

A MILK-BORNE EPIDEMIC OF SEPTIC  
SORE THROAT IN PORTLAND,  
OREGON \*

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R. L. BENSON, M.D.

AND

H. J. SEARS, PH.D.

PORTLAND, ORE.

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The epidemic here reported, which includes 487 cases of septic sore throat, with twenty-two deaths, occurred almost exclusively among the customers of a single raw-milk dairy. All but one of the patients who died had drunk this milk. Prompt detection of the cause of the epidemic and equally prompt control of the milk supply by heating were made possible by complete cooperation between the clinicians, the city health bureau and the dairy management, and resulted in checking further extension of the epidemic within twenty-four hours after the suspicion of a milk-borne epidemic was first brought to the attention of the health bureau, March 27, 1922.

HISTORY OF THE OUTBREAK

A child, aged 2 years, died, March 25, 1922, with the clinical picture of sore throat and acute encephalitis. Other cases occurred in various parts of the west side of Portland on this day and the next two days, all evidently referable to the milk of a single dairy. Several cases appeared in a forty-bed hospital and many in a home for girls, but it was asserted that the latter institution obtained its milk from a different source—a certain pasteurizing dairy. The city health bureau authorized us to undertake an investigation, and on the morning of March 28, it was easily determined that the girls' home, the hospital referred to above and a predominance of the cases in homes owed their infection to a single raw-milk dairy. On our recommendation, the health bureau at once ordered heating of all

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\* From the departments of pathology and bacteriology, University of Oregon Medical School, and the City Health Bureau, Portland, Ore.

the milk of this dairy by whatever method would be feasible, and placed two employes of the bureau in charge of operations at the dairy. Within twenty-four hours after this plan was put in operation, the incidence of new cases of septic sore throat declined to such an extent that the very few which appeared could be ascribed to contact infection. A more detailed study of the epidemic brought out the facts which follow.

#### CONDITIONS AT THE DAIRY

We found fifty-one milking cows of various breeds, well housed in a wooden structure with concrete floors and with proper facilities for flushing floors and handling excreta. The system of cooling milk appeared efficient. We learned that cows having diseased udders were kept in their regular stalls along with healthy cows, and in some instances only the diseased quarter was excluded from the milking. This condition, together with the fact that milkers did not always handle the same shift of cows, but sometimes exchanged shifts, would make it possible for a milker to include milk which should be discarded. Except for the points mentioned, we found the sanitary conditions generally good, and the city milk inspection had always given this dairy one of the best ratings in the city as regarded bacterial count and general quality of the milk.

#### CULTURES OF MILK SAMPLES

Cultures of the whole milk of the herd were taken, March 28, and gave a very few hemolytic streptococcus colonies. At this time, however, the whole milk did not include the milk of cows which were known to have diseased udders.

More instructive are the results of culture of the individual milk of each cow, and it is best to consider some of these separately.

Cow 1 had a large abscess on one hind leg, but its milk had been included with that of the herd. Cultures revealed *Streptococcus viridans* in the abscess pus and no unusual flora in the milk; nevertheless, we excluded this animal from the herd.

Cow 51 had a consolidation of the left front quarter of the udder. The dairyman insisted that the milk of this animal had not been included in the whole milk for two weeks. Examination of the milks from separate quarters showed all of normal gross appearance

except that from the left front quarter, which sample appeared greyish and mucinous. On standing twenty-four hours this milk settled out differently from that of the other quarters (Fig. 1). The lower half of the milk column consisted of yellowish, creamy pus, containing numerous pus cells and many streptococci in chains. Cultures revealed 10,000,000 hemolytic streptococci per cubic centimeter in the milk from this quarter, a few in the left rear quarter, and none in the other two quarters. It will be shown farther on that this cow, whose milk gave a pure growth of



Fig. 1.—Milk samples from each quarter of Cow 51 after standing twenty-four hours. The arrow indicates the upper line of pus, which has settled out in the sample from the consolidated quarter.

hemolytic streptococcus of human origin, was the probable source of the epidemic, perhaps from being milked into the herd milk unknown to the operator of the dairy. We learned afterward that this cow, which had a markedly increased temperature, had been kept in the same row of stalls as other cows which were furnishing milk. We shot her, April 9, and performed necropsy. The only noteworthy change was an almost complete purulent consolidation of the left front quarter of the udder, and slight infiltration in the left hind quarter (Fig. 2).

