Last year's outbreaks of salmonellosis in Philadelphia reemphasize the need for vigilant health department supervision of food processing and distribution practices.

Smoked Fish as a Vehicle of Salmonellosis

By I. OLITZKY, Ph.D., A. M. PERRI, M.D., M.P.H., M. A. SHIFFMAN, D.V.M., M.P.H., and M. WERRIN, V.M.D.

DURING the 1955 Memorial Day weekend, May 28–30, there occurred in Philadelphia three outbreaks of gastroenteritis in which smoked fish was the vehicle for the transmission of *Salmonella* organisms. The events preceding and including the outbreaks have the elements of a classic picture of *Salmonella* food infection.

To those concerned with the public health aspects of food production, distribution, and consumption, it has long been apparent that delicatessen foods are always potential vehicles for bacterial intoxications and infections. The factors supporting this potential are: The foods are generally consumed without further cooking, and some processors and many distributors and consumers disregard their perishable nature.

More than a decade ago, Kleeman, Frant, and Abrahamson (*1*) reported in detail two outbreaks in New York City of food poisoning associated with smoked fish. These events led to changes in the New York City Code with respect to the production and distribution of smoked fish products (*2*). One of the outbreaks affected 47 persons in 18 families and resulted in 2 deaths. The investigation of the food plant where it occurred revealed the following epidemiological chain, quite similar to that observed in Philadelphia.

Fish in the plant were contaminated with *Salmonella typhimurium*, apparently conveyed by sewage in the washing, soaking, and brining vats.

The process of salting and smoking the fish was not drastic enough to destroy the pathogens.

The lack of refrigeration throughout the entire food distribution system provided almost ideal temperatures for bacterial growth.

All four authors are associated with the Philadelphia Department of Public Health, Dr. Olitzky as principal bacteriologist and assistant chief, public health laboratory section, and his colleagues as chiefs of their respective sections: Dr. Perri, communicable disease control; Dr. Shiffman, milk and food sanitation; and Dr. Werrin, veterinary public health.

Smoked Fish

The annual processing and consumption of smoked fish in the United States—of kippered salmon, smoked sablefish, smoked whitefish, smoked carp, lox, and similar products—amount to millions of pounds. Even with this volume, the methods of processing have not been touched by technological advances, partly because, perhaps, many of the processing plants are small businesses, family-owned.

In the past, smoking of foodstuffs was essentially a means of preservation. With modern methods of preservation based on low-temperature storage, there is less need for a heavy smoke. In effect, the light smokes now used are primarily for flavoring the fish.

There are many variations in the smoking process for different types of fish and other food products. One variation applies to the preparation of kippered salmon, one of the products implicated in the Philadelphia outbreaks.

Salmon are usually received in a frozen state and are thawed in tanks or in running water. After thawing, each fish is split and cut into approximately 1-pound pieces, which are then brined from one-half to 2½ hours in a salt solution having 90° to 95° salometer reading. The fish, after being dyed a uniform color with certified dye, are placed on small hooks on wire-bottomed trays. The fish are allowed to drain in the smokehouse racks for several hours and then are heat dried at 80° F. for 8 to 12 hours. To finish off the kippering process, the fire is built up with sawdust and wood chips or shavings to give a hot smoke for about 1 hour at 175° to 180° F. The kippered salmon are cooled by means of circulating air, and then they are wrapped by hand.

There is no question that fish processed in the manner described are perishable products, to be kept under constant refrigeration. The wrappers on the kippered salmon in the Philadelphia outbreaks were clearly printed with a notation that the product was perishable and was to be refrigerated, but we found that these instructions were generally disregarded by the retailers. We found also that whitefish and lox are distributed unwrapped.

The Philadelphia Outbreaks

The first outbreak of salmonellosis in Philadelphia, designated the W family outbreak, was reported as food poisoning to the communicable disease control section of the City of Philadelphia Department of Health on June 2, 1955. The mother in the family and her two children had symptoms of fever, abdominal pain and diarrhea at 6 a. m., Saturday, May 29. The family had eaten smoked whitefish, kippered salmon, bagels, and cream cheese at 6 p. m. the evening before, May 28. The father ate the food but did not become ill.

