THE ELKTON MILK EPIDEMIC OF TYPHOID FEVER.

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Elkton, the county seat of Cecil county, Maryland, is a town of 2542 inhabitants, built upon a red clay soil, rather flat as to surface, but sloping gently toward the Elk river. This small stream is not navigable, is but slightly influenced by the tides, and is only about 25 feet below the highest part of the town.

The public water supply is obtained from the river, a mile and a half above the town. The stream above the waterworks flows through a farming country, and is unprotected. There is no impounding reservoir, the water being distributed by the pressure from a stand-pipe 100 feet high. The *Bacillus coli* has been found on several occasions in the town supply, but not during the year 1900. The quality of the water is at no time above suspicion.

The town is unsewered. Surface-closets are largely used, and the better houses are supplied with water-closets discharging into cesspools, some of them uncemented, and some probably penetrating the 15 feet of clay into the gravelly sub-soil.

The majority of families obtain their drinking water from private wells 20 to 30 feet deep. Typhoid fever has been present in Elkton every year, and two epidemics have occurred, one in 1884, which was traced to a dairy, and the one in 1900 which is now under consideration.

Of the four dairymen delivering milk in Elkton in 1900 the largest business was probably that of A., whose farm is about three miles distant.

On his way to town every morning A. obtained milk from two other farms, both of which remained free from sickness in 1900. Whether the milk was distributed mixed or unmixed could not be learned.

More than half of A.'s supply was obtained from his own herd of 22 or 23 cows. A.'s manner of handling milk was not better nor worse than is usual with small dairy farmers. The well is about 15 feet from the barn-yard fence, and beside it stands a large wooden trough in which the cans were set to cool the fresh milk. This water served all the purposes of the family and the dairy. Two samples of water were obtained from this well at different times in October, 1900, and two determinations were made upon each sample. *B. coli* was isolated in all four instances.

In September, 1900, a case of typhoid fever occurred on the adjoining farm B. Mrs A., wife of the dairyman, assisted in nursing the case at B. during the two or three weeks preceding death, which occurred on Oct. 5th. Before this date Mrs A. and her son, aged 15, were ailing, but the boy continued to milk the cows, and Mrs A. to prepare the milk for market, until about Oct. 8th, when both were obliged to cease work. A homœopathic physician was called and pronounced a diagnosis of "Summer grip." Neither of them was severely ill, though both when seen by myself on Oct. 28th were pale, weak and emaciated. The older son, aged 21, suffered a more severe attack early in November, the same diagnosis being made. The father alone of the family remained well. They refused to submit blood specimens for the Widal test, and the attending physician, though admitting a doubt as to the nature of the illness and professing his belief in this means of diagnosis, withheld his consent to a blood examination.

The notification law is fairly well observed in Elkton, and previous to this time there had been but three cases of typhoid fever, all in one family, using the public water-supply. These cases, A. D., age 32, August 12th; E. D., age 71, Sept. 12th; and M. D., age 36, Sept. 19th, were all in the care of the Health Officer, Dr Bratton, who attributed the first case to an infected well at a house which the young man frequented. The two later cases cannot be so accounted for. Possibly they belong to the milk outbreak, though it is very unlikely. The family began to be supplied with A.'s milk late in August, at which time A.'s milk was probably not infected. The excreta in all the D. cases were disinfected.

On October 11th three cases of typhoid fever were recognized in Elkton; on the 12th, one case; 13th, two cases; 14th, three cases; 15th, three cases; 16th, three cases; 18th, six cases. These cases were attributed by the local Health Officer, Dr Bratton, to A.'s milk. The evidence on the 18th was as follows: Infected households, 17; using

the public water-supply, 11; using private wells, 6; using A.'s milk, 17. Among the 21 cases there was but one in which doubt was felt about the use of A.'s milk. Mrs M., aged 63, attacked on Oct. 12th, was not a regular customer of any milkman. There were but two persons in her house, neither of them caring for milk, but they did occasionally stop A.'s waggon and buy cream and milk for table use (in coffee and on fruit). A date when milk had been bought within two or three weeks preceding this illness could not be fixed.

