

AN EPIDEMIC OF SCARLET FEVER SPREAD BY ICE CREAM.*

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Ice cream is seldom mentioned in the literature as a vehicle for the transmission of scarlet fever. Typhoid fever outbreaks from this source are not uncommon, but we have been able to find only one scarlet fever epidemic in which ice cream was regarded as a plausible causative agent. This outbreak is mentioned by Chapin (1). It was reported by Buchanan (2), and took place in South Kensington, England, in 1875. Following a large dinner party where the dessert was "frozen pudding" there were fifteen cases of scarlet fever. Buchanan did not seem to be quite certain whether the epidemic should be attributed to this pudding or to the uncooked cream from the same dairy which was served in coffee.

An epidemic of scarlet fever occurred in Flint, Michigan, during the latter part of July, and the first ten days of August, 1924. Previous to July 22, the average number of scarlet fever cases reported for the first 29 weeks of 1924 was six per week, and the largest number reported in a single week was fourteen. From July 22-28 inclusive, 41 cases were reported, a number far in excess of the maximum for any other seven-day period in the year.

This state of affairs in the middle of the summer, when the incidence of scarlet fever is usually low, demanded investigation, and milk was naturally regarded with suspicion. While making a survey of the dairies and their employees, Mr. Howard R. Estes, Dairy and Food Inspector, Flint Department of Health, learned that an ice cream maker, whom we shall hereafter designate as "Lee," was under quarantine for scarlet fever. Mr. Lee had continued working for three days after onset of the disease, and had made ice cream while he had a sore throat and an eruption. The factory in question was a small one, in which the entire process of ice cream manufacture was carried out by Lee. Inquiry brought out the fact that all of the new scarlet fever cases had eaten ice cream sold by Lee's concern, the "A" Company.

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The City Health Officer, Dr. R. A. Stephenson began a detailed investigation. At his request, workers from the Michigan Department of Health arrived in Flint on July 31, 1924. The field work upon which this study is based was performed by members of the state and city health departments. All of the laboratory work was done by the Bureau of Laboratories, Michigan Department of Health.

PROCEDURE OF INVESTIGATION.

As soon as cases of scarlet fever were reported, the homes of these individuals were visited by a physician. Epidemiological and clinical histories were taken. Swabs from each tonsil and from the nasopharynx were taken on all patients, and on the other members of the household. A second visit was made before release from quarantine, and if his consent was forthcoming, a Dick test was done on the patient at this time. The routine of quarantine enforcement was carried out by additional calls, and by different workers. Complete histories were obtained from 100 of the 116 cases reported.

Control histories were elicited from 117 individuals who were not attacked during the scarlet fever epidemic. Whenever practical, these histories were obtained by visiting houses in the same neighborhood in which cases were under quarantine. Other histories were procured from individuals being treated at the City Health Center for various ailments, none of them related to scarlet fever.

CLINICAL AND LABORATORY FINDINGS.

The clinical picture was typically that of scarlet fever. Of the 94 cases concerning whom this information is available, 67 or 71.28 per cent. were mild, 22 or 23.40 per cent. moderately severe, and 5 or 5.32 per cent. severe. There were three fatal cases. Desquamation was observed in 88 of the cases. The most frequent complications were cervical adenitis and otitis media. The symptoms and physical signs bore no close resemblance to those of septic sore throat.

Of the 83 cases on which cultures were taken, 70 or 84.33 per cent. were positive for hemolytic streptococci. Cultures were obtained from 93 contacts. Twenty or 21.51 per cent. of these contacts showed hemolytic streptococci. Of the twenty positive, nine individuals are known to have later developed scarlet fever. Of 37 controls four or 10.82 per cent. were positive for hemolytic streptococci.

Dick tests were performed on 55 scarlet fever cases. One of them gave a faintly positive reaction; two gave pseudo-positive reactions; and the remaining 52 were negative. All of these tests were done late

in the disease, when a negative result should be obtained (3). The potency of the toxin used was established by retesting a group of 15 known positive inmates of the Michigan Reformatory, Ionia, with the same material. The 15 prisoners gave positive readings with the same lot of toxin as that used in Flint.

Toxins were prepared from cultures of hemolytic streptococci isolated from the throat, and from the discharging ear of the ice cream maker who is believed to have caused the epidemic. These toxins were produced according to the method outlined by G.F. and G.H. Dick (4). They were tested on ten inmates of the Ionia Reformatory, known to be Dick positive, and on five inmates who had been attacked by scarlet fever since admission and were known to be Dick negative. Both the toxin from Lee's throat, and that from his discharging ear gave positive skin reactions on the ten Dick positive individuals, and negative ones on the five known to be Dick negative. Also, these toxins were neutralized by serum from a convalescent scarlet fever patient.

