Staphylococcal Food Poisoning

A Report of Two Related Outbreaks, and a Discussion of the Data Presented

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IT is the intention of this paper to present and discuss two distinct but related outbreaks of food poisoning caused by staphylococci which were present in baked hams. The interval between outbreaks was one week, and both hams were apparently contaminated at a similarly widely separated period of time by the same source. There has been secured from most of the persons reported ill in these outbreaks information concerning the incubation periods, the symptomatology, and the duration of illness. From these data, the frequency of occurrence of the various symptoms, the rate of recovery, and a correlation between the various incubation periods and duration of illness is presented.

INVESTIGATION OF THE OUTBREAKS

On June 22, 1949, the writer, District Health Officer for the Sixth Sanitary District, State of Wisconsin Board of Health, was informed by Dr. George M. Shinners, Commissioner of Health for the City of Green Bay, that Dr. F. B. Vande Loo of Wrightstown had just reported two separate outbreaks of food poisoning, each occurring one week apart, in that village. Dr. Vande Loo was contacted and from him it was learned that there had been a considerable number of persons who had become ill following the partaking of food at two weddings in the village. One wedding, the B-S, was on Saturday, June 11; the second wedding, the V-R, was on Saturday, June 18. In both instances food was served and eaten at the respective bride's parents' homes between 5 and 6 P.M. of the day of the wedding. Both homes were visited and complete lists of guests present at each wedding dinner were secured. A list of all foods available at each dinner was obtained, as well as pertinent information concerning the source and methods of preparation of the foods. Questionnaires were prepared and mailed to all the guests present at each of the dinners.

Eighty-five persons were present at the B-S dinner on Saturday evening, June 11. Of this number, 67 completed and returned the questionnaires. All of them had partaken of food at the dinner, and 34 or 50.7 per cent had become ill.

The V-R wedding was attended by 108 persons on June 18, and the physician's report of the outbreak was made simultaneously with that of the preceding one. Questionnaires were completed and returned by 87 of the 108. Thirty-nine of the 87, all of whom had been exposed to the food, became ill—44.6 per cent.

Of the 34 persons who became ill at the B-S dinner, 33 or 97.1 per cent had eaten baked ham. Of the 39 persons who became ill at the V-R dinner on June 18, all (100 per cent), had partaken of baked ham. It may be mentioned here that with the exception of three items, the foods available at the V-R dinner matched those of the B-S affair. The population of Wrightstown is about 600, and many of the families are of single ethnological stock and interrelated by marriage. What is remarkable, epidemiologically, is that none of those present at the first dinner were present at the second.

On June 22 (the day the outbreaks were reported), the remains of a whole ham, still unsliced, which had been eaten at the B-S dinner, was obtained from the B home where it had been kept refrigerated. On June 23, two hams used at the second wedding dinner on June 18 were obtained at the V home. One of the hams at the V home had been sliced completely, but the second ham re-

mained essentially whole. These also had been kept under refrigeration since the outbreak.

The hams used at both dinners were ordered through separate local grocers in Wrightstown. However, both local dealers had obtained the hams, completely baked, from a single source, R, in Green Bay. The Green Bay Health Department secured from R's the information that the hams in question were about 22 lbs. each, and were labeled graded hams. These hams are received by them, sealed and refrigerated, via railroad car. They are then stored under refrigeration, and delivered to the bakery by refrigerated truck. Baking of the hams was done in both cases by the B Bakery of Green Bay. The hams were prepared by rolling them in dough and baking them in the oven. Three employees of the bakery could have handled and contaminated these hams. Immediately after baking, the B. Bakery delivered the hams while still hot and completely covered by dough to each of the local Wrightstown dealers. In both instances, the hams were delivered at noon of the day preceding the respective wedding feasts. Information solicited from each of the grocers indicated that with delivery of the hams came the advice that the hams should not be refrigerated while warm. In each instance, the hams were obtained by the customers about 3 to 4 hours after they were received by the grocers, each of whom faithfully relayed advice against refrigeration. Thus, the hams were unrefrigerated for at least 24 hours before being eaten—enabling them to act as excellent media for that period of time. The dough seals of the hams were not opened until a short while before each dinner.