The Health Officer considered this evidence strong enough to warrant advising A. to discontinue the sale of milk pending further investigation. A. continued his business, though his customers steadily forsook him. He ceased selling on Oct. 28th. On that date the figures were as follows:

Infected families, 32; using the public water-supply, 18; using private wells, 14; using A.'s milk, 32. Total number of cases, 39.

Among these was the case of Mary D., aged 10, who was ill when brought into Elkton on Oct. 20th, from a farm where her mother was employed as a domestic. Her home in Elkton was supplied with A.'s milk, and had a private well. Her sister, Jennie D., who was not out of town, became ill on Oct. 24th. It was subsequently learned that A. left milk daily for Mary D.'s use at the farm. This farm-house, infected by A.'s milk, is not included in our figures.

The outbreak subsided after Oct. 29th, the record being (Jan. 1st, 1901) as follows:

Infected houses, 39; using town water, 21; using private wells, 18; using A.'s milk, 39. Total number of cases, 64.

In the S. household there were three cases, the last of which occurred 35 days after the last delivery of A.'s milk. This third case is not included in our figures. The S. family, besides two undoubted milk cases, adds to the record the interesting case of Alice M., who visited the town for two days only, stopping with the S. family on Oct. 5th and 6th. She returned on Oct. 7th to her home in New Jersey, where she failed with enteric fever on Oct. 14th. The first case in the S. family fell ill on Oct. 16th.

But one case was traced to mixed milk. Mrs B. was supplied by a neighbour who sold milk in a very small way, part of her stock being regularly obtained from A.'s waggon.

In the W. family was a negro servant, whose chief food consisted of oatmeal and milk. She left Elkton about the middle of October, and

went to Glasgow, Delaware, where she became ill, and died of typhoid fever on Nov. 13th.

In the B. family was a married daughter, aged 38, who left Elkton late in October to visit friends in Pennsylvania. About 10 days after leaving Elkton she was attacked with typhoid fever.

The most interesting series of cases, and one which supports in a striking manner the causative relation of A.'s milk to the epidemic, occurred at the jail. The jailer's wife, aged 35, and her two sons, aged 17 and 13, had typhoid fever. None of them admitted the use of A.'s milk as a drink; two of them used it in coffee and on oatmeal and raw fruit, and one of them only as ice-cream. Ice-cream was made regularly once a week from A.'s milk. No milk was given in any form to the prisoners. The iron bars kept the prisoners in, and the milk out. The inmates of the prison proper numbered from 15 to 20 during the period of this outbreak. There were, however, two negro men among them who were not criminals. One was an epileptic and the other an insane man. These two slept in the jail, and during the day were employed in domestic service and in errands about the town. The jailer, anxious to have his insanitary building condemned by the authorities, declared that these two men had all their meals with the prisoners, but it is certain that they had daily access to the family provisions, and it is most significant that these two men were both attacked with typhoid fever in the first week of November. Here were some 24 persons exposed under one roof to conditions identical in all respects, except as to a single article of diet and as to the visits in the town. Down to Oct. 29th, A.'s milk reached as far as the prison bars which divided the inmates into two classes; six on this side, who could get milk, and of whom five had typhoid fever; and eighteen on the other side, who could not get milk, all of whom escaped. No other case appeared at the jail until about the 8th of December, when a white man, after ten days' incarceration, developed typhoid fever. He was a tramp, had been in the town but a few days before his arrest, and his history threw no light upon the source of his infection. This case was followed by two others which could not be traced to any source outside the jail.

Summing up, we find first that the town of Elkton had a single infected house on Oct. 1st. On Oct. 5th, a death from typhoid fever occurred on a farm 3 miles from town. On the adjoining dairy farm, two persons, known to have been in intimate contact with the preceding fatal case throughout its course, became ill with a fever during the first week of October.

