HEPATITIS IN HOSPITALS

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Long before any serological diagnostic tests were available hepatitis was recognised as a risk to patients and as an occupational hazard to health service staff. Epidemiological evidence pointed to blood as the chief source of infection. Attention was drawn to the problem by reports of outbreaks among patients resulting from the use of vaccine that contained infective human serum or from equipment that was re-used without effective sterilization or among a small number of staff after surgical treatment of an infective patient (Findlay *et al.*, 1939; Biggar, 1943; Trumbell and Greiner, 1951). These outbreaks are prevented simply by excluding human serum from vaccines and by effective sterilization and the use of disposable equipment: the rare cluster among staff that arises from treatment of one patient is self-limiting.

Hepatitis of any type did not appear to spread readily to cause epidemics that involved both patients and staff and to establish itself endemically in any hospital departments other than institutions for the mentally subnormal. In the nineteen-sixties however dramatic outbreaks drew attention to hepatitis as a serious complication of the maintenance of patients with chronic renal failure by dialysis. Apart from the few situations where conditions are particularly favourable for epidemic and endemic spread, the acquisition of viral hepatitis in hospitals is usually the result of a single sporadic event.

Reservoirs of infection other than human have not been identified, though insects may sometimes act as mechanical vectors of at least one type of hepatitis virus (Leading article, 1979). This being so, the frequency of the introduction of hepatitis infection to hospitals depends largely on their prevalence in the populations served by the hospitals. Britain, in the world context, has a low prevalence of all types of viral hepatitis. Statutory notifications of infective jaundice, which began in England and Wales in mid 1968, provide an

approximate assessment of the incidence of acute icteric hepatitis: notification rates declined from 47 per 100,000 population in 1969 to 12 per 100,000 in 1975 and since then have not risen above this level (CMO DHSS Report, 1980). Most of the infections are caused by type A virus (HAV) and approximately a quarter are type B (HBV) (Stewart *et al.*, 1978). One study suggests that about one eighth may be caused by types other than A or B (NANB) (Farrow *et al.*, 1981). HAV circulates by faecal-oral spread in the incubation period or early acute stage of infection. HBV is maintained in populations by the existence of a persistent carrier state and spread is from blood to blood. Other normal body fluids eg. saliva, semen, sometimes contain HBV, probably due to extravasated serum (Heathcote *et al.*, 1974). The estimated carrier rate among the general population in Britain is 0.2 per cent but higher rates are found in many other parts of the world and rates of 10 per cent or more are found in SE Asia and parts of Africa (Barbara *et al.*, 1977; WHO Report, 1977). Only 2-3 per cent of the population in Britain have serological evidence of previous infection and immunity (Tedder *et al.*, 1980).

Though there are as yet no serological tests for NANB viruses, two of these agents appear to have similar attributes to HBV eg. a symptomless carrier state and blood to blood spread (Bradley *et al.*, 1980). Another two are probably similar to HAV in routes of transmission (Wong *et al.*, 1980).

Although, theoretically, HAV might be transmitted by blood during the short viraemic period of infection this does not appear to happen often. Sensitive screening tests for hepatitis B surface antigen have eliminated most HBV infections from blood transfusions but NANB infections remain as causes of post-transfusion hepatisi (Hollinger *et al.*, 1981). Any of these types of hepatitis virus may be introduced to hospitals by patients with acute hepatitis, by patients or staff who are either symptomless carriers or in the incubation period of an attack, or by blood or blood products. Whether there is any spread within the hospital to patients or staff depends on the type of virus and whether conditions are favourable.

EPIDEMIC AND ENDEMIC SPREAD

Type A. The only part of the hospital world in which HAV finds the conditions conducive to its spread is in institutions for the mentally subnormal. Low standards of hygiene among patients favour faecal-oral transmission from patient to patient and thence to staff. In these institutions HAV outbreaks are common and the infection may become endemic. HAV infection can be controlled by giving human normal immunoglobulin prophylaxis to contacts after the appearance of overt infections (Krugman and Giles, 1970).

Foodborne outbreaks of HAV have been reported in general hospitals but this type of spread is not specifically related to the hospital environment; it occurs occasionally in catering establishments of any type by contamination of food, usually by infective food handlers (Eisenstein *et al.*, 1963).