The two children were hospitalized for treatment by their family physician. Stool cultures performed at the hospital were reported as negative for enteric pathogens, but cultures performed at the public health laboratory on July 2 were positive for *Salmonella newport.*

On June 3 a sanitarian from the health department milk and food section visited the W family. Fortunately, some of the fish was still in the refrigerator, uneaten, and he took it to the laboratory for analysis. The finding of large numbers of *Salmonella* organisms in the fish alerted the department to expect reports of other cases of food poisoning since large quantities of smoked fish products are consumed on weekends.

The pertinent facts of the W family cases and of the other 2 Philadelphia outbreaks are given in table 1. The children and mother in the W family are listed here as cases 1, 2, and 3, and the father, who was not ill, as case 4.

The S family outbreak was the next. The mother, father, and 2 children in the family ate smoked whitefish at 10 a. m. on May 29. The 2-year-old child (case 5) became ill 47 hours after the meal and was treated at a local hospital where her illness was diagnosed as salmonellosis.

The other members of the family (cases 6, 7, and 8), although asymptomatic, were found on routine culturing to be excreting *S. newport.* The grandmother (case 9) of the children took care of the sick child, and, although she did not partake of the food, she became ill with fever and diarrhea on June 10. Cultures taken from her on June 16 were found to be positive for *S. newport.*

The third and largest outbreak occurred as the result of a buffet supper, attended by some 30 persons, on May 29 at 6 p. m. Immediate steps were taken June 5 to study the outbreak after an alert practitioner telephoned the department that he was treating four patients who had symptoms of food poisoning.

Most of our information about the supper was obtained at the home where it was served. The foods consumed were smoked whitefish, lox, tunafish, salmon salad, potato salad, hard-boiled

Table 1. Cases of salmonellosis in the Philadelphia outbreaks, 1955

Case	Sex	Age	Incubation period (hours)	Dates of positive stool cultures	
				First	Last
	W family: Food eaten May 28, 6 p. m.				
1	Male	6	12	July 2	July 2
2	Female	3	12	do	Do.
3	do	29	12	[1]	
4	Male	32	[2]	[1]	
	S family: Food eaten May 29, 10 a. m.				
5	Female	2	47	Sept. 9	Sept. 9
6	do	30	[2]	June 10	July 14
7	Male	36	[2]	do	June 10
8	do	7	[2]	June 16	July 14
9 [3]	Female	55	?	do	June 16
	Buffet supper: Food eaten May 29, 6 p. m.				
10	Female	37	9	July 1	July 15
11	Male	50	[2]	[4]	[4]
12	do	30	12	June 15	June 15
13	Female	25	[2]	do	Do.
14	Male	32	24	June 9	June 9
15	do	5	24	do	Aug. 1
16	do	53	20	[1]	
17	Female	49	20	[1]	
18	Male	32	24	July 1	July 1
19	Female	26	24	[4]	[4]
20	Male	58	24	[4]	[4]
21	Female	46	39	June 14	June 14
22	Male	46	89	June 8	June 8
	Carrier: Food source unknown				
23 [5]	Female	30	?	June 10	June 10

[1] No cultures made. [2] No illness. [3] Grandmother who took care of grandchild (case 5) became ill on June 10. [4] No positives. [5] Carrier found at plant A was ill on May 6.

eggs, blintzes, sour cream, noodle pudding, and ginger ale. The smoked fish products were eaten by 13 people. Eleven of them became ill.

The case histories revealed that the incubation periods ranged from 9 hours to 89 hours with a mean of 26 hours.

Case 10 became ill on May 30 at 3 a. m. and had severe abdominal cramps, vomiting, and diarrhea. Case 12 became ill at 6 a. m. and had similar symptoms and chills as well. Case 13, wife of case 12, ate some of the food but was not ill. Case 11, husband of case 10, also remained asymptomatic after partaking of the food.

Eight persons, cases 14–21, became ill 24 hours after the supper. All 8 had symptoms of severe diarrhea and abdominal pain, and 1, the hostess (case 21), was hospitalized. Case 22 became ill 89 hours after the meal. He had chills, slight fever, and abdominal pain.

A stool culture taken from the hostess on June 14 was positive for *S. newport*. The organism was isolated also from the feces of 6 others and from 1 of the 2 asymptomatic individuals.

Food Processors and Retail Outlets

The health department started its sanitation investigation after receiving routine notification of the outbreaks in which smoked fish was the apparent vehicle. Calls at the affected households established where the fish products had been bought in each instance.