Beginning on Oct. 11th, the town of Elkton suffered an outbreak of typhoid fever numbering 39 cases in the first eighteen days, during which time the dairyman's business continued. Twenty additional cases occurred within the three weeks following the milkman's last sale, and four cases from the latter date to the end of the epidemic. There were in all 39 houses infected, all supplied with A.'s milk. In the 39 houses occurred all the typhoid fever which appeared in Elkton during the last three months of 1900. Taking into account the three cases which developed shortly after leaving Elkton, the one case which came to Elkton while ill, and the three cases in jail in December, we have 64 cases of typhoid fever, of whom 61 were consumers of A.'s milk, and the 60th case fell ill within 18 days of A.'s last delivery. After a further interval of 13 days came the first of the four cases which are not attributable to A.'s milk. None of these happened within the period of immediate influence of A.'s milk, namely, from the appearance of fever at A.'s farm, in the first week of October, down to Nov. 21st, twenty-three days after the milk ceased to be sold.

In the outbreak two deaths occurred, both women; one white, aged 56, and the other a young coloured woman.

Three patients who recovered had suffered previous attacks, one in the milk epidemic of 1884, one in 1893, and one in 1898. The last named was a prisoner and probably not a milk case.

Period of Incubation.

The case of Alice M. shows a period of incubation not longer than 9 days; Oct. 5th to 14th. Cases in which the date of infection can be accurately determined are somewhat rare.

Emil Janchen[1] (1898) reported an outbreak in which the date of infection was known, and the symptoms of onset were marked. A number of regiments returning from autumn manœuvres passed, without halting, through a village where typhoid fever was prevalent. These troops showed no special incidence of typhoid fever. One regiment, however, halted in this village, on a hot day, after a tiresome march, and the soldiers drank freely of the infected water. This occurred on the 10th of September, and the symptoms of invasion of typhoid fever appeared on succeeding dates as follows:

[1] *Wiener klin. Wochenschr.* Jahrg. xi. p. 667.

Sept.	12th	2	days	later	3 cases
„	13th	3	„	„	7 „
„	14th	4	„	„	6 „
„	15th	5	„	„	4 „
„	16th	6	„	„	4 „
„	17th	7	„	„	5 „
„	19th	9	„	„	1 „
„	20th	10	„	„	2 „
„	21st	11	„	„	1 „
„	22nd	12	„	„	1 „
„	23rd	13	„	„	1 „
„	24th	14	„	„	1 „

These 36 cases completed the outbreak. The numerical strength of the regiment is not given, but it may be assumed to have contained 1200 men (the peace footing in Germany) of susceptible ages, giving an attack rate of 3 per cent. Fatigue probably shortened the period of incubation in these cases.

Stokes and I[1] reported in 1898 an outbreak in which the date of infection was precisely determined. In a suburban community of 400 persons, the pump, which supplied water of good quality, became disabled on the night of July 3rd. The supply for July 4th was drawn from a well which contained *B. coli*. On July 5th the regular supply was restored. The use of infected water was, therefore, confined to the 4th of July. On the 9th, 10th, and 11th of July some 25 persons were seized with gastro-intestinal symptoms. All had diarrhœa, and nearly all had fever. One had fever, bloody stools, and loss of weight; two had delirium, chills, fever and diarrhœa. All recovered in from 3 to 7 days. None of these were regarded as cases of typhoid fever. On July 27th two young ladies, and on August 1st a third, fell ill with typhoid fever. Other sources of infection than the water supply of July 4th were carefully excluded. Here, after one day's exposure, we have incubation periods of 23 and 28 days. The attack rate was ·75 per cent. among 400 people of all ages.

In the Marylebone epidemic[2] of 1873 is recorded the case of a child who drank the infected milk but once. On the afternoon of July 19th she is said to have drunk two pints, and her illness began on July 24th; a young subject, massive dose, and short incubation.

[1] *Report of the State Board of Health of Maryland*, 1898, p. 103.

[2] *Report of the Medical Officer to the Local Government Board*, 1874, No. II. pp. 103—136.

