STAPHYLOCOCCAL FOOD INTOXICATION DUE TO CHEDDAR CHEESE.[1] I. EPIDEMIOLOGY.[2]

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INTRODUCTION

Staphylococcal food intoxication is recognized as the most common type of food poisoning in the United States (3) (14) (8) (21). Even though food poisoning in general is poorly reported many different types of foods have been incriminated in staphylococcal food intoxications (3) (14) (21). In recent years, with improved supervision in sanitary production and processing of milk and dairy products and increased use of pasteurized milk, the number of reported cases attributable to milk and dairy products has been low (Table 1). Of the cases or outbreaks due to dairy products, those reported as being due to cheese are uncommon. This paper reports an outbreak of 200 cases due to cheddar cheese. Because of the infrequency of outbreaks of this nature, the literature on staphylococcal food intoxication due to cheese will be reviewed briefly.

TABLE 1—REPORTED OUTBREAKS OF STAPHYLOCOCCAL FOOD POISONING

Year	All Foods		Milk and Milk Products	
	Outbreaks	Cases	Outbreaks	Cases
1953	81	4045	1	?
1954	100	4868	4	114+
1955	102	4130	2	24
1956	111	4313	26	700+
1957	58*	1660*	0	0

SOURCE: Reference 4 and 5.

*Laboratory confirmed cases only. In prior years data included cases based on clinical diagnosis.

LITERATURE REVIEW

Vaughn (*20*) in 1884 stated "It is well known that cases of severe illness follow eating of some cheese." He observed that they were of frequent occurrence in the North German countries and the United States, while in France where much cheese was used there was no record of such cases. In 1884 he studied "poisonous or sick cheese" following a report of 300 cases of cheese poisoning in Michigan in a six month period. All the cheese involved came from one factory and the description of the manufacturing process indicates that it was cheddar type cheese. While staphylococcal food poisoning was not recognized at that time, he concluded that the causative agent was a chemical poison and not a bacterial one; however, he further concluded that "this chemical poison might be generated by the agency of bacteria."

According to Dack, (3) Dr. Sternberg, a United States Army Surgeon stationed at Johns Hopkins University in 1884 recovered micrococci from cheese produced in Michigan that had caused illness. He concluded, "It seems not improbable that the poisonous principle is a ptomaine developed in the cheese as a result of the vital activity of the above mentioned micrococcus or of some other micro-organisms which had preceded it and had perhaps been killed by its own poisonous products."

Jordan (*9*) in 1917 stated that cases of cheese poisoning were relatively numerous. He merely commented on "cheese poisoning" without elaborating, so this may or may not have been staphylococcal food poisoning. It should be remembered, however, that staphylococcal food poisoning was not generally recognized at the time of this report even though Barber (*2*) had demonstrated three years earlier that attacks of gastro-enteritis were caused by a toxin produced by staphylococci.

Levin (*11*) in 1917 examined some American cheese that had caused illness and isolated a toxigenic bacillus. Mention is made of this report because the term "cheese poisoning" was used and because a toxigenic organism was isolated even though it was a bacillus rather than a coccus. Stone (*18*) in a review mentions "Jack cheese" as being involved in a staphylococcal food poisoning outbreak.

MacDonald (*12*) described four severe cases of staphylococcal food poisoning in Great Britain from home made goat's milk cheese. *Staphylococcus aureus* was recovered from the cheese and from freshly drawn milk from one of the goats. The staphylococcal count on the fresh milk was 200 per ml, and there was no clinical evidence of mastitis.

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[2]Under the same title, in another issue, part II, Laboratory Evaluation, will be published.

Tanner (*19*) lists 21 cases in eight families in Germany as being due to staphylococcal enterotoxin in cheese based on symptoms and epidemiological evidence. Mandry (*13*) reported on three outbreaks involving 18 persons in Puerto Rico in 1930 in which cheese was involved. Staphylococci were recovered from the cheese in each outbreak. Filtrates of organisms isolated from two of the outbreaks were given to human volunteers and produced symptoms similar to those of the original cases. Jordan's (*10*) report included results of studies on the organism isolated from one of these outbreaks. In reporting 183 food poisoning outbreaks of the "toxin" type that occurred in Great Britain during a 10 year period, Scott (*17*) stated three were due to cheese.

