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COMMON-SOURCE EPIDEMIC OF HEPATITIS DUE TO GLAZED AND ICED PASTRIES[1]

STEPHEN C. SCHOENBAUM,[2] OPHELIA BAKER[3] AND ZDENEK JEZEK[4]

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Sixty-one clinical cases of hepatitis occurred in Ogemaw County, Michigan, in late April and May 1968. The clustering of cases in time and the high attack rate for persons 10–19 years of age suggested a common source of exposure. Investigation implicated a local bakery, where one of the employees directly involved in the baking had had an icteric illness one month before the outbreak. Comparison of exposure histories of patients versus healthy family members established pastries covered with glaze or icing as the vehicle of infection. The glaze and icing were applied to the pastries after all baking had been completed. During the epidemic, immune serum globulin was given on a community-wide basis. No secondary cases of hepatitis were identified.

epidemics; epidemiologic methods; food contamination; hepatitis; immune serum globulin

In April and May 1968 a large common-source epidemic of hepatitis occurred in Ogemaw County, Michigan. Investigation documented that the source of the outbreak was a local bakery and that glazed and iced pastries served as the common vehicle. Roueché (1) has described some aspects of the investigation of this epidemic. The purpose of this paper is to describe the epidemiologic studies which enabled the source to be identified and characterized.

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[1] From the Viral Diseases Division, Bureau of Epidemiology, Center for Disease Control, Atlanta, GA 30333 (address for reprints) and from the Michigan District #2 Health Department, West Branch, MI.

[2] Currently, Department of Medicine, Peter Bent Brigham Hospital, Boston.

[3] Currently, Saginaw Community Hospital, Saginaw, Michigan.

[4] Senior Medical Officer, World Health Organization.

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THE EPIDEMIC

Over the year before the epidemic only seven cases of viral hepatitis had been reported to the district health department from Ogemaw County (12,000 population). In the first two weeks of April 1968 two cases were reported: one was in an assistant at a bakery in West Branch, the largest city in the county; the other was in an employee of an ice-cream and sandwich stand in Rose City, a town about 15 miles (24 km) from West Branch. Then, over a one-month period from April 28 to May 26, 61 more cases of hepatitis (all but one icteric) occurred in Ogemaw County residents (figure 1).

The medical practitioners in the area reported most of the cases. In addition, since the epidemic generated considerable concern, many cases of icteric illness were reported spontaneously to the district health department by local residents. This led to the identification of 13 persons who did not live in Ogemaw County but who were known by local residents to have had hepatitis in April or May 1968 (figure 1). Three of these cases occurred early in

