An outbreak of hepatitis B associated with reusable subdermal electroencephalogram electrodes

Research

Recherche

Hepatitis B Outbreak Investigation Team*

***The list of team members appears at the end of the article, on page 1131.**

This article has been peer reviewed.

CMAJ 2000;162(8):1127-31

Abstract

Background: In early 1996 an outbreak of hepatitis B was detected among patients who attended an electroencephalogram (EEG) clinic in Toronto operated by a neurologist. In this article we report the results of an investigation conducted to determine the extent and source of the outbreak.

Methods: Notifications were sent to 18 567 patients who had attended any of 6 EEG clinics operated by the neurologist between 1990 and 1996 asking them to see their physician to be tested for hepatitis B virus (HBV) infection; 2957 envelopes were returned. Of the remaining 15 610 patients, results of laboratory tests were available for 10 244 (65.6%). A detailed follow-up of patients with newly acquired hepatitis B and those with chronic infection (carriers) was conducted. Viral DNA sequencing was used to compare strains of available HBV isolates.

Results: A total of 75 patients were identified in whom hepatitis B developed between 1991 and 1996; all of them had had at least one EEG performed in which reusable subdermal electrodes had been used. No cases were detected among patients who participated only in sleep studies, for which disk electrodes had been used. The peak rate of HBV infection (18.2 cases per 1000 person-EEGs) occurred in 1995. One technician performed all of the EEGs at the clinics and was found to be positive for hepatitis B e antigen. DNA sequencing confirmed that the virus isolated from the technician was identical to the virus isolated in 4 cases of hepatitis B tested. Infection control procedures were found to be inadequate.

Interpretation: The hepatitis B outbreak was a result of a common source of infection, the technologist, and inadequate infection control practices. Reusable subdermal EEG electrodes were the likely vehicles of transmission. Health care workers should follow recommended infection control practices and be vaccinated against hepatitis B.

Transmission of hepatitis B virus (HBV) to patients has been associated with health care workers who are known hepatitis B carriers, especially those with detectable hepatitis B e antigen (HBeAg). HBV transmission has been reported in a variety of health care settings, including acupuncture and dermatology clinics,[1–4] operating rooms,[5–12] hemodialysis units[13] and drug trials.[14] Medical devices such as finger-prick instruments for assessing blood sugar levels have also been associated with HBV transmission.[15] The outbreak described in this article is the first one that links HBV transmission with the use of subdermal electroencephalogram (EEG) electrodes.

Methods

The first suggestion of an association between an EEG clinic and hepatitis B was detected during a routine hepatitis B case investigation by a public health inspector. The inspector discovered that many of the patients, who had no other identifiable risk factors, had attended an EEG clinic within the preceding 6 months. By early January 1996 one EEG clinic in met-

ropolitan Toronto appeared to be the common link among several patients with acute hepatitis B. During the investigation it was discovered that the neurologist in charge of the clinic also operated a second clinic in Toronto and that the same technician was responsible for performing all EEGs in both clinics.

To determine the extent of the outbreak, lists of EEG clinic patients were compared against the reported cases of hepatitis B in the surrounding geographic area. Information packages were sent to all patients known to have attended any of 6 EEG clinics and 2 associated sleep study clinics operated by the neurologist between 1990 and 1996. At the time of the investigation, only 2 of the 6 clinics were operating. A press conference was held and a press release issued to the media to notify people who had moved since the time of their EEG. Telephone lines were set up to answer questions both from clinic patients and their physicians. Death certificates were reviewed to find those in which hepatitis B or other associated conditions were listed as the cause of death.

All clinic patients were asked to visit their physician to be tested for hepatitis B surface antigen (HBsAg), antibody to hepatitis B core antigen (anti-HBc) and antibody to HBsAg (anti-HBs). Standard survey forms to collect epidemiological data (e.g., type of tests ordered, presence of symptoms, history of hepatitis B vaccination) were included in the information package along with a stamped return envelope. A laboratory form for testing at the provincial public health laboratory was included to encourage centralized testing. Athough transmission of HIV and hepatitis C virus were considered to be unlikely in this outbreak, physicians and their patients were offered the option of testing for these agents.

For this investigation a case of hepatitis B was defined as one involving any person who attended one of the clinics 2 weeks to 9 months before the onset of acute hepatitis B, had no previous history of hepatitis B and had any of the following: detection of anti-HBc IgM, conversion from HBsAg positive to HBsAg negative between acute and convalescent serum samples, conversion from anti-HBc negative to anti-HBc positive between acute and convalescent serum samples, or a clinical diagnosis of hepatitis B by an attending physician in the absence of other causes of hepatitis.