The U. S. Public Health Service (*6*) has recorded several outbreaks during the period 1944-1952. In 1944, 71 cases occurred in Virginia due to cheese from which *Staphylococcus aureus* was recovered. In 1945 there were three outbreaks with one occurring in Kentucky involving 5 cases after eating "Asiago cheese" made in Wisconsin. Epidemiological evidence incriminated the cheese. Examination of cheese submitted by one of the families involved showed hemolytic coagulase-negative staphylococci. A specimen of cheese from the same factory and same lot revealed beta hemolytic coagulase-positive staphylococci. Seventeen cases in Puerto Rico resulted from eating a native type cheese made by a farmer in his home from milk from one of his cows. All persons who ate the cheese became ill including a family who purchased 3 ounces and distributed this among seven children, each child eating 10 to 12 grams. One child aged 4 died. Laboratory examination of the cheese showed contamination with hemolytic *Staphylococcus aureus* and *Escherichia coli*. Nine cases in two families in widely separated areas were reported from Indiana. Cheese manufactured by one company and distributed in both areas had been consumed by those who became ill. Samples analyzed from one area revealed the presence of staphylococci but organisms isolated from samples from the other area could not be positively identified. The cheese was ordered removed from the market and destroyed. There were no further outbreaks. In 1946 *Staphylococcus aureus* was recovered from "native type" cheese that caused three cases in Puerto Rico. In 1947 cheese made at a monastery was responsible for sixteen cases in four outbreaks in Kentucky in which *Staphylococcus aureus* was isolated. In 1948 three cases in Oregon were attributed to "cheddar type cream cheese" that had been held in an unrefrigerated show case for three months and from which hemolytic staphylococci were recovered. In addition, Dauer and Sylvester (*5*) recorded one outbreak from homemade cheese in 1953; nine cases from food containing cream cheese, and one family outbreak from cheese in 1954; nine cases due to cheddar cheese from which staphylococci were isolated from the center of unopened samples in 1955; and one outbreak with eighty cases from cheese sauce in 1956. In 1958, 60 cases were reported (*15*) from Indiana and Michigan due to ingestion of cheddar cheese produced in Wisconsin.

Allison (*1*) bacteriophage typed strains of staphylococci from 47 outbreaks of enterotoxin food poisoning of which five were isolated from cheese. Four of these were from the United States. One was from Egypt and he indicated that cheese seemed to be a common vehicle of staphylococcal food poisoning in that country.

In reviewing the above reports, it is apparent that in some outbreaks complete studies were done even to the point of using human volunteers for confirmation. In some of the reports, the diagnosis was based on less conclusive, but reasonably substantial data. In other instances there was no indication of the basis for diagnosis.

A very obvious point observed in reviewing these reports is the inadequacy of explanatory data on the type of cheese involved. The vehicle was specified as "cheddar" cheese in only three instances. In another the description of the process used to manufacture the cheese indicated it was of the cheddar type. From the literature the impression is gained that staphylococcal food intoxication due to commercially manufactured cheese is rare but does occur.

Perhaps some of the outbreaks noted above should not be included in a summary of staphylococcal intoxications due to cheese. The outbreak due to "cheese sauce" is an example. It appears that cheese may have been involved as a vehicle only by chance and that a sauce of other foods not containing cheese may have served equally as the vehicle. It is listed here, however, since it was a cheese mixture and since it was staphylococcal food poisoning.

IOWA OUTBREAK

Two hundred persons suddenly became ill Sunday evening, August 24, 1958, at a state institution with a population of about 1100 adults almost all of whom were apparently healthy before this outbreak. Most of the cases developed during a two hour period about 3 to 5 hours after the evening meal. The illnesses were characterized by sudden onset, nausea, repeated vomiting, severe diarrhea, abdominal cramps and exhaustion. Three or four patients had a

slight trace of blood in the vomitus or stool. In most cases the vomiting and diarrhea lasted 2 to 3 hours. On Monday morning almost all were sufficiently recovered to resume usual activity. One remained in bed until Tuesday because of exhaustion. Another who previously had been having trouble with a duodenal ulcer had an acute exacerbation of ulcer symptoms and was hospitalized for about four weeks.

Because of the symptoms, the explosive nature of the outbreak, and the fact that it occurred 3 to 5 hours after the evening meal, staphylococcal food poisoning was suspected. The meal consisted of natural American cheddar cheese, rye bread, boiled beans with bacon, luncheon meat, coffee and sugar cookies.

TABLE 2—GROUPS OF PERSONS WHO ATE EVENING MEAL AND ATTACK RATES

Group No.	Classification	Meal Time	Total Persons	Cases	A/R
I	Kitchen Help	3:00	50	2+	4%
II	Main Group	4:15	650	180	38%
III	Additional Group	5:15	100	18	18%
IV	Hospital	4:15	100	0	0
		TOTAL	900	200	

The institution personnel were fed in four groups as shown in Table 2. The menu was the same for all groups except some persons in the hospital group who were on special diets. Approximately 200 did not eat this particular meal.

