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Food-borne diseases have been with us as a problem since the dawn of time. The foods have differed, the cause and means of their contamination have changed and are constantly changing, but so long as man eats it is a problem with which he must cope. Whether prehistoric man developed trichinosis, shigellosis or some other strange, presently unknown variant when he consumed his first mastodon is not documented but it's a good bet that he contracted something.

At times he has even himself played an unwitting role as the vehicle. A remarkable story in this vein is related of the Indians of the Windward Islands who abruptly, and as it turns out, for religious reasons, suddenly gave up cannibalism in the middle of the 16th century. These Indians commonly raided Puerto Rico and ate all that they could scavenge. On one of these ventures a monk was so obtained and after being duly seasoned and toasted was consumed. It is recorded that the Indians very shortly thereafter developed severe diarrhea; several of them died. And it was this, so it is told, that resulted in the termination of their cannibalistic practices.

Now, neither mastodon nor human appears on any of our current reports as the suspect vehicle in food-borne outbreaks. I wouldn't say that there have been no such episodes recently in this country - I can only say they haven't been recorded, for in this country the documentation of food-borne disease outbreaks is so poor that I doubt such an event would stand better than a one in twenty chance of being properly investigated and reported if it did occur.

A relative handful of outbreaks have been reported annually to the National Office of Vital Statistics. Of those reported, at least half have been investigated and evaluated in such a perfunctory manner as to produce meaningless results.

In 1959, for example, 38 States reported three or fewer food-borne disease outbreaks. Sixteen reported none. One State, California, reported 139, or over 40 percent, of all recorded in this country. I doubt California is such a hazardous State in which to eat but they have taken a more pronounced interest in the problem, in no little part I suspect, thanks to that distinguished senior statesman of food-borne disease, Dr. K. F. Meyer, who resides and works in San Francisco.

England in 1959, reported over 900 general and family type outbreaks. If all sections of the United States reported a proportionate number of outbreaks by population as recorded in England, we would have over 3,600 outbreaks per year - reported were 300. The simple fact is that the data we have at present are incomplete, inadequate and worth little more than the most perfunctory documentation from a national viewpoint.

In the face of this, we, as a nation, are coming to rely increasingly on partially or totally prepared foods, processed in central locations and distributed, with modern transportation, over increasingly wide areas. The potential for problems on an unprecedented scale is greater every day. This is a problem which cannot be ignored although in our complacency, there is a good chance that it will, until we experience an epidemic which approaches catastrophic proportions. Epidemics involving hundreds or even thousands will be insufficient.

Each local outbreak, however limited it may appear, should be treated with as much concern and dispatch as we now deal with a case of chickenpox in an adult. A case of adult chickenpox may simulate smallpox and smallpox must be seriously considered in the differential diagnosis. Similarly, each

food-borne outbreak, however limited its apparent scope, should be regarded potentially as part of a major Statewide or interstate outbreak until, similarly, proven otherwise.

The key to the problem lies primarily of course in the local health departments although a partial approach by means of the national surveillance of certain selected diseases known to be transmitted through foods, such as hepatitis and salmonellosis, has a real role to play as I shall describe later.

In local areas, the first requisite is a high index of suspicion. Any unusual incidence or cluster of cases of a disease whether by geographic area, by classroom in a school, or by organization should precipitate an immediate investigation. A change in the usual age distribution pattern in cases of disease particularly should be viewed with suspicion.

The investigation of suspect food-borne outbreaks is probably the least complicated type of epidemiological investigation carried out. In teaching epidemiology the approaches and methods used are discussed and taught to illustrate the most simple and comprehensible of the techniques used in epidemiology. Successful investigation need not and should not be the prerogative of the physician. Some of the best of the investigators I have been privileged to work with have included food and drug people, health educators, local public health nurses, and bacteriologists. They shared a number of attributes, however, particularly a healthy skepticism, persistence and a mania for detail.

Where, despite good motivation, notable failures have occurred, it has more often than not resulted from a fragmentation of the investigation such that different professionally competent individuals each took a phase of the

investigation and communication between the different groups was poor. This, I believe, is the most unfortunate circumstance of all. The problems of the field must often be solved in the laboratory or the warehouse and referred back to the field and in turn referred back to the laboratory or warehouse. It is most akin to solving a jig saw puzzle - only with all members of the group fully conversant with all pieces of the puzzle as they develop is it possible to form a coherent picture.

