A Waterborne Outbreak of Hepatitis A in Meade County, Kentucky

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Abstract: In November 1982, Meade County, Kentucky health officials noted a sudden increase in the incidence of hepatitis A. Using a standardized interview of 73 cases (68 serologically confirmed), and 85 controls (all negative for antibody to hepatitis A virus), the most important risk factor identified was household use of untreated water from a single spring. A dose-response relationship was found for consumption of unboiled spring water. Water samples taken from the spring during the outbreak were contaminated with fecal coliforms. (*Am J Public Health* 1985; 75:161–168.)

Introduction

Water has often been identified as a common source of hepatitis A (HA) infection.[1–4] Although the usefulness of serologic testing to establish the diagnosis of HA in the outbreak setting has been recently documented,[5,6] almost all previous outbreak reports have relied on clinical and biochemical data alone.

Background

On December 28, 1982, we were notified by the Meade County Health Department that 20 county residents had reported recent onset of HA. All patients had reportedly consumed water from a local spring, known as Buttermilk Falls (BF), and public concern abounded.

From 1976 to September 1982, only one case of HA had been reported to the Meade County Health Department. The only two physicians in the county indicated that they had seen an unspecified number of cases of HA in the three months prior to the outbreak but "never had time to report them." An epidemiologic investigation begun on January 4, 1983 is the basis for this report.

Methods

We reviewed patient records of the Meade County Health Department and the two private physicians. We participated with the local health department staff in a two-hour question-and-answer program on HA conducted by the local radio station. On that program we asked persons with symptoms suggestive of hepatitis to contact the local health department and/or their personal physicians to have blood taken for HA testing. We also contacted nearby emergency rooms and hospitals for possible cases of HA. We then interviewed 85 suspected HA patients over a period of three weeks using a standard questionnaire.*

We asked each patient to bring to the interview two acquaintances who were not ill to serve as possible controls. However, very few patients did this; so we solicited volunteers who were not ill through radio broadcasts.

The serum samples were tested for HA virus IgG and IgM antibody (anti-HAV IgG and anti-HAV IgM)[7] by the Hepatitis Branch, Division of Viral Diseases, Center for Infectious Diseases, Centers for Disease Control, Atlanta, Georgia.

A case-control study was conducted using the following as a case-definition:

1. A person whose serum contained IgM-type antibodies to HA virus, or
2. A person who refused phlebotomy but had either jaundice in the absence of gallbladder disease or previous blood transfusion, or any four of the following symptoms: anorexia, nausea, vomiting, fever, abdominal pain or dark urine, with onset of symptoms between October 15, 1982 and January 28, 1983.

We used 1980 census data to define denominators for all rates.**

Statistical testing and calculation of odds ratios (ORs) were done using published programs for unmatched case control studies.[8]

Results

The epidemic curve for this outbreak showed a sharp increase in HA cases after November 26, 1982 (Figure 1). The shape of the epidemic curve suggested a common-source outbreak.

Hepatitis cases were reported from only eight of the 15 EDs (Table 1) with over two-thirds of the cases from three EDs. The highest attack rates occurred in the part of the county without easy access to treated city water. There were no significant differences in attack rate by sex; for both males and females, those age 19 and under had the highest attack rates and attack rates decreased with increasing age.*** Eleven of the 73 cases (15 per cent) were preschoolers, while 27 (37 per cent) were school-aged children or teenagers. All cases were White, as was 96 per cent of the county population.

Among the 69 symptomatic cases, most experienced jaundice (93 per cent), dark urine (93 per cent), nausea (84 per cent), and anorexia (83 per cent). In patients over age 40, nausea was less common while fever and light-colored stools were more common.

We interviewed 213 people and obtained a blood sample from all but five. Among the 85 potential cases, 69 met the case definition criteria: 64 were anti-HAV IgM positive, while five refused phlebotomy but met other case criteria. Of the remaining 16 potential cases, seven were anti-HAV IgM

*The questionnaire enabled us to identify previously unreported possible HA cases among contacts of the patients.

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**Meade County is divided into 15 census enumeration districts (EDs). Age and sex-specific population data for the EDs were supplied by the Urban Studies Center, Louisville, Kentucky.

***Data available on request to author.

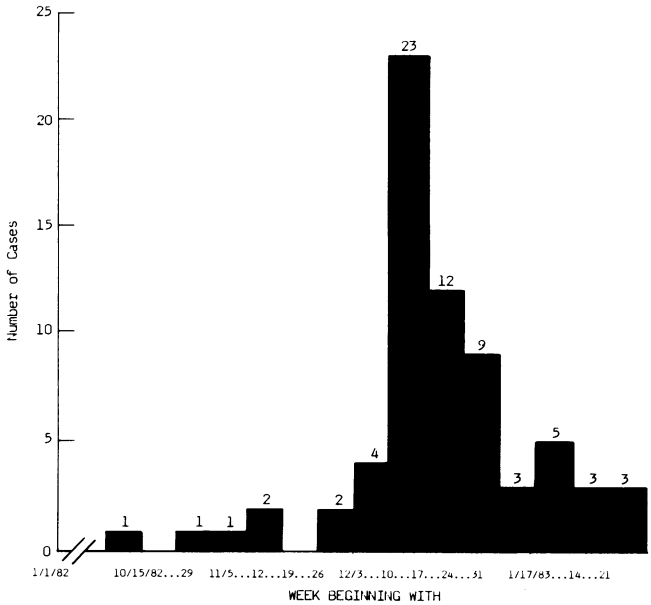

FIGURE 1—Cases of Hepatitis A in Meade County, KY, by Week of Onset of Symptoms, October 15, 1982–January 28, 1983

