

# Milk-borne Outbreaks Due to Serologically Typed Hemolytic Streptococci\*

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IN the twenty-five year period, 1917-1941, a total of 168 outbreaks of milk-borne disease have been investigated by the New York State Department of Health. A milk-borne outbreak is defined as one demonstrated to have been transmitted by a common milk

the use of raw milk except two of typhoid fever, one of bacillary dysentery, and one of scarlet fever. The typhoid fever and bacillary dysentery outbreaks were due to pasteurized milk contaminated after processing, and the scarlet fever outbreak resulted from milk

TABLE 1  
*Milk-borne Outbreaks, New York State  
(Exclusive of New York City)  
1917-1941*

Disease	Outbreaks		Cases	
	Number	Per cent of Total	Number	Per cent of Total
Typhoid and Paratyphoid Fever	76	45.2	1,209	12.1
Septic Sore Throat and Scarlet Fever	57	34.0	6,812	68.2
"Gastroenteritis"	24	14.3	1,423	14.2
Bacillary Dysentery	5	3.0	411	4.1
Diphtheria	5	3.0	123	1.2
Poliomyelitis	1	0.6	11	0.1
Total	168	100.0	9,989	100.0

supply and to have affected persons residing in more than one household. Ten thousand residents of the state, exclusive of New York City, were affected in these epidemics, the smallest involving 3 persons and the largest an estimated 1,100 individuals.

All the 168 outbreaks were traced to

labeled "pasteurized" although evidence indicated that it had not been properly processed.

Table 1 presents the distribution of outbreaks according to the type of milk-borne disease and the number of cases resulting. Although typhoid fever and paratyphoid fever have caused the largest number of outbreaks, 45.2 per cent of the total, only 12.1 per cent of the cases have been due to these diseases. Septic sore throat and scarlet fever outbreaks, comprising 34.0 per cent of those studied, contributed 68.2

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TABLE 2

*Reported Milk-borne Outbreaks Due to Serologically Typed Hemolytic Streptococci*

<i>Year Reported</i>	<i>Place</i>	<i>Number of Cases</i>	<i>Griffith Type</i>
1936	Chelmsford, England <sup>4</sup>	1,600	2
1937	Doncaster, England <sup>5</sup>	364	2
1938	Mørkøv, Denmark <sup>6</sup>	100	Not typable
1939	Pinneberg, Germany <sup>7</sup>	450	5
1939	Vegle, Denmark <sup>8</sup>	128	3
1939	Romford, England <sup>9</sup>	18	2

See Bibliography

per cent of all cases. It is apparent, therefore, that these hemolytic streptococcus infections present the most important public health problem in the upstate New York area in terms of cases of illness resulting from outbreaks of milk-borne disease. Furthermore, very few milk-borne outbreaks of typhoid fever have occurred in recent years, so that hemolytic streptococcus outbreaks have assumed even greater relative importance.

In recent years, the Lancefield classification of hemolytic streptococci<sup>1</sup> has been utilized extensively in the search for the source of milk-borne outbreaks of scarlet fever and septic sore throat. By this means, beta hemolytic streptococci falling into Group A, the group including approximately 95 per cent of strains pathogenic for man, may be distinguished from those belonging to other groups. The value of this serological procedure is emphasized by the findings of Sherman and Niven<sup>2</sup> who have reported that beta hemolytic streptococci may be recovered from as high as 8.5 per cent of samples of commercial pasteurized milk, and 18.0 per cent of similar samples of raw milk. The prevailing strains isolated by these authors from pasteurized milk proved to be Group D and from raw milk Groups B and C.

The differentiation by Griffith<sup>3</sup> of the various hemolytic streptococci pathogenic for man into 30 or more serologically specific types has not only provided a more exact means of identi-

fication of the source of milk-borne outbreaks but also has permitted further study of the epidemiological characteristics of the different strains of these organisms. Since the introduction of this procedure, at least six reports of its use in conjunction with the investigation of apparently milk-borne outbreaks have been published and are summarized in Table 2.