But let me cite a very mundane example: In one of our major cities in which functions a knowledgeable competent health department, an outbreak of over 50 cases of diarrhea subsequently shown to be salmonellosis occurred among a group of students. Investigation was carried out promptly and foods consumed at a single restaurant identified as the common factor to each of the students. So far so good. A routine inspection was promptly carried out at the restaurant but it was all too painfully apparent that the investigator had not been made a part of the team in the investigation. He reported, and I quote, "the inspection revealed: 1) Flies in kitchen; 2) Work table unclean; 3) Floor of cellar unclean; 4) Floor of refrigerator unclean; 5) Roast beef, Virginia ham and turkey on top of counter; 6) No evidence of rats or mice." So what? There is nothing here which says "why did this epidemic occur at this time and in this place?" Was the restaurant at fault, or more serious, was this a commercially prepared product shipped in interstate commerce? It's all past history now - no one will ever know.

A few years ago I had occasion to investigate an outbreak of botulism in a city not far from Buenos Aires. Twenty-one persons became ill, twelve died, sometime after eating at a well-known fashionable restaurant. The food had been

quickly identified as pimientos which are served raw in whole or half sections as a garnish or particular expensive dishes. Upon investigation, it was discovered that the restaurant owner purchased a commercially canned product which he emptied into an open casserole and from which he took portions as needed. Since, in Argentina, it is common practice to keep pimientos thus obtained under oil, it was assumed that all conditions had been right for the growth of the clostridia in the casserole. Clearly the owner was at fault. So strongly did the local populace feel, that an attempt had been made to burn the restaurant. The owner, however, denied using the layer of oil technique and, in fact, when we checked, there was no evidence of oil in the casserole. Further, a pH determination of the contents showed the material to be too acid to permit the active production of botulinus toxin. Through counting and weighing of pimientos from other cans, it could be shown that the entire outbreak was consistent with one can only having been contaminated. The evidence thus strongly pointed to the outbreak having been caused by preformed toxin in a commercially processed material. The owner was innocent - the problem, one of major national concern. I might add, parenthetically, that a year later the owner was found guilty and punished accordingly. The important point, however, is that the clinical, field and laboratory phases all contributed a necessary piece to the puzzle. To fit each piece, a thorough knowledge of the entire picture was mandatory.

Although the most important role in the problem of food-borne disease must be taken by local health departments, a program of national surveillance of certain major diseases can and has contributed materially in the detection of the more major interstate food-borne outbreaks. The potential for this approach has only begun to be realized. In brief, surveillance is concerned with a current

continuing appraisal of reported cases of a variety of the major diseases. Any unusual pattern of occurrence of cases on any epidemiological basis is discussed with the State health authorities and an effort is made to elicit reasons for the occurrence. Recently, this approach contributed materially to the recognition of the interstate epidemic of hepatitis related to the consumption of raw clams. Since this is a current problem, previously unrecognized and because of the significance of this epidemic both for the present and the future, I should like to relate its development from the inception of the investigation and conclude with a few observations on several problems about which we yet should still hear a good deal - the problems of marketing and harvesting raw shellfish.

The principal suspect area from which the clams derived in this epidemic has now been closed and presumably is still closed. However, as will become apparent, there is a notable analogy here to the eternal battle of wits between the Revenooers and the moonshiners. A major still has been seized but the problem is far from solved.

But let me document the steps taken in the investigation in which a great many persons on the federal, State and local levels have participated.

In March, we received in the Surveillance Section at CDC a sheaf of tabulations listing hepatitis cases in New Jersey by week, by age and by county. As we examined this we were particularly struck by one feature - 80% of the cases had occurred in adults. Normally, not more than 20 to 50 percent of cases occur among adults. When the proportion of adult cases exceeds this, there is generally very good reason and that reason is a common source outbreak.

