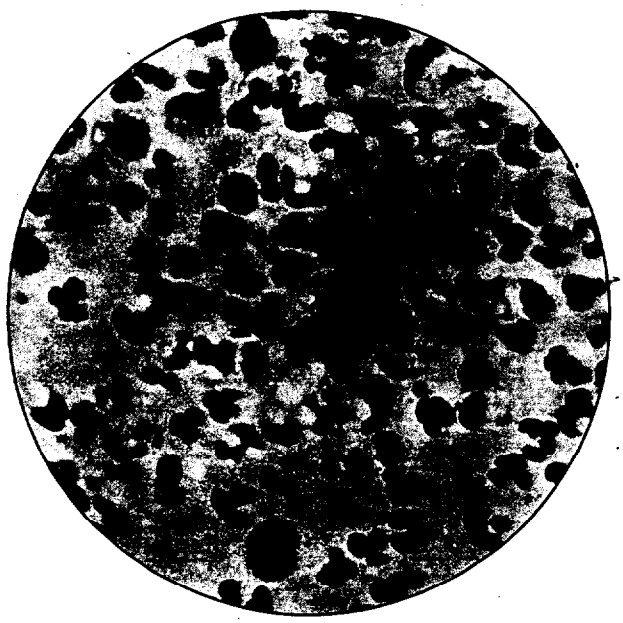

FIG. 2.

FIG. 3.

The microscopic appearance of the slime from the milk of the 2 cows having inflamed udders shows a marked difference in appearance. Fig. 3 shows a considerable variety of cells; of even greater interest are the large numbers of bacteria and the marked phagocytosis. No one would hesitate to say that cells must be pus cells which have multiple nuclei and are engaged in collecting such large numbers of bacteria within their bodies. The discharge from the udder into milk of streptococci, bacilli, and of phagocyting white blood corpuscles, and their appearance in milk sediment, must be accepted as evidence of the existence of udder inflammation. This condition was shown plainly in every smear which was made from the slime obtained from these inflamed udders.

6. BACTERIOLOGY.

A. ORGANISMS ISOLATED IN PREVIOUS EPIDEMICS.

The bacteriological examination of cultures from throat exudates in a number of patients and from the milk slime of gargety cows was undertaken with three objects in view: (1) to determine, if possible, whether any particular organism was common to all the cases; (2) to ascertain if any organism was common both to the throat exudates and to the slime; and (3) to study and identify any organisms found which were believed to be of significance.

As a result of studies in previous epidemics it is now generally held that the streptococcus is the chief etiological factor in septic sore throat. Further, the predominance of organisms of the streptococcus type in the inflamed udders of garget cows has drawn attention not only to the possible significance of this organism, but has suggested the probable original source of the human infection. In addition to this primary infection of the milk, another possibility presents itself in the chance of an accidental introduction into the milk of pathogenic organisms from individuals suffering from streptococcic infection and handling the milk.

In the Finchley epidemic in 1904 the streptococcus was first isolated from the throats of the affected patients, while *Str. pyogenes* was first detected in the suspected milk by Pierce[1] in the Guildford outbreak in 1903. Since that time, in the majority of outbreaks,

[1] *Brit. Med. Jour.*, 1903, 2, p. 1492.

the streptococcus has been isolated either from the throats of patients or from the milk supplied to the homes where infections developed.

The more careful studies of the latest outbreaks seem to strengthen the probability that the specific organism is a streptococcus resembling in many respects, but in others differing from, the pyogenes type. On account of its variations it has been classified separately as *Str. epidemicus*. The salient characteristics of *Str. epidemicus*, as described by Davis, Hamburger,[1] and Stokes and Hachtel, are as follows:

The organism is gram-positive and usually occurs in pairs existing separately or in short or longer chains. When freshly isolated, the pairs show a capsule, differing from the capsule of the pneumococcus in that it is not indented between the individuals in the pairs. It is frequently described as a halo and is rapidly lost on cultivation, but reappears after animal passage. On blood agar, according to Davis,[2] the colonies are larger and more moist than those of *Str. pyogenes*, but they do not have the mucoid appearance of *Str. mucosus*. The colonies are surrounded by a distinct zone of hemolysis, generally, but not always, narrower than the zone produced by *Str. pyogenes*, and exhibiting a faint greenish tint by transmitted light. *Str. epidemicus* is only partially dissolved by bile, and it acidifies milk with frequent but not constant coagulation. Dextrose, lactose, saccharose, and dextrin are fermented with acid production but no gas, while raffinose, mannite, and inulin are not attacked. Broth is uniformly clouded. Davis states that the organism is highly virulent for mice, rabbits, and guinea-pigs. Stokes and Hachtel confirm its pathogenicity for mice. The organisms isolated during the Chicago and Baltimore epidemics correspond to the above description.

