Hepatitis B antigen (HB\textsubscript{S}Ag) and/or antibodies (anti-HB\textsubscript{S} and anti-HB\textsubscript{C}) in fulminant hepatitis: pathogenic and prognostic significance\textsuperscript{1}

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SUMMARY  Hepatitis B surface antigen (HB\textsubscript{S}Ag) and antibodies to both the surface and core antigens of the hepatitis B virus (anti-HB\textsubscript{S} and anti-HB\textsubscript{C}) have been studied in 64 consecutive cases of fulminant hepatitis. HB\textsubscript{S}Ag was detected by counterelectrophoresis in 23 (35-9\%) but by radioimmunoassay in 38 (59-3\%). Anti-HB\textsubscript{S} was detected by passive haemagglutination in 26 (40-6\%), coexisting HB\textsubscript{S}Ag and anti-HB\textsubscript{S} were found in 16 cases (25\%). Using an indirect immunofluorescence technique, anti-HB\textsubscript{C} was found in all of the cases in whom either HB\textsubscript{S}Ag or anti-HB\textsubscript{S} was present. The highest survival rate was observed in patients with no evidence of HBV infection (31-3\%) and was lowest in those who had both HB\textsubscript{S}Ag and anti-HB\textsubscript{S} detected simultaneously (6-2\%). The prognosis of those who exhibited anti-HB\textsubscript{S} only was no better than those with HB\textsubscript{S}Ag alone. In a further case, transient interruption of the asymptomatic chronic HB\textsubscript{S}Ag carrier state with seroconversion to anti-HB\textsubscript{S} was associated with the development of a fulminant hepatitis syndrome. The results suggest that an unusually strong and rapid immune clearance of HB\textsubscript{S}Ag may be involved in the pathogenesis of fulminant hepatitis.

Fulminant hepatitis (FH) may occur in association with both types of viral hepatitis, halothane anaesthesia, and certain drugs and poisons (Rueff, Benhamou, 1973). There has been almost no data since the discovery of a specific surface antigen (HB\textsubscript{S}Ag) of hepatitis B virus (HBV) to indicate whether the type A or type B infection is predominantly responsible in cases of fulminant viral hepatitis. The pathogenesis of FH remains mysterious. The influence of virus strains, as well as both the role of cellular and humoral immunity, have been considered determining factors of the disease pattern (Almeida, Waterson, 1969; WHO report 1973).

In order to clarify the role of HBV and of the immune response in the pathogenesis of FH, HB\textsubscript{S}Ag, as well as antibodies to both hepatitis B surface and core antigens (respectively referred to as anti-HB\textsubscript{S} and anti-HB\textsubscript{C}), were determined in the present study of 64 cases of FH and the findings were correlated with survival.

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Methods

Patients Studied
Sera were obtained from 64 consecutive FH cases hospitalised in two intensive care units in Lyons, France. According to the criteria of the fulminant hepatic failure surveillance study (Trey, 1972), only patients who developed a syndrome of hepatic failure and coma within eight weeks of the onset of an illness and with no evidence of previous liver function abnormality were considered as fulminant hepatitis cases. Clinical and laboratory features and their prognostic values have already been reported in many of the patients (Robert et al., 1974). Twenty-nine patients were male and 35 female and their ages ranged from 3 to 77 years (mean 36 years).

Procedures
The sera were initially tested for HB\textsubscript{S}Ag and anti-HB\textsubscript{S} in the Laboratory of Hygiene in Lyons by agar gel diffusion (AGD). The specificity of positive results was established by tests of identity with known reference reagents. All sera were further
examined for HBsAg by counter electrophoresis (CEP) (Pesendorfer et al., 1970) and radioimmunoassay (RIA) using Ausria I kits, supplied by Abbott Laboratories. An aliquot of freshly separated serum was kept and shipped frozen in dry ice to the New York Blood Centre where it was retested for HBsAg by radioimmunoassay using the same method. The specificity of positive results obtained only by RIA was confirmed by repeating the test after neutralization with known human anti-HBs positive sera (Prince et al., 1973). Anti-HBs was detected by passive haemagglutination (PHA) (Prince et al., 1972), whereas anti-HBc was determined by a modification of the indirect immunofluorescence test of Brzosko et al. (1973). With the technique used (Trepo et al. in preparation) background nuclear fluorescence resulting from autologous anti-HBc bound in vivo was abolished by preincubating the substrate liver sections with goat anti-human gammaglobulin for 30 minutes, before applying the test serum.