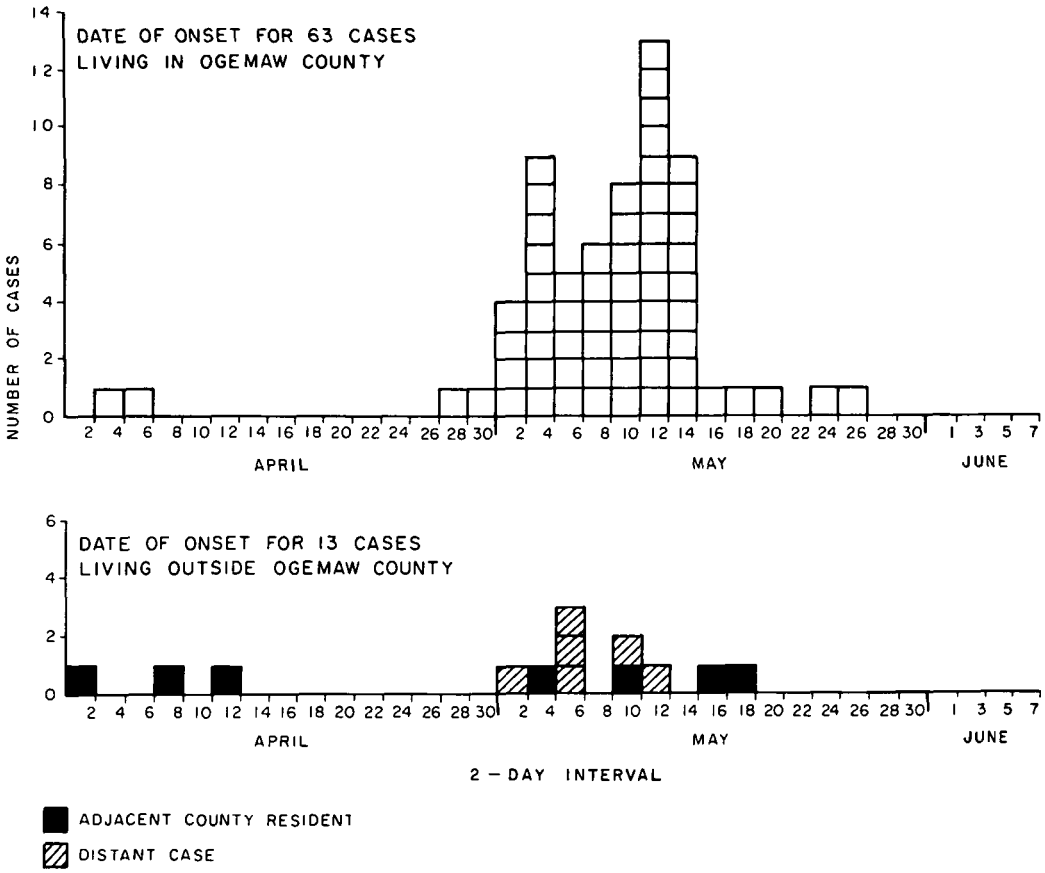

FIGURE 1. Reported cases of hepatitis—Ogemaw County, Michigan, April–May, 1968.

April, but the other 10 were temporally associated with the epidemic in Ogemaw County.

Interviews with all Ogemaw County residents reported to have hepatitis led to characterization of the epidemic. The highest attack rates (table 1) were for persons 10–19 years of age. There were no cases in children under five years of age; the oldest patient was 54. The attack rate for males was almost twice as high as the attack rate for females.

School children accounted for 70 per cent of the cases. Ogemaw County contains all or part of four school districts, and attack rates were highest in the West Branch School District. In that district there is a large public school (1525 students, kindergarten through grade 12) and a parochial school (240 students, grades 1 through 8). Two cases of hepatitis occurred in students at the parochial school (0.8 per cent), while 36 cases occurred in students at the public school (2.4 per cent).

Attack rates by grade for the West Branch Public School (table 2) were uniformly low through grade 6 and then rose to a peak of 8.6 per cent in grade 10. Investigation also revealed that on April 5 the school had closed for a 10-day spring vacation.

The occurrence of most of the Ogemaw County cases within a 29-day period is compatible with the known normal variation in the incubation period of hepatitis A (15–45 days), suggesting that this virus was the likely causative agent and indicating a common vehicle of infection with a single or short period of exposure between April 5 and 12.

TABLE 1

Hepatitis attack rates by age and sex, Ogemaw County, April 28–May 26, 1968

Age group	No. of cases			Attack rate per 1000 population		
	Male	Female	Total	Male	Female	Total
0–4	0	0	0	0.0	0.0	0.0
5–9	2	2	4	3.3	3.4	3.3
10–14	12	6	18	16.3	9.7	13.2
15–19	16	7	23	28.7	15.0	22.5
20–24	1	3	4	3.8	10.1	7.1
25–29	0	1	1	0.0	3.4	1.8
30–34	3	0	3	10.5	0.0	5.1
35–39	1	2	3	3.6	6.7	5.2
40–44	2	0	2	7.5	0.0	3.5
45–49	1	0	1	3.4	0.0	1.6
50–54	2	0	2	7.4	0.0	3.1
55+	0	0	0	0.0	0.0	0.0
Total	40	21	61	6.7	3.5	5.1

TABLE 2

Hepatitis attack rates by grade, West Branch Public School

Grade	No. in class	No. ill	Attack rate (%)
K	126	2	1.6
1	128	0	0.0
2	121	0	0.0
3	107	0	0.0
4	106	2	1.9
5	120	1	0.8
6	111	1	0.9
7	110	3	2.7
8	120	6	5.0
9	143	7	4.9
10	128	11	8.6
11	112	1	0.9
12	93	2	2.2