Type B. Institutions for the mentally sub-normal provide some of the conditions which tend to establish HBV as an endemic infection. Patients with Down's syndrome appear to have an inherent abnormality of immune response which causes them to become persistent symptomless, and usually highly infective, carriers after exposure to HBV (Krugman and Giles, 1970; Gust *et al.*, 1978). Infection is spread by inapparent parenteral routes eg. bites or scratches by which saliva or small portions of serum from skin abrasions are transferred from patient to patient. The infection is sometimes transmitted to staff in the same way. Dramatic epidemics do not arise in these institutions but the underlying endemic infection becomes evident from time to time when either a patient or a member of staff developes an acute type B attack.

Units in which patients with chronic renal failure are maintained by intermittent dialysis are the only general hospital departments in which it is the rule for hepatitis B infection to arise in explosive outbreaks and then to become endemic. The tendency of patients with chronic renal failure to become persistent symptomless, but highly infective, carriers after exposure to HBV is a central factor. At first the known association between blood transfusions and hepatitis tended to obscure the fact that dialysis associated hepatitis is essentially a cross-infection problem. The infection may be introduced by blood transfusion or by the admission of a carrier patient or a patient incubating the infection, but sooner or later one of the patients being treated in a unit will be a highly infective carrier. In these units there are many opportunities for blood spread; patients are heparinized and they haemorrhage readily from shunts, fistulae or other sites. One infected patient in a unit will lead in time by blood spread to infection of other patients. Transmission may be direct from blood falling on to exposed skin lesions or by sharing of equipment, or indirect from environmental contamination. A pool of carrier patients is built up and staff are infected by accidental inoculation, contamination of skin abrasions or splashes of blood into the eye or mouth. Infection may spread to other departments and other hospitals via blood specimens or by carrier patients who may haemorrhage and present themselves in casualty departments. Dialysis associated hepatitis B can be controlled and prevented by a programme which includes serological screening of blood transfusions and patients before admission and at regular intervals afterwards, dialysis in

isolation of carrier patients, and adequate cross-infection precautions (Polakoff *et al.*, 1972; DHSS Report, 1972; PHLS Reports, 1974, 1976).

Though screening serum for HBsAg has provided a useful approach to the prevention of HBV infection its value depends on whether effective action can be taken on the basis of the test results. In the case of transfusions, HBsAg positive blood is removed from use and so most post-transfusion type B hepatitis is prevented. In renal units HBsAg positive patients are removed to isolation for dialysis and so epidemic and endemic infection is prevented. In institutions for the mentally sub-normal (MSN) however, where HBV infection is spread between patients in the course of day to day life, effective action to prevent transmission from HBsAg positive patients is not feasible, so that screening programmes cannot lead to the elimination of endemic HBV infection.

An outbreak in an oncology unit in the USA that involved both patients and staff illustrates the potential risk of HBV spread where there is an aggregation of immunocompromised patients who are liable to become symptomless persistent and highly infective carriers after exposure to HBV (Wands *et al.*, 1974). In these units however there are fewer opportunities for patients to be exposed to, or to transmit, HBV infection than in renal units or in institutions for the MSN and, indeed, in Britain there have been no reports of HBV outbreaks in these departments. Sensible cross-infection precautions and the use of specific immunoglobulin after accidental exposure to HBsAg positive blood should provide adequate control in these units.

Type non-A, non-B

Serological tests to exclude HAV, HBV and other relevant virus infections show that there are other hepatitis viruses which cause both post-transfusion infections and sporadic attacks from unknown sources. Two such agents appear to have attributes similar to those of HBV i.e. a symptomless carrier state, blood to blood spread and a tendency to progress to chronic hepatitis which seems greater than that of HBV (Bradley *et al.*, 1980; Knodell *et al.*, 1977). These similarities suggest that NANB agents might cause infection in hospitals and that the problem, like type B hepatitis, should be particularly obvious in high risk areas such as renal units. NANB infections might well pass unnoticed in units with widespread HBV infection but they should be apparent in Britain where renal units have been free of HBV outbreaks since 1973. In fact, clusters of patients with abnormal aminotransferase levels have been observed in several units and, in the earliest type non-B outbreak reported, chronic liver disease developed later in about half of the affected pa-

tients (Galbraith *et al.*, 1975). These clusters may be caused by NANB viruses, though similar episodes have been ascribed to drug therapy or to toxic chemicals from dialysis tubing (Simon *et al.*, 1979; Neergaard *et al.*, 1971). The feature that distinguishes the possible NANB outbreaks from HBV outbreaks is that none of the staff in the units developed acute hepatitis, few had abnormal aminotrasferase levels and these few were minor elevations (Polakoff, 1981). Specific serological tests for NANB agents are of course needed to define the nature and extent of these infections but the absence of acute hepatitis among dialysis unit staff since HBV infection was eliminated seems reliable evidence that NANB infection does not present the same order of risk as HBV infection to hospital staff.