Cow 21 had had no increase of temperature reported, and had been milked in with the herd previous to the onset of the epidemic. Culture of her milk gave an abundant growth of hemolytic streptococci, which, as shown below, was of the bovine type. It was considered advisable to kill this cow also. Necropsy showed a purulent infiltration of the udder (Fig. 3).

The milk samples from four other cows yielded hemolytic streptococci in small numbers. A comparative study of the hemolytic streptococcus cultures isolated from these six cows is given in Table 1.



Fig. 2.—Udder of Cow 51, left front quarter, which yielded hemolytic streptococcus of human type: *M*, massive consolidation. (Reduced to one-fourth natural size from drawing.)

About three weeks after the whole herd was examined, eight cows which either had diseased udders or had gone dry in one or more quarters were examined, but no hemolytic streptococci were found.

From the data of Table 1 it will be seen that the culture from the diseased quarter of Cow 51 is the only culture isolated from the entire herd which seems to resemble in essential qualities the organism found in the human cases of septic sore throat. All other cow strains differ markedly from the human strains in cul-

tural characteristics and, following the method of Avery and Cullen,<sup>1</sup> their high limiting H ion concentrations in glucose broth identify them definitely as of bovine origin. Culture 51 L F from Cow 51 is, on the other hand, in this respect a human strain. The virulence of this culture for rabbits and white mice was also similar in every way to that of the human strain.

#### CULTURES FROM THE DAIRY EMPLOYEES

The one hemolytic streptococcus culture isolated from the dairy employees was from the throat of a



Fig. 3.—Portion of udder of Cow 21, which yielded hemolytic streptococcus of bovine type: *M*, consolidated area, very similar to that in Cow 51. (Reduced to one-fourth natural size.)

milker who had large, red, inflamed tonsils, and who had complained of a mild sore throat. This culture could not be distinguished in any way from those isolated from the patients with sore throat and from the diseased quarter of Cow 51. It had a  $p_H$  value of 5.3, and a serum prepared against it definitely agglutinated strain 51 L F, though, on account of a propensity

1. Avery, O. T., and Cullen, G. E.: J. Exper. Med. 29: 215 (Feb.) 1919.

to spontaneous agglutination which could not be overcome, this serum could not be shown to agglutinate its own specific strain.

#### CULTURES FROM THE DAIRY EMPLOYEES

The hemolytic streptococcus isolated from patients was similar in all respects to the organism commonly described as the incitant of this disease. On horse blood agar plates, well isolated colonies were from 0.5 to 1 mm. in diameter, were of a whitish, watery appearance, and were surrounded by a perfectly transparent zone of hemolysis having a diameter from two to four times that of the colony. The characteristics of the colony placed the organism definitely in the beta group of Smith and Brown.<sup>2</sup> Growth in infusion broth was generally of the flaky type, and accumulated on the sides and bottom of the tube, leaving the medium quite clear. All cultures fermented lactose, salicin and maltose, and failed to attack mannite and inulin. The majority of cultures were incapable of attacking saccharose, but there were a few exceptions. Litmus milk was acidified slowly, as a rule, and was not coagulated in any case in seven days. No tendency to a reduction of the litmus was observed in any milk culture. The limiting H ion concentration in glucose broth fell within the limits of  $p_H$  5.4 and  $p_H$  5.2.