A discussion with Dr. Bill Dougherty, the State Epidemiologist, suggested a ready explanation. Some months previous, they had uncovered an epidemic of serum hepatitis in a particular doctor's practice. There had been over 40 cases with 15 deaths. Immediately they had instituted a program to insure more complete reporting of hepatitis cases. Major hospitals throughout the State were called weekly to obtain information on the cases of hepatitis admitted. Since more adult than child hepatitis cases are customarily hospitalized, this appeared to be a logical answer - a bias in reporting. We agreed, however, that it would be well to check this hypothesis by field study. One county was selected. All pediatricians were called in an effort to uncover unreported childhood cases. The adult cases were called to confirm the diagnosis and to review briefly possible common sources. Surprisingly, when the review was complete, only two cases among children had been uncovered, three of the twenty-odd adult cases proved to be other than infectious hepatitis - the disproportionate occurrence among adults remained. Further, the adults comprised a unique group. They were largely comprised of quite prosperous business and professional men who traveled a good deal and ate out rather more frequently than the average.

Not three months before, an outbreak of hepatitis had occurred among a similar type group in Pascagoula, Mississippi and Mobile, Alabama. The cause - oysters taken from waters off the Mississippi Coast - the first recorded outbreak of hepatitis in the U. S. traceable to raw shellfish and only the second in the medical literature.

Impressed by the similar findings in New Jersey, a more intensive series of histories relating to raw shellfish consumption were obtained from persons

in the Newark area. Ten of the first 15 interviewed had consumed clams in the preceding 60 days. The immediate question - was this an unusual proportion of clam eaters among prosperous people in New Jersey? Control studies were carried out in three separate areas. The house of the victim was identified and persons in each of four families residing one block away were interviewed. Between 6 and 15% of those interviewed had eaten clams in the preceding three month period. Surprisingly, four of this control group who had consumed clams stated they had not been feeling well and, when asked as to the trouble, they complained of symptoms common at the onset of hepatitis, one man was overtly jaundiced.

Immediately, tracing was begun proceeding from the restaurant where clams were consumed, to the distributor to the wholesaler - a procedure not unfamiliar to those here. The restaurants mentioned were as numerous as the cases. The distributors often bought from two or three wholesalers and the wholesalers purchased commonly from a variety of sources depending on the season of the year and the availability of clams. To identify one ultimate source looked like a monumental task.

To uncover this source, we felt that if we could at least develop an hypothesis as to where on the Eastern Seaboard the clams were coming from, we could determine whether the distribution from this source corresponded with the restaurant eating pattern of cases. At this time we hadn't a tentative idea as to the source of the clams.

We learned at this time of 21 hepatitis cases occurring in South Delaware believed to be among adults. There was a rumor that clams were involved. A quick trip to Delaware revealed the cases to be part of a person-to-person type spread in a local high school. The investigation was extended, however, to Northern

Delaware and here five of thirteen cases admitted to having eaten clams in the preceding 60 days - the restaurants, two in Maryland, New York, Boston, and Miami.

A return to New Jersey and a review of the problem with them indicated little more success. At this time, we talked with some of the local buyers and clambers in hopes that with a better comprehension of the practices of the industry, we might develop some additional leads.

We learned that clamming is done essentially by independent operators who, technically at least, obtain these by raking or tonging. Certain waters deemed free of pollution are delineated by the health department as "open waters;" the policing is the responsibility of the Conservation Department. Dredging of clams under sail is legal, power dredging is not. It was, however, openly stated that power dredging was a common practice; it was usually done at night. Where a boat was equipped for sail dredging, it commonly employed a kicker to help it along. Policing of the closed waters was regarded as a laughable matter. Until recent date, the only effective policing had been carried out during the daylight hours; most of the boats carried radios and were alerted as necessary. The closed waters were essentially represented by areas where clams were absent. I should add that the only other State where this information was sought was New York State. The replies carried a somewhat different accent; the answers were the same.

The individual clambers sold to local buyers who in turn commonly sold some of the produce to fish stores and restaurants in the vicinity, but the bulk went to wholesale markets. It was stated that it had been a poor year in New Jersey and that few of the clams went through the Fulton Fish Market, the wholesale market in New York.