and IgG negative; they were added to our control group since they resided in Meade County and serologically could be considered at risk for HA; the other nine potential cases, whose blood was drawn within eight weeks from onset of symptoms, were anti-HAV IgG positive only, indicating pre-epidemic HA infection; they were eliminated from the study. Four of the potential controls who were positive for anti-HAV IgM were added to the 69 symptomatic cases already identified, thus totaling 73 cases. Among the remaining potential controls, 46 were anti-HAV IgG positive and anti-HAV IgM negative; they were eliminated from the study. This left us with 78 people to serve as controls to which we added the seven anti-HAV negative persons from the case group, resulting in 85 controls for analysis.

Since a public spring was the focus of concern among local health officials, we started our analysis looking at water as the possible source of infection. Many Meade County residents get their water from untreated sources, including springs, wells, and rain. Almost everyone who used spring water at the time of the outbreak got their water from Buttermilk Falls (BF). The water was pumped into trucks, and hauled to people's homes to be stored in cisterns. A cistern water source was reported by 56 cases (77 per cent), and 40 controls (47 per cent). Consumption of cistern water, adjusted for age, and sex, was significantly associated with HA. Odds Ratio (OR) was 3.5 (95 per cent CI = 1.7–7.0). A BF water source was reported by the same 56 cases and 32 (38 per cent) of the controls. Consumption of BF water was significantly associated with HA (Table 2). To eliminate potential biases caused by age, sex, and city water consumers, we controlled for these variables, and found a minimal decrease in the point estimates of the ORs (Table 2). However, when we controlled for ED of residence, we found a stronger association for BF water consumption and HA.

We then examined the risk of HA associated with drinking boiled and unboiled BF water separately. Boiled BF water was defined as that consumed as hot coffee and tea. Unboiled BF water was defined as all other consumption: plain water, reconstituted orange juice, powdered milk, Kool-Aid, and ice tea. The OR for HA associated with consumption of boiled BF water was 2.0 (95 per cent CI = 0.9 – 4.5) after controlling for unboiled BF water consumption. In contrast, the OR for HA associated with consumption of unboiled BF water was 4.1 (95 per cent CI = 2.1 – 8.0). Furthermore, a significant dose-response relationship was demonstrated for consumption of unboiled BF water and the risk of developing HA (Table 3), i.e., the more unboiled BF water consumed the greater the risk of getting HA.

Using the epidemic curve (Figure 1), we grouped the cases into three categories based on date of symptoms' onset:

1. Before 11/26 (pre-common-source outbreak);
2. Between 11/26 and 12/31 (common-source outbreak);
3. After 12/31 (post-common-source outbreak).

The association of HA with BF water was very strong (OR = 14.9) and highly significant in the common-source outbreak group but was weak and nonsignificant in the other two groups (Table 4). This suggests a five-week time-span for HA contamination of BF associated with this outbreak.

We searched carefully for other sources of HA virus in this outbreak. No more than 12 cases or 18 controls reported eating at any single restaurant during the three-month study period. Similar numbers were found for the consumption of different brands of milk and for shopping at different supermarkets. ORs adjusted for age and drinking BF water were calculated for the 21 potential sources with the greatest frequency; we found no relationship that could not have occurred by chance.***

***Data available on request to author.

TABLE 1—Hepatitis A Attack Rates by Enumeration District (ED) Meade County, KY, October 15, 1982–January 28, 1983

ED	Population	No. of Cases	Attack Rates*
50	855	11	128.7
51	680	13	191.2
52	1,913	26	135.9
53	491	1	20.4
54	1,340	2	14.9
56	764	4	52.4
57	2,696	7	26.0
58	1,782	9	50.5
TOTAL	10,521	73	69.4

*Attack rate=cases per 10,000 population.

TABLE 2—Risk of Hepatitis A Associated with Consumption of Buttermilk Falls Water, Meade County, KY, October 15, 1982–January 28, 1983

Analysis Category	Odds Ratio	95% Confidence limits
Unadjusted	4.4	2.3– 8.5
Adjusted for age and sex*	4.0	2.0– 8.0
City water users excluded	3.9	1.8– 8.0
Adjusted for residence (ED)*	6.3	3.2–12.5

*Adjusted by Mantel-Haenszel method. Referent group is non-consumers.