Patients found to be HBsAg-positive carriers were interviewed by telephone to assess when they became carriers, the presence of other risk factors for hepatitis B and the need for vaccination of contacts.

A public health inspector and public health physician reviewed the infection control programs at the 2 clinics operating at the time of the investigation. The procedures for performing EEGs and the infection control procedures were observed, logbooks were examined and the dry-heat sterilizers were removed for testing to ensure that they were working properly.

To assess the possibility that the technician was the source of infection, a detailed interview covering his health history, health practices and condition of his hands was conducted. After informed consent was obtained, a sample of his blood was sent for HBV subtyping and DNA sequencing.

Laboratory testing of the majority of clinic patients was performed at the Toronto Public Health Laboratory. All patients were screened for HBsAg, anti-HBs and anti-HBc. Other markers such as hepatitis B core IgM, HBeAg and antibody to HBeAg were screened for if appropriate. All serological testing was performed using the AxSYM system or the AUSAB CORE, CORE–M, HBe and Anti-HBe tests (Abbott Laboratories, Chicago).

To attempt to determine the source and route of spread of the outbreak, specimens from 14 outbreak patients, the technician and 10 control subjects were submitted to the Laboratory Centre for Disease Control, Ottawa, for hepatitis B subtyping and sequencing. Subtyping was performed using a standard immunodiffusion method.[16,17] DNA sequencing was performed by polymerase chain reaction amplification using a gel extraction kit (QIAGEN Inc., Mississauga, Ont.) and a dye terminator kit (Applied Biosystems, Foster City, Calif.). A region of the S gene, known to contain point mutations corresponding to the common serotypes, was sequenced. Phylogenetic analysis was carried out using the PHYLIP phylogeny inference package (Department of Genetics, University of Washington, Seattle).

Because some patients had multiple EEGs, the calculation of infection rates was done using person-EEGs as the denominator. For such analyses people with evidence of prior HBV infection or immunization against hepatitis B were excluded. Statistical significance was set at a level of 0.05.

To assess the possibility of patient-to-patient spread, we hypothesized that the number of cases of hepatitis B would be greater among those whose EEG was performed after rather than before an EEG of a previously known HBsAg-positive carrier. For this assessment the period was restricted to Jan. 1, 1994, to Jan. 18, 1996, because the rate of HBV infection was highest then. Because there was no systematic method by which the electrodes were used, it was decided to define possible exposure to a carrier patient based on double the number of sets of reusable subdermal electrodes available at each clinic (30 at one clinic and 50 at the other). We then compared the cumulative number of cases that occurred among patients who had had an EEG after the test of a known carrier and the same number of patients who had had an EEG before the carrier's test.

Results

Information packages were sent to 18 567 patients; 2957 (15.9%) were returned. Of the remaining 15 610 patients 7872 (50.4%) visited their physician, who completed and returned the forms that requested clinical and laboratory information. Additional information was obtained for 2294 (14.7%) of the patients by matching laboratory data records with patient lists. Information on 78 other patients arose from investigations by public health investigators. There was no information obtained for the remaining 5366 (34.4%). The response rate varied inversely with the length of time since the last EEG was done.

Of the 10 244 people for whom data were obtained 624 (6.1%) had evidence of immunity to hepatitis B (either presence of HBsAg antibodies in the absence of infection or history of hepatitis B vaccination). A total of 1124 (11.0%) had evidence of past exposure to HBV, as indicated by the presence of anti-HBc. Of these, 962 had had an EEG procedure at one of the clinics: 875 (91.0% of the 962) had evidence of resolved past infection with HBV and 87 (9.0%) were hepatitis B carriers. There was no evidence of HIV or hepatitis C virus transmission associated with this outbreak.

In all, 75 patients met the case definition of hepatitis B. Four patients were admitted to hospital because of the severity of their symptoms. Although a few patients had other possible risk factors for hepatitis B (e.g., travel out of coun-

try, visit to manicurist or chiropodist), no other risk factor, either singly or combined, could explain the outbreak.