All of these epidemics have been reported in the foreign literature. It is of interest to note that three of the six were attributed to Griffith Type 2 strains.

For a number of years, the Division of Laboratories and Research of the New York State Department of Health has undertaken the collection and preservation of strains of hemolytic streptococci recovered during the course of the epidemiological investigation of milk-borne outbreaks. This procedure permitted Stebbins to identify retrospectively by Griffith typing the specific strains of hemolytic streptococci encountered in certain earlier investigations.<sup>10</sup> Since July, 1940, an attempt has been made to conduct this phase of the study immediately following the recovery of the presumptive causative organism. A tabular presentation of the studied epidemics is given in Table 3.

Griffith's Type 3 hemolytic streptococcus has been identified more frequently than any other single type, being encountered in three of the nine outbreaks investigated.

Each of the outbreaks enumerated

TABLE 3  
*Milk-borne Outbreaks Due to Serologically Typed Hemolytic Streptococci*  
*New York State, Exclusive of New York City*

Date	Place	Disease	No. of Cases	Griffith Type	Mode of Contamination of Milk
March, 1935	Baldwinsville, Onondaga Co.	Septic sore throat	500	27	Infection of cow's udder
Jan., 1936	Wellsville, Allegany Co.	Scarlet fever	201	3	" " " "
Dec., 1936	Owego, Tioga Co.	Scarlet fever	532	15-17 *	" " " "
July, 1940	Waddington, St. Lawrence Co.	Septic sore throat	48	19 †	Direct infection of milk (?)
Sept., 1940	Kirkwood town, Broome Co.	Scarlet fever	6	not typable	Infection of cow's udder
Jan., 1941	Pultney, Steuben Co.	Scarlet fever	33	3	" " " "
Nov., 1941	Huntington Sta., Suffolk Co.	Septic sore throat	116	11-12 *	" " " "
April, 1942	Cannonsville, Delaware Co.	Scarlet fever	44	3	" " " "
April, 1942	Coxsackie, Greene Co.	Septic sore throat	200	2	" " " "

\* Cross-typing

† Typing inconclusive but strongest agglutination with type 19 antiserum

provides interesting data relative to the epidemiological characteristics of milk-borne epidemics due to serologically typed hemolytic streptococci. The present report, however, will be limited to various phases of one of the more recent smaller outbreaks; namely, that which occurred in Cannonsville, Delaware County.

#### CANNONSVILLE OUTBREAK

During April, 1942, a small milk-borne outbreak of hemolytic streptococcus throat infections occurred in this relatively isolated rural community of approximately 275 inhabitants. It thus provided a unique opportunity to investigate the distribution of hemolytic streptococci among the general population. Moreover, the incriminated milk was found to have been secured from a large cheese plant handling milk from 356 producers, making the determination of the actual source of infection a distinct challenge.

Records of illness were obtained by house-to-house survey for 28 of 197 persons interviewed in Cannonsville and

for 16 of 42 individuals in the surrounding area. Thus the outbreak involved 44, or 18 per cent, of the 239 persons included in the study group. Seventy-seven per cent of the cases occurred in persons 15 years of age or over, and 61 per cent among males.

All of the cases occurred during the 3 week interval between April 5 and April 25. The dates of onset are shown graphically in Figure 1.