Supervisory personnel at the institution stated that all persons who became sick had eaten cheese; some ate only cheese and bread; however, not all persons who ate cheese became sick. Unfortunately it was not feasible to obtain detailed information needed to establish attack rates (*16*) among persons who ate each food item and those who did not.

A few case histories will serve as examples of the illnesses that occurred.

Case 1. A resident ate a cheese and rye bread sandwich and coffee at 5:15, became sick with nausea and abdominal pains about 9:15, and in the next two hours vomited 8 or 9 times and had 6 or 7 bowel movements. About 11:00 p.m. he was exhausted, went to sleep and had no more trouble.

Case 2. A resident ate only a cheese sandwich at 5:15 and became sick with nausea, diarrhea, vomiting and abdominal cramps about 9:00 p.m.

Case 3. A clerk in the steward's office, went to the kitchen cooler and cut a slice of cheese from a partially used wheel. He made a sandwich of cheese, luncheon meat and rye bread and took it back to the steward's office where he ate it at 5:30. He had no other food but drank a cup of coffee. About 8:30 he was nauseated, had abdominal cramps and later had diarrhea and vomited several times. He had about four liquid bowel movements per day for the following two days.

Case 4. Another clerk in the steward's office, made a sandwich in the same manner and with the same foods as Case 3. He ate at 5:30 p.m., drank water in place of coffee, became sick with nausea, vomiting and diarrhea about 8:30 p.m. and was exhausted to the extent that he remained in bed the following day.

Case 5. A staff member ate a slice of cheese about 3"x3"x⅛ to ¼ inch thick as it was being sliced about 11:00 a.m. Later he went off duty and returned home. He became ill about 3:30 p.m. with nausea, abdominal pain and chills. Between 4:00 p.m. and 8:30 p.m. he vomited 8 to 10 times and had an equal number of bowel movements. The following day he was exhausted but had no other complaints.

Case 6. On the following day institution officials were colllecting several cheese samples for laboratory examination. A helper boastfully said "There is nothing wrong with this cheese. I ate some yesterday. Nothing makes me sick anyway." He proceeded to eat a slice of the cheese being sampled. Four and a half hours later he complained of nausea and abdominal cramps, vomited, and developed diarrhea.

The foods on the menu for this meal were prepared and handled in the following manner:

1. The beans were boiled in a steam kettle starting about noon. Locally cured bacon was added after the beans were partially cooked.

2. The luncheon meat was a commercially prepared USDA inspected product and had been refrigerated prior to slicing and after slicing prior to serving. Portions of the same lot were served subsequent to August 24, without unfavorable results.

3. The rye bread was made at the institution.

4. The cheese served was from a shipment of about 1900 lbs. (61 wheels or flats representing 13 lots) received August 21 from the cheese factory* at another state institution. It was made during the period January 1-April 28, 1958. It had been shipped from the cheese factory to its destination, a distance of about 125 miles, in an uncovered truck and placed in the kitchen refrigerator at 40°F upon arrival about 3:00 p.m. The shipment was held in the cooler until seven wheels were removed for slicing at 11:00 a.m.

*Cheese from this factory was not distributed through commercial channels.

August 24. After removal of the rind, the cheese was cut into large rectangular pieces and then sliced on a mechanical slicing machine. The slices were placed on a tray with paper, from a roll of kraft paper, between each layer and returned to the cooler. It was not possible to determine identity of the wheels that were served, since identifying marks were destroyed in the cutting process. Thus the seven wheels may have come from any of the 13 lots that were represented in the shipment. Two men sliced the cheese and were said to be free of boils, cuts and other skin defects. They had not complained of any respiratory infections.

During the evening of the outbreak, institution officials suspected that the disease was food borne and collected samples of remaining foods. Specimens of cheese, rye bread, and luncheon meat were sent to the State Hygienic Laboratory. In addition, a sample of ice cream that had been served at the noon meal was submitted to the laboratory. Subsequently, additional samples were collected from remaining cheese at the institution. Samples also were taken at the cheese factory from remaining cheese of the same lots from which the institution shipment was made. Coagulase-positive beta hemolytic *Staphylococcus aureus* was recovered from 75 of 84 cheese specimens. All other foods were negative for staphylococci. Complete laboratory procedure and results are presented in the second paper of this series.