Three types of EEGs were performed: in-clinic EEGs (regular EEG done in a clinic setting), ambulatory EEGs (patient monitored for 24 hours) and sleep studies. Having an in-clinic EEG was associated with HBV infection. Each of the 75 patients found to have hepatitis B had at least 1 in-clinic EEG; none had had only ambulatory EEGs or sleep studies (relative risk = infinity, $p < 0.001$). Among the people who had had in-clinic EEGs, a dose–response relationship was observed (Table 1). One technician who moved from clinic to clinic did all of the in-clinic EEGs.

Before Jan. 19, 1996, reusable subdermal electrodes were used almost exclusively for in-clinic EEGs. The procedure involved placing thin metal rods with sharpened ends under the patient's scalp. Although the technician did report using some reusable disk electrodes, a survey of a random sample of patients revealed the use of such electrodes to be very infrequent. After Jan. 19, 1996, the technician switched to using only disk electrodes for all EEGs. On Feb. 22, 1996, the clinics were closed. Ambulatory EEGs and sleep studies were done using only disposable disk electrodes.

There were no written infection control procedures for any of the clinics. The technician reported that he did not wear gloves when conducting EEGs and that subdermal electrodes were cleaned using brushes and cleaning solutions including hypochlorite, and then bundles of electrodes were subjected to dry-heat sterilization. Although the technician indicated that the use of needle electrodes rarely resulted in bleeding, patients' reports of bleeding were more common.

The distribution of the 75 hepatitis B cases by the date of the in-clinic EEG is shown in Fig. 1. The earliest case involved a patient whose EEG was performed in 1991, and the last case involved a patient whose EEG was on Jan. 17, 1996; 47 of the 75 cases occurred in 1995. Infection rates by year ranged from 2.5 per 1000 person-EEGs, in 1992, to 18.2 per 1000 person-EEGs, in 1995. The mean incubation period from in-clinic EEG to onset of illness was 119 days.

No cases of hepatitis B resulted from the 223 in-clinic EEGs done on susceptible people attending the clinics between Jan. 20, 1996 (when the use of subdermal electrodes was discontinued), and Feb. 22, 1996 (when the clinics were closed). Applying the mean rate of acute HBV infection in 1995 (18.2 per 1000 person-EEGs) to the period when only disk electrodes were used, we estimated the expected number of cases of hepatitis B to be 4 (assuming a Poisson distribution). The observed number of cases during this period was 0 ($p = 0.02$).

For our assessment of the possibility of patient-to-patient transmission, we noted that 27 of the identified hepatitis B carriers were known to be chronic carriers before their in-clinic EEGs and had undergone the EEGs between Jan. 1, 1994, and Jan. 19, 1996. The number of cases of acute hepatitis B among the 990 susceptible patients who had had their in-clinic EEGs done after the carriers' EEGs did not differ significantly from the number of cases among the 990 patients who had had their EEGs done before the carriers' tests (10 v. 6, $p = 0.31$).

The technician was found to be HBeAg positive. All other relevant clinic workers were anti-HBc negative. Examination of the technician's hands revealed no cuts, skin conditions or other factors that may have enhanced transmission. He denied any past skin conditions or injuries. He also denied receiving needle-stick injuries from using the subdermal electrodes. Although he had received multiple blood transfusions in the early 1970s, he had no clinical history of hepatitis B, and no records of previous serologic tests could be found.

DNA amplification was not achieved for 3 of the 7 out-

Table 1: Rates of hepatitis B among patients attending EEG clinics between 1990 and 1996, by number of in-clinic EEGs conducted*

No. of EEGs per person	No. of cases positive for HBV	No. of cases negative for HBV	Total no. of cases	Rate of hepatitis B (and 95% CI) per 1000 people†
0	0	1809	1809	0
1	51	6404	6455	7.9 (5.7–10.1)
2	9	887	896	10.0 (3.5–16.6)
3	4	176	180	22.2 (0.7–43.8)
4	4	83	87	46.0 (2.0–90.0)
≥ 5	7	186	193	36.3 (9.9–62.6)
Total	75	9545	9620	7.8 (6.0–9.6)

Note: HBV = hepatitis B virus, EEG = electroencephalogram, CI = confidence interval.
*Patients with evidence of prior HBV infection or who had been vaccinated against hepatitis B are excluded.
†χ^2 for linear trend = 26.78, $p < 0.001$.

