EPIDEMIC HEPATITIS B: A SUSTAINED OUTBREAK IN A LARGE MILITARY POPULATION

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A sustained outbreak of viral hepatitis occurred at an Army base in Texas between January 1971 and June 1973. Seven hundred ninety-two admissions but no deaths were recorded in a military population of 35,000. Cases were sporadic, with highest attack rates in low-ranking soldiers with disciplinary problems. Twenty-nine per cent of patients had histories of intravenous drug use within six months prior to hospitalization; most of the rest had close personal contact with jaundiced persons. Of 505 patients tested, 31% were seropositive for hepatitis B antigen (HBsAg) by counterelectrophoresis. Comparison of 38 hepatitis patients (cases) to 34 orthopedic patients (controls) revealed marked differences in rates of exposure to jaundiced persons and shared needles. Sixteen (94%) of 17 antigenemic cases tested were of subtype ayw. Seven (78%) of nine HBsAg-negative cases tested were antibody (anti-HBs) positive three months later.

drug abuse; epidemics; hepatitis B antigen; hepatitis virus; military personnel

INTRODUCTION

Large scale epidemics of viral hepatitis have usually been due to the short incubation period (type A, infectious) hepatitis agent transmitted in contaminated food or water (1-3). A notable exception occurred in the US Army during World War II, when several major epidemics of long incubation period (type B, serum) hepatitis were traced to lots of yellow fever vaccine containing contaminated human serum (3-5). A markedly different kind of outbreak recently took place at a large Army base in Texas and is described in this report. The outbreak was characterized by an unusually long course (January 1971–June 1973), sporadic occurrence of cases, an association with drug abuse, and a predominance of type B infection.

MATERIALS AND METHODS

Background. Fort Hood is located in a rural area of central Texas 90 km north of Austin, the nearest city. The average strength of military personnel is 35,000. The troops are involved in combat training and related support activities; no basic training is given. The post hospital serves all active duty military personnel and their dependents. Hospitalization is routine for military personnel with a diagnosis of...
acute hepatitis but not for uncomplicated cases in dependents.

**Epidemiologic and clinical data.** Incidence rates of hepatitis were obtained from official statistical reports of the Army Surgeon General (Health of the Army reports). The rates were based on the number of military patients with an admission diagnosis of viral hepatitis. Further information about hepatitis cases was acquired from chart reviews, interviews with patients, and discussions with medical personnel.

Hepatitis patients were routinely questioned by psychiatric social workers and preventive medicine interviewers as well as by examining physicians as to intravenous use of illicit drugs (usually heroin). Histories taken by physicians and social workers were entered in each patient’s chart; a positive history obtained by either or both was considered positive for this report. For purposes of this study, only histories of exposure (e.g., intravenous drug use, hepatitis contact) occurring within the immediate six months (maximum incubation period of hepatitis B) were recorded.

**Serology.** Beginning in January 1972, 12 months after the start of the epidemic, sera from newly admitted hepatitis patients and blood donors were routinely tested for hepatitis B surface antigen (HB$_s$Ag) in the hospital laboratory using a commercially available counterelectrophoresis (CEP) system (Spectra Biological, Oxnard, CA). In the case-control study, sera were tested for HB$_s$Ag using both CEP and radioimmunoassay (RIA) with appropriate absorption procedures (6). CEP-positive sera were subtyped for HB$_s$Ag determinants $d$, $y$ (7), $w$ and $r$ (8). Antibody to HB$_s$Ag (anti-HB$_s$) was detected by passive hemagglutination using red cells coated with purified HB$_s$Ag of subtypes $ad$ and $ay$ (9). Anti-HB$_s$ titers of 1:8 or greater were considered positive. Control type 0 cells were used to detect nonspecific reactions.