By this time, we had been informed of cases in Nassau and Westchester Counties, New York, in Connecticut and Rhode Island - clearly a distributional pattern suggesting dispersion through the Fulton Fish Market. The source, we felt, must lie further Northeast.

We proceeded Northeast to Nassau County only to find that the cases largely traced back to restaurants and distributors in New York City. There were none who obtained clams locally which might suggest a source on Long Island.

A quick visit to the Fulton Fish Market and a review of market records indicated that actually a fair proportion of their clams did derive from New Jersey. Actually, on the basis of evidence gathered at the market, we could exclude from consideration Maine, Georgia, Florida and Delaware, States accounting for probably 1% of the total clam supply.

At this point there was a break. Tracing of restaurant sources had been continuing apace in several States. The two Delaware cases who had eaten in Maryland were reported to have eaten clams sent up from Chincoteague, Virginia. One of the Nassau County cases traced via a New York restaurant and one of the New Jersey cases traced to a second New York restaurant also were believed to have consumed clams originally derived from Chincoteague.

Virginia we knew also permitted the use of floats, large pontoon supported structures into which clams could be placed and held for periods up to a month. We could, in our minds, picture one of these floating adjacent to a sewage outfall. When we got to Chincoteague, we found that the cases all traced to one dealer who accounted for perhaps 30% of the production in Chincoteague. The floats were anchored well offshore, there was no sewage outfall and no reported hepatitis for at least 6 months in the area. The dealer concerned purchased clams from various

New York sources during the fall months. These he planted. This process involves spreading the clams on a clam bed; the clams burrow, and within 48 hours via their rapid pumping and filtering system they are converted for bacteriologic purposes to Virginia clams. Throughout the winter this dealer continued to obtain clams, supposedly excess stock, from one dealer in New Jersey. These were held in the floats since, in winter weather, the clams hibernate - they become metabolically inactive, they do not pump water and will not bury when planted. Effectively, these remained New Jersey clams although immersed in Virginia waters. Since this was his only outside source, the arrow of suspicion pointed back again to New Jersey and to Raritan Bay.

Continuing investigations in the New Jersey area increasingly suggested Raritan Bay and now, with this hypothesis, the cases were checked to determine if the persons involved ate at restaurants receiving all or part of their supply from Raritan Bay. About 250 cases traced thus far (and this number will reach 500 or more in time) are presumed to have eaten Raritan Bay clams. About 30 ate clams which apparently derive from other sources. Some who consumed clams may have done so quite incidental to the development of hepatitis. However, at least ten of these relate to a clam bed off Greenwich, Connecticut where the persons concerned dug their own clams.

The residences of the New Jersey cases when plotted are shown to cluster closely around Raritan Bay. Many of the cases have been traced from Pennsylvania, New York, Rhode Island, Massachusetts and Connecticut. Most relate to clams shipped from Raritan Bay via Virginia, some individuals consumed the clams in New Jersey and other clams reached the consumers through distributors in the New York or Philadelphia market.

There are many additional corroborating pieces of epidemiologic evidence. We were anxious to determine, if we could, the exact source of the pollution on this very extensive bay. We hoped by relating substantial numbers of cases to one or more specific buyers that we could proceed to interview the clambers supplying them thereby delineating certain areas as more suspect than others. We soon learned that the 20 or so buyers sell back and forth to each other so frequently that identification of a specific one was impossible. Of the more than 100 clambers several sold to more than one buyer which further confounded the problem.

However, in interviewing the cases, we learned of a New Year's Eve party which had been given by a dentist and attended by some 20 persons. Eight consumed clams; five had diarrhea the following day. The diarrhea is significant for in many outbreaks in which polluted water or shellfish are consumed, diarrhea of a type referred to as "sewage poisoning" follows a day later and variably typhoid fever or hepatitis in about a month. One of the persons so ill developed hepatitis 40 days later. The dentist had obtained the clams from clambers on the Bay while out in his motor boat. He volunteered to take us to the exact spot. This spot interestingly was in closed waters, the clambers were from New Jersey, the waters were New York waters.