A hemolytic streptococcus was isolated from samples of the contaminated ice cream. This organism, however, proved to be of bovine origin, when its characteristics had been determined by final hydrogen ion concentration in unbuffered broth (5). A filtrate prepared from it by the same method employed for producing the toxins gave negative skin reactions on all of the 15 Dick positive prisoners.

EPIDEMIOLOGICAL FINDINGS.

The 116 scarlet fever cases, reported in Flint from July 25 to August 10, are shown by date of onset in the following table, and are shown graphically in Fig. 1.

July.		August.	
Date.	No. of cases.	Date.	No. of cases.
25	3	1	9
26	6	2	7
27	3	3	3
28	25	4	4
29	27	5	2
30	10	6	3
31	8	7	0
		8	2
		9	2
		10	2

The incidence of scarlet fever returned to normal between August 5 and August 10, and the maximum number reported on any single day during the remainder of 1924 was seven cases.

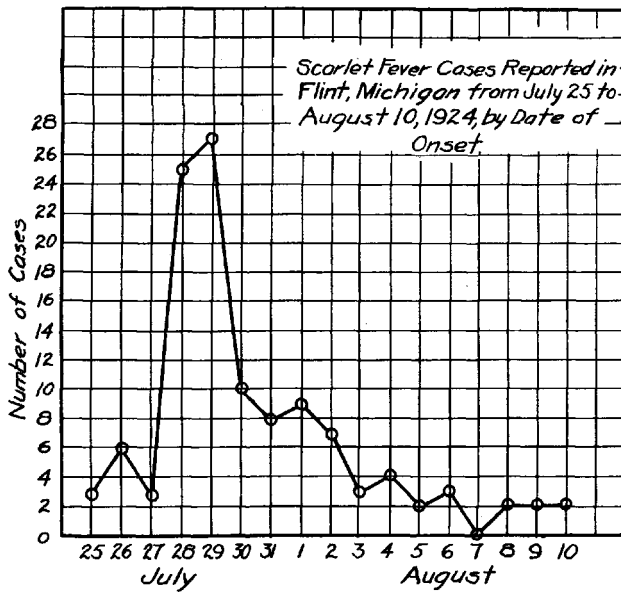


FIG. 1.

The sex and age distributions of the 100 cases from whom complete histories were obtained were as follows:

The high percentage of adults, and the excess of males over females are scarcely the expected findings in an outbreak caused by ice cream. One would logically expect more children, and more females to be attacked when either milk or ice cream is the vehicle of infection. McCoy, Bolton, and Bernstein (6) report a similar unusual age distribution of cases in an epidemic of diphtheria which was attributed to ice cream.

Age groups.	Male.	Female.	Total.	Males: per cent. of total males.	Females: per cent. of total females.	Both sexes: per cent. of total.
0-4.....	8	7	15	14.04	16.28	15.00
5-9.....	7	9	16	12.28	20.93	16.00
10-14.....	10	8	18	17.55	18.61	18.00
15-19.....	5	4	9	8.77	9.30	9.00
20-24.....	11	8	19	19.30	18.60	19.00
25-29.....	10	3	13	17.54	6.98	13.00
30-34.....	2	2	4	3.51	4.65	4.00
35-39.....	2	2	4	3.51	4.65	4.00
40-44.....	1		1	1.75		1.00
45-49.....						
50-54.....						
55-59.....						
60-64.....	1		1	1.75		1.00
Total.....	57	43	100	100.00	100.00	100.00

The age groupings of the cases and the control individuals who were not attacked are tabulated below:

Age.	Scarlet fever cases.		Controls.	
	No.	Per cent.	No.	Per cent.
Under 20.....	58	58.00	56	47.88
Over 20.....	42	42.00	61	52.12
Total.....	100	100.00	117	100.00

The sex distribution of cases and of controls was as follows:

Sex.	Scarlet fever cases.		Controls.	
	No.	Per cent.	No.	Per cent.
Male.....	57	57.00	37	31.62
Female.....	43	43.00	80	68.38
Total.....	100	100.00	117	100.00

Although the two groups are obviously at some variance in the matters of age and sex, they are so much alike in other particulars that the variations do not destroy the value of the control series.

The sanitary condition of the premises where the patient, or the control individual, lived were as follows:

Sanitation of homes.				
	No. cases.	No. controls.	Per cent. cases.	Per cent. controls.
Excellent.....	39	40	39.00	34.19
Good.....	29	43	29.00	36.75
Fair.....	21	33	21.00	28.21
Poor.....	11	1	11.00	0.85
Total.....	100	117	100.00	100.00

The epidemic was not confined to any economic status. Both the poor and the more prosperous were attacked.