**Case-control study.** A case-control study was conducted in a limited group of individuals to look at certain points which could not feasibly be examined in the entire population which experienced the epidemic. It involved all patients (males) admitted to the hepatitis and orthopedic wards during February and March 1973. Orthopedic patients were selected as controls because, as a group, they were most likely to be of the same age, rank, and military background as the hepatitis patients. A confidential exposure history was taken in an identical manner by one of us (JJK) using a standard questionnaire, and sera were collected for HB$_s$Ag and anti-HB$_s$ determinations and for liver function tests. All available hepatitis patients were rebled three months later for repeat determinations.

**THE OUTBREAK**

The hepatitis outbreak at Fort Hood began in January 1971, peaked in August 1972, and terminated in June 1973 (figure 1). Eight hundred and thirty-one hepatitis admissions but no deaths were recorded during this 2 1/2-year period, of which 792 (96 per cent) involved military personnel. There was no seasonal variation in incidence, and there were no parallel rises in incidence among other Army personnel in the United States or overseas.

All patients were acutely ill when first seen, and presented with jaundice, fatigue, malaise, anorexia, nausea and dark urine. On admission, they had enlarged, tender livers and abnormally elevated levels of serum bilirubin and serum glutamic oxaloacetic transaminase (SGOT). The clinical illness was generally mild, but 11.5 per cent of patients had a chronic course, requiring one or more readmissions.

The extraordinary nature of the Fort Hood outbreak was revealed by annual incidence data extending back to World War II (figure 2). For more than 20 years prior to 1971, the annual rates of viral hepatitis among military personnel at Fort Hood were similar to those in the rest of the Army in the United States (<2.3/1000/
Hepatitis B outbreak in military population

Figure 1. Incidence of viral hepatitis in US Army active duty personnel at Fort Hood, Texas, in the continental United States and in all overseas commands, by month, January 1970 to June 1973.

Figure 2. Incidence of viral hepatitis in US Army personnel, by year, 1946 to 1973.

year), but were two to fourfold lower than those in the Army overseas. In 1971, however, the incidence of hepatitis at Fort Hood rose to 10.0/1000/year, and in 1972 it rose again to 14.8/1000/year. The 1972 rate was triple those in the United States and overseas for 1972, and was nearly nine times greater than the rate at Fort Hood in 1970. As a consequence, hepatitis became the leading cause of hospital entry for soldiers, being responsible for 12 per cent of all admissions in 1972, whereas in 1970 it accounted for only 1.5 per cent of admissions.

Preliminary investigation by Fort Hood medical personnel indicated that this outbreak did not conform to previous hepatitis outbreaks in military populations because 1) no clusters or common sources could be detected, 2) the rise in hepatitis rates in 1971 and 1972 coincided with evacuation of drug users from Vietnam to Fort Hood for treatment and rehabilitation, and 3) many of the hepatitis cases appeared to be associ-
ated with intravenous drug use. Because of the unique features of the outbreak, a more detailed epidemiologic investigation was requested in October 1972.

**Epidemiologic Investigation**

The epidemiologic investigation was conducted by Walter Reed Army Institute of Research and Fort Hood epidemiologists from November 1972 through July 1973, and comprised three phases: initial inquiries, a chart review, and a case-control study.

**Initial findings.** Information collected by preventive medicine interviewers during the 12-month period ending in August 1972 (table 1) indicated that the majority of patients must have contracted their infection while stationed at Fort Hood. Less than 40 per cent of patients admitted frequent parenteral use of drugs. Only 8.6 per cent of cases (26 of 203 queried) were accompanied by another case from the same unit (100 to 200 men each) within any given month. Analyses of rates by dietary history, dining facilities, living quarters, and history of immunizations failed to reveal a common source.

**Table 1**

<table>
<thead>
<tr>
<th>Exposure histories obtained from 468 military hepatitis patients by preventive medicine interviewers, Fort Hood, September 1971 to August 1972</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. positive</td>
</tr>
<tr>
<td>More than 6 months at Fort Hood</td>
</tr>
<tr>
<td>Ingestion of potentially contaminated food and water*</td>
</tr>
<tr>
<td>Hepatitis contact†</td>
</tr>
<tr>
<td>Intravenous drug use†</td>
</tr>
<tr>
<td>History of hepatitis‡</td>
</tr>
<tr>
<td>Arrived with hepatitis</td>
</tr>
<tr>
<td>Tattoo‡</td>
</tr>
<tr>
<td>Blood transfusion‡</td>
</tr>
</tbody>
</table>

* Raw shellfish; unprocessed water from shallow wells, springs, and creeks; and food or water from a dining facility having a food handler with hepatitis.
† Within 6 months prior to admission.
‡ A separate prior illness.