TABLE 3—Dose-Response Association for Risk of Hepatitis A and Consumption of Unboiled Buttermilk Falls Water, Meade County, KY, October 15, 1982–January 28, 1983

Glasses per Day	Cases by Age			Controls by age			Odds Ratios* (95% confidence limits)
	0–19	20–39	40+	0–19	20–39	40+	
0	9	5	3	20	26	11	1.0 (referent)
1–6	15	9	3	9	7	3	4.5 (2.0– 9.9)
7+	14	13	2	3	5	1	11.2 (4.6–27.3)

*Test for trend, p = 0.00002

Environmental Investigation

The rock formations in Meade County consist of limestone.† Little surface runoff is found in the area except near the Ohio River. Instead, rainwater percolates through the porous limestone strata, dissolving them and creating sinkholes (Figure 2). These sinkholes are used for the dumping of human and animal wastes. Groundwater then flows through a system of conduits and fractures in the limestone. Because the sinkholes are often a direct connection between the land surface and the underground flow systems, polluted water may pass directly from the surface to the ground water system. The effluent from this underground network appears on the surface as a spring, such as Buttermilk Falls.

Pathogenic organisms coming from septic tanks and/or barnyards (animal wastes) may contaminate water, percolating directly to the underground water system. A leaking septic tank could also communicate with this water system. Spring water is thus easily contaminated, although exact flow paths are difficult to determine without an extensive dye tracing effort. It is notable, however, that rainfall for Meade County in the last four months of 1982 was 15.33 inches (3.37 inches above normal), suggesting the possibility of extensive wash-out of underground pools of contaminated water.

On December 27, 1982, an official from the Meade County Health Department took samples of water from BF and some privately owned wells belonging to patients with HA. Water from the wells had no fecal coliforms, but BF water had more than 400 fecal coliforms per ml. Buttermilk Falls water samples one week later had only 10 fecal coliforms per ml, and by January 10, 1983, BF water contained no fecal coliforms. No water testing of BF had been done during the six weeks before the outbreak.

As one case lived in the assumed watershed area of Buttermilk Falls, we flushed 25 ml of fluorescein dye into his septic tank and recovered dye-stained rags two weeks later from the spring. However, we did not test the septic tanks of other cases nor did we perform a more extensive dye study.

Discussion

In 1966, Taylor *et al,* analyzed data from 48 domestic and foreign outbreaks of hepatitis[9]; 17 were associated with well-water consumption resulting in a total of 1,146 cases or 67 cases per outbreak. This was not the first HA outbreak with a documented waterborne source in Kentucky.[10] Many people in rural Kentucky drink untreated water from springs and wells. Anecdotal reports suggest the chlorine taste and expense of city water as possible explanations. Perhaps for the same reasons, some people who have access to city water also drink well or spring water.

Both anti-HAV IgG and IgM were measured for 98 per cent of the people interviewed. These antibody tests were extremely useful in classifying subjects as cases or controls and in eliminating persons who were not at risk of acquiring HA because of long-standing immunity (anti-HAV IgG positive). Considerable misclassification of cases and controls would have occurred without our use of serologic testing.

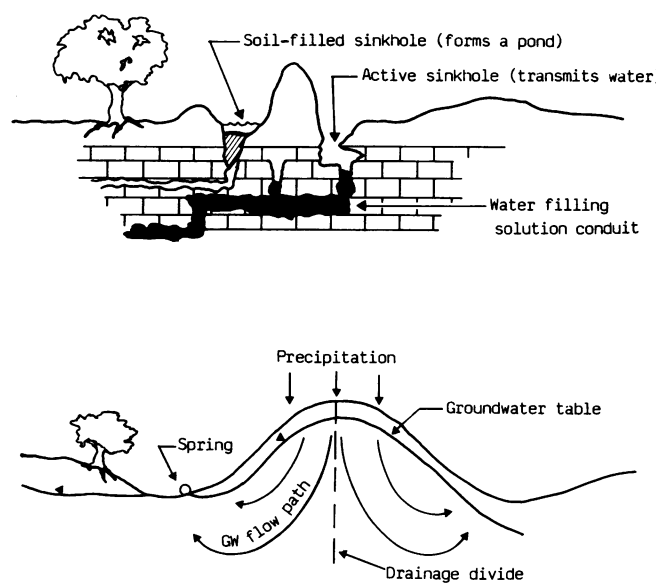

FIGURE 2—Groundwater Flow in Meade County, KY

TABLE 4—Risk of Hepatitis A Associated with Consumption of Buttermilk Falls Water by Date of Onset of Symptoms Meade County, KY, October 15, 1982–January 28, 1983

Date of Onset	No. of Cases*	Odds Ratio†	95% Confidence Limits
10/15–11/26	5	1.1	0.2–7.0
11/27–12/31	50	14.9	6.1–36.5
1/1 – 1/28	14	2.2	0.7–6.9

*4 cases were asymptomatic.
†Adjusted for age by Mantel-Haenszel method.

†Townsend MA and Haney DC: personal communication: The geology and hydrology of Buttermilk Falls near Brandenburg, Kentucky, University of Kentucky, 1983.

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Answers to Questions About AIDS Available from the Public Health Service

The National AudioVisual Center has recently published two free brochures describing three new videotapes that discuss the illness, AIDS (acquired immune deficiency syndrome).

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