Hepatitis outbreaks that spread to involve patients and staff do not arise in hospital departments other than those described above. Hepatitis infections are common among patients treated with anti-haemophilic factor concentrates but these, like transfusions, are direct from product to patient and subsequent spread between patients or from patient to staff has not been reported. The use of materials produced from voluntary blood donors in this country, rather than imported materials, substantially reduces the incidence of these infections (Craske *et al.*, 1975; Skidmore *et al.*, 1980).

Small clusters of patients or staff with acute hepatitis sometimes result from infections acquired from one highly infective individual. As these small outbreaks result from accidental inoculation or contamination in the same way as single infections, they are discussed together with sporadic hepatitis.

SPORADIC INFECTIONS

Apart from direct transmission from blood or blood products the possible sources of sporadic hepatitis infections in hospitals are patients admitted with hepatitis, patients admitted for treatment of other conditions during the incubation period of hepatitis infection or symptomless carriers among patients and staff.

Patients with acute hepatitis are nursed in isolation in separate rooms or cubicles with precautions against transmission by blood and 'enteric' spread (Cossart, 1977). Isolation of cases is traditional, though it is probably not essential.

Patients with type A attacks are most infective in the incubation period when large amounts of virus are excreted; once symptoms develop the number of virus particles decreases sharply to disappear at latest by the end of the second week of the acute illness (Tufvesson *et al.*, 1979).

When type B hepatitis has been diagnosed enteric precautions are no longer necessary. The patient is infective for several weeks, sometimes months, during the incubation period and remains so during the acute illness (Hoofnagle *et al.*, 1978). The number of virus particles usually declines as the attack resolves but, unless there is laboratory evidence to the contrary, the patient's blood should be regarded as infective throughout the stay in hospital. HBV is absent from faeces but may occasionally be present in small numbers in normal body fluids (Feinman *et al.*, 1979).

Patients with acute hepatitis diagnosed, by exlusion, as type NANB require both 'enteric' and blood precautions as there are at present no serological tests to distinguish the several agents that comprise this group.

More than 0.2 per cent of patients admitted to hospital in Britain for treatment of conditions other than acute hepatitis can be expected to be HBsAg carriers; laboratory markers of high infectivity are detectable in the serum of about one-fifth but the remainder are of low infectivity i.e. there are so few HBV particles present that the infection is unlikely to be transmitted unless the inoculum is large e.g. a blood transfusion (Dow *et al.*, 1980; Tedder *et al.*, 1980).

As might be expected, HBsAg carrier rates are higher among those who have had repeated opportunities of exposure to HBV e.g. recipients of multiple blood transfusions, drug abusers, promiscuous homosexual males. Exposure to HBV infection, either in early infancy when immune responses are immature, or at any time in individuals immunocompromised by inherent defects, disease or therapy usually results in the development of the persistent symptomless, but highly infective, carrier state. In the general population in Britain HBsAg carriage is less common among women and female carriers are usually not highly infective (Barbara *et al.*, 1978). However in some ethnic groups with high HBsAg prevalence rates this is not the case; in these groups the highly infective carrier state is common among women of child-bearing age, who usually transmit the infection to their newborn (Derso *et al.*, 1978).