In an early attempt to elicit more information, one of us (AMA) interviewed all patients on the hepatitis ward on November 30, 1972. Of the 26 men present, all but one were less than 24 years of age and in the lowest five of the nine enlisted ranks; nine (35 per cent) admitted using heroin with shared needles within six months prior to admission; and 22 (85 per cent) had a history of disciplinary problems while in the Army severe enough to result in temporary confinement, reduction in rank, or loss of pay. Their median length of military service was 27 months and their median time at Fort Hood was 11 months. Of the 17 patients who denied drug abuse, all but one (a 41-year-old man just returned from Korea) stated that they had had close personal contact with a jaundiced person within the previous six months, and five said that at least one of their contacts was a heroin user. The young patients stated that they frequently (at least once a week) shared marijuana cigarettes and sips from wine bottles with friends, suggesting the possibility of oral-oral transmission.

**Chart review.** The hospital charts on all military patients with hepatitis who were admitted during the epidemic period (January 1971 to June 1973) were reviewed. Reported figures are restricted to first-admission data. Of the 674 men, 90 per cent were less than 25 years of age, 91 per cent were white, 75 per cent were single, and 88 per cent had been in the Army for more than a year. Twenty-nine per cent had a history of intravenous drug use. Thirty-one per cent (159 of 505) of those tested on admission were seropositive for HB$_a$Ag. In contrast, only 0.7 per cent of 2346 units of blood donated by soldiers at Fort Hood during the same period were HB$_a$Ag positive.

Comparisons between patients seropositive and seronegative for HB$_a$Ag on admission showed that the two groups were virtually identical in demographic characteristics, but that HB$_a$Ag-positive patients were significantly more likely ($p < .02$) to
TABLE 2
Comparisons between military hepatitis patients seropositive and seronegative for HB\textsubscript{Ag} (first admission data only), Fort Hood, January 1972 to June 1973

<table>
<thead>
<tr>
<th></th>
<th>HB\textsubscript{Ag}-positive</th>
<th>HB\textsubscript{Ag}-negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases, total</td>
<td>159</td>
<td>146</td>
</tr>
<tr>
<td>Ages ≤ 24 years</td>
<td>146</td>
<td>316</td>
</tr>
<tr>
<td>Nonwhite</td>
<td>32</td>
<td>65</td>
</tr>
<tr>
<td>Lowest 4 enlisted ranks</td>
<td>135</td>
<td>288</td>
</tr>
<tr>
<td>Married</td>
<td>34</td>
<td>95</td>
</tr>
<tr>
<td>Asian tour, ever</td>
<td>84</td>
<td>183</td>
</tr>
<tr>
<td>&lt; 1 year in Army</td>
<td>19</td>
<td>40</td>
</tr>
<tr>
<td>Intravenous drug use*</td>
<td>52</td>
<td>76</td>
</tr>
</tbody>
</table>

* Within 6 months prior to admission.

FIGURE 3. Incidence of viral hepatitis according to military rank, Fort Hood, Texas, 1972.

have a history of drug abuse (table 2). In addition, the average length of hospitalization was 50 per cent longer for HB\textsubscript{Ag}-positive patients (27 days vs. 18 days), suggesting that they tended to have a more severe illness. (The length of hospitalization was based on the clinical course and was not influenced by the duration of antigenemia.)

