MILK-BORNE STREPTOCOCCAL INFECTIONS*

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In these brief notes on milk-borne streptococcal infections I propose to deal only with those of scarlet fever and sore throat.

That milk may be a vehicle of infection has long been established, and, although the recognition of streptococci as infective agents followed much later, so much work on the subject has been done during the last twenty years or so that it is now possible not only to classify strains of this organism as of human or bovine origin but to identify many of the strains concerned with individual cases of illness.

Milk outbreaks, whether due to streptococcal or other infections, have certain well-known characters, such as their sudden, often explosive, onset; the almost precise limitation of attacks to the consumers of a particular milk; the special incidence upon classes who can afford, or upon persons who drink, most milk; the persistence of attacks as long as the infected milk is used, and their sudden cessation upon its disuse or sterilization. While such characters are common to all epidemics dependent upon milk-borne infection, the outbreaks themselves may vary greatly in their duration, extent, and severity, from a few cases of mild scarlatina occurring in a few days in houses served by a single roundsman to a widespread epidemic, lasting several weeks, of attacks of serious illness with considerable mortality.

TWO RECENT OUTBREAKS

I have recently been concerned with two milk-borne outbreaks of disease, both in this part of the world, and both presenting what may be considered the classical characters of such outbreaks, but which differed from each other considerably in many ways. They serve, I think, as illustrations of two different ways in which infective organisms may gain access to milk—namely, by direct contamination by some person handling it or indirectly by the proliferation in the udder of the cow of organisms derived from a human source. One of the outbreaks was of scarlet fever, the other of streptococcal sore throat.

I

In the scarlet fever outbreak some 66 persons were attacked in 10 days, 44 of the cases being attacked on the fourth and fifth days of the outbreak. The cases were promptly notified, and at the same time a number of persons, estimated at about 100, were reported to have suffered from sore throat. Two deaths occurred, both of elderly patients, one a sufferer from scarlet fever, the other from sore throat. All these persons were consumers of either milk or cream from a certain dairy. On the sixth day of the outbreak two members of the dairyman's family were segregated, and from the sixth to the tenth day the milk was boiled, and no further cases occurred. The dairyman concerned supplied some 65 gallons of fresh, unpasteurized milk daily to about 300 customers, chiefly in a residential area. Most of the milk was delivered in bottles, but some into customers' jugs, and there was also a small counter trade in milk and cream. The dairy was an old-established one with a good reputation, and its premises, which included a milk shop, were clean, and there was a good supply of both hot and cold water in the shed in which the milk vessels were cleaned and stored. This shed was in direct communication with the dwelling-house.

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The dairyman and his wife were elderly people apparently in good health, who had little to do with the milk. With them lived their grown-up son and daughter, the son being one of the roundsmen employed in the business, and the daughter serving in the milk shop. The son, when seen on the sixth day of the outbreak, said that his throat had been rough for a few days, but that, except for this, he was, and had been for a long time, quite well. Because of this "rough throat" he was ordered to have nothing to do with the milk, and three days later he went to stay with friends at a distance. On this day the daughter, who had been slightly unwell the previous day, developed scarlet fever, and was immediately isolated. The son returned from his visit 18 days later, but, as he was then desquamating, he was at once taken to the isolation hospital. This desquamation is of interest because, according to the statements of the man himself and others, including medical men who saw him on several occasions, he never had a rash. Swabs from the throats of several of the patients, including the dairyman's daughter, examined just as the outbreak ceased, showed the presence of haemolytic streptococci of scarlatinal type II. On the return of the son his throat, as well as those of his parents and all the personnel of the milk business, were swabbed. The swabs from the dairyman and the son yielded haemolytic streptococci of the same type as that previously obtained from patients; those from the rest of the personnel were negative. It will thus be seen that haemolytic streptococci of scarlatinal type II were obtained from the throats of certain scarlet fever patients, of a man who had a sore throat, and who desquamated, but was not known to have had a rash, and from another man who presented no sign of either scarlet fever or sore throat.

The dairy obtained its milk from two farms, and careful inquiries made at both failed to disclose any circumstances affecting either their personnel or their cows which might account for the infection of the milk.