Bacteriologic study of the hams was made at the Green Bay Cooperative Laboratory. Swabs were taken by incising to the bone in the unexposed whole portions of the hams and swabbing the areas of meat nearest the bone. An excellent growth of Gram-positive hemolytic *Staphylococcus albus* was obtained from these hams. The three employees of the bakery who unsealed the refrigerated hams, rolled them in dough and baked them, were questioned and examined. None showed evidence of superficial skin, eye, ear, or finger infection. One of the bakers, however, did admit that he had had a mild "cold" about June 11 from which he recovered about June 18. Upon examination by Dr. George M. Shinners, this baker, and the other two as well, exhibited evidence of pharyngeal injection, whereupon throat swabs were immediately taken from all three suspects. Cultures revealed the presence of Gram-positive hemolytic *Staphylococcus albus*. Facilities were not available for a determination, by bacteriophage typing, of the similarity of strain of the staphylococci isolated from the hams and throats; nor could tests for enterotoxin production be conducted.

INCUBATION PERIOD

From the data procured in this investigation and presented in Table 1, the median incubation periods and interquartile ranges were determined for each outbreak, and (since there was no significant difference) for both outbreaks combined. The median incubation period for the B-S outbreak was 4.2 hrs., and that for the V-R outbreak was 3.0 hrs. The combined median is 3.35 hrs.

The interquartile ranges for the B-S and the V-R affairs were 3.0 to 5.4 hrs.,

TABLE 1

Number and Per cent of Persons Becoming Ill at Various Incubation Periods at each of Two Outbreaks and both Outbreaks Combined

Incubation period in hours	*B-S Outbreak*		*V-R Outbreak*		*Combined*	
	No. Becoming Ill	*Per cent Becoming Ill*	*No. Becoming Ill*	*Per cent Becoming Ill*	*No. Becoming Ill*	*Per cent Becoming Ill*
Under 1	1	3.2	0	0	1	1.5
1–1.9	1	3.2	4	10.7	5	7.4
2–2.9	3	9.7	6	16.2	9	13.2
3–3.9	5	16.1	17	46.0	22	32.4
4–4.9	8	25.8	5	13.5	13	19.1
5–5.9	6	19.4	3	8.1	9	13.2
6–6.9	1	3.2	0	0	1	1.5
7–7.9	2	6.5	1	2.7	3	4.4
8–8.9	3	9.7	1	2.7	4	5.9
9–9.9	1	3.2	0	0	1	1.5
Totals	31	100.0	37	99.9	68	100.1

TABLE 2

Frequency of Symptoms Reported at B-S and V-R Outbreaks

Symptoms	B-S Outbreak		V-R Outbreak		Combined	
	No. of Persons Complaining	Per cent of Total Involved	No. of Persons Complaining	Per cent of Total Involved	No.	Per cent
Diarrhea	28	82.4	27	73.0	55	77.5
Vomiting	26	76.5	28	75.7	54	76.1
Weakness	23	67.6	27	73.0	50	70.4
Nausea	17	50.0	15	40.5	32	45.1
Headache	14	41.2	13	35.1	27	38.0
Fever	7	20.6	9	24.3	16	22.5
Abdominal Cramps	5	14.7	6	16.2	11	15.5
Bloody Vomitus	6	17.6	3	8.1	9	12.7
Bloody Diarrhea	3	8.8	2	5.4	5	7.0
Leg Cramps	0	0	4	10.8	4	5.6
Thirst	0	0	1	2.7	1	1.4
No. of Persons Reporting	34		37		71	

Note: 2 persons reporting ill at V-R outbreak failed to mention symptoms.

and 2.4 to 3.65 hrs., respectively. The second outbreak was somewhat more "explosive" in nature.

SYMPTOMATOLOGY

The symptoms, in order of reported frequency, are listed in Table 2. Diarrhea and vomiting were present in slightly over 75 per cent of persons taken ill. Weakness was also a prominent complaint. The other symptoms, in descending order of frequency were: nausea, headache, fever, abdominal cramps, bloody vomitus, bloody diarrhea, leg cramps, and thirst. The parallelism in the frequency of these symptoms in each outbreak is noteworthy.