Clam samples were obtained from this and adjacent areas including open waters. The clams when pulled up were immersed in a black muck which the investigator asserted looked a lot like sewage sludge. In point of fact, as I shall mention he was probably correct. The specimens all yielded coliform counts above those considered maximum acceptable, the highest interestingly, coming from so-called open waters.

Additional evidence incriminated this area. The peak occurrence of cases in the epidemic appeared five to six weeks following the date at which the bay froze over and clamming was reported to be difficult to impossible. Close questioning of certain of the clammers revealed, however, that they were able to obtain clams even when ice covered much of the bay. Notably there is a ship channel which circles the end of Staten Island and is kept open year around; it was adjacent to the ship channel that the dentist obtained his clams. Tottenville, a town of 20,000, sits on the end of Staten Island and pumps raw sewage in profusion directly into this ship channel. The clams were proliferating, as was suspected, in sewage sludge.

Although Raritan has represented the major source, we know also of cases related to the Greenwich, Connecticut area. The Atlantic City area has thus far not been implicated in the outbreak. However, a number of scientific meetings were held in Atlantic City during April. Three separate scientists have queried their colleagues with respect to the occurrence of diarrhea associated with clam consumption. The results were all quite similar. To cite one study done by Dr. Levin in Buffalo: of 55 who ate no clams, 6 experienced diarrhea while of 17 who consumed clams, 10 came down with diarrhea. The Atlantic City clams are locally harvested; the diarrhea very likely is sewage poisoning. Hepatitis virus, fortunately, was not in the waters at that time. These waters have also now been closed by the State because of laboratory evidence of pollution.

As you think of it, the clam and oyster are unique in our dietary. These animals sit on the bottom pumping literally gallons of water daily - if sewage be in the water, I think of them as a sewage filter. (Notably, the Pascagoula oysters were said to have a sort of creosote taste; the clams from Raritan Bay

have for many years been less popular than others because they were said to have an oily, iodine taste.) This creature is dug off the bottom and shipped live to the consumer and it remains live essentially until dipped into a sauce and popped in the mouth - intestine and all. There is nothing we eat which is analogous.

Years ago, when typhoid was more of a problem, oysters, clams and mussels were regarded much more suspiciously than they are today. Over 150 years ago in France, the first cases of typhoid were attributed to eating raw shellfish. The first recognized outbreak in the U. S. occurred in 1894 in Connecticut and between then and the famous 1924 oyster typhoid epidemic there were 16 known outbreaks. England, more acutely cognizant of the potential of the problem during the 20's attributed one-third of their typhoid fever cases to the consumption of raw shellfish.

The 1924 oyster - typhoid outbreak in the United States which resulted in over 300 cases in Chicago, Washington and New York was regarded as a catastrophic event. (The number of cases which occurred, by the way, will be dwarfed by the present hepatitis epidemic.) The oyster industry suffered irreparable damage. A great deal of research and study followed.

The problems then were apparently little different than now and after a decade of study, this statement appeared in 1938 in a Report of the American Public Health Association Committee on Shellfish.

"With respect to waters from which shellfish intended for the half-shell trade may be taken, your committee is of the opinion, in view of the difficulties encountered in enforcing sanitary regulations to be observed by those engaged in gathering and marketing such shellfish, that before they can be considered to be

free of all possibility of spreading disease, they will have to be gathered from clean areas and then be passed immediately prior to shipment through a properly operated State supervised and licensed, cleansing or conditioning plant."

The war followed, cases of typhoid dropped and the shellfish problem became a forgotten chapter. The statement that shellfish, wherever taken, cannot be considered free of a disease spreading potential unless further processed was obscured.

We have now written Chapter I, Oyster Hepatitis Outbreak in Mississippi, and Chapter II, The Raritan Bay Clam Hepatitis epidemic in Book 2 of what is really an old problem. We now have an intensified surveillance program in this hepatitis area and, unless rather drastic changes are effected in the harvesting and marketing of shellfish, we anticipate writing a number of additional chapters.

It is obvious to us, as I'm sure it is to you, that all clams and oysters are not contaminated but there is an all too pronounced analogy here to the consumption of raw milk or raw pork from wholly unknown sources. Eating raw shellfish may be said to be a little like playing Russian roulette on the half shell.