The dairyman's son would seem to have been the source of infection of this outbreak. In its early stages he was suffering from a "rough throat," later he desquamated, and the swab then taken from his throat yielded haemolytic streptococci of the same type as that recovered from the throats of scarlet fever patients. Moreover, this man had had more to do with the milk than anyone else. He received it on its arrival and poured it from the farm churns into the dairy storage churns. He bottled the milk received in the evenings for the next morning's delivery, and on arrival of the morning's milk from the farm poured most of it into delivery churns for the second round. He also had a milk round, though a small one, and it is significant that, although he delivered milk at only 47 houses, cases of scarlet fever occurred in 20 of these houses, as compared with 29 of the 236 houses served by the two other roundsmen; thus, while cases of scarlet fever occurred in 12.2 per cent. of the houses served by the two other roundsmen, such cases occurred in 42.5 per cent. of the houses at which the dairyman's son delivered milk.

II

The other outbreak to which I have referred, that of sore throat, occurred among the same large urban population, but at an interval of about a year. As sore throat is not a notifiable disease, some time elapsed before its presence in epidemic form was recognized. Attacks were spread over about a month, during which members of over 1,000 families were affected, and 65 deaths occurred. The primary illness was in most cases follicular tonsillitis, often severe, and this was in many instances accompanied, or followed, by complications, mostly of a septic character. Relapses were common. Some of the earlier patients were thought to have "influenza throats," while others were

suspected to be suffering from diphtheria, and many swabs were sent to the municipal laboratories for examination for Klebs-Löffler bacillus. The swabs, however, yielded not K.L.B., but streptococci, and inquiries then made led to the discovery that all the patients were consumers of milk from a particular dairy. This was a large dairy distributing some 1,500 gallons of milk daily to some 6,000 consumers, chiefly of the well-to-do classes. Except that it had no pasteurizing plant, the dairy was exceptionally well equipped with modern dairy appliances. It had an excellent reputation, and was very clean. Up to the time of the inquiries no suspicious illness had occurred among its personnel. Its milk was obtained from a number of local farms, the churns from which were emptied into large mixing tanks on arrival, and, after being clarified, the milk was bottled mechanically for distribution. On a certain morning some weeks after the earliest cases had been attacked, a sample of the milk from each farm was taken on its arrival at the dairy and was examined microscopically at the municipal laboratory. One of these samples was found to contain abundant streptococci, and on the use of this milk being stopped the epidemic ceased. Inquiries were then instituted at the farm at which this milk was produced. It was found to be a model of its kind; the cowsheds were modern buildings, well lighted and ventilated, kept scrupulously clean, and provided with ample supplies of hot and cold water. The cows were groomed daily and milked mechanically, and all the milk, except a little used locally, was sent every morning and evening in sealed churns to the dairy. The farm was in charge of a resident bailiff, who, about two months before the outbreak of tonsillitis, had been in hospital for appendicitis. On his return a few weeks later he found some of the cows suffering from mastitis, and from then onwards certain other cows suffered from inflammatory conditions of the udders, leading to the removal of some of them from the herd. Three cows had been removed a day or two after the streptococci were discovered in the milk from this farm.

Except for the bailiff's appendicitis there had been no recent illness among the personnel of the farm prior to the epidemic of tonsillitis among the dairy's customers, but almost simultaneously with the earliest of these cases similar cases had occurred in the bailiff's house and in a cottage which communicated with it and, somewhat later, in the family of one of the milkers. Cases continued to occur among the personnel of the farm for some weeks, the bailiff himself being one of the later patients to be attacked. The patients at the farm, like those in the town, suffered from complications of a septic character as well as from relapses. Two of the attacks proved fatal.

In the course of inquiries after the cessation of the outbreak, swabs were taken from a number of patients, then mostly convalescent, both from among the dairy's customers and the personnel of the farm, and some of the swabs from patients of both groups yielded haemolytic streptococci, which were also isolated from some of these same patients several weeks later.

The streptococci conformed generally to the reactions of the common *Streptococcus pyogenes*, but had certain colonial and serological characters which permitted of their identification; their haemolytic properties were marked, as was also their virulence for mice. These characters agreed very closely with the description of organisms yielded by patients during epidemics of tonsillitis in America in recent years.