DURATION OF ILLNESS AND RATE OF RECOVERY

Table 3 presents information received concerning the duration of illness in each outbreak. The calculated median duration of illness for the first outbreak (B-S) was about 1 (0.99) day with an interquartile range between 0.5 and 1.7 days. The median duration for the second outbreak was about 2 (1.99) days, and the interquartile range between 0.6 and 3.35 days. The range of both outbreaks combined was 0.53 to 2.9 days, with a median of 1:25.

The rate of recovery is obviously more rapid in the first outbreak, the second outbreak seeming to require an extra day to achieve the same rate.

RELATIONSHIP BETWEEN INCUBATION PERIOD AND DURATION OF ILLNESS

A possible inverse relationship between the incubation period and the duration of illness is suggested by a consideration of the data. For example,

TABLE 3

Duration of Illness and Rate of Recovery

Duration in days	B-S Outbreak			V-R Outbreak			Combined		
	No. of Persons	Cumulative		No. of Persons	Cumulative		No. of Persons	Cumulative	
		No.	Per cent		No.	Per cent		No.	Per cent
Under 1	15	15	50.0	16	16	42.1	31	31	45.6
1–1.9	10	25	83.3	3	19	50.0	13	44	64.8
2–2.9	1	26	86.7	7	26	68.5	8	52	76.5
3–3.9	1	27	90.0	6	32	84.4	7	59	86.8
4–4.9	2	29	96.7	3	35	92.2	5	64	94.2
5–5.9	1	30	100.0	3	38	100.0	4	68	100.0
Total	30			38			68		

TABLE 4

Correlation Between Duration and Incubation

Incubation Period in Hours	*Duration of Illness in Days*						*Total*	*Midpoints of Incubation Period*	*Means of Duration Arrays*
	0–0.9	*1–1.9*	*2–2.9*	*3–3.9*	*4–4.9*	*5–5.9*			
1–1.9	..	..	..	..	2	2	4	1.5	5.0
2–2.9	4	2	2	1	..	..	9	2.5	1.5
3–3.9	8	2	4	5	1	2	22	3.5	2.3
4–4.9	9	2	..	1	1	..	13	4.5	1.2
5–5.9	5	1	1	1	1	..	9	5.5	1.6
6–6.9	..	1	..	..	..	..	1	6.5	1.5
7–7.9	1	1	..	..	..	..	2	7.5	1.0
8–8.9	2	1	1	..	..	..	4	8.5	1.3
9–9.9	..	1	..	..	..	..	1	9.5	1.5
Totals	29	11	8	8	5	4	65		
Midpoints of Class Ranges of Duration	0.5	1.5	2.5	3.5	4.5	5.5			
Means of Incubation Period Arrays	4.5	5.3	4.1	3.8	3.3	2.5			

Correlation Coefficient = 0.332

in the first outbreak (B-S) the incubation period mean was about 4 hrs., and the mean duration about 1 day; in the second outbreak (V-R) these are 3 hrs. and 2 days respectively.

Sixty-five of the cases studied had submitted information concerning both incubation and duration. From this information a correlation table (Table 4) was composed. The correlation coefficient is 0.332.

The following points become apparent:

1. In 13 of the 17 patients (76.5 per cent) who were ill for 3 or more days, the incubation period was less than 4 hrs.
2. Not one of the 17 who were ill for 3 or more days had an incubation period of 6 or more hrs.
3. Of the 8 persons whose incubation periods were 6 or more hours, only 1 was ill for 2 or more days.
4. With the exception of the first vertical column of the table, the longer the duration of illness the shorter was the incubation period. This relationship is not so consistent where the means of the duration arrays are calculated at the various midpoints of the incubation periods.