Age, race and occupation-specific attack rates could not be calculated because the numbers at risk were not obtainable. However, denominator data for military ranks were available for 1972. Figure 3 shows that the incidence of hepatitis was strikingly rank related, with highest rates in the lowest enlisted ranks. Hepatitis was almost non-existent among officers (4000 at risk), including those who were low ranking and therefore at nearly the same ages as the low-ranking enlisted men. Since those in the lowest two enlisted ranks were usually in these ranks for disciplinary reasons rather than shortness of Army service, the incidence of hepatitis appeared to be more strongly related to social and behavioral factors than to age.

Case-control study. A case-control study was carried out to determine to what extent hepatitis patients differed from other soldiers in 1) rates of exposure to potential sources of hepatitis B, and 2) rates of seropositivity for HB\textsubscript{Ag} and anti-HB\textsubscript{s}.

Hepatitis patients (cases) and orthopedic patients (controls) admitted during February and March 1973 were similar in age and the proportion who were Vietnam veterans but differed markedly in the proportion with histories of intravenous drug use, exposures to jaundiced persons, and prior episodes of hepatitis (table 3).

Nineteen (50 per cent) of the hepatitis patients but none of the orthopedics patients were seropositive for HB\textsubscript{s}Ag on admission. Seventeen of the HB\textsubscript{s}Ag-positive cases were subtypable, of which 16 (94 per cent) were adw. Subtype adw was found in a 36-year-old man with no history of exposure.

None of the hepatitis patients and three (9 per cent) of the controls had antibody in their serum on admission. Three months

TABLE 3
Comparison between 38 hepatitis and 34 orthopedic patients admitted to the hospital at Fort Hood during February and March 1973

<table>
<thead>
<tr>
<th></th>
<th>Hepatitis</th>
<th>Orthopedic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ages 20–24 years</td>
<td>26</td>
<td>19</td>
</tr>
<tr>
<td>Vietnam tour, ever</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>Hepatitis contact</td>
<td>29</td>
<td>9</td>
</tr>
<tr>
<td>Drug abuse</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Shared needles</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Prior hepatitis</td>
<td>10</td>
<td>3</td>
</tr>
</tbody>
</table>
TABLE 4
Results of serologic tests and liver function studies in patients admitted for hepatitis in February and March 1973

<table>
<thead>
<tr>
<th>Cases, total</th>
<th>HBsAg-positive</th>
<th>HBsAg-negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-HBs on admission 6/12 (50%)</td>
<td>7/9 (78%)</td>
<td></td>
</tr>
<tr>
<td>SGOT, mean 868 (± 100)</td>
<td>761 (± 106)</td>
<td></td>
</tr>
<tr>
<td>Bilirubin, mean 5.7 (± 0.9)</td>
<td>5.6 (± 0.8)</td>
<td></td>
</tr>
</tbody>
</table>

later, the majority of hepatitis patients tested, including those who were originally HBsAg-negative, had anti-HBs in their serum (table 4). Of the 12 antigenemic patients (a/yw subtype) from whom convalescent sera were obtained, only one (8 per cent) remained antigen-positive at three months, and in this instance the low RIA reactivity of the convalescent specimen indicated that the serum was in the process of being cleared of antigen.

Mean serum bilirubin and SGOT values on admission did not differ significantly (p > .05) between HBsAg-positive and HBsAg-negative cases.

DISCUSSION

A rising incidence of viral hepatitis associated with drug abuse has been noted in both civilian (10) and military (11) populations in the United States since the late 1960's, and a similar phenomenon has been observed abroad (12). Investigations have revealed that up to one-half of the patients are seropositive for HBsAg by CEP (10, 11, 13) and most of the CEP-positive cases are of subtype a/yw (14). Cases occur sporadically, and transmission appears to be from person-to-person, either by shared needles or by close personal contact (12, 13). Despite the high frequency of type B disease, the case fatality rate has been less than 1 per cent.