In 17 cases more than one specimen was available for serial studies.

Results

The serological findings show that, at the time of admission to the intensive care unit, out of 64 cases, 16 were found to be positive for HBsAg by AGD (25%), 23 by CEP (35.9%), and 38 by RIA (59.3%). All the sera found to be positive by AGD or CEP were detected by RIA.

Anti-HBs was found in 26 cases (40.6%) by PHA, in titres ranging from 1:8 to 1:4096 (mean 1:330), but was detected in only five of these cases by AGD (9.3%). Either HBsAg or anti-HBs was found in 48 cases (75%) and both HBsAg and anti-HBs were present in 16 patients (25%). Anti-HBc was detected in all of the cases with either HBsAg or anti-HBs, but it was found in none of the 16 patients (25%) without detectable HBsAg or anti-HBs.

One further case of FH, not included in this series of 64 cases, was studied. Fulminating hepatitis was associated with termination of the HBsAg carrier state and the appearance of anti-HBs in this additional case. This was a haemodialysed patient, previously recognized as an asymptomatic, chronic HBsAg carrier, who had repeatedly normal serum transaminases values for more than a year before this episode. At the time FH developed, HBsAg was no longer detectable and only anti-HBs and anti-HBc could be demonstrated in the serum. The patient survived and HBsAg reappeared in the blood at the time of recovery, anti-HBs disappeared and anti-HBc remained present.

The relationship between the serological findings and survival is outlined in the Table. Thirteen of the 64 patients recovered (20.3%). Five of the 16 patients without HBsAg or anti-HBs survived (31.3%), in contrast with only eight out of 48 of those with HBsAg and/or anti-HBs (16.6%). Only one of the 16 patients with both surface antigen and antibody survived (6.2%), as compared with 2/10 (20%) of those with anti-HBs alone and 5/22 (22.8%) of those with HBsAg alone.

With the exception of a 77 year old woman, all patients over 40 died. If this exceptional case is omitted, the mean age was lower in the patients who survived (25-7 years) than in those who died (37.1 years).

Suitable follow-up specimens were available in 17 cases in whom no exchange transfusion was attempted. Three subjects who were repeatedly positive for HBsAg alone for up to seven, eight, and 12 days respectively, survived. Three patients had only anti-HBs detected repeatedly; one died. In 11 cases, persistence or decrease in HBsAg titre, with increasing anti-HBs titre, was followed by death in spite of total clearance of HBsAg and replacement by high titre anti-HBs in six. Clearance of HBsAg occurred between one and nine days (mean four days) after the patients were admitted to the intensive care unit; in four, HBsAg was cleared from the serum and replaced by high titre anti-HBs within 48 hours.

Discussion

Fifty-nine percent of these cases of FH were aetologically related to the HBV as indicated by detection of HBsAg. If those 10 additional subjects who demonstrated anti-HBs and anti-HBc without HBsAg be included, this proportion would increase to 75%. Although previous exposure to HBV in these cases cannot be ruled out, the presence of anti-HBc in all of them would indicate that recent replication of