DISCUSSION

It is extremely difficult to estimate the incidence of illness due to food poisoning. The term "food poisoning" is used here in its commonly accepted sense today, and it does not include such well defined food-borne clinical entities as typhoid and paratyphoid fevers, amebic and bacillary dysenteries, scarlet fever and septic sore throat, and trichinosis. Neither does it include botulism, nor illness due to food-borne chemicals. In the sense in which it is here used it refers to those food-borne episodes of gastroenteritis produced by staphylococcal enterotoxin, or by foods contaminated with bacterial organisms other than those responsible for the diseases mentioned above. In fact, disease produced by staphylococcal enterotoxin should now be considered a clinical entity in its own right.

The difficulty in estimating the incidence of food poisoning in this country is due to several factors, the first of which is that such illness is reportable in about only 14 states of the United States. However, the clinical nature of the illness is such that relatively few cases come to the attention of the physician, with the exception of those

occurring in institutions. While outbreaks are often dramatic in onset, the duration of the acute illness is short, there are no direct sequelae, and the case fatality rate is negligible. Thus, what so often first appears as a typhoon soon leaves as a gentle breeze, with much initial excitement but no lasting damage. Not even a vague concept can be obtained of the thousands of cases which must occur in smaller outbreaks, or of the many others who may endemically present an almost sub-clinical picture. The following quotation, previously printed in this *Journal,* aptly expresses the situation in respect to reporting: "Sometimes newspaper accounts of such epidemics serve as the first notice to the health officer that something has happened."[1] This appears to be somewhat of an understatement to the writer whose experience has shown a ratio of four newspaper accounts to each official report. In a recent publication an effort was made to demonstrate that, according to the reports made to the U. S. Public Health Service, food poisoning is definitely increasing in incidence,[2] and in another it is stated that gastrointestinal diseases are a major cause of absenteeism in industry (18.6 to 30.6 per cent).[1]

This type of illness has been present among us ever since prehistoric man, in his struggles against the vagaries of nature, first learned to preserve food. And the same factors which have militated against our securing reasonable estimates of the incidence of this disease, have operated against our efforts to secure other essential knowledge. Thus, as recently as 1944, referring to poisoning by staphylococcus enterotoxin, Dolman[3] states, "from the onset the literature . . . has been rather confusing and contentious." And while this statement was made with particular reference to the physical properties of the enterotoxin, it can be extended with equal justification to its physiological properties, the vehicles of transmission, the severity and duration of the illness, and undoubtedly many other considerations.

It is chiefly due to the work of Dack, et al.,[4–6] who in 1931 showed that staphylococcus enterotoxin was responsible for many of the outbreaks, that the impetus was given for the clarification of an extremely confusing concept of the illness. Dolman,[1] who distinguished alpha and beta toxins from the enterotoxin, also contributed much toward this clarification. Despite the seemingly accepted status of enterotoxin gastroenteritis as a distinct clinical entity, one finds the current literature, and many standard references on the subject, replete with outmoded concepts and statements.

In this presentation of two apparently related outbreaks, it is realized that additional bacteriologic study would have been of utmost value. Determination of the identity of strain of the staphylococci isolated from the two sets of contaminated hams and then further identification with those found in at least one of the three positive throat cultures would have been ideal. The subsequent determination of the enterotoxin-producing ability of these identical strains would have left little to be desired. Unfortunately, as mentioned previously in this article, the available facilities were inadequate for such study. It is believed, however, in view of the short incubation periods and the clinical picture presented in both outbreaks, that an epidemiologic diagnosis of staphylococcus enterotoxin poisoning in which the vehicle was baked ham and in which the source of contamination was probably one or more of the bakers with positive throat cultures will not be disputed. It is believed that the information procured in these investigations, and the subsequent study of the data presented here may prove of some value.

Within the past decade the differentiation of food poisoning into two basic

types, the enterotoxic and the bacterial infectious has received universal recognition. Clinical differentiation is usually based on the marked difference in the incubation periods of the two types and occasionally on differences in the type and severity of symptoms and the duration of illness. It is in respect to the two latter, particularly, that recent American literature seemingly abounds in omissions and contradictions. In England, where the staphylococcus enterotoxin type is receiving belated recognition, it is not surprising that there should be little effort to present differentiations between the two forms clinically. But a review of the literature in this country, from the year 1943 to the present, also reveals the same situation, and in the few instances where these factors are considered there is great inadequacy and much variability.