The kippered salmon eaten by the S family came from the J delicatessen, where sanitary conditions were found to be relatively good. The variety of smoked fish eaten by the W family was purchased at the G delicatessen, which had a refrigerated showcase in need of cleaning. The smoked fish products, however, were not stored in the showcase of the G delicatessen but were kept on top of the counter. The internal temperature of smoked whitefish tested at the store by our sanitarian was found to be 70° F. Presumably, the fish would stay on the counter until sold or otherwise disposed of and would remain at room temperature all the time.

The smoked whitefish eaten at the buffet supper had been purchased at the F delicatessen. There, too, the smoked fish were kept on a counter, fully exposed and unrefrigerated. The internal temperature of a sample smoked fish was 63° F. The fish were kept out all day at room temperature, and at closing time they were placed in a walk-in refrigerator, where the temperature was 36° F. There was some evidence of rodents in the storeroom although general sanitary conditions in the delicatessen were good.

Smoked fish are transported from the processor to the delicatessen in a refrigerated truck

where the temperature is maintained at about 40° F. One truck from processing plant A served the area containing the three retail outlets investigated. Since the sale of smoked fish products is heavy on weekends, and delivery of the fish usually precedes the weekend, it is quite possible that orders for all three stores came from the same shipment, but we could not ascertain that as a fact.

The processors said that they instruct the delicatessens about the need for refrigerating smoked fish because of its perishability. Nevertheless, many of the delicatessens fail to keep the products under refrigeration, and, since the stores may be open until the early hours of the morning, the fish are likely to remain at room temperature for a long time.

The Processing Plants

Each of the 3 retail outlets was served by the 2 food processors in Philadelphia who prepare smoked fish of the variety considered here. The A plant is located near the dock area on the Delaware River, where the buildings are old and where the original city was founded. Some attempts to improve the old building occupied by the A plant had been made. The floor was in fairly good condition in the room where the fish are thawed, washed, cut, brined, and wrapped. The walls had been recently tiled, and stainless steel tables had been provided for cleaning the fish and for the final wrapping. Housekeeping was poor. Boxes, odd containers, and miscellaneous objects and racks had accumulated on the floor and under tables. The windows were not effectively screened, and a dead mouse was found in the storeroom.

Most germane to the outbreaks was the condition of the toilet rooms and the handwashing facilities. The toilet rooms used by employees in the processing and wrapping operations were remote. The water closets were barely operative. The basin for handwashing was not provided with hot water. The cold water barely flowed. No sanitary towels or soap were available. The entire toilet premises were encrusted with a long-standing accumulation of dirt.

Conditions were generally good in plant B, which is housed in a relatively modern building. Even there, however, a handwashing basin adjacent to one toilet room did not have flowing water because of inadequate supply lines. When large quantities of water were used elsewhere in the plant, water would not run out of the faucets in the wash basins.

During the first inspection of processing plant A, samples of water from the soaking tanks, samples of brine from the salting tanks, and samples of freshly processed fish ready to be sent to the retail outlets were collected and taken to the laboratory for bacteriological analysis, shown in tables 2 and 3. The results of the analysis of water and brine from the plant are in line with the insanitary conditions there.

Table 2. Bacteriological findings in water and brine from plant A

Bacteria	Water		Brine
	Tank 1 [1]	Tank 2 [2]	
Coliforms (MPN/100 ml.)	9, 300	2, 100	110, 000
Escherichia coli (MPN/100 ml.)	700	400	15, 000
Enterococci (MPN/100 ml.)	930	90	230
Bacterial count (plate) per ml	14, 000	1, 500	16, 000

[1] Tank used to wash fish. [2] Tank used to soak and store salmon filets.

Table 3. Bacteriological findings in smoked fish from plant A

Bacteria	Kippered salmon	Smoked whitefish
Bacterial count (plate) per gram [1]	900	1, 580, 000
Staphylococci (coagulase-positive) per gram [2]	0	31, 000
Enterococci (MPN/gm.) [3]	0	0
Salmonellae	0	0

[1] Plate count agar (Difco). [2] Salt agar similar to mannitol salt agar (Difco). [3] SF medium (Difco).

It is of interest to compare the bacteriological findings of the fish samples from the A plant with the findings for the fish obtained from the W household, in tables 3 and 4. It is readily apparent, particularly with respect to the kippered salmon, that the bacterial population increased tremendously by the time the fish reached the consumer.