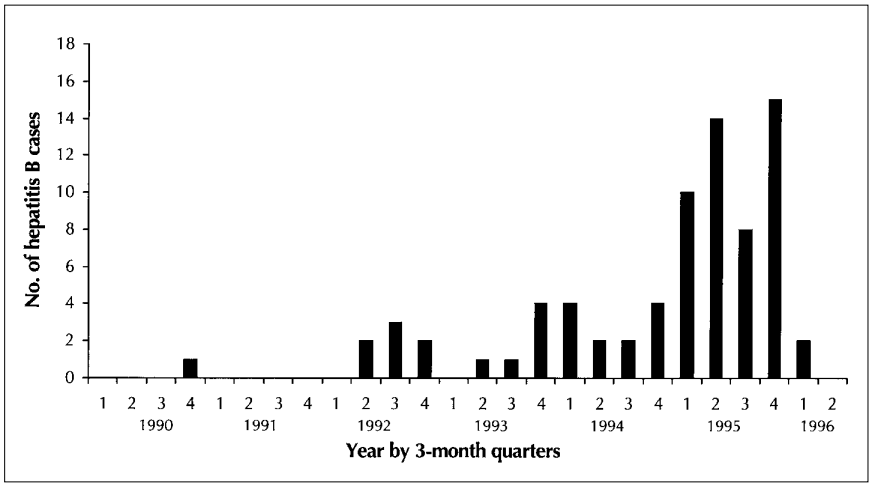

Fig. 1: Distribution of hepatitis B cases among patients attending electroencephalogram (EEG) clinics in Toronto between 1990 and 1996, by date of EEG.

break cases tested. The viral DNA patterns of the remaining 4 cases were identical to those of the technician. The viral DNA sequence from a deceased person whose clinical picture did not quite meet the outbreak case definition was also identical to this grouping. In addition, a clinic patient who was found to be an asymptomatic HBeAg carrier with no risk factors for hepatitis B had a viral DNA sequence identical to that of the technician's. For 5 hepatitis B carriers and 10 control subjects who acquired hepatitis B in the community unrelated to this outbreak, the viral DNA sequences were distinctly different from the technician's and from each other's. A detailed epidemiological review of the people with the identical viral sequences failed to identify any common factor other than having an in-clinic EEG.

Interpretation

This report describes a large outbreak of hepatitis B associated with EEGs. At the peak of the outbreak, in 1995, the rate of hepatitis B among the clinic attendees was 1773 per 100 000 population, which is 600 times the reported annual rate of hepatitis B in Ontario in the same year (2.9 per 100 000).[18] The results of our investigation suggest that the source of this outbreak was the EEG technician, that the subdermal electrodes were the vehicles of transmission and that transmission was facilitated by inadequate infection control practices. The technician was unaware of his HBeAg carrier status, did not wear gloves during the EEG procedures and could have inadvertently received needlestick injuries (causing contamination of the subdermal electrodes before their use). Alternatively, he could have had minor cuts or abrasions on his hands that could have been a source of the infection. Viral DNA sequencing confirmed that the virus isolated from the technician was identical to the isolates in the outbreak cases and that it differed from the isolates of HBV carriers attending the clinics and from the viral strains causing acute infections in the community. Unfortunately, all of the needle electrodes used at the clinics were discarded before the investigation. In-depth discussions with the technician and more detailed analysis of available data failed to disclose the exact means by which some susceptible patients were infected and others were not.

This outbreak is unusual because most other large outbreaks associated with HBeAg-positive health care workers involved invasive procedures. Heptonstall[19] reported that the risk of HBV transmission to patients from surgeons who are HBeAg positive is about 6 per 100 surgical procedures. In the outbreak we investigated, the technician was using subdermal electrodes and, in 1995, had a transmission rate of about 2 per 100 EEGs. Although the infection control practices at the clinics were not adequate, the outbreak indicates the potential harm that can occur in such situations.

This outbreak shows the need for excellent infection control for all health care workers. As stated in existing guidelines,[20] it is preferable to use noninvasive techniques (e.g., disk electrodes) rather than invasive ones (e.g., subdermal electrodes). Although the number of observations is limited, no HBV transmission was detected when noninvasive disk electrodes were used. Vaccination of health care workers against hepatitis B is another option to minimize the risk of transmission and is strongly recommended.[21] Mass vaccination of the population can also be considered;[21] although it will not show immediate results, it will provide protection against this and more common potential sources of HBV infection.

We thank Dr. Beth Bell, US Centers for Disease Control and Prevention, Atlanta, for her assistance.

Competing interests: None declared.

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