The symptomatology enumerated in published reports of outbreaks of staphylococcal food poisoning varies tremendously. Not infrequently the illness is described by the presentation of two[5] or three[8, 9, 12] symptoms such as vomiting, diarrhea, and cramps or abdominal pain. In some reports 8 to 10 symptoms may be presented.[4, 7, 10] In only one report,[7] however, was there an effort to include a statistical analysis of the frequency of the symptoms (on 10 of 81 ill persons), and in only one clinical description was an effort made to present the major symptoms in order of appearance. Certainly more comprehensive and inclusive data along these lines is required for a proper differentiation in the clinical picture (if one exists) between these two most common types of food-borne illness, and such data are not difficult to obtain. In this paper there has been included a summary of the frequency of appearance of the symptoms in 71 of the cases involved. No effort was made to obtain a possible sequence for them. (I was not aware of the lack of information along these lines at the time of investigation.) It is recognized that there may be no appreciable difference in the clinical picture presented by the toxic and infectious types, but it is felt that this should first be determined before it is ruled out.

There is marked variation, as well, in reports of the severity and duration of this illness. Only too frequently these are expressed in terms which do not admit of proper evaluation. We thus find such descriptions of duration as:

various aches and pains were complained of for several weeks by some.[7]

60 per cent of the patients returned to work after the first week.[7]

the average hospital stay was 12–72 hours.[13]

recovery is usually prompt and occurs in 1–5 days. It may be prolonged in some cases for one to two weeks.[4, 10]

symptoms are short in duration, usually lasting 3–6 hours.[13]

in the majority the durations were 2–3 hours; in a few, 2–3 days.[8]

And in an exceptionally excellent report one finds, "Food intoxication due to staphylococci was also probably fairly common, but since these outbreaks were usually mild and of short duration, very few were investigated."[14] This, in spite of the fact that outbreaks of staphylococcal food poisoning have been reported at least as frequently as that for all other known causes combined.

If there is, then, so wide and vague a difference in reports of the duration of this illness, varying from 2 hrs. to 5 days, how much greater will be the variance for a factor such as severity of illness, which is much more difficult to evaluate? Estimates will range from "usually mild," as quoted above, to severe shock with cyanosis and cardiac arrhythmias"[7] mentioned in another report. Many elements must enter into any evaluation of the severity of an illness—the extent of the symptomatology, the severity of the symptoms which present themselves, the duration of the illness, the degree of incapacity or dis-

ability both during and after the attack, and the case fatality rate. There is little justification for broadly considering attacks of enterotoxin gastroenteritis as mild. It is felt that the mildness or severity of an attack will vary directly with the amount of enterotoxin ingested, its concentration in the gastrointestinal tract, the susceptibility of the individual, and the rate of destruction or excretion of the toxin. That this is true in respect to the incubation period, particularly so far as the first three factors are concerned, has been proved by Dack, Dolman, and others.

The presence of a rapid recovery rate might logically be expected to obtain from the ingestion of a preformed nonreproducing toxic agent which is not absorbed and is rapidly excreted or destroyed. This concept of lack of absorption is reinforced by failure of exposed individuals to develop immunity to the toxin except by subcutaneous injection.[3] It must be remembered that an illness may be short in duration, yet severe in character.

It was Dack who suggested a possible relationship between the length of the incubation period and the severity of the illness—"the illness tends to be more severe when the incubation period is short."[5] It is believed that the table of correlation between the incubation periods and durations which has been presented in this paper will offer some support to the generalization above.

SUMMARY

1. A report of two apparently related outbreaks of streptococcal food poisoning in which the vehicle was baked hams probably contaminated by the same source at widely separated periods of time is presented.

2. From information gathered in the investigation, data concerning the symptomatology, duration of illness, rate of recovery and a possible correlation between the incubation periods and duration of illness are discussed.

3. The need for additional, easily procured, data is stressed. This will remove a great deal of the confusion which seems to be evident in present concepts of the clinical nature of staphylococcus enterotoxin food poisoning.

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