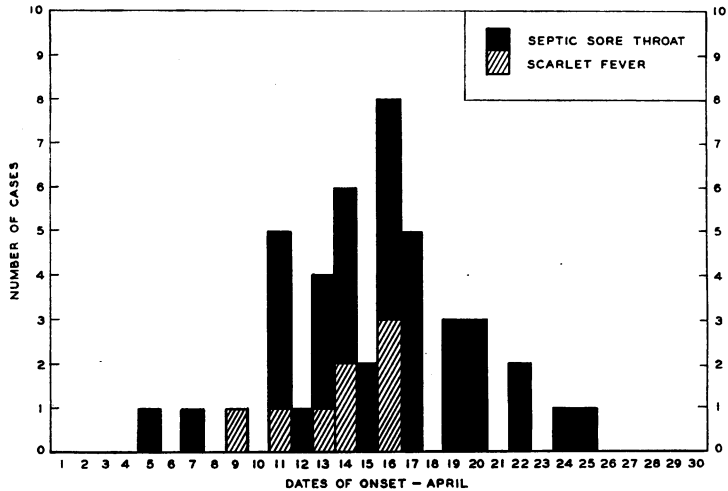
Thirty-seven of the 44 persons affected had first symptoms between April 11 and April 20, the peak daily incidence of 8 cases occurring on April 16.

#### CLINICAL CHARACTERISTICS

Illness was characterized by sudden onset of sore throat, fever (up to 103° F.), headache, cervical lymphadenopathy, and generalized arthralgia and myalgia. No deaths occurred among the 44 cases. In 8 instances, scarlatinal rashes were observed and, since the causative organism thus demonstrated its ability to elaborate erythrogenic toxin, this observation again indicates how illogical it is to distinguish between

FIGURE 1

DATES OF ONSET OF 44 CASES OF HEMOLYTIC STREPTOCOCCUS THROAT INFECTIONS  
CANNONSVILLE, DELAWARE COUNTY  
APRIL, 1942



cases of septic sore throat and scarlet fever.

A striking characteristic of the outbreak was that of the joint manifestations experienced by 16 patients, or more than one-third of those ill. In some instances, only transient involvement of one or two joints with pain and limitation of motion was noted but in others severe polyarthritides was experienced with swelling, redness, and tenderness about the joints. In this category, 4 cases of migratory joint involvement clinically suggestive of active rheumatic fever were observed and the persons so affected experienced an asymptomatic period of 1 to 2 weeks between throat symptoms and these joint manifestations. One of the persons affected had previously experienced an acute attack of rheumatic fever.

Throat cultures were secured from 35 of the 44 cases either at the time of, or shortly after, the acute episodes of sore throat. Twenty-three of these yielded hemolytic streptococci, 17 of which were identified serologically as Lancefield Group A, 2 Group B, 3 Group D, and

1 could not be classified. Fifteen of the 17 Group A strains were established as belonging to Griffith's Type 3, thus indicating this organism to be the epidemic strain; the 2 remaining Group A strains proved refractory to typing.

#### INCRIMINATION OF MILK SUPPLY

At the outset of the investigation, it was apparent that the cases occurring in the outbreak were particularly concentrated among workers in the Q cheese plant. This plant, employing 30 workers, constituted the sole large commercial establishment in the area and, with the exception of dairy farming, constituted the principal source of livelihood of the residents of the community.

Milk used in Cannonsville was found to be almost exclusively unpasteurized. Many families obtained milk from their own cows, a few purchased small quantities from three small dealers in the community, and the remainder of those using fluid milk secured their supply from the Q cheese plant. The majority of workers consumed milk while at work and were permitted to take milk

in their own containers for use at home. In addition, a few families residing in the immediate vicinity obtained their supply there although no members were actually employed in the plant. Table 4

SEARCH FOR SOURCE OF INFECTION

At the time of the investigation, the bulk of the milk was being utilized in the production of cheddar type cheese. Of the approximately 123,000 lbs. of

TABLE 4  
*Attack Rates among Consumers and Non-consumers of Milk from the Q Cheese Plant According to Association with Plant*  
*Outbreak of Hemolytic Streptococcus Throat Infections*  
*Cannonsville, Delaware County, April, 1942*

Association with Cheese Plant	Consumers Q Plant Milk		Non-consumers Q Plant Milk		Total		Attack Rate Per cent		
	No.	Cases	No.	Cases	No.	Cases	Consumers Q Plant Milk	Non-consumers Q Plant Milk	Total
Plant workers	25	15	5	2	30	17	60.0	40.0	56.7
Persons living in households of plant workers	39	14	34	2	73	16	35.9	5.9	21.9
Others	19	9	117	2	136	11	47.4	1.7	8.1
Total	83	38	156	6	239	44	45.8	3.8	18.4

presents the attack rates experienced by consumers and non-consumers of milk from the Q plant according to the type of their association with this establishment.

