

MILK EPIDEMIC OF ANGINA, ORIGINATING FROM A  
COW WITH MASTITIS AND DUE TO *STREPTOCOCCUS*  
*PYOGENES* (LANCEFIELD GROUP A)

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(With 1 Figure in the Text)

SINCE the appearance of the first reports (about 1880) on explosive epidemics of angina, probably due to spreading of the infection through milk, a great many investigations of "epidemic septic sore throat" have been published. In Denmark a comprehensive study of this subject has been published by S. Ahrend Larsen (1933), covering several epidemics that were investigated thoroughly. Not until the last years, however, has a rational grouping and typing of the streptococci been practicable (F. Griffith, 1934; Rebecca C. Lancefield, 1935). As yet, therefore, only a few studies have been published of epidemic sore throat with bacteriological examination of the streptococci according to modern principles of classification (e.g. Camps & Wood, 1936; R. Watson, 1937; G. H. Ramsey, 1935).

An instance of such investigation is presented in this paper.

In the first week of September 1936 an epidemic of septic sore throat broke out in Mørkøv, a railway village in Holbæk county, with about 750 inhabitants. This epidemic comprised about 100 cases, and nearly one-half of them made their appearance within three days—as many as twenty-nine persons were attacked on one day.

As this epidemic thus was very explosive and widespread (for a village of that size), the county medical officer reported the epidemic—on 10 September—to the National Health Service, and an investigation of the epidemic was undertaken in co-operation with the State Serum Institute. At the direction of the county medical officer, one of the three dairies in the town had commenced at once to pasteurize all the milk it distributed. So this investigation was planned to ascertain the *nature, course, distribution, and cause of the infection*. One of us (E. J. H.) visited practically every household in which the ailment occurred.

In several of these homes we still found patients in whom the disease had lasted a few days or had set in quite recently. The clinical picture of these cases was quite uniform: very sudden onset of sore throat most often accompanied by subjective and objective phenomena, going on even to phlegmon and

abscess formation, and involving as a rule a general condition in a rather marked degree.

Cultures from the throat in twenty-three cases that were still in the acute stage showed also a quite uniform outcome: nearly all the cultures showed a vigorous growth of beta-haemolytic streptococci, often in nearly pure culture.

In the week before the outbreak of the epidemic sporadic cases of this disease had appeared here and there in the town, from one to three new cases daily. Then, on 4 September, fifteen new cases occurred, and twenty-nine new cases on 5 September. On 6 September the frequency fell off again, only six new cases being recorded on that day. Still, in the following week, three to five new cases kept appearing daily (cf. curve for epidemic, Fig. 1). The curve represents exclusively cases with well pronounced clinical features and definite statements about the onset of illness. In addition, nearly all the families involved included also one or a few cases with very mild symptoms.

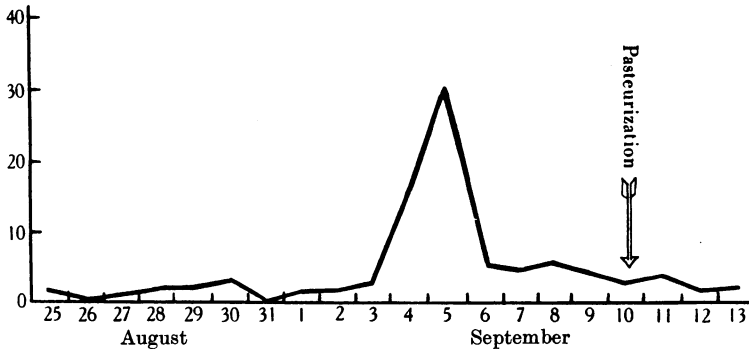


Fig. 1

The cases were distributed all over the town at the same time as the epidemic was limited to this village, only two cases having appeared in the neighbouring village of Stigs Bjergby.

The explosive character of the epidemic, its geographical distribution and limitation, as mentioned, were suggestive of a food epidemic. All the patients were questioned with a view to the possibility of a contact infection and also about their consumption of milk and other food articles. Thus it was found that, with one exception, *all the patients had been taking milk distributed by one dairy—the A. dairy.*

On further inquiry as to the distribution of milk by the three dairies in the town the following information was obtained: The M. dairy and the S. dairy distributed daily about 90–100 l. of milk in Mørkøv, while most of the milk from these dairies was sold in villages near by, in which no case of the disease occurred. The daily distribution of milk by the A. dairy amounted to about 130 l. of raw milk, sold to about 160 households; of this amount about 90 l. were sold unbotled, while 40 l. were distributed in bottles. This dairy also

supplied a little milk to a few households in Stigs Bjergby, a neighbouring village.