The Clifton epidemic[1] of 1897 included the case of a child of 9, who drank the infected milk on but one day, her attack following "at the end of a week."

In the Mont Clair, N.J., outbreak (1894)[2], 9 persons were said to have drunk the infected milk once only. These fell ill from 14 to 27 days later. In this epidemic the fatality was 13 per cent., and 28 out of 44 families using the milk were attacked.

The Great Harwood outbreak[3] reported by Sargeant included one person whose attack came two days after a single glass of the infected milk. In contrast with this was the case observed by Power[4], in which the attack followed a single glass of milk after an interval of 3 weeks.

In the Elkton epidemic the first 21 cases seem to indicate periods of incubation averaging under rather than over 14 days. In the 60th case the time from the last drink of milk to the first visit of the physician was 19 days. If this case be regarded as the last one due to milk, it probably indicates for this outbreak the longest period of incubation.

Attack Rate.

The dairyman claimed to be regularly supplying 80 houses. This statement was made at a time when his interest would have been served by proof that a great part of his route was free from typhoid fever. On this basis the house incidence was 48·75 per cent. In the 39 infected houses were 180 people, so that the attack rate in these houses was $33\frac{1}{3}$ per cent. The case rate was 1·54 per house. Taking the milkman's estimate of 80 exposed houses, with 4·6 persons per house, we should have 368 persons exposed, giving a general attack rate of 16·3 per cent. The light fatality, 3·3 per cent., suggests a contagium of slight virulence; but milk as a vehicle usually means large dosage, and the dose is related to the period of incubation, the attack rate, and perhaps to the fatality.

In the Clifton epidemic, before referred to, it was observed that the attack rate was highest among the people who received the unmixed

[1] D. S. Davies, *Lancet*, 1897, vol. II. p. 1442.

[2] R. C. Newton, *New York Med. Record*, vol. XLV. p. 713.

[3] *Lancet*, 1895, vol. I. p. 1328.

[4] Quoted by Dawson Williams from Report, 1892, of a Committee of the Clinical Society of London to investigate Periods of Incubation etc., *Twentieth Century Practice*, vol. XIII. p. 371.

milk of the infected dairy. Two other milk-vendors received a small part of their supply from the infected milk. The houses served by these two vendors with mixed milk were attacked at the rate of 41·8 per cent. and 38·5 per cent. respectively, as against 54·4 per cent. for the unmixed milk.

In an epidemic recently reported at the Iowa State College[1], the attack rate was 8·8 per cent., the fatality 4·8 per cent., and the striking observation is made by Dr Kennedy that among the football players, who were served a double allowance of milk, the attack rate was 50 per cent. The whole number of cases, 42, appeared in a period of 27 days, the last two cases being separated from the last service of infected milk by a period of 19 days.

The influence of dosage is also apparent in the incidence of the disease upon children. Cameron[2] reported an outbreak, at a barrack, due to milk, in which the attack rates were as follows:

Among	600	constabulary,	20	cases,	3·3 per cent.
„	40	women,	2	„	5 „
„	100	children,	10	„	10 „

The fatality was 15·6 per cent., all falling on the men. In the milk epidemic at Stamford, Connecticut[3], 34·8 per cent. were between 1 and 10 years old, and 16·8 per cent. were 5 years old and under. In the Waterbury outbreak[4], 23·3 per cent. of cases were 10 years old and under. In our epidemic at Elkton there were 19 cases between the ages of 20 months and 10 years; 31·66 per cent.

I have to acknowledge particular indebtedness to Dr Howard Bratton, Health Officer of Cecil county, for important details concerning this interesting epidemic.

[1] *Iowa Health Bulletin*, vol. XIV. p. 91.
[2] *Dublin Journ. of Med. Sci.* Nov. 1899, vol. CVIII. p. 330.
[3] H. E. Smith, *Report of State Board of Health of Connecticut*, 1895, p. 168.
[4] H. E. Smith, *Ibid.* 1890, p. 248.