Milk, water, and the principal food supplies were investigated in the search for a common vehicle of infection. No commercial milk was produced locally, and the commercial producers distributed their milk in other parts of the state. Yet, there was no evidence of an unusual occurrence of hepatitis anywhere else in the state. A municipal water and sewage system serves only the city of West Branch. The other Ogemaw County residents live in houses with individual wells and septic tanks. Had the municipal water supply been contaminated one should have seen even more cases within the city, more cases in adults, and at least some cases in children less than five years old. Since the public school was supplied by municipal water this could have been contaminated; however, the same main served both the elementary school and the high school, thus offering no ready explanation for the disproportionate number of cases in high school students. Also, several of the adults who were ill had had no contact with the West Branch schools.

Food served in restaurants and ice cream stands, salads sold at delicatessen counters in markets, and products from the local bakery were all made locally. Since many persons in the West Branch area knew that a person who worked in the local bakery had had hepatitis about a month prior to the epidemic, there was a prevalent rumor that the bakery was the source of the outbreak. Even though almost all Ogemaw County residents with hepatitis had a history of having eaten products from the bakery, it was not possible on the basis of these interviews alone to know whether the bakery was really the source of the epidemic or simply a very popular establishment in a small community. Relatively few patients had a history of recent exposure to the other locally prepared foods.

INVESTIGATION OF THE SOURCE

The source of the outbreak was established and characterized by four investigations: 1) Reported patients living outside Ogemaw County were interviewed to ascertain their possible exposure to Ogemaw County and potential sources in it. 2) The bakery and its food preparation techniques were observed to determine whether there were practices which might permit the spread of hepatitis virus. 3) A case-control study was conducted in Ogemaw County to determine for residents which exposures were likely to have been associated

with hepatitis. 4) A market survey was performed to determine who patronized the bakery.

Out-of-County patients. All 10 persons who had had hepatitis at the same time as the Ogemaw County residents had been in Ogemaw County in the first two weeks of April. Four lived in adjacent counties, four lived elsewhere in Michigan, and two lived outside Michigan (Indiana and Connecticut). All 10 had eaten glazed or iced pastries from the bakery in West Branch in the first two weeks of April, and eight had had single specific exposures on either April 5, 6, 8, or 9. The bakery was the only exposure common to all of these persons. Some persons in this group had had no contact with the municipal water supply, with any restaurant, or with other food-handling establishments. The median incubation period, from ingestion of pastries to onset of illness, was 29 days.

The three persons ill in early April lived in an adjacent county. In the month before the epidemic they had had no contact with Ogemaw County. These persons were relatives of the employee in the ice cream and sandwich stand who also was ill in early April, and it is possible that all of these persons were infected simultaneously.

The bakery. Besides over-the-counter sales in West Branch, the bakery also supplied all sweet rolls and doughnuts and some of the bread to the restaurants in West Branch and to selected grocery stores in Ogemaw County. The baker's assistant who had hepatitis was involved in practically every phase of the production of bakery products. In particular, he was responsible for making and glazing doughnuts and for icing much of the pastry. The glaze and icing were both viscous materials composed mostly of sugar and a little water. They were made up in large batches which were kept at room temperature. Both were sometimes kept for several days, and old batches were used to start new ones. Observation revealed that icing was spread on baked pastry by hand and that items were picked up and dipped in the glaze by hand. The pastries were then ready for sale. In contrast, even though the dough for making bread and rolls was mixed and shaped by hand, it was then baked in a 350–400 F (176.6–204.4 C) oven for 15–45 minutes. Bakery products not sold on one day were sold on the next business day or were frozen and sold in the next 1–2 weeks. Therefore, bakery products contaminated on a single occasion could be available for sale over a period of weeks. The baker's assistant had visited his physician on April 6 complaining of vomiting and a "cold." He continued to work until April 11 when a definite diagnosis of hepatitis was made. Co-workers reported that he had had dark urine for at least four days before he stopped working. He did not return to work until April 23.