The raw milk distributed by the A. dairy was supplied by four farms, the stocks of which comprised altogether fifty-eight milking cows. Some details concerning the milk supply from N. M.'s farm are of particular interest and significance. Every morning the milk was collected from this farm by the dairy per motor-truck. As a rule this farm furnished daily two pails of milk from the preceding evening and three to four pails of morning milk. This milk was the first to arrive each morning at the dairy, where the dairyman would put his hand on the buckets and pick out the warmest ones, containing the morning milk (as a rule 40–50 l.) which were set aside and filtered through a cotton filter. Often this milk was mixed with 10 l. from another bucket. These 50 l. of milk were poured into one container, from which the milk was sold as ordered by the various households in the village of Mørkøv. The rest of the milk from N. M.'s farm was pasteurized; sometimes, however, some of this milk was distributed non-pasteurized to a few households in the village of Stigs Bjergby. *Thus more than one-half of all the unbottled milk sold in Mørkøv was derived from three or four cows on N. M.'s farm.*

Through this investigation it was established that out of the forty-three households in which the septic sore throat occurred forty-two received their milk, not pasteurized, from the A. dairy. Among these household seven received now and then some milk from the other two dairies in the village, but no case of sore throat appeared in any household that received its milk exclusively from these two dairies. Among the forty-two households that received their milk from the A. dairy, the milk was delivered unbottled and non-pasteurized to thirty-five households (i.e. 83 % of the households involved), while bottled milk was also delivered to eighteen of these households (43 %), and bottled milk alone was delivered to seven households (17 %). The bottled milk did not come from the same farm that furnished the unbottled milk, but the dairyman would not deny that the two kinds of milk might be mixed now and then.

In view of these data it seemed reasonable to assume that the spreading of the infection might be attributable to the milk from the A. dairy.

The questions then arose: What was the original source of the streptococci present in the milk? Would it be possible to demonstrate this source and establish the identity between the streptococci derived from that source and the strains of streptococci isolated from the patients?

Throat cultures were made from twenty-three patients and also from fourteen persons who were handling the milk in the dairy or on the four farms that furnished the milk distributed by this dairy. No case of sore throat had occurred among these fourteen persons during the epidemic or in the immediately preceding period. Further, through kind and generous co-operation by the veterinary physicians, Drs Leth-Jørgensen and Rømer, the fifty-eight milking cows of the four farms were examined carefully and samples of their

milk were sent in for further examination by the Hygienic Laboratory of the Royal Veterinary College and by the State Serum Institute, and a comparison was made of the results obtained by the two laboratories. As soon as the specimens of milk were received by the State Serum Institute, cultures were made from them on blood agar plates (5% horse blood).

#### SEROLOGICAL INVESTIGATION

The throat cultures were made on blood agar plates in the homes of the patients. After incubation for 24 hr. at 37° C., the cultures were inspected, and colonies showing beta-haemolysis were isolated and cultivated in subcultures.

Altogether forty-eight strains of beta-haemolytic streptococci were isolated. On examination with Lancefield's grouping sera, twenty-one of these strains were found to belong to group A. Of these twenty-one strains seventeen were isolated from patients, three from healthy persons who had been in contact with the milk, and one from a cow, M36.

Among the remaining twenty-seven strains, particular mention is to be made of six beta strains (belonging to Lancefield's group B) that were isolated from cows on one of the other three farms that furnished the milk to this clientele. A hasty inspection of the plates from this material might suggest that the colonies obtained were identical with the strains obtained from the patients. This illustrates clearly the significance of the Lancefield grouping.

One of us (J. E.) then made a more thorough examination of the twenty-one suspected instances of infection with the A strain by means of the Griffith typing sera. This investigation was performed in part in Griffith's laboratory, but it did not result in any exact typing of the strains, so that it seemed reasonable from the findings to assume that in this epidemic we were dealing with a new type or a degenerated unspecific phase of a previously classified type. Experiments were made to produce in rabbits an anti-serum for the strain M36, but we did not succeed in obtaining any serum serviceable for agglutination on slides. The findings thus were rather suggestive of a phase of degeneration. Further identification of the A strains was carried out by means of the usual biochemical tests as recorded here schematically for strain M36:

Haemolysin in solution	Hydrolysis of sodium hippurate	Reduction of methylene blue in milk	Growth on bile media		
			10%	40%	
+	0	0	0	0	
Fermentation tests					
Aesculin	0	Mannitol	0	Lactose	+
Raffinose	0	Salicin	+	Sorbitol	0
Inulin	0	Sucrose	+	Trehalose	+

All twenty-one A strains gave the same results as recorded here for M36, excepting that three strains gave also a slight fermentation of aesculin on the fifth or sixth day of incubation, and seven strains showed growth on 10% bile. No particular importance is to be attached to these two deviations, as strains

which are otherwise taken to be identical will often show minor variations just in these two respects.