Whether or not they had meals away from home during the ten day period before onset, or for controls before the date of the history, was determined for both groups. The results were:

Meals away from home.				
	No. of cases.	No. of controls.	Per cent. of cases.	Per cent. of controls.
Yes.....	29	27	29.00	23.08
No.....	71	90	71.00	76.92
Total...	100	117	100.00	100.00

Inquiries regarding attendance at picnics or large public gatherings of any kind gave the following results:

Attendance at picnics or large public gatherings.				
	No. of cases.	No. of controls.	Per cent. of cases.	Per cent. of controls.
Yes.....	10	7	10.00	5.98
No.....	90	110	90.00	94.02
Total...	100	117	100.00	100.00

The frequency with which milk was used by cases and controls was:

Milk—use of.				
	No. cases.	No. controls.	Per cent. cases.	Per cent. controls.
As a beverage.....	65	71	65.00	60.68
On cereals.....	9	6	9.00	5.13
Coffee, tea, only.....	15	28	15.00	23.93
None.....	11	12	11.00	10.26
Total.....	100	117	100.00	100.00

The dairies from which the cases and controls obtained their milk, together with the proportion of the total city milk supply, furnished by each dairy, are listed below, and are shown graphically in Fig. 2.

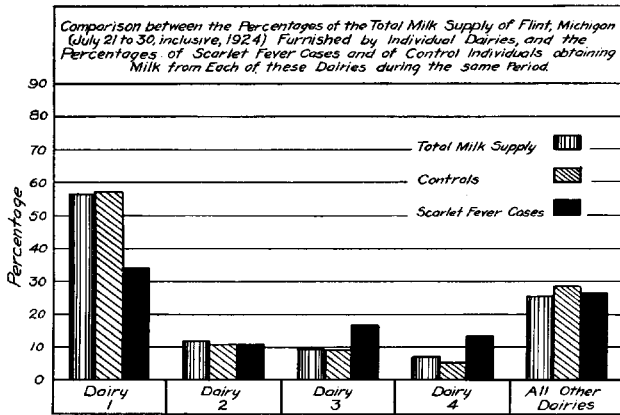


FIG. 2.

Dairies which furnished less than five per cent. of the total Flint supply are grouped under the classification "all others." The source of the milk supply for seven of the controls was not recorded.

Milk—source of supply.

Dairy.	No. cases obtaining milk from each dairy.	No. controls obtaining milk from each dairy.	No. gal. milk sold in Flint during period 7/21-7/30.	Per cent. cases obtaining milk from each dairy.	Per cent. controls obtaining milk from each dairy.	Per cent. of total city supply furnished by each dairy.
Dairy 1.....	29	46	33,535	32.58	46.94	46.40
Dairy 2.....	9	10	8,094	10.11	10.20	11.20
Dairy 3.....	15	9	7,105	16.85	9.19	9.83
Dairy 4.....	12	5	5,041	13.48	5.10	6.98
All others...	24	28	18,494	26.98	28.57	25.59
Total.....	89	98	72,269	100.00	100.00	100.00

All three percentages correspond rather closely. No single dairy

supplied a larger percentage of cases than would be expected, when the proportion of the city's total supply furnished by the dairy in question is considered.

The sanitation of premises, the histories of meals away from home, and of attendance at public gatherings, and the frequency of use and the source of milk supplies are negative. Cases and controls are similar groups in all these respects, and appear to be fairly representative samples of the population of Flint. With regard to known scarlet fever contact there is a slight, but not a significant variation. Eight or 8.0 per cent. of the cases reported such contact, and five or 4.3 per cent. of controls. The findings concerning the history of a previous attack of scarlet fever are more conclusive. They are as follows:

History of previous attack of scarlet fever.				
	No. of cases.	No. of controls.	Per cent. of cases.	Per cent. of controls.
Yes.....	4	11	4.40	13.41
No.....	87	71	95.60	86.59
Total...	91	82	100.00	100.00

The frequency with which ice cream was used by patients and by control individuals is not the same for the two groups:

Ice cream—use of.				
	No. cases.	No. controls.	Per cent. cases.	Per cent. controls.
Frequently.....	60	28	60.00	23.93
Occasionally.....	34	60	34.00	51.28
None.....	6	29	6.00	24.79
Total.....	100	117	100.00	100.00

The percentage of cases who ate ice cream frequently is much higher, and the percentage who used no ice cream much lower than the corresponding percentages among the controls.