Case-control study. To confirm and extend the evidence obtained from the out-of-county patients implicating the bakery as the likely source, a case-control study was designed. A questionnaire was constructed to facilitate uniform recording of history of exposure to a possible common vehicle in the first two weeks of April. All Ogemaw County patients were re-interviewed by telephone or in person (almost one-third had no phone), and interviews were completed for all 61 patients, including the 41 who were 10–19 years of age. In addition, all persons 10–19 years of age who were household members of reported cases were surveyed using the same technique. Interviews were completed for 56 of 57 household members in this age group.

Ninety-two per cent of the patients 10–19 years of age had eaten products from the bakery in the first two weeks of April versus only 47 per cent of the household members (table 3). This difference is highly statistically significant: Chi-square = 19.21 with continuity correction, $p < 0.0005$. Although a history of drinking water from the municipal supply was prev-

alent among the patients, it was even more prevalent among the household members.

Market survey. A survey of patrons of the bakery was conducted on June 3, 1968. One of the investigators sat unobtrusively behind a counter in the bakery, estimating the age of each patron and noting the hour of the sale and the type of product purchased. Inherent limitations of this survey are that it is based on one day's sales and was conducted two months after the presumed event of contamination. Nonetheless, figure 2 shows that the age distribution of the bakery patrons and the age distribution of the persons with reported cases of hepatitis were similar.

Almost half of the bakery patrons were estimated to be 10–19 years of age. A small number of persons 10–19 came to the bakery early in the morning, a large number came during "lunch hour," and another large group came later in the afternoon. This pattern corresponds with the school schedule. Only students from grades 7–12 in the public school were allowed to leave the school grounds at lunch time and

TABLE 3

Comparison of exposure history of the patients with hepatitis in Ogemaw County in the 10–19-year age group with the exposure history of household members in that age group

	Cases				Household members			
	Exposure			% exposed	Exposure			% exposed
	Yes	No	DK*		Yes	No	DK*	
Bakery	37	3	1	92†	26	29	1	47†
West Branch ice cream and sandwich stand	28	12	1	70	39	17	0	70
Rose City ice cream and sandwich stand	8	32	1	20	6	50	0	11
Municipal water	36	5	0	88	51	4	1	93
Any restaurant	15	25	1	38	22	31	3	42

* "Don't know" responses to questionnaire.

† $p < 0.0005$.

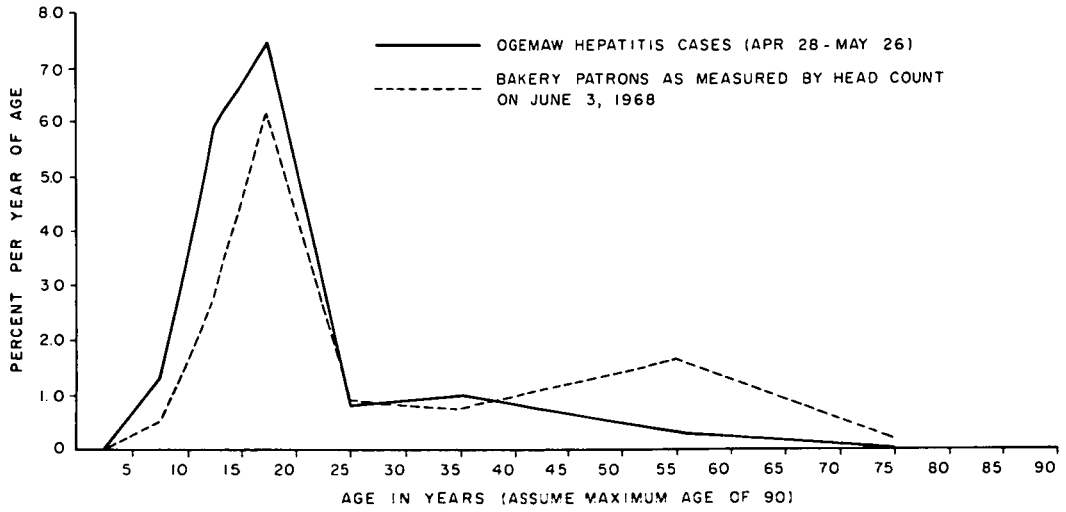

FIGURE 2. Frequency polygon showing per cent distribution by age of patrons of local bakery vs. per cent distribution by age of cases of hepatitis in Ogemaw County, Michigan.

since the bakery was nearby, many students went downtown and had pastry or doughnuts for lunch. Students in grades K-6 and students at the parochial school were not allowed to leave school at lunch time.