Table 4. Bacteriological findings in smoked fish from W family outbreak [1]

Bacteria	Kippered salmon	Lox	Smoked whitefish
Bacterial count (plate) per gram	1.3×10^{9}	20×10^{9}	180×10^{6}
Staphylococci (coagulase-positive) per gram	26×10^{6}	6.5×10^{6}	6×10^{6}
Enterococci (MPN/gm.)	11×10^{6}	11×10^{6}	11×10^{6}
Salmonella newport	Present	Present	Present

[1] Culture media the same as listed in table 3.

Source of Salmonella Organisms

At the same time plants A and B were being subjected to sanitary inspection, a medical officer from the communicable disease control section of the health department visited both processing plants and arranged to collect fecal samples from all employees. He examined approximately 70 employees and found one, an employee in plant A, to be excreting *S. newport.* Finding of the salmonella carrier was reported by the laboratory on June 13, 11 days after the first cases were reported to the health department.

The carrier (case 23), a woman aged 30, gave a history of illness beginning May 6, 1955, 3 weeks before the outbreaks. She had fever, abdominal pain, and vomiting, and was treated in the outpatient department of a local hospital. The hospital, however, made no effort to take cultures or to diagnose the illness of the patient, who continued to work at the processing plant until she was discovered to be a carrier. In this particular instance, the failure of the hospital to take a culture from a patient with an obvious gastrointestinal complaint had serious consequences.

Upon questioning, the owners of plant A denied that the carrier handled, wrapped, or packed smoked fish, but the carrier, when questioned, stated that she wrapped and packed smoked fish 7 out of 8 hours a day.

Discussion and Conclusions

Improved bacteriological techniques and more conscientious reporting of cases by hospitals and practitioners than in the recent past are the main factors behind the apparent increase in outbreaks of salmonellosis in Philadelphia as well as throughout the rest of the country. Salmonellosis was made reportable in Philadelphia in 1944 and in the State of Pennsylvania in 1952. Typhoid and paratyphoid A and B infections have been reportable to the Pennsylvania State Health Department since 1861.

To this day, however, many outbreaks of salmonellosis in family groups are not reported. Because of the long incubation period perhaps, the family gives no thought to the probability that the illness may be due to a food infection. Many persons have been made conscious, and erroneously so, of virus infections. As a result, illness caused by *Salmonella*, which has a short course, may be mistaken for the so-called epidemic nausea, diarrhea, and vomiting of virus origin. Because of failure to perform laboratory studies, many cases of salmonellosis may go undiagnosed even though the sick are treated by physicians. There is no question, however, that practicing physicians have become increasingly aware that gastroenteritis may be due to *Salmonella* infections rather than to other causes.

Epidemiological investigations of food poisoning or food infection outbreaks often are frustrating experiences. Although the elements in the chain of events can be visualized and theorized, it is impossible in many instances to obtain solid laboratory proof to support the theory. Frequently, the suspected food is not available for analysis, or the source of the etiological agent, the carrier, cannot be found.

We were fortunate that the suspect food from one of the outbreaks was available to us and that analysis revealed the causative organism. Thanks to the cooperation of many physicians treating the victims, fecal specimens could be examined. We were able to find a carrier in one of the food-processing plants. The lack of washroom facilities in the plant was conducive to the establishment of the anal-oral route of infection. There was almost complete lack of refrigeration of the fish products in the local retail outlets. Thus, all the elements necessary to close the epidemiological investigation were present.

Salmonella newport

S. newport is the second most prevalent *Salmonella* type found in food infection outbreaks. *S. typhimurium* heads the list. *S. newport* is widely distributed in the United States. In studying 310 cultures of *S. newport* during the period 1934–47, Edwards, Bruner, and Moran (*3*) found that 220 cultures were isolated from cases of gasteroenteritis. A Public Health Service report (*4*) on food poisoning outbreaks in 1954 indicates that *S. newport* was often implicated in the 1,090 cases representing 22 outbreaks associated with food during that year.

S. newport itself would seem to be one of the more potent inciters of gastroenteritis in the *Salmonella* group. The carefully controlled feeding experiments reported by McCullough and Eisele (*5*) revealed that, of the *Salmonella* types used, *S. bareilly* and *S. newport* could produce illness with small dosage levels. One of the subjects became ill after ingesting 152,000 *S. newport* organisms. Although we do not know the number of organisms introduced to foods by the feces-contaminated hands of carriers, it is readily apparent in our study that the lack of refrigeration in the retail outlets did result in more than enough organisms to produce symptoms of gastroenteritis.