The dealers who furnished the ice cream, and the cases and controls who used their products are shown as follows, with the proportion of the total city ice cream supply, sold by each dealer during the period, July 21-30.

Ice cream—source of supply.

Factory.	No. cases obtaining ice cream from each factory.	No. controls obtaining ice cream from each factory.	No. gal. ice cream sold in Flint during period 7/21-7/30 inclusive.	Per cent. cases obtaining ice cream from each factory.	Per cent. controls obtaining ice cream from each factory.	Per cent. of total city supply of ice cream furnished by each factory.
Factory A ..	77	17	1360	81.91	19.32	9.82
Factory B ..	5	10	4431	5.32	11.36	32.02
Factory C ..	5	18	2830	5.32	20.45	20.45
Factory D ..	3	12	2063	3.19	13.64	14.91
Others	4	31	3153	4.26	35.23	22.80
Total.....	94	88	13837	100.00	100.00	100.00

Of all the cases investigated, 81.91 per cent. partook of ice cream made by Factory A; yet this factory sold only 9.82 per cent. of the total city supply. Of the controls, 19.32 per cent., as compared with 81.9 per cent. of cases, ate Factory A ice cream.

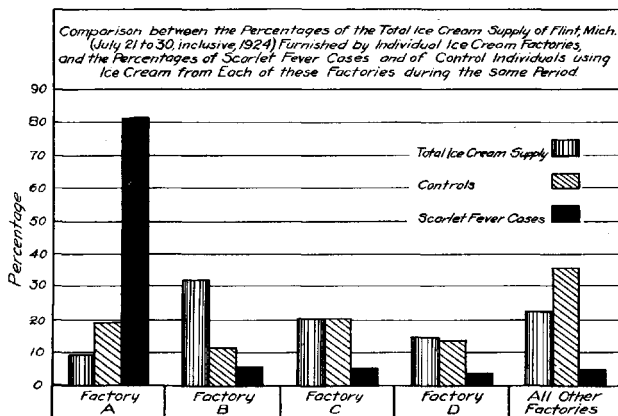


FIG. 3.

The scarlet fever patients who were known to have used A company ice cream, and those who gave no such history are listed by date of onset below:

Date of onset.	Number using "A" ice cream.	Number not using "A" ice cream.	Per cent. using "A" ice cream.	Per cent. not using "A" ice cream.
July 25	2	0	2.60	0.00
26	3	3	3.89	13.04
27	3	0	3.90	0.00
28	20	4	25.97	17.39
29	23	4	29.87	17.39
30	8	1	10.39	4.35
31	7	1	9.09	4.35
August 1	6	2	7.79	8.70
2	1	3	1.30	13.04
3	0	3	0.00	13.04
4	2	2	2.60	8.70
5	1	0	1.30	0.00
6	1	0	1.30	0.00
Total...	77	23	100.00	100.00

None of the suspected ice cream was sold before July 25, and none after July 30. Undoubtedly, the majority of it was consumed on July 26, and July 27. Forty-three or 55.84 per cent. of the persons using A Company ice cream were attacked on July 28 and July 29.

The date of onset of twelve patients was later than August 1. Only four of these individuals had eaten A Company ice cream. The incubation period of the disease appears to have been short. In the majority of cases it was not longer than forty-eight to seventy two hours, and probably was not longer than five days in any one case.

OUTBREAKS IN NEARBY VILLAGES.

From July 28 to August 2, nine cases of scarlet fever were reported from Mt. Morris, a village with 1,500 inhabitants, five miles from Flint. During the same period three cases were reported from Goodrich, a small hamlet whose population is 400. Like the patients in Flint, the epidemiological findings with regard to contact, sanitary conditions, and milk supplies were negative, but seven of the nine Mt. Morris cases, and two of the three Goodrich cases gave a history of having eaten the suspected brand of ice cream. In checking the order book of this concern, it was found that from July 21-30 no ice cream was sold outside the city of Flint by A company except in Mt. Morris and Goodrich. No abnormal incidence of scarlet fever was reported from any of the other villages near Flint. These two outbreaks were apparently of the same origin as the Flint epidemic.

THE MANUFACTURE OF THE SUSPECTED ICE CREAM, AND
ITS CONTAMINATION.

The A ice cream company bought the prepared "mix" for their product from a large creamery, located in a neighboring village. The "mix" consisted of cream, milk, and condensed milk, and was pasteurized at the creamery. Besides to the A company, the creamery sold the "mix" to a number of other ice cream manufacturers, including one other Flint factory, among whose customers no abnormal incidence of scarlet fever was reported. For this reason, and because of its pasteurization, the contamination of the "mix" at the creamery seems decidedly unlikely.