An equal number of males and females in each age group patronized the bakery on the day of the survey, yet the sex distribution of the cases was almost 2:1 males to females. From the interview material obtained during the case-control study it was determined that for persons 10–19 years of age who had eaten any pastry from the bakery, 68 per cent of the males (34/50) had eaten two or more items on any single occasion versus only 39 per cent of the females (13/33): Chi-square = 5.49 with continuity correction, $p = 0.02$. Thus, the sex difference observed in the epidemic is more likely to have derived from a quantitative difference in exposure to contaminated pastries among those who patronized the bakery rather than from a sex difference in patronage.

As soon as the bakery was identified as the likely source, liver function tests were performed on each employee. All tests were normal. Since there was no evidence of active hepatitis in any bakery employee at that time, the bakery continued in operation. The use of pastry tubes for spreading icing and tongs for dipping items into the glaze was instituted in order to minimize hand contact with baked pastries.

As cases were diagnosed all direct family contacts were given immune serum globulin by their family physicians. Globulin was given in a dose of 0.5 cc for persons up to 50 lb (22.7 kg), 1.0 cc for those 50–99 lb (22.7–45.3 kg), and 2.0 cc for those 100 lb (45.4 kg) or more. Beginning on May 14 globulin was offered to children in the West Branch school district; and shortly thereafter free globulin was offered to all residents of West Branch and the surrounding area through the district health department. In all, between 7000 and 8000 cc of immune serum globulin manufactured and provided by the state health department were administered. No secondary cases of hepatitis were reported in Ogemaw County for over a year after the epidemic.

Discussion

We have no virologic evidence to prove that this epidemic was caused by hepatitis A virus. The epidemiology, however, does make hepatitis A the most likely agent in that the median incubation period for cases with known single exposures was 29 days (too short for hepatitis B or "C"), and the entire epidemic occurred in a 30-day period—consistent with established variation in the incubation period of hepatitis A.

It has usually been possible to narrow the time of exposure in explosive foodborne outbreaks of hepatitis to a two- to three-day period (2–5). Thus, in practice, contamination of food is a relatively unusual event despite the fact that a food handler with hepatitis A could potentially be excreting the virus over a period as long as a few weeks (6–8). In the Ogemaw County outbreak, exposures were known to have occurred on April 5, 6, 8 and 9. But, because of the practice of keeping the glaze, icing, and even the pastry itself for more than one day, it is possible that the outbreak occurred as a result of a single contamination. The data indicate that the group most affected by the epidemic—high school students—were most likely to have been exposed during a school lunch hour. April 5 was the last day school was in session before a 10-day spring vacation. During the vacation period the students were distributed over much of the county and much less likely to be exposed to a central source in West Branch. Also, had the exposure occurred during vacation the age-clustering in the high school group should have been less marked and one might have expected more cases in siblings. Thus it is strongly suspected that the majority of exposures to contaminated pastries were on Friday, April 5.

To explain the epidemic it must be assumed that a large number of pastries were contaminated with sufficient hepatitis virus to cause clinically evident hepatitis. The contamination was not grossly apparent to anyone working in the bakery or to anyone eating the pastries. The source of the virus (feces, urine, blood, or saliva being the most likely) is not known. The data suggest that either certain persons or persons at certain stages of hepatitis (perhaps just before clinical jaundice) may excrete a very large dose of virus concentrated in very small amounts of material.

Secondary cases occur infrequently following common-source epidemics of hepatitis. This is probably because many of these epidemics are identified in semi-closed communities and immune serum globulin is then widely used to protect the remaining persons in these communities. In Ogemaw County globulin was also used widely, and this probably played a role in suppressing secondary cases and in interrupting transmission of the disease.

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