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Total no. of cases</th>
<th>No. cases with HBsAg only</th>
<th>No. cases with anti-HBsAg only</th>
<th>No. cases with HBsAg and anti-HBsAg</th>
<th>No. cases with either HBsAg or anti-HBsAg</th>
<th>No. cases with neither HBsAg nor anti-HBsAg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alive</td>
<td>13</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Dead</td>
<td>51</td>
<td>17</td>
<td>8</td>
<td>15</td>
<td>40</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>64</td>
<td>22</td>
<td>10</td>
<td>16</td>
<td>48</td>
<td>16</td>
</tr>
<tr>
<td>Survival rate %</td>
<td>20.3</td>
<td>22.8</td>
<td>20</td>
<td>6.2</td>
<td>16-6</td>
<td>31.3</td>
</tr>
</tbody>
</table>

Table Relationship between HBsAg and/or anti-HBsAg positivity and survival in 64 fulminating hepatitis cases
HBV had occurred (Hoofnagle et al., 1973). Several other reports have shown that HBV may be responsible for the majority of cases of FH (Boughton, 1968; Kassur et al., 1974; Redeker, 1974).

Such a high prevalence of type B hepatitis in this series of FH could partially be explained by the frequency of hepatitis B antigen in non-fulminant cases in Lyons (47% by radioimmunoassay), as well as by the large proportion of cases that occur after transfusion or injections.

The titre of HBs antigenemia appears to be unexpectedly low in FH. It was below the limit of sensitivity of CEP and could be detected only by RIA in 15 out of the 38 FH cases with HBs antigenemia (39.5%). This is in marked contrast with the findings in 306 cases of non-fulminant acute, type B hepatitis, where only 37 (12%) were missed by CEP (Trepo et al., 1973).

Serial blood samples were available from 17 patients with FH; nine of them cleared HBsAg from their blood. The mean duration of HBs antigenemia as judged by RIA in these cases was 5.2 days, this being much shorter than the mean duration of HBs antigenemia (67 days) that we have previously observed in non-fulminant hospitalized cases of acute, type B hepatitis, using the same RIA method (Trepo et al., 1973). These findings support those of (Dudley et al., 1971) who reported that the titre of serum HBsAg was inversely proportional to the degree of liver damage present.

The apparent rapid disappearance of HBsAg can be explained by the early appearance of anti-HBs during the peak of liver damage in 26 out of 48 patients with supposedly HBV related FH (54.2%). Anti-HBs to titres sufficient to be detectable by AGD was observed in six of these 26 cases (9.3%). Again this pattern of anti-HBs response is strikingly different from that seen in non-fulminant, acute, type B hepatitis, when anti-HBs is generally detected during convalescence or even later (Barker et al., 1973) and, when present, is detectable in only 0.5% by AGD, whereas it could be found in 12.5% of FH cases (Ashcavai and Peters 1971). Moreover, FH was observed in five out of 12 consecutive cases of acute hepatitis in which anti-HBs was detected by CEP within the first week of jaundice (Dragosics, Pesendorfer, and Wewalka, personal communication). The rapid immune clearance of HBsAg by anti-HBs observed in FH would explain the difficulty in detecting HBsAg and obviate the need to use radioimmunoassay.

The overall survival of cases of FH who had no evidence of exposure to HBV was 31.3%, whereas the survival rate of those with either HBsAg and/or anti-HBs was considerably lower (16.6%). Further breakdown of the survival rate of patients with the type B infection showed that those in whom anti-HBs could be detected either alone or during and/or after HBs antigenemia did no better than those in whom only HBsAg could be detected. In fact, 15 of 16 patients who were positive for both HBsAg and anti-HBs died.

In this context, it is relevant that FH coincided with transient replacement of HBsAg by anti-HBs in a previously asymptomatic HBsAg carrier and that recovery was associated with reappearance of HBsAg and loss of anti-HBs.

Our results suggest that development of anti-HBs is not associated with an improved prognosis in fulminant hepatitis. On the contrary, they suggest that an unusually dramatic immune clearance of HBsAg may be involved in its pathogenesis. These findings may explain the reported failure of attempts to treat HBsAg positive FH by infusion of anti-HBs (Acute Hepatic Failure Study Group, 1974: Dupuy et al., 1975).

**References**


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WHO: Geneva.