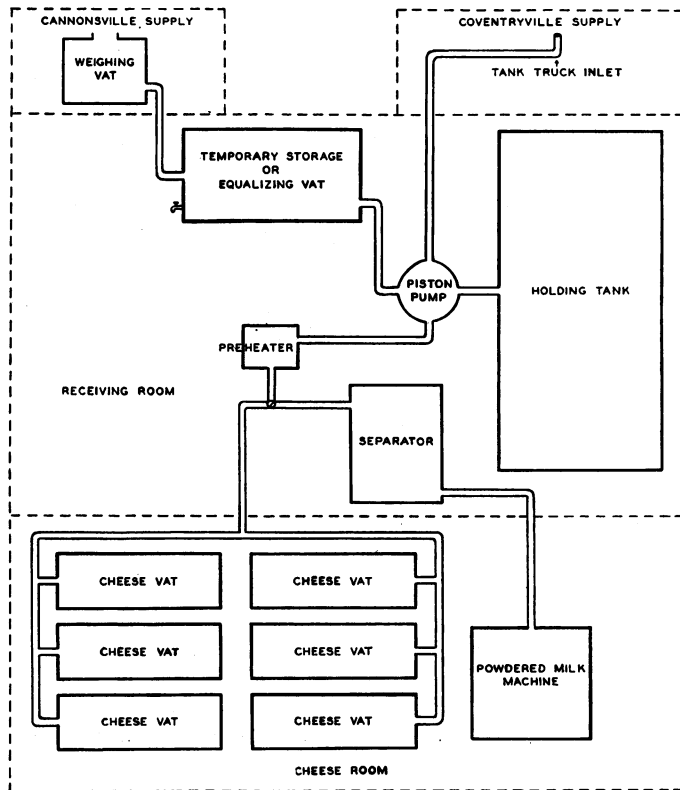
Regardless of consumption of milk from the plant, the workers experienced the highest frequency of illness, 56.7 per cent being affected. Almost 22 per cent of the household contacts of these workers also were ill but those in this group consuming milk from the plant experienced symptoms approximately six times more frequently than those denying use of this milk. Only 2 individuals, or 1.7 per cent, of those having no contact with the plant and denying use of milk from this source were ill. These 2 patients had onset late in the course of the outbreak, one on April 20, and the other on April 26, and it is believed represent either secondary cases or coincidental, sporadic, sore throats unassociated with the outbreak. The 9 cases occurring among users of the milk in households in which no member was employed at the plant afford further confirmation of the hypothesis that infection was transmitted by the milk.

milk handled daily in the plant, 48,000 were received from local dairymen in 40 qt. cans and 75,000 were brought to the plant by tank truck from a receiving station in Coventryville, some thirty-five miles distant. The local product was poured into the weighing vat and flowed by gravity to a temporary storage or equalizing vat (Figure 2). The bulk of this was usually used immediately by pumping through a preheater to a separator or to the cheese-making vats.

The Coventryville supply was pumped directly from the tank trucks to the holding tank and from there to the preheater and separator or to the cheese vats.

The employees drinking milk at the plant did so in the cheese room. A common dipper was used and the milk was taken either from a pipe coming from the storage tanks or directly from the cheese vats. Milk to be used outside the plant was obtained from an outlet from the temporary storage vat in the receiving part of the plant. Since the use of this milk was known to have resulted in illness and it came from that part of the plant where contamination

FIGURE 2  
SCHEMATIC DIAGRAM  
Q CHEESE PLANT  
CANNONSVILLE, DELAWARE COUNTY



from a human source was least likely to occur, the source of infection of the milk appeared to exist prior to receipt of the milk at the plant. Moreover, since the Coventryville tank truck supply only rarely was introduced into the temporary storage vat, suspicion was directed chiefly toward the local supply reaching the plant in 40 qt. cans.