As it was not practicable with Griffith's type sera to establish conclusively that all twenty-one strains belonged to the same type, one of us (E. J. H.) tried to obtain a reasonable probability of the identity of the strains by cross-agglutination tests and absorption tests.

A series of rabbits was immunized with a *Streptococcus* strain isolated from cow M36 and with two *Streptococcus* strains picked out by chance among the seventeen "typical" strains:

(1) In preliminary tests the agglutinin titre was determined for the homologous strain (in Widal tubes; formalinized broth culture, incubation for 10 hr. in water-bath at 50° C.). With this technique most of the sera showed agglutination in dilutions 1 : 400-1 : 800.

(2) Then each of the three strains was agglutinated with all three sera. No difference in the titre could be demonstrated.

(3) Finally, absorption tests were made in each of the three sera with all three strains (absorption with large amounts of sediment from formalinized broth cultures; serum dilution 1 : 10; incubation for 10 hr. at 37° C.).

(4) In conclusion, the absorbed sera were used for agglutination tests as mentioned under (2). No agglutinin could thus be demonstrated in these sera in dilution 1 : 25.

Like the other bacteriological and serological examinations of the strains, these experiments indicate that the strains are identical.

The bacteriological and serological investigation of the streptococcal material gave the following findings:

*In 74 % of the examined patients it was possible to demonstrate the presence of streptococci that were all of the same type with regard to the properties here investigated.*

The same *Streptococcus* was isolated from the purulent discharge from the ear of a patient with otitis media.

The same type of *Streptococcus* was demonstrated in an apprentice in the A. dairy. Further, the same type was isolated also from a farm hand and from a maid working on N. M.'s farm, besides from a cow (M36) belonging to the stock of this farm. Prior to the bacteriological examination of the milk, this cow had been examined by the veterinary surgeon, and mastitis was not demonstrated at that time. Now, however, a thorough clinical examination of the cow revealed some slight, subacute, mastitic changes in the left anterior teat. The milk from the quarter of the udder here concerned was found, when left standing, to show macroscopic morbid changes.<sup>1</sup> On bacterial count this milk was found to contain about 100,000 streptococci per c.c.

Through further inquiry on this farm it was learned that the owner had had an attack of sore throat about 2-3 months before, and that he afterwards had been troubled for a long time with "catarrh of the throat"; he had been treated for this condition by the family physician. Throat cultures gave a growth of *Strep. pyogenes* type 17. The housekeeper was said to have had a severe attack of sore throat at the same time. The farm hand and the maid stated that they had not been ill at all. All four persons on this farm claimed emphatically that they never drank raw milk.

<sup>1</sup> For details concerning the examination of the milk, the clinical examination of the cow and the further course of its mastitis, see: H. C. Bendixen & F. C. Minett (1938).

It is quite easy to imagine that cow M36 has been infected from one of the persons here mentioned—perhaps after acquiring an unnoticed lesion of the teat—and that the infection then has been spread through the milk from the cow to the villagers of Mørkøv. While we may thus readily construct the mode of transmission of the infection in this epidemic, it is difficult to explain why the epidemic broke out explosively when it did. Nothing in the condition of the cow offered any explanation of this. The mastitic processes might well have been some weeks old, and there was no sign of any acute exacerbation or abscess formation. An examination of the conditions for growth of the *Streptococcus* strains in the milk from cow M36 showed nothing to indicate that the capacity for growth was particularly good at 3, 13, 22 and 37° C., so it would hardly be reasonable to look for an explanation of the sudden outbreak of the epidemic in the possibility that the milk about 3 September might have been left standing a long time before it was distributed to the consumers. Perhaps the explanation is to be found in the conditions of the supply of milk to the dairy and its distribution from the dairy (see above): On the farm the milk of the sick cow was always mixed with the milk from two or three other cows. If the dairy in setting aside the milk to be sold unbottled happened to pick out the very bucket in which one-third or one-quarter of the content came from cow M36, there was a possibility of spreading 50 l. of rather markedly contaminated milk to the consumers in Mørkøv. This may explain why so many cases appeared within 3–4 days. The striking number of cases that occurred before the real outbreak suggest that the milk has been contaminated for a considerable length of time, although less heavily, so that only the more susceptible persons were infected. On this farm all the milking was done by machinery, followed by “hand-stripping”, and this naturally implies the possibility that small amounts of contaminated milk might be added to large amounts of sound milk. Nor could the possibility be excluded that the milk from the other farms (for instance, the bottled milk) now and then was mixed with some of the streptococci-containing milk.