Several inspections of the dairy herd were made, and on at least one occasion milk from each quarter of every cow was bacteriologically examined. Haemolytic streptococci were recovered from the milk of many of the cows, only a few of which had clinically apparent mastitis. All

the organisms were of the bovine type, and on no occasion were haemolytic streptococci of human type recovered from the milk. In this connexion it should be borne in mind that attempts to isolate streptococci of the human type from the milk were not undertaken until some time after the attacks of tonsillitis had ceased, and that in the meantime cows which might have been excreting such organisms may have ceased to do so or may have been removed.

AN AMERICAN OUTBREAK

Reference has been made to outbreaks of tonsillitis in America. Of these one of great extent and severity was that which occurred at Chicago during three months of 1911 and 1912 during which, it was estimated, some 10,000 persons were attacked.¹ The epidemic resembled in many ways the one I have just described, the clinical features of the attacks being almost precisely similar, and haemolytic streptococci of a somewhat special character were isolated from the throats of many of the patients. Infection was conveyed by milk from a certain farm at which certain of the milkers had been suffering from sore throat and certain of the cows from mastitis. Following this outbreak, Drs. Davis and Capps² conducted a series of experiments to determine whether haemolytic streptococci derived from human sufferers from tonsillitis were pathogenic for cows and "to determine possible avenues of udder infection through the teats." As a result of their experiments they found that while haemolytic streptococci of human origin could be applied to the uninjured surface of cows' udders and teats without causing infection, yet when applied to an injured or abraded surface of the teat or injected directly into the udder through the milk channels the organisms may proliferate enormously, and mastitis may be caused lasting for several weeks. Such mastitis may exist without physical evidence, though pus may be secreted in the milk as well as streptococci in enormous numbers for several weeks. The appearance of the milk may or may not be altered.

COMMENTARY

Although no haemolytic streptococci of human type were found in the milk in the recent English epidemic of tonsillitis there can be little doubt that they would have been found had the necessary bacteriological investigations been undertaken while it was in progress, for it has been seen that such organisms, with identical characters, were isolated both from the dairy's customers and from the farm personnel, between which, except for the milk, there was no possible source of infection exclusively common to both.

The extent and duration of the outbreak can hardly be explained except on the assumption that the milk was grossly infected for some weeks with organisms pathogenic to man, and that this can occur in the case of haemolytic streptococci of human origin is demonstrated by the experiments of Davis and Capps.

It will have been noted that the attacks among the dairy's customers and among the farm personnel were coincident, and this suggests that both were infected at the same time from the same source—namely, the milk. The source of the infection of the milk, while not definitely proven, is believed to be a prior case of similar illness occurring in a house a few miles from the farm which it was the bailiff's duty to visit daily, taking with him butter and cream. Some weeks previously an inmate of this house had suffered from an attack of sore throat which he had acquired elsewhere, and from which he suffered a relapse about a week before the first attacks of the outbreak. The bailiff did not milk the cows at his farm, but it was his duty to examine any which were not well. It has been seen that both during and prior to the outbreaks

of tonsillitis several of the cows at the farm had suffered from mastitis and other inflammatory infections of the udder, and it is thus possible that the bailiff may have conveyed to one or other of such cows the infection which in some way he had brought from the patient at the house he visited daily.

Incidentally, it may be mentioned that following the cases at the farm there was a small outbreak among the occupants of this house and that the doctor who treated patients both at the farm and at the house considered that all of them were of the same nature.

Both the outbreaks I have described, the one of scarlet fever and the other of sore throat, were due to haemolytic streptococci of closely allied though distinguishable types and in both the infection was spread by milk. While, however, the scarlet fever epidemic lasted only for a few days and the attacks, numbered by tens, were almost limited to persons served by a single roundsman, himself a carrier of infection, the epidemic of sore throat was spread over several weeks and the patients, numbering many hundreds, received their milk from many roundsmen, none of whom, so far as is known, was infected. The difference in the duration of the outbreaks is doubtless attributable, at any rate in part, to the circumstance that scarlet fever is notifiable, this permitting of prompt preventive measures, while sore throat is not. The difference in their magnitude, however, is only to be explained, I think, by the different ways in which infection was spread. The scarlet fever patients owed their infections, I believe, to the direct infection of the milk by the infected roundsman by whom they were served, while to account for the many hundreds of attacks of sore throat occurring among persons living in all parts of the area served by a large dairy, some gross infection of the milk must be assumed. It has been seen that when the milk from a single farm of the many supplying the dairy was discontinued the outbreak ceased, and it would thus seem that for this milk to have infected so many consumers, greatly diluted as it was with other milk before it reached them, it must have been grossly infected. Such gross infection of milk with organisms pathogenic to human beings is, I think, best to be explained, in the light of the experiments of Davis and Capps, by the infection of cows, already susceptible owing to the condition of their teats and udders, with organisms derived from a human source.