When the "mix" arrived at the A factory, it was dumped from ten gallon cans into a pasteurizing vat with a hinged cover and thoroughly stirred. During this, and all of the other processes of manufacture, the material was handled by Mr. Lee, who is known to have been suffering from scarlet fever at the time. The stirred mix was not allowed to stand for "ripening," as is the usual custom of ice cream makers. It was at once dumped into the receiving, or feed tank of the ice cream freezer. Except for a very coarse meshed screen, the top of this feed tank was open. The flavoring materials were added at this point.

Once in the freezing compartment, the mix was enclosed. The frozen ice cream, still of a flowing consistency, was released by means of a shutter into a packing can. It passed through the shutter opening rapidly, and in large volume, into the open can. The frozen mass was packed down into cans, and set away to harden at a low temperature (about 10° F.) in large wooden vats filled with cracked ice and salt. The cans were covered with wax paper and then a metal top.

Opportunities for contamination were obviously numerous. Lee might easily have infected the ice cream while he was carrying out any one of the processes incident to its manufacture. It seems most probable that the contamination occurred by his coughing or sneezing when he poured the mix into the feed tank, or when he released the frozen mass from the freezer. Lee made no attempts to observe a consistently sterile technique, so that the contamination of any, or all, of his utensils must also be considered. Ice cream is a notoriously favorable medium for bacterial growth. The work of Buchanan (7), and Pennington and Walker (8), Heinemann (9), and Prescott (9) has established the fact that enormously high bacterial counts are practically always obtained from samples of commercial ice cream. Fabian (10) concludes that after the mix is pasteurized, every sub-

sequent operation has the general tendency to increase the number of bacteria. According to Pennington and Walker (8), the proportion of streptococci, as compared with other organisms, is strikingly high in finished ice cream—a statement which suggests that hemolytic streptococci of human origin would find ice cream a suitable medium for growth and multiplication.

The process of going through a "freezer" does not kill bacteria, and organisms can live through all the steps of the manufacture and storage of ice cream. Especially in a one-man, unsupervised factory, the "mix" and the frozen product can be very easily contaminated. That the A company's ice cream was infected with the causative agent of scarlet fever by its maker, a scarlet fever patient, is an entirely reasonable assumption.

DISCUSSION.

A rapidly developing epidemic in hot July weather, when scarlet fever is out of season, immediately suggested dissemination through some food product. The results of detailed investigations confirmed these suspicions, and definitely fixed the responsibility for the epidemic on an ice cream maker who continued working while he was clinically a scarlet fever patient. Mr. Lee made all of the ice cream sold by his company over the week end of July 26, a pleasant, warm Saturday and Sunday which invited ice cream consumption. Of the 116 patients, 62 or 53.45 per cent. were attacked within three days of this Sunday, and an additional 36 or 31.03 per cent. during the following week.

Milk supplies were found to have no relation to the outbreak. The patients had no such opportunity for infection as would be afforded by contact at a large picnic, or public gathering, and they had not taken meals at any common eating place. Both adults and children were attacked.

The scarlet fever diagnosis of Mr. Lee cannot be questioned, if one accepts the production of potent Dick toxin from his own hemolytic streptococci as a conclusive laboratory finding. That Mr. Lee could have infected the ice cream, he made, is a reasonable assumption from a bacteriological standpoint. The truth of this assumption we believe to be proved by the evidence at hand. The very general use of A ice cream by patients both in Flint and Mt. Morris, its markedly less frequent use by control individuals, and the fact that the A factory furnished only 9.82 per cent. of the total Flint supply, all point clearly to the ice cream as the source of the epidemic.

SUMMARY.

1. Outbreaks of scarlet fever spread by ice cream are seldom mentioned in the literature.

2. An epidemic of scarlet fever which totalled 116 cases occurred in Flint Michigan from July 25 to August 10, 1924. At the same time, nine cases were reported from Mt. Morris, and three cases from Goodrich, vilages near Flint.

3. Detailed epidemiological investigation, by means of case histories and control histories on well persons, confirmed early suspicions and established the fact that the epidemic was spread by ice cream.

4. A filtrate prepared from a culture of hemolytic streptococci, isolated from the ice cream maker, who caused the outbreak, gave typical reactions on individuals known to be Dick positive.

5. The ice cream made by this man was eaten by 81.91 per cent. of cases investigated, but comprised only 9.82 per cent. of the total Flint supply. It was used by only 19.32 per cent. of control individuals.

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