Spread between patients

Transmission of type A or B infection from patient to patient requires contamination of the environment or of equipment with faeces containing HAV or with blood or other body fluids containing HBV. Observation by staff of adequate standards of hygiene in hospitals and appropriate sterilization or disinfection of equipment should prevent such contamination in all except the 'high risk' situations already described. The possibility of transfer of HBV from patient to patient by instruments, such as fibreoptic endoscopes, which

are disinfected but not sterilized between use has been suggested. However no evidence of infection was found in patients investigated or treated with such instruments after their use for known HBsAg carriers (McClelland *et al.*, 1978; Morgan *et al.*, 1978). In one study patients with acute type B infections had a higher incidence of medical investigation requiring puncture of the skin in the six months before their illness than patients with non-B type hepatitis (Stewart *et al.*, 1978): nevertheless, the association is not necessarily causal; the life-style of some patients who acquire HBV infections may tend to lead to other conditions that require medical investigation.

Spread from patients to staff

Studies of the prevalence of serological markers of past HAV infection among health service staff show that HAV contributes little to hepatitis as an occupational hazard (Szmuness *et al.*, 1977; Maynard, 1978).

Apart from institutions for the MSN, there seems to be little risk unless there is a lapse in hygienic precautions when tending faecally incontinent children who are in the incubation period of HAV infection. Small outbreaks arising from these circumstances have been reported in the USA (Orenstein *et al.*, 1981).

In contrast, studies of the prevalence of antibody to HBsAg (anti-HBs) among hospital personnel in the USA show that levels are related to occupation. Among those with the greatest opportunity for parenteral exposure to patients' blood, i.e. surgeons, pathologists, prevalence rates were five times those found among staff with little patient contact, where rates were similar to those of the general population (Denes *et al.*, 1978). Most of these infections are acquired symptomlessly and active immunity develops without any detrimental effect. Nevertheless the incidence of acute hepatitis is increased proportionally in the groups at increased risk. Similar serological studies have not been reported in Britain but reports of acute hepatitis B confirmed by laboratory tests, which have been made to the Public Health Laboratory Service Communicable Disease Report since mid 1972, include details of occupation. The average annual totals in the years 1973-1980 of all patients with acute hepatitis B and of those in specified health service staff categories is shown in the table (PHLS CDR unpublished). Over the years there was little variation in the totals reported annually or in the numbers in any staff category except that of laboratory workers. In this group there was a sustained decline to reach in recent years less than half the numbers reported in earlier years. This decrease is almost certainly related to improved precautionary measures in laboratories (Grist, 1981).

Incidence rates based on the reports for England 1975-1979 were similar for surgeons, physicians, laboratory staff and dentists – approximately 18 per 100,000 but the rate for nurses was lower – 7 per 100,000. Comparisons between these rates, based on small numbers, and the overall rate of 3 per 100,000 among the adult population, should be made with caution. Physicians appear to be aware of, and use, the laboratory facilities for diagnosis of acute hepatitis B in most cases (PHLS Report, 1980) but, possibly, the known occupational risk could lead to laboratory diagnosis of a larger proportion of infections among staff than among the general population, which would artificially increase differences. Estimates based on these reports of the relative risk to staff are, therefore, only approximations but their trend confirms the occupational hazard for these staff categories. Despite the increased risk, attacks of acute hepatitis B among staff seem few in terms of the number of highly infective HBsAg carriers treated in hospitals each year: for example, in England and Wales it is estimated that there are each year almost three million surgical operations (including deliveries with skin incision or manipulation) (OPCS HIPE Report, 1977). Among these patients there may be as many as 1500 highly infective carriers yet among surgeons the annual average of reported acute hepatitis B attacks is no more than three. Symptomless infections, which usually result in immunity, are estimated to occur in the ratio of 2 : 1 to acute infections; on this basis, the average total of HBV infections, acute and symptomless, among surgeons is probably about nine each year. This small number of infections relative to the large number of infective patients emphasizes that HBV will not be transmitted if there has been no accidental inoculation or contamination. Specific hepatitis B immunoglobulin for prophylaxis after accidental exposure affords effective though not complete protection (Hoofnagle *et al.*, 1979). In Britain this material has been available on request since 1973 and follow-up studies of staff given prophylaxis after accidental exposure showed that only three per cent developed hepatitis, that none of the attacks were severe and that none developed HBsAg carriage without symptoms (MRC/PHLS Report, 1980). Since then the dose of immunoglobulin has been doubled and there have been few clinical attacks among those who received prophylaxis (Polakoff, unpublished). It is of interest that only two per cent of the 453 health service staff who developed acute hepatitis B during 1973-1980 represented the few failures that must be expected among the large number who receive prophylaxis: the remainder – 98 per cent – did not receive prophylaxis presumably because the relevant exposure had either passed unnoticed or had not been reported.