The 123,000 lbs. of milk brought to the plant daily were supplied by 356 producers and represented the output of 6,069 cows. Although the epidemiological evidence suggested that the source of infection of the milk probably existed on one of the 116 farms contributing to the supply brought directly to Cannonsville, a systematic examination was made of each of the 2,029 cans

of milk received at both of the depots. A Breed smear examination was made of samples of each of these cans. On the basis of the presence of chained streptococci or excessive numbers of leucocytes (an estimated 500,000 or more leucocytes per ml.), 73 of the 356 herds were selected for further study. Each of these 73 producing farms was subsequently visited and, in addition to careful examination of each cow in these herds, information was obtained with respect to history of teat injury among the cows, or illness or superficial infections among residents of the farm. Whenever histories of teat injury were obtained or evidence of bovine mastitis was discovered, samples of milk were taken for bacteriological examination.

A total of 150 such quarter samples of milk from cows in 55 herds were examined and from 17, or 11.3 per cent, beta hemolytic streptococci were isolated. Each of these strains was identified serologically: one was found to be Lancefield Group A, 8 Group B, and a similar number Group C. The Group A organism was further identified as Griffith Type 3, identical with the strain previously demonstrated as the cause of the outbreak.

The milk containing the Type 3 hemolytic streptococci came from a cow on a farm sending its milk directly to Cannonsville. The cow had had its right hind teat stepped on and crushed some time in late February or early March, approximately 6 weeks prior to the beginning of the outbreak. The resultant injury had been treated by the son of the owner of this particular farm, and a teat dilator and milk tube had been used repeatedly in an effort to maintain this animal in the milking line. At the time of the veterinary examination on April 23, a severe, acute mastitis was found to involve the affected quarter.

Nineteen other cows in the herd were found to be normal, and 1 proved to be suffering from a benign mastitis due to an organism other than beta hemolytic streptococcus.

Histories of recent illness were obtained from 3 of 7 members of this household including the boy who had cared for the cow's injured udder. The first person affected was the mother, who experienced a severe attack of so-called "grippe" in late March. Shortly thereafter the 14 year old daughter developed scarlet fever. The son next developed a severe sore throat with fever and swollen glands in the neck. He was sufficiently ill to spend several days in bed and to consult a physician. The dates of onset in the mother and daughter definitely preceded the outbreak. It seemed impossible to ascertain definitely the date of onset in the boy,

but he sought medical care about April 18, and he had been suffering for some time before that. It appears likely, therefore, that his onset also antedated the outbreak, and in view of his caring for the incriminated cow he seems the most probable source of the cow's infection.

Repeated throat cultures were taken from this boy's throat, and were consistently negative for hemolytic streptococci; however, the first culture was taken approximately 2 weeks after cessation of his acute symptoms. Group A beta hemolytic streptococci were isolated from the throats of both of the other persons on the farm who were ill, and upon typing were found to be Type 3.

#### THROAT CULTURE SURVEYS

We were curious as to the prevalence of the Type 3 hemolytic streptococcus in the community, and as to the extent to which it might be disseminated subsequently through the population. Accordingly, at the time of, and again at approximately 1 and 2 months after the outbreak, throat cultures were obtained from a large sample of the population. Persons cultured included workers in the Q plant, non-employees who consumed milk from this source, and individuals having no contact of any sort with the plant. The bacteriological findings of these surveys are presented in Table 5, and shown graphically in Figure 3.