¹ Miller and Capps: *Journ. Amer. Med. Assoc.*, Vol. lviii, 1912.

² Davis and Capps: *Journ. Infect. Dis.*, Vol. xv, 1914.

INTUSSUSCEPTION ILLUSTRATED BY THREE UNUSUAL EXAMPLES

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Three cases of intussusception recently operated upon at the Hospital for Sick Children have certain points of interest. In the first I was able to discover the exact cause; in the second a recurrence was shown to have the same point of origin as the previous intussusception; and in the third, recovery followed intestinal resection and anastomosis in a baby aged 8 months.

CASE I

This baby girl, aged 6 months, provided an opportunity of obtaining a good specimen of bowel indicating the cause of the intussusception. As a rule the intestine of such of these children as come to the post-mortem room is gangrenous, and it is impossible to determine precisely the exact starting-point of the intussusception by an examination of it.

This baby, however, died twenty-four hours after operation from respiratory failure, the cause of which was proved by the necropsy to be mal-development of the diaphragm.

At the operation the apex of the intussusception reached half-way down the descending colon; on following it backwards the colon was found to pass under the right costal margin, so that the incision had to be prolonged upwards. The liver lay completely in the right side of the chest. The point of origin of the intussusception, which reduced easily, was six inches proximal to the ileo-caecal valve, and could be felt as a definitely localized and thickened patch in the bowel wall, of the area of a sixpenny bit. The surrounding gut was not obviously thickened.

The necropsy showed that the muscle of the diaphragm was absent, save for a few fibres in its left posterior part; the rest was solely represented by a thin complete fibrous sheet; this lay over the liver, which was herniated into the right side of the chest. The right lung was unexpanded and occupied only the apex of that side of the chest. The Peyer's patches in the ileum were large, and the thickening in the bowel wall corresponding to the starting-point of the intussusception was an almost polypoid hypertrophy of the lower end of one particularly big patch. This is well shown in the figure. There could be no doubt that this thickened part of the patch projecting into the lumen of the bowel had acted like a polyp in causing intussusception. The mesenteric glands were moderately enlarged.

Half-scale drawing of bowel of Case I. The upper figure shows the large size of the lymphoid patch, and the lower profile sketch indicates how it projected into the lumen.

CASE II

Operation on this boy, aged 6 months, revealed an intussusception which had reached the splenic flexure. Reduction was difficult, but the intestine was considered viable. The starting-point, which was unusually high, being eighteen inches proximal to the ileo-caecal valve, was indicated by a definite dimple, but the whole of the affected bowel was so oedematous that no localized thickening could be felt. There was no evidence of a Meckel's diverticulum.

At the age of 12 months this boy was again presented to me by his mother, within two and a half hours of a recurrence of his symptoms. Even after this short time the intussusception, which had again reached the splenic flexure, was difficult to reduce. Healed scars of the peritoneum covering the bowel showed clearly the extent of the previous invagination, and this second intussusception had the same starting-point as the first. Again there was a dimple, but no localized thickening could be felt, the whole of the bowel involved being oedematous. A year has passed since the second operation, and there has been no recurrence.

CASE III

A baby girl, 8 months old, was brought to the Hospital for Sick Children with a history of having been seized by abdominal pain seven days before. She had vomited once at the onset, but since then had taken her food well, and had not apparently had further pain. She passed one stool on the first day, but since then the bowels had not opened, except for the passage of a little dark blood on the fourth day.

On examination she did not appear to be in pain, but was pale and listless. The abdomen was distended, particularly in its upper part, where it was marked by the pattern of underlying coils of bowel. No localized tenderness was discovered, nor could a tumour be felt apart from the general