The virulence of the cultures for rabbits was low, several animals failing to die from intravenous injections of as high as 1 c.c. of a twenty-four hour broth culture. Frequently the organisms could be isolated from the blood of the animal after several days, but would subsequently disappear from the blood stream, and necropsy would reveal either kidney and liver abscesses, or joint infections or both. White mice regularly succumbed to intraperitoneal injections in about two days, with a generalized bacteremia.

#### CONCLUSIONS FROM EXAMINATION OF VARIOUS CULTURES

It has been stated that all hemolytic streptococcus cultures from the throats of patients with septic sore throat in this epidemic had (in glucose broth) a limiting H ion concentration between the limits of  $p_H$  5.4 and  $p_H$  5.2. Of the various samples of cow's milk examined,

2. Smith and Brown: J. M. Res. 31:455, 1915.

only one, that from the left front quarter of Cow 51, gave a hemolytic streptococcus culture whose limiting H ion concentration fell within the same limits; viz.,  $p_H$  5.2. The  $p_H$  for all other milk samples, including even that from the left hind quarter of Cow 51, fell within the limits of from 4.5 to 4.3, indicating a bovine origin for the organisms. We have shown that one milker had a tonsillitis of marked degree, which yielded a hemolytic streptococcus having a  $p_H$  value of 5.3, and agreeing in all respects with cultures from patients with sore throat and from the left front quarter of Cow 51. The presumption, therefore, is that the milker in question was responsible for the infection of this cow's udder; that she developed a mastitis of human streptococcal origin in one quarter, and that her milk, which was proved to contain 10 million hemolytic streptococci

TABLE 1.—Comparison of Six Hemolytic Streptococcus Cultures from Cows

Culture	Lac-tose	Man-nite	Sali-cin	Mal-tose	Saccha-rose	Litmus Milk*	$p_H$
51 L F †	+	—	+	+	—	A	5.2
51 L H	+	—	+	+	+	ACR	4.3
21	+	—	+	+	+	ACR	4.5
3	+	+	+	+	+	ACR	4.5
17‡	+	+	+				
23‡	+	+	+				

\* A, acid; C, coagulation; R, reduction of litmus.

† L F and L H refer to the left front and left hind quarters, respectively.

‡ These cultures were lost; therefore the data in regard to them are incomplete.

per cubic centimeter, was at some time included by mistake in the whole milk of the herd. Such a massed infection of the dairy milk supply accounts logically for the sudden outbreak of a highly virulent epidemic like the one here described. By a comparison of the dates at which several patients in a hospital drank the milk, it was concluded that the herd milk must have become infected on one particular day, March 22, or perhaps on two successive days. This agrees well with the time of onset of the majority of cases, as gathered by the survey of the dairy route.

#### STATISTICS OF THE EPIDEMIC

In order to obtain as thorough and accurate information as possible concerning the extent and character of the epidemic, one of us made a complete canvass of

the dairy route in the company of the regular driver of the milk wagon. The accompanying map (Fig. 4) gives an idea of the distribution of the customers, and hence of the cases.

The dairy supplied 300 families, including 1,200 individuals; one hospital containing thirty-five patients and thirty-four attendants and help, a total of sixty-