In the first survey, at the time of the outbreak, 30 of the cases occurring among consumers of milk from the Q plant were cultured and 15, or 50 per cent, were positive for the Type 3 hemolytic streptococcus. Of 33 additional consumers of Q milk who did not become ill, 2, or 6.1 per cent, were found to be carriers of a Type 3 organism, whereas none of the 104 members of the general population who denied the use of Q milk were found to

TABLE 5  
*Results of Throat Culture Surveys*  
*Outbreak of Hemolytic Streptococcus Throat Infections*  
*Cannonsville, Delaware County, April, 1942*

	First Survey (April 20-21)					
	Drank Q Milk			Did Not Drink Q Milk		
	Cases	Not Cases	Total	Cases	Not Cases	Total
Number Cultured	30	33	63	5	99	104
Number Positive						
Hemolytic Streptococci	22	13	35	1	26	27
Group A	17	2	19	.....	6	6
Type 3	15	2	17	.....	.....	.....
Other than Group A	5	11	16	1	20	21
Per cent Positive						
Hemolytic Streptococci	73.3	39.4	55.6	20.0	26.3	26.0
Group A	56.7	6.1	30.2	.....	6.1	5.8
Type 3	50.0	6.1	27.0	.....	.....	.....
	Second Survey (May 19)					
	Drank Q Milk			Did Not Drink Q Milk		
	Cases	Not Cases	Total	Cases	Not Cases	Total
Number Cultured	21	32	53	6	91	97
Number Positive						
Hemolytic Streptococci	14	14	28	1	32	33
Group A	8	2	10	.....	7	7
Type 3	5	.....	5	.....	.....	.....
Other than Group A	6	12	18	1	25	26
Per cent Positive						
Hemolytic Streptococci	66.7	43.8	52.8	16.7	35.2	34.0
Group A	38.1	6.3	18.9	.....	7.7	7.2
Type 3	23.8	.....	9.4	.....	.....	.....
	Third Survey (June 30)					
	Drank Q Milk			Did Not Drink Q Milk		
	Cases	Not Cases	Total	Cases	Not Cases	Total
Number Cultured	12	27	39	5	89	94
Number Positive						
Hemolytic Streptococci	4	9	13	.....	27	27
Group A	1	1	2	.....	4	4
Type 3	.....	.....	.....	.....	.....	.....
Other than Group A	3	8	11	.....	23	23
Per cent Positive						
Hemolytic Streptococci	33.3	33.3	33.3	.....	30.3	28.7
Group A	8.3	3.7	5.1	.....	4.5	4.3
Type 3	.....	.....	.....	.....	.....	.....

harbor Type 3 streptococci. At the time of the second survey on May 19, the percentage of cases among Q milk consumers who still harbored the Type 3 organism had dropped to 23.8 per cent. None of the other consumers of Q milk were found to carry the Type 3 streptococcus, and again no Type 3 carrier was found among the general population denying use of Q milk. At the time of the third survey on June 30, no Type 3 streptococcus was encountered, and all three groups were essentially uniform as to the percentage of hemolytic streptococci isolated, and the

percentage of these in turn which were of Group A.

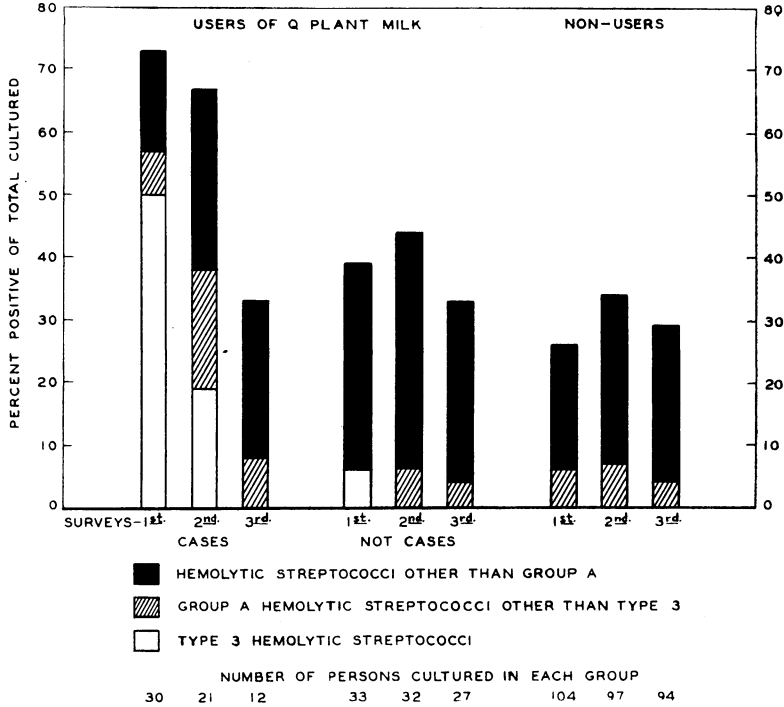
It is of interest that the frequency of nasopharyngeal carriers of all hemolytic streptococci and of Group A strains as well in the population unexposed to the Q milk remained relatively constant throughout the three surveys.