Since the laboratory findings indicated that the cheese was contaminated prior to being shipped from the cheese factory, a sanitary inspection of the cheese factory was made. The plant proper was of satisfactory construction but there was lack of room separation. The equipment (cheese vat, curd knives, rakes, agitator, whoops, etc.) that was used in the manufacturing process was in good repair and clean. The surge vat, separator, strainer buckets, and pipes were in a poor state of repair. The milk used for cheese manufacturing was obtained from an institution herd and 7 commercial dairy herds. Cans of raw milk were dumped directly into the cheese vat. Subsequent operations were essentially those generally used in the manufacture of cheddar cheese. The highest temperature of the milk during the cheese making process was about 100°F. The result was cheddar cheese made from unpasteurized milk. This fact was confirmed by phosphatase tests on the cheese.

Samples of the milk from herds supplying the cheese factory were obtained. Coagulase-positive beta hemolytic *Staphylococcus aureus* organisms were isolated from milk from two of the eight herds. The bovine bacteriophage patterns of these isolates were similar to those obtained from the cheese.

Tests on one strain isolated from one lot of the cheese using kittens indicated the strain was enterotoxigenic.

Nose and throat swab specimens were taken from all persons (six) working in the cheese factory at the time of inspection. One person was found to be a nose and throat carrier of coagulase-positive beta hemolytic *Staphylococcus aureus;* however, he was not working in the cheese factory during the January-April period when the cheese in question was made. Cultures from the five other employees were negative. Four persons who had worked at the plant during at least part of the January-April period were not available for tests.

DISCUSSION

The clinical manifestations of the illness, incubation period, epidemiological findings and laboratory results including kitten tests, indicate without doubt that the outbreak was due to staphylococcal food intoxication from natural American cheddar cheese. Since the cheese served at the meal was from 7 wheels taken at random from the shipment of 61 wheels representing 13 lots it is likely that cheese from more than one lot was used. Cheese from some of these lots had been consumed previously without unfavorable results being reported. Thus it appears some lots were safe and some were not. This may be one reason for the relatively low attack rate among the entire population that ate the meal. It was believed that everyone who ate the meal ate the cheese. The problem of determining which, if any, lots were safe and which contained enterotoxin arose. Since all lots yielded coagulase positive beta hemolytic staphylococci, it was concluded that all lots were potentially capable of causing gastro-enteritis. It was not feasible to do kitten tests on strains from all lots and there were no human volunteers. Finding staphylococci in the raw milk supply that were similar in bovine phage type to those found in the cheese manufactured earlier in the year from the same milk supply along with the fact that the milk had not been pasteurized indicated that contamination of the milk occurred prior to delivery to the cheese plant. The period during which the enterotoxin was produced is not known. It has been reported that staphylococci will multiply at 50-108° F but grow best at 98° F. (7). With proper cooling of milk on the farm, bacterial growth with resultant enterotoxin formation would be at a minimum; however, the temperatures of 86 to 100°F maintained for several hours during the cheese manufacturing process would promote rapid bacterial growth. In addition, the cheese was held at room temperature for 24 to 48 hours before it was placed in the curing room at

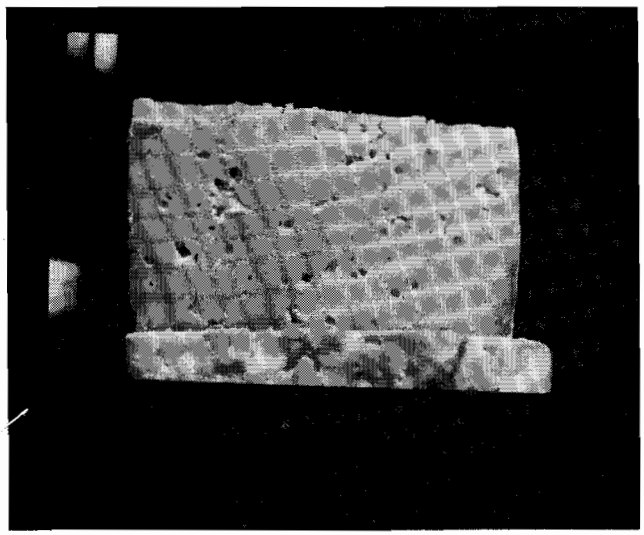

FIGURE 1

Droplets of fluid noted on freshly cut surface of this lot of cheese.

a temperature of about 36°F. In the process of obtaining samples of cheese, small droplets of fluid were observed on the freshly cut surface of cheese from one lot (Fig. 1) and on the slicing knife. This is of interest since Vaughn (*20*) also noted drops of a slightly opalescent watery fluid on the freshly cut surface of poisonous cheese.

SUMMARY

Two hundred cases of staphylococcal food intoxication resulted from eating natural American cheddar cheese that was 4 to 8 months old. The cheese was made from raw milk. Coagulase-positive beta hemolytic *Staphylococcus aureus* of similar phage type was isolated from the cheese and from the milk of two of eight herds supplying milk to the cheese factory.

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