TABLE 2.—Deaths from Septic Sore Throat

Case	Sex*	Age, Years	Date of Death	Date of Onset	Contributing Causes of Death
1	♂	2	3/25/22	3/24/22	Acute encephalitis
2	♂	1	3/27/22	3/25/22	Peritonitis
3	♂	86	3/29/22	3/24/22	Myocarditis
4	♂	66	3/30/22	3/24/22	Myocarditis; double pneumonia
5†	♂	59	3/30/22	3/26/22	Cardiorenal disease; decompensation
6	♂	79	3/31/22	3/24/22	Erysipelas
7	♂	8	3/31/22	3/25/22	Septicemia
8	♂	18 mo.	3/31/22	3/25/22	Peritonitis; septicaemia
9	♂	11 mo.	3/31/22	3/25/22	Peritonitis; erysipelas; slight; bronchopneumonia; encephalitis; septicaemia
10†	♂	34	3/31/22	3/24/22	Hemolytic streptococcus septicaemia; laryngitis
11	♂	10 mo.	4/ 1/22	3/25/22	Peritonitis; septicaemia
12	♂	8	4/ 1/22	3/26/22	Tonsillitis; appendicitis
13	♂	52	4/ 1/22	.....	Septic myocarditis; septile cholecystitis
14	♂	27	4/ 2/22	3/27/22	Myocarditis
15†	♂	66	4/ 2/22	.....	Encephalitis; septicaemia; endocarditis
16	♀	40	4/ 5/22	.....	Erysipelas
17	♀	35	4/ 5/22	3/27/22	Pleurisy; erysipelas; pneumonia
18	♂	2	4/ 8/22	3/24/22	Peritonitis
19	♂	72	4/ 8/22	.....	Septicaemia; multiple arthritis; bronchopneumonia
20†	♂	47	4/12/22	3/29/22	Central pneumonia
21	♂	1	4/12/22	3/26/22	Pneumonia; erysipelas
22	♂	52	4/24/22	3/26/22	Streptococcus septicaemia; toxic goiter; erysipelas; goiter heart; acute nephritis

\* In this column, ♂ indicates male; ♀ female.

† Necropsy.

‡ This is the only septic sore throat death in a nonuser of milk from the dairy mentioned in this report.

nine; a girls' home containing 104 adults, and a small grocery depot which kept no milk book, but which supplied an indefinite small number of customers. At least 1,400 persons were using the milk and cream.

The total number of cases of septic sore throat arising on this milk route during the week from March 24 to March 31 is computed at 487. Of these, 166 were severe, i. e., either had serious complications or



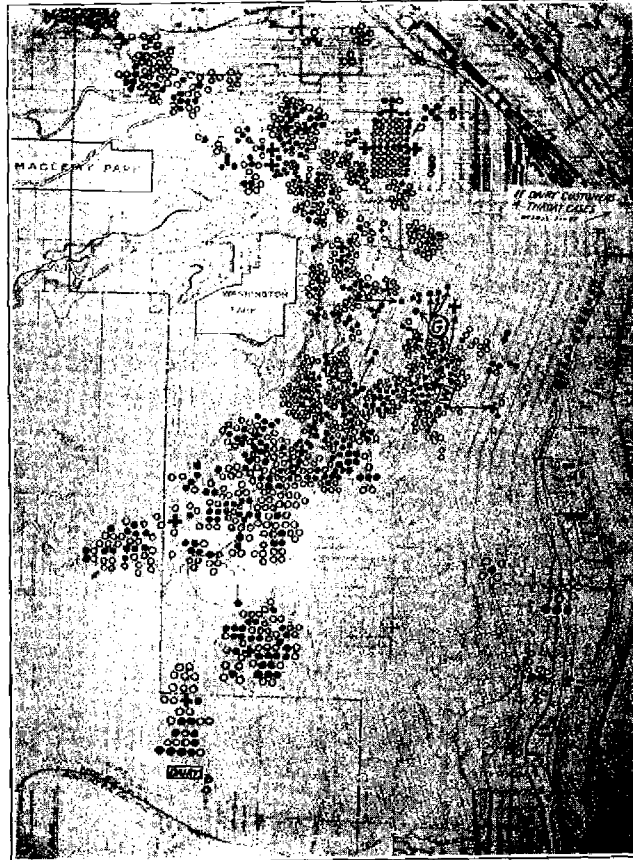


Fig. 4.—Map of west side of Portland, showing results of survey of dairy route: Rings designate unaffected users of milk in question; solid circles, users of milk acquiring septic sore throat; crosses, deaths among users; arrows indicate infection by drinking this milk obtained through another person; *P*, cases in hospital; *W*, girls' home (104 users, not indicated by dots); *G*, grocery store and milk depot, giving rise to at least four cases.

gave trouble from protracted sepsis; 321 were listed as moderate or mild cases. Twenty-three cases, with three deaths, occurred among sixty-nine users of the milk in the hospital; forty-five cases, without fatalities, among 104 users in the girls' home. The remainder of the cases were in private homes. Four known cases arose among those who obtained this milk through the small grocery agency. Several persons who were not customers of the dairy became infected by drinking the milk in the homes of regular customers, and two deaths are included in this category.