As to the duration of the massive contamination, the form of the epidemic curve suggests that the contamination was of brief duration, probably 1 day. (In one case the data established with certainty 3 September as the date of infection.)

In most of the cases the *incubation period* was from 1 to 2 days, but sometimes no doubt considerably longer. It is impracticable to decide which of the cases appearing at the “tail-end” of the epidemic had actually been infected on 3 September, while the incubation period somehow had been prolonged, and what persons had contracted the infection later than 3 September (pasteurization of the milk was not commenced until 10 September, i.e. after the epidemic proper was over).

Nearly 10% of the late cases involved the possibility of infection either through milk or through contact. None of the cases observed during the epidemic proper indicated contact as the only possibility for transmission of

the infection. After the conclusion of this investigation, however, a few scattered cases occurred here and there in the village, undoubtedly transmitted by contact.

*Percentage of "takes"*

Data were obtained concerning altogether forty-three households with 172 members, among whom ninety-two had sore throat during the epidemic, i.e. 53.5%. This percentage of "takes" is a maximum number, in so far as about 10% of the patients (see above) possibly did not have a primary milk infection. On the other hand, this percentage is also a minimum number, as the number of households which received their milk from the A. dairy was about two to three times as great as the number of households with any case of sore throat. Now, of course, all the raw milk distributed by this dairy need not necessarily have contained streptococci, and hence the number of customers cannot be used to estimate the number of persons that were exposed to the infection through the milk.

*Age distribution*

As always in milk epidemics of sore throat, there were a large number of adults among the patients. About one-third of the patients were less than 15 years old, while about two-thirds were over 15, distributed as follows:

<i>Age and sex distribution of patients</i>							
Age (years)	0-1	1-4	5-9	10-15	>15	Males	Females
Number of patients	0	6	9	9	61	39	51

*Clinical features*

The cases of sore throat encountered in this epidemic did not differ clinically from the type generally observed in milk epidemics. Characteristic was the marked affection of the general condition of the patients, often from the very onset of illness and prior to the manifestation of sore throat, with high fever, mental haziness and pronounced malaise. The throat showed marked redness, often a pronounced diffuse oedema and tendency to phlegmon formation, sometimes with abscess formation. As a rule the regional lymph glands were considerably involved.

As in many other milk epidemics of sore throat, the complications constitute a serious feature. Among ninety-two cases the complications were as follows:

Peritonsillar abscess	8
Suppurative cervical adenitis	1
Otitis media	2
Rheumatic fever (arthralgia)	2
Myocarditis	1
Total of complications in	14 of 92 = 15.2%

There was no instance of nephritis, erysipelas or broncho-pneumonia. Nor was any exanthematous eruption observed. No patient died in connexion with the epidemic.

Notwithstanding the fairly severe symptoms and the rather frequent complications, we think the epidemic may be characterized as being only moderately severe.

## SUMMARY

A report is given of a milk epidemic of septic sore throat, comprising about 100 cases.

The epidemic originated from a cow with a slight degree of mastitis, produced by a *Streptococcus pyogenes* (Lancefield's group A).

The same *Streptococcus* (which we did not succeed in typing) was isolated from 74 % of the patients examined and from three persons who were handling the milk.

It seems reasonable to assume that the cow was infected from the milkers. Owing to particular conditions in the distribution of the raw milk, it is possible that the milk delivered raw in the village involved on one day a massive contamination.

The epidemic is characterized as moderately severe. No case terminated fatally.

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## REFERENCES

- BENDIXEN, H. C. & MINETT, F. C. (1938). *J. Hyg., Camb.*, **38**, 374.  
CAMPS, F. E. & WOOD, J. L. M. (1936). *Lancet*, **2**, 756.  
GRIFFITH, F. (1934). *J. Hyg., Camb.*, **34**, 542.  
KEEVIL, N. L. & CAMPS, F. E. (1937). *Lancet*, **2**, 207.  
LANCIEFIELD, R. C. (1935). *J. Exp. Med.* **61**, 335.  
LARSEN, AHREND S. (1933). Investigations into Milk Epidemics in Denmark, especially Septic Sore Throat Epidemics. Dissertation, Copenhagen.  
RAMSEY, G. H. (1935). *Ann. Proc. Int. Ass. Dairy & Milk Insp.* **24**, 163.  
SWIFT, HOMER, LANCIEFIELD, R. C. & GOODNER, K. (1935). *Trans. Ass. Amer. Phys.* **1**, 217.  
WATSON, R. (1937). *Brit. Med. J.* **1**, 1189.

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