B. NATURE AND COLLECTION OF SPECIMENS (PRESENT EPIDEMIC).

The exudate from the throats of 13 patients and the pus from a suppurating cervical gland were removed with a sterile swab and planted on Löffler's medium. The tubes were incubated and shipped immediately to the Hoagland Laboratory. The milk slime, obtained from the 2 suspected cows in Dairy X by means of the clarifier, was drawn into sterile bottles and immediately forwarded. All material was examined upon its receipt.

C. PROCEDURE OF EXAMINING MATERIAL.

The outlined procedure was followed with all material: The swabs were rubbed over the surface of the culture, then shaken in a tube of serum broth which was incubated over night at 37.5° C. This broth culture was then plated on rabbits' blood agar by the Conradi method, and the plates incubated. Colonies were fished and those yielding suspicious diplococci or streptococci were isolated on blood agar, nutrose agar, and in ascitic broth. The milk slime was planted in serum broth and then plated and subcultured as above.

[1] *Jour. Am. Med. Assn.*, 1912, 58, p. 1109; also, *Bull. 263, Johns Hopkins Hosp.*, 1913, 24, p. 1.

[2] *Jour. Am. Med. Assn.*, 1912, 58, p. 773.

TABLE 5.

CULTURE	ORIGIN	CHAIN FORMATION	COLONIES ON BLOOD AGAR			GROWTH IN BROTH	SOLUBILITY IN BILE	HEMOLYSIS	LITMUS MILK	CARBOHYDRATES†					PATHOGENICITY	
			Size	Color	Hemolytic Zone					Dextrose	Lactose	Saccharose	Salicin	Raffinose		
CI/2'.....	Throat	Short	Medium	Green	Meth.* brown	Uniform turbidity	—	Meth. brown	+	+	+	+	+	+	Rabbit, suppurative arthritis	Group A
CII/2'....	"	Medium	"	"	" "	Uniform turbidity	—	" "	+	+	+	+	+	+		
CIV/1....	"	Short	Large	"	" "	Uniform turbidity	—	" "	d	+	+	+	+	+	Rabbit died, 7 days	
J.....	"	.....	Small	"	" "	Uniform turbidity	—	" "	+	+	+	+	+	+		
CIII/1....	"	Medium	"	"	" "	Uniform turbidity	—	" "	d	+	+	+	—	+		Group B
CV/1.....	"	Short	"	"	No Color	Uniform turbidity	—	" "	+	+	+	+	—	+		
CV/3.....	"	"	Medium	"	Meth. brown	Granular sediment	—	" "	+	+	+	+	—	+	" " 28 "	
CVI/1....	"	Long	Large	"	" "	Ropy sediment	—	" "	+	+	+	+	—	+	" " 8 "	
CVIII/2 ..	"	Medium	Small	Faint green	" "	Uniform turbidity	—	" "	+	+	+	+	—	+		
CIV/1....	"	"	Medium	Faint green	No color	Uniform turbidity	—	No Color	+	+	+	+	+	—		Group C
CV/3.....	"	Long	Small	Faint green	" "	Granular sediment	—	" "	d	+	+	+	+	—		
CVI/2.....	"	Short	Medium	Green	" "	Uniform turbidity	—	" "	+	+	+	+	+	—		
CVII/1 ...	"	Long	"	Faint green	Meth. brown	Granular sediment	—	Meth. brown	+	+	+	+	+	—	" " 2 "	
K.....	"	Medium	"	Green	Hemolysis	Ropy sediment	—	Hemolysis	+	+	+	+	+	—		
CVII/1/x .	Cervical gland	Long	"	Faint green	Meth. brown	Granular sediment	—	Meth. brown	+	+	+	+	+	—		

* Methemoglobin brown.

† There was no action in mannite, inulin, and dulcite.