There were twenty-two deaths in the epidemic, twenty-one of these among users of milk from the dairy in question. This gives a mortality rate of  $4\frac{1}{3}$  per cent. of those affected. Three of the fatalities were in patients who were already ill in the hospital with some preexisting condition when the epidemic started. Several others were in senile individuals. Table 2 gives the main facts concerning deaths in this series.

Necropsies were performed in three of the fatal cases, and the anatomic diagnoses were as follows:

CASE 5.—Acute pharyngitis, laryngitis, and cervical lymphadenitis; acute tracheitis and bronchitis, with early confluent bronchopneumonia of right lung; moderate bilateral pleural effusion; serofibrinous peritonitis with moderate ascites; slight serofibrinous pericarditis; marked hypertrophy and dilatation of both sides of the heart in the presence of marked arteriosclerotic narrowing of the left coronary artery; marked arteriosclerosis of the aorta and the kidneys; chronic passive hyperemia of the liver; large, fresh infarction of the spleen; cholelithiasis; encapsulated pulmonary tuberculosis.

CASE 10.—Acute purulent peritonsillitis, laryngitis, and cervical and mediastinal lymphadenitis; acute tracheitis and bronchitis, with early bronchopneumonia; edema of the glottis; marked hyperemia and moderate edema of the meninges; streptococcus septicemia; red splenic tumor; slight aortic atheroma.

CASE 15.—Moderate inflammation of the upper respiratory tract, with enlargement of the cervical lymph nodes; streptococcus septicemia and encephalitis; chronic and acute vegetative endocarditis of the aortic valve; cloudy swelling of the parenchymatous organs; diffuse scarring of pia-arachnoid.

The survey of 487 cases of septic sore throat elicited that the frequency of the main complications occurred thus: erysipelas, 20; otitis media, 14; arthritis, 12; septicemia, 12; peritonitis, 10; vomiting, diarrhea, 10;

skin eruptions, 6; myocarditis, 5; endocarditis, 1; appendicitis, 2; encephalitis, 2; laryngitis, 3; sinus infection, 3; neuritis, 1; nephritis, 2; subcutaneous hemorrhage, 1.

Cervical lymphadenitis occurred in nearly all cases, often requiring paracentesis. Erysipelas came sometimes from the ruptured middle ear, sometimes from the nares, and in one instance from the eye.

Contact infections were quite the exception. We found evidence of less than a dozen such cases on our house-to-house survey. In the hospital, one physician became infected in this way, and in the same institution three nurses became infected, presumably from one particular patient whom they attended. There were a very few contact infections also in the girls' home.

#### SUMMARY

It is evident from the data obtained that this epidemic, with 487 cases and twenty-two deaths, was caused by the drinking of raw milk from one dairy, which had been rated as one of the best in the city.

Similar strains of hemolytic streptococcus were obtained in almost pure culture from the inflamed udder of a cow of the herd, from one milker's throat, and from the throats of numerous septic sore throat patients and contacts. All these strains were shown to be of the human type.

It is probable that the milker in question infected the udder of the cow, producing purulent mastitis; that, on one or more occasions, this cow was milked in with the herd, and that the massed infection thus produced resulted in the epidemic.

This cow's udder had both human and bovine strains of hemolytic streptococci. One quarter, containing a human strain, had a massive mastitis indistinguishable grossly from garget; another quarter, having a bovine strain, was only slightly consolidated.

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