Salmonella Carriers

A convalescent carrier was the source of the etiological agent in the Philadelphia outbreaks. We do not know at this time what percentage, if any, of the others in the outbreaks will become chronic carriers.

The chronic carrier state in humans is rarely observed with salmonellae other than *Salmonella typhi*. Recent experiences indicate that the convalescent carrier state may last longer than was generally assumed. Every person reported as a case in the outbreaks and as having had a positive culture is being considered as a convalescent carrier, and cultures are taken as follows:

The first, second, and third stool cultures are taken at least 5 days apart, beginning after the 14th day of the last dose of any antibiotic or chemotherapeutic agent. If the first 3 cultures are negative, the fourth culture will be taken 1 month after the third culture. If any of the first 3 cultures are found to be positive, the person will be referred for further treatment. The fifth and sixth cultures will be taken a month apart, and the seventh culture will be taken at the end of the sixth month—again provided that the cultures are negative. If cultures taken from anyone from the fourth month on are positive, then the individual will be considered a chronic carrier of salmonellae and will be placed on a list of chronic carriers.

The results of the followup stool cultures on the cases to date of this report are shown in the last column in table 1. *S. newport* was found in the feces of some of the victims 2 to 3½ months after the outbreaks.

Lessons To Be Learned

Although the cases we report here are new, the lessons to be learned are old, but they are repeated again for the educational value attributed to repetition. We are aware that even the most rigid food-handler examination program is not perfect in detecting carriers of bacterial enteric pathogens. It is possible for a food handler to become a carrier soon after the annual or semi-annual fecal examination. Thus, in addition to legislation, the importance of educating management and workers in the food industry to the prime requirement of providing and using adequate washroom facilities is paramount.

The failure of retail outlets to refrigerate items that are highly perishable and that are consumed without further cooking cannot be condoned. It is quite apparent that health departments must exercise constant surveillance of local food processors, distributors, and retailers in order to enforce the refrigeration requirements of perishable foods.

The public must be educated to the fact that light smokes and salts used in present day smoked fish processing are not in themselves sufficient for the safe preservation of fish products.

Summary

We have described three outbreaks in Philadelphia in 1955 of salmonellosis in which smoked fish products served as vehicle for the transmission of *Salmonella newport* from carrier to susceptible consumer. Eleven adults

and 4 children were made ill directly by consumption of the food, and 1 adult was made ill through secondary infection. The chain of events leading up to these outbreaks was:

The failure of a hospital clinic to culture a stool specimen from a patient with gastrointestinal symptoms.

The failure of a food processing plant to provide adequate sanitary facilities for its personnel.

The failure of retail outlets to refrigerate a highly perishable food item.

REFERENCES

(1) Kleeman, I., Frant, S., and Abrahamson, A. E.: Food poisoning outbreaks involving smoked fish—Their epidemiology and control. Am. J. Pub. Health 32: 151–158, February 1942.

(2) Sanitary code of the city of New York. Sections 148 and 148a, Pt. 5, Regulations 85–97, October 1942.

(3) Edwards, P. R., Bruner, D. W., and Moran, A. B.: Further studies on the occurrence and distribution of *Salmonella* types in the United States. J. Infect. Dis. 83: 220–231 (1948).

(4) Dauer, C. C., and Sylvester, G.: 1954 Summary of disease outbreaks. Pub. Health Rep. 70: 536–544, June 1955.

(5) McCullough, N. B., and Eisele, C. W.: Experimental human salmonellosis. III. Pathogenicity of strains of *Salmonella newport*, *Salmonella derby*, and *Salmonella bareilly* obtained from spray-dried whole egg. J. Infect. Dis. 89: 209–213, November–December 1951.

Surgeon General Scheele Resigns

Effective August 2, 1956, Dr. Leonard A. Scheele resigned as Surgeon General of the Public Health Service to become president of Warner-Chilcott Laboratories.

Marion B. Folsom, Secretary of Health, Education, and Welfare, commented that Dr. Scheele's "imagination, skill, and resourcefulness" have played "a particularly significant role in the development of many new and expanded programs which have notably advanced the health of the American people."

Commissioned in the Regular Corps of the Public Health Service in 1934, Dr. Scheele gave 22 productive years to Government service, including 4 years in the armed services. He was appointed director of the National Cancer Institute in 1947 and was appointed Surgeon General in 1948.