#### CONTROL MEASURES

As soon as preliminary evidence suggested that the milk used at or taken from the plant was the probable vehicle of infection (April 17), the distribution of this milk for drinking purposes was



FIGURE 3  
THROAT CULTURE SURVEYS  
HEMOLYTIC STREPTOCOCCUS THROAT INFECTIONS  
CANNONSVILLE, DELAWARE COUNTY



discontinued. On April 23, the cow ultimately incriminated was segregated and its milk discarded. On April 28, results of typing the hemolytic streptococcus isolated from samples of milk from this cow were available and indicated that it was the cow probably responsible for the outbreak. It was slaughtered on May 8. When udder tissue obtained at autopsy was submitted for bacteriological examination, Type 3 organisms were again recovered.

As previously stated, the principal product of the Q plant was cheddar type cheese and it was known that this cheese was being purchased by a large dealer for possible shipment to England. All cheese processed and stored in the plant between April 5, the date of last shipment, and April 22, when pasteurization of milk was begun, was embar-

goed. Samples were taken from cheese processed on each day during the interval and although large numbers of beta hemolytic streptococci were readily recovered from them, none of the many strains studied proved to be members of Lancefield's Group A. Because it was impossible, nevertheless, to state that strains of hemolytic streptococci pathogenic for man were not present in the cheese, it was treated by a process in which it was heated to a temperature of over 170° F. for several minutes, insuring destruction of any pathogenic microorganisms which might be present.

SUMMARY

An attempt has been made to determine the Griffith type of hemolytic streptococci isolated in nine milk-borne outbreaks of hemolytic streptococcus

throat infections in New York State from 1935 to 1942. A different type has been encountered in each outbreak with the exception of three outbreaks due to Type 3.

The epidemiological study of a recent outbreak of 44 cases of Type 3 hemolytic streptococcus throat infection occurring in a small rural community is described in detail. The infection was found to be transmitted by raw milk secured at a local cheese plant.

Although the cheese plant handled milk representing the output of 6,069 cows, it is believed that the cow responsible for the outbreak was located by means of Breed smear examination of cans of milk received at the plant, and subsequent veterinary and bacteriological follow-up of suspected herds.

On the involved farm it was found that prior to the outbreak there had been one case each of scarlet fever, sore throat, and so-called "grippe." The suspected cow had suffered a teat injury, followed by development of acute mastitis upon manipulation of the injured part by the person with the sore throat. Hemolytic streptococci obtained from the throats of people on the farm and from udder tissue secured from the cow at autopsy also were found to be Type 3.

Three throat culture surveys were made in the community, the first at the time of the outbreak, the second a month later, and the third approximately two months after the outbreak.

In the first survey, Type 3 hemolytic streptococci were found only in throats of consumers of milk from the incriminated cheese plant. The per cent infected with this type was less in the second survey, and in the third survey

no Type 3 hemolytic streptococcus was isolated.

To prevent any possibility of transmission of the infection through the cheese, that produced during the outbreak period was embargoed and released only after being reprocessed by a method involving heating the product above 170° F. for several minutes.

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