The outbreak at Fort Hood shared all of the features mentioned above, suggesting that it was part of the same widespread phenomenon. However, since no similar outbreaks occurred in the rest of the Army during the same period (15), it must be assumed that there were predisposing features, as yet undiscovered, unique to Fort Hood. It may be that drug abuse was more prevalent there than at other Army posts, but this would be impossible to prove retrospectively. That the outbreak at Fort Hood was not a one-time event in the Army has recently been demonstrated by the emergence of a similar but more severe outbreak among US military personnel in Germany (16).

Although less than a third of cases were HBsAg-positive by CEP, it is highly probable that a much larger proportion were due to type B infection. This can be inferred from the demographic similarities between antigenemic and nonantigenemic patients (table 2), the high proportion of HBsAg-negative patients who had anti-HBs in their convalescent sera (table 4), and the knowledge that CEP is a relatively insensitive test for HBsAg (6). Based on the information obtained from the chart review and the case-control study, it is estimated that, if all were tested, approximately 85 per cent of the cases occurring during the epidemic would have had serologic evidence of type B infection (95 per cent confidence limits = 59-98 per cent).

The epidemic at Fort Hood was widely believed to have been due primarily to parenteral drug abuse, but only one-third of the patients admitted to parenteral use of drugs. This figure is substantially below those recently quoted for sporadic hepatitis in the civilian population of the United States (10) but is similar to that quoted in a study of endemic drug-related hepatitis in US Marines (11, 17). It is likely that the true rate of intravenous drug use among patients at Fort Hood was appreciably higher than indicated by their histories, but the degree of error could not be assessed...
because of the lack of an objective means of making an accurate estimate.

Transmission by nonparenteral routes may also have contributed to the outbreak at Fort Hood, as it apparently did in the vaccine-related outbreak during World War II (5, 18). This mode of transmission of hepatitis B is supported by studies showing that \( \text{HB}_e \text{Ag} \) can be detected in the saliva and urine of antigenemic persons (20–22), that serum containing \( \text{HB}_e \text{Ag} \) is infective when given by mouth (23), and that transmission within families presumably occurs by a nonparenteral route (24). Since close personal contact with known heroin users was common among patients who themselves denied parenteral use of drugs, the possibility exists that drug users were the principal source of infection. This is further suggested by the fact that the predominant antigen subtype (\( \text{ayw} \)) was the same as that characteristically found in drug users with hepatitis (14).

American participation in the Vietnam war has created interest in the possibility that \( \text{adr} \) strains of hepatitis B virus would be introduced and propagated in the United States by servicemen returning from Southeast Asia. The lack of this subtype in the sample of patients tested at Fort Hood provides evidence against this possibility, and indicates that the epidemic was not due to importation of an Asian strain of hepatitis B virus.

Documentation of epidemics is usually more accurate and complete in military than in civilian populations because of the existence of well-defined populations at risk, uniform hospital admission policies, and relatively complete reporting. These advantages made it possible to observe the association between clinical hepatitis B and social status, as reflected by military rank. Although age is strongly associated with rank and may have been a significant risk factor, it is unlikely that age per se was the most significant determinant of the risk of illness, since young officers were spared. Therefore, it appears that social behavior, especially in regard to drug use and living patterns, was probably the most important risk factor.

Termination of epidemics can be attributed to cessation of exposure to sources of infection or to elimination of susceptibles from the exposed population. No direct control measures were put into effect during the epidemic at Fort Hood because none was known to exist for hepatitis B. The establishment of a drug abuse control program in mid 1972 may have contributed indirectly to the control of hepatitis. Whether the hepatitis epidemic ended because of a decline in exposure to contaminated needles or for some other reason was impossible to determine, primarily because there was no reliable means of monitoring rates of intravenous drug use.

Control of the hepatitis epidemic at Fort Hood was made virtually impossible by the lack of effective preventive measures for sporadic type B infection. Hyperimmune serum globulin has been shown to be efficacious in preventing or suppressing hepatitis B acquired by nonparenteral means (25, 26) but was not available for testing or use during the outbreak. The Fort Hood outbreak and subsequent epidemics of hepatitis B demonstrate the need for an effective vaccine against this disease.

**References**

5. Freeman G: Jaundice following yellow fever vacci-