TABLE 5.—*Continued.*

CV/2.....	Throat	Long	Large	Green	Meth.	brown	Ropy sediment	—	Meth.	brown	x	x	x	x	—	—		Group D
CVIII/1...	"	"	Medium	"	"	"	Ropy sediment	—	"	"	a	x	x	x	—	—	Rabbit died, 7 days	
CIX/2....	"	Medium	Small	"	"	"	Uniform turbidity	—	"	"	x	x	x	x	—	—		
23.....	Milk slime	Long	Medium	"	"	"	Ropy sediment	—	"	"	x	x	x	x	—	—	Rabbit, suppurative arthritis	
24.....	Milk slime	"	"	"	"	"	Ropy sediment	—	"	"	x	x	x	x	—	—	Rabbit died, 8 days	
K-2.....	Throat	"	.....	"	"	"	Ropy sediment	—	"	"	x	x	x	x	—	—		
M128/1...	Milk	.....	.....	"	"	"	.....	—	"	"	x	x	x	x	—	—	Not pathogenic for mice	Group E
S128/4....	Milk slime	.....	.....	"	"	"	.....	—	"	"	x	x	x	x	—	—	Not pathogenic for mice	
M152/4...	Milk	.....	.....	"	"	"	.....	—	"	"	x	x	x	x	—	—	Not pathogenic for mice	
S152/4....	Milk slime	.....	.....	"	"	"	.....	—	"	"	x	x	x	x	—	—	Not pathogenic for mice	
S187/3....	Milk slime	.....	.....	"	"	"	.....	—	"	"	x	x	x	x	—	—	Not pathogenic for mice	
S189/1....	Milk slime	.....	.....	"	"	"	.....	—	"	"	x	x	x	x	—	—	Not pathogenic for mice	
S189/4....	Milk slime	.....	.....	"	"	"	.....	—	"	"	a	x	x	x	—	—		

Litmus milk: *x*=acid coagulation, *a* =acid production but no coagulation.
Carbohydrate reactions: *x*=acid coagulation, —=no action.

1. *Morphology.*—Observations were made on young cultures in ascitic broth. Both the Hiss and the Rosenow capsule stains were used.

2. *Hemolysis.*—One-half cubic centimeter of an 18-hour ascitic broth culture was added to 1 c.c. of a 5 per cent suspension of washed sheep and human erythrocytes, respectively. Readings were taken at the end of 2 hours' incubation, and over night at room temperature. This method is considered by the authors as yielding more definite evidence of hemolytic action than that obtained by observing the colonies on blood agar.

3. *Solubility in bile.*—One cubic centimeter of a 24-hour broth culture was mixed with 0.2 c.c. of sterile ox-bile. Readings were taken after 30 minutes and 2 hours at 37.5° C.

4. *Carbohydrates and milk.*—The carbohydrates were Kahlbaum preparations and were employed in the form of Hiss serum waters. Decreamed litmus milk and the carbohydrate media were inoculated with approximately 0.1 c.c. of an 18-hour ascitic broth culture. Viability of the cultures used for inoculation was tested each time by planting on nutrose agar. Readings were taken during 7 days' incubation.

5. *Pathogenicity.*—One cubic centimeter of an 18-hour ascitic broth culture was injected into the ear veins of rabbits weighing approximately 500 grams.

D. RESULTS.

Table 5 shows the general morphological, cultural, and biochemical characters of the organisms isolated.

The colonies of all the strains of streptococci isolated on rabbits' blood agar showed a greenish tint by transmitted light. They varied in size from pin points to aggregations somewhat larger than the usual *Str. pyogenes* colonies. The mucoid appearance produced by *Str. mucosus* was never observed. The growth in broth varied with the presence or absence of enriching ingredients, and experience showed the advisability of disregarding this feature as a point of differentiation. From careful observation of the form of the cocci when grown in ascitic broth, it would be difficult to distinguish any reliable diagnostic differences. The occurrence of the cocci in pairs was frequent, and usually these pairs were linked together in short and sometimes moderately long chains. The use of the Hiss and the Rosenow stains failed to reveal a true capsule. When freshly isolated from the body, particularly on the direct smears made from the blood or pus of the infected rabbits, a distinct encircling zone could be seen about the paired or chained cocci, but its appearance would scarcely warrant its being designated as a true capsule. None of the organisms in the series was appreciably dissolved by ox bile, and only one—and that from a cervical gland—

produced any hemolysis when added to a suspension of washed sheep or human erythrocytes.