Only one cluster of acute HBV infections among staff exposed to a single patient has been reported in Britain. At time of operation and subsequent

intensive care the patient was in the incubation period of an acute attack, when the viraemia is at its height (Shannon, 1980).

HBV vaccines that appear safe and effective have been developed (Szmuness *et al.*, 1980). The use of HBV vaccines on a limited basis for staff at high risk should reduce the occupational hazard.

Type non-A, non-B. There are no serological tests for these agents, so that the incidence of these infections cannot be estimated on the basis of laboratory confirmed reports of acute hepatitis. Transmission of NANB infection from a patient to a nurse in the USA was confirmed experimentally (Tabor *et al.*, 1978). However the absence of clinical infections and the rarity of hepatic dysfunction among staff in departments in which NANB infections would be expected, i.e. dialysis units, suggest that either the precautions against cross-infection observed by staff in these units are highly effective or that NANB infections are not transmitted in these circumstances as frequently or effectively as HBV (Polakoff, 1981).

Spread from staff to patients

Type A. There is no evidence of spread of HAV infection from staff to patients.

Type B. Transmission of HBV infection from staff to patient seems rare. Of the small number of staff reported to have infected patients, some did so during the incubation period or convalescent stage of an acute attack, others had chronic hepatitis or were symptomless carriers: the sources include three dental surgeons (Rimland *et al.*, 1977, Levin *et al.*, 1974, Hadler *et al.*, 1981), a nurse (Garibaldi *et al.*, 1972), an inhalation therapist (Snydman *et al.*, 1976), a gynaecologist (PHLS Report, 1980) and a general practitioner (Grob *et al.*, 1981). Blood to blood exposure of patients during surgical procedures appeared to result from trauma to the dental surgeons' ungloved hands during the course of treatment and from punctures with sharp instruments through the gynaecologist's glove and skin. The exposures of patients to the general practitioner and to the therapist were due to lapses in aseptic techniques; the physician, who had multiple uncovered lesions of his hands, appeared to have contamined needles and syringes used for injection or venepuncture; the inhalation therapist worked ungloved despite severe exudative dermatitis.

The opportunity for staff to transmit HBV infection to patients is limited to those whose blood contains so many HBV particles that a small inoculum will cause infection and who undertake procedures during which accidental blood to blood contact with patients is possible. In general this restricts pos-

sible sources among staff to surgeons and dentists who are either symptomless carriers or experiencing a clinical infection.

In Britain acute hepatitis B is so uncommon even among health service staff that there are only about five or six cases in surgeons and dentists in a year and the number of highly infective symptomless carriers among these two groups at any time has been estimated as 14 at most (PHLS Report, 1980). Despite the high infectivity of the blood of this small number, their patients are at no risk of infection without a relevant accident and, unless there is certain evidence of transmission to patients, the professional activities of HBsAg carriers among staff should not be limited except in particular high risk areas of work i.e. renal units and blood product laboratories. It is worthy of note that a history of surgery or dental surgery within six months of the onset of acute hepatitis B is by no means certain evidence that the patient has acquired the infection during surgical treatment. Although the incidence of acute hepatitis B in the general population in Britain is low, the incidence of surgical operation is high (OPCS HIPE Report. 1977). In a random sample of the population almost three per cent can be expected to have a history of surgery in the previous six months. Gynaecological condititions and pregnancy increase the incidence of surgery among women of child-bearing age, so that almost six per cent of women in this age group will have had an operation or a delivery, with incision of the skin or manipulation, in the previous six months. Similar proportions of patients with acute hepatitis B can be expected to have this history by chance and an association between surgery and HBV infection cannot be considered causal without further evidence.

Type non-A, non-B. As some NANB agents have a symptomless carrier state and blood to blood spread, staff to patient transmission is theoretically possible but there are no reports of clusters of patients with NANB infections related to surgery.

Table 1. — *PHLS CDR Acute hepatitis B reports from laboratories in England, Wales and Northern Ireland. Average annual number 1973-1980.*

All reports	Reports of health service staff						
	All	Surgeons	Physicians	Laboratory workers	Nurses	Dentists	Ancillary
967	57 (6% of total)	3	10	5	28	3	10

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