The various streptococci isolated appear to form general groups when classified according to their carbohydrate reactions. Altho any classification of streptococci according to carbohydrate fermentation is acknowledged to be incomplete and unsatisfactory, yet, lacking more valuable methods, the following grouping is tentatively offered. All the strains acidified dextrose, lactose, and saccharose, all acidified litmus milk, but none fermented inulin, mannite, or dulcite; hence their behavior toward raffinose and salicin is taken as a basis for the grouping.

Group A.—Salicin and raffinose fermented. All produced the methemoglobin darkening when added to erythrocyte suspension, but none gave a true hemolysis. All strains appeared as diplococci in short or medium chains. One of the strains, "CI/1," produced a suppurative arthritis in a rabbit, and from the lesion the organism was recovered and proved to be identical with the strain inoculated. Strain "CIV/1" killed a rabbit in 7 days.

Group B.—Raffinose fermented but not salicin. All except one produced methemoglobin, but no true hemolysis. The morphology was the same as in Group A. Two rabbits injected with two of the strains died in 8 and 28 days, respectively, of coccidiosis with no sign of streptococcic infection. In connection with this group there may be noted the observation of Stokes and Hachtel that their strains of *Str. epidemicus* developed the ability to attack raffinose on cultivation.

Group C.—Salicin fermented but not raffinose. There were no significant morphological features. Three strains produced no change in the erythrocyte suspensions, 2 gave the methemoglobin reaction, while 1 strain, "K," produced true hemolysis. It is interesting to note that this strain was obtained from a suppurating cervical gland, and was the only one in the whole series producing hemolysis. From the throat of this case, 3 strains were isolated, one, "K-2," falling in Group D, while the others, "K-3" and "K-4," differed from all the other strains examined in their ability to attack mannite. Strain "CVII/1" killed a rabbit in 2 days. The

organism was recovered from the heart's blood and corresponded in all respects to the original strain.

Group D.—Neither salicin nor raffinose fermented. All produce methemoglobin but no hemolysis. All the organisms isolated from the milk slime from the infected cows fall into this group. These strains agree with the description of *Str. epidemicus* as given by Davis, and Stokes and Hachtel, with the single exception that, altho the colonies on blood agar had a greenish tint, none of these strains produced true hemolysis when added to red blood corpuscle suspensions. The members of Group C, like those of D, fail to attack raffinose, but do attack salicin. Inasmuch as other authors make no mention of the behavior of *Str. epidemicus* toward salicin, it is impossible to draw sharp and complete comparisons.

In connection with the present series of cultures, there attaches a pertinent significance to some observations, made by the authors earlier in the year, on cultures of streptococci obtained from milk slime. At the time, a preliminary attempt was made to ascertain the nature of the predominating organism in milk and milk slime from several cows suffering from infected udders. The whole milk and the milk slime obtained by the clarifier was examined by the procedure already described. Cows No. 128 and 152 had frank cases of garget, Cow 187 had a slight infection of one quarter, while Cow 189 was supposed to be a normal animal, altho the quantity and nature of the slime obtained from the milk of this cow strongly suggested the presence of inflammation. The organisms isolated from these 4 cows are included in Group E. It may be pointed out that, in the case of the 2 severely infected animals, suspicious streptococci were found in both the milk and the slime, while, in the case of the other 2 animals, these streptococci were present only in the slime. The great similarity between the reactions of the members of Group E and those of Group D is strikingly suggestive.

SUMMARY.

1. Two epidemics of septic sore throat occurred simultaneously in May, 1913, in Cortland and Homer, New York, the two communities being 3 miles apart.

2. Over 70 per cent of the cases in each community occurred among the patrons of a dairyman who was the only dairyman selling milk in both places, and who supplied less than 7 per cent of the total milk supply. Adjacent towns had no cases and, further, they received no milk from the suspected dairy.

3. Physical examination of the cows and microscopical examination of milk sediments showed the existence of acute udder inflammation in 2 cows in the herd of the suspected dairyman.

4. Bacteriological examination showed that cultures from the throats of 4 patients contained streptococci apparently identical with strains of streptococci obtained from the milk slime from the 2 cows suffering from garget. Cultures from the throats of 8 other patients contained streptococci of this same type but differing, by slight variations only, in their carbohydrate fermentations.

5. The streptococci isolated from the milk slime from the 2 garget cows and the throats of 4 patients in the present epidemic correspond in all respects to strains of streptococci isolated previously from 3 cows of another herd known to be suffering from garget, and from the milk slime from 1 cow supposed to be normal, but which gave an abnormal amount of slime.