Occupational and non-occupational hepatitis B virus infection among hospital employees in Jerusalem: a basis for immunisation strategy

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Abstract

The present study was designed to assess the risk of hepatitis B virus (HBV) infection among hospital employees, who often contract the infection before the beginning of their employment, and to suggest a prevention strategy. The study population consisted of 2518 subjects working or studying at the two Hadassah University hospitals, on Mount Scopus and at Ein Kerem in Jerusalem. The total prevalence for anti-HBc positivity as an indicator for past or present HBV infection was 17.6%. Several variables, including country of birth, age, and duration of employment significantly affected the rate of anti-HBc positivity. The highest rates for anti-HBc+ were found in personnel of selected departments such as haemodialysis (31.8%), haematology/oncology (28.3%), and the blood bank (24.0%), after adjustment for country of birth, age, and sex. Specific occupations in the hospital were associated with an increased rate of anti-HBc positivity. Thus the highest rate of HBV infection (after adjustment for country of birth, age, and sex) was shown for housekeepers (32.4%) and departmental secretaries (23.6%), who take care of waste products containing blood, or who transfer vials containing blood to the hospital laboratories. By comparison, anti-HBc was positive in 17.2% of nurses, 15.6% of physicians, and only 7.8% of administrative clerks. Israel is a country of immigration, and anti-HBc rates were four times higher in employees born in countries where HBV is more endemic—for example, in north Africa and Mediterranean countries—than in employees born in western Europe or

the United States. However, rate of anti-HBc + increased significantly with age as well as duration of employment in the hospital, irrespective of country of birth. These data indicate that although HBV infection often occurs in Israel before commencement of employment in the hospital, hospital employees are at significant risk for contracting HBV infection during their professional lifetime regardless of where they were born. Moreover, paramedical personnel such as housekeepers and departmental secretaries are in the highest risk group for contracting HBV. Finally, as a result of the high background of anti-HBc positivity in selected ethnic groups, mandatory screening for anti-HBc before employment in medical institutions in Israel is recommended for them, then active vaccination against HBV for employees at risk. Employees who immigrated from western Europe and the United States should be immunised without pre-vaccination screening for HBV.

Hepatitis B virus (HBV) has been considered an occupational hazard to hospital staff for over two decades. As early as 1951, Trumbull and Greiner¹ noticed the importance of the accidental transfer of "homologous serum jaundice" to employees who were exposed to infected blood. In the late 1960s, outbreaks of haemodialysis associated hepatitis were reported,²⁻⁴ and followed up by the Centre for Disease Control in the United States.⁵ The annual incidence of infection among haemodialysis personnel was found to be 100 times higher than the incidence reported for the general population. In Sweden in the early 1970s a national registry showed a five times higher incidence of clinical HBV infection among medical personnel as compared with the incidence in the general population.⁶ Later, a number of seroepidemiological studies among medical employees⁷⁻¹⁹ showed the risk of contracting HBV infection as a result of contact with blood among special subgroups (physicians, nurses, and laboratory technicians). The prevalence of HBV

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Table 1 Distribution of Mount Scopus hospital employees by occupation, sex, and mean age

Occupations	No*	Men (%)	Mean age (SD)
Physicians	105	83.8	38.8 (8.3)
Nurses†	311	8.7	35.6 (9.8)
Laboratory workers	53	18.9	36.4 (7.8)
Department secretaries	37	2.7	35.5 (9.5)
Administration clerks	34	44.1	34.5 (9.9)
x Ray technicians	12	58.3	39.1 (11.6)
Food handlers	47	48.9	38.0 (11.6)
Housekeepers	39	76.9	34.4 (8.7)
Others	139	44.6	38.8 (11.1)
Total	777	34.0	36.8 (9.9)

*Data on occupation were unavailable for six subjects.

†Including nurse's assistants.

markers among medical personnel was found to be 2–7 times higher than in the general population,^{8 9 12 13} volunteer blood donors,^{11 14 19} and other matched controls.¹⁵

Israel is situated in an area with intermediate endemicity for HBV infection^{20 21}; however, most of its population immigrated from countries where HBV is more prevalent than in western Europe or the United States. A review of studies conducted in Israel in the 1970s²⁰ showed a twofold higher prevalence of HBV markers among hospital employees as compared with the general population. This finding was, however, strongly influenced by the variation of background HBV infection among different ethnic groups, and it was therefore not known to what extent employment in hospitals in Israel is indeed associated with an increased risk for contracting HBV infection.

In March 1986, a multidisciplinary committee at the Hadassah University Hospitals decided to implement an immunisation programme for all employees who have contact with blood at their workplace. The first step in that programme was a serological survey to determine the prevalence of anti-HBc in the entire hospital population, to characterise epidemiological determinants among employees, and to suggest an immunisation strategy against HBV.

Subjects and methods

Employees of the two Hadassah hospitals in Jerusalem were eligible for screening between 1986–1988. At the Hadassah Centre in Mount Scopus all 850 permanent employees were offered the screening

Table 2 Prevalence of HBV markers among Mount Scopus hospital employees*

Marker	No positive	Rate/100
Anti-HBc	138	17.6
HBsAg	14	1.8

*783 employees.

procedure, while at the Hadassah Ein Kerem Centre, only 1184 of 3588 workers (33%) of departments at higher risk, as determined by surveys conducted in other countries,^{16–19} were eligible. The response rates for screening were 92% at Mount Scopus and 86% at Ein Kerem, giving a study population of 783 and 1022 respectively (total 1805). Also, 713 students were tested in 1988. This group comprised 392 medical students, 200 dental school students, and 121 nursing school students. The study population thus totalled 2518 subjects.

All participants filled out a self administered questionnaire that included sociodemographic information, as well as history of possible past exposure to hepatitis viruses, history of clinical hepatitis, previous immunisations, and medications.

All serum samples were tested for anti-HBc, which was used as the primary marker to detect past or current HBV infection. Positive anti-HBc samples were also tested for anti-HBs and HBsAg. All assays were performed using radioimmunoassay or enzyme linked immunosorbent assay (ELISA) (Abbott, N Chicago, IL).

Prevalence rates of the hepatitis B markers by age, sex, country of birth, and occupation were calculated for the Mount Scopus hospital population in as much as it represented a defined total population of one hospital. Table 1 presents the distribution of the population, sex, and mean age for each occupation. Prevalence of anti-HBc by hospital departments was calculated for the pooled population of both Mount Scopus and Ein Kerem hospitals, for departments with similar prevalence rates.

The χ^2 test was used for the univariate analysis for comparing prevalence rates of subgroups. The indirect method of standardisation and its 95% confidence interval (95% CI) were used for comparing rates of small groups. Specific rates for sex, age, and origin among Mount Scopus employees were

Figure 1 Prevalence of anti-HBc by age (Mount Scopus hospital).

Figure 2 Prevalence of anti-HBc by country of origin.

used as standard rates. A logistic regression model was used as the multivariate analysis to assess the independent effects of the demographic variables on the prevalence of positive anti-HBc. The variables were coded as follows: woman = 1, man = 0; age ≥ 40 = 1, age < 40 = 0; endemic origin = 1, non-endemic origin = 0.

Results

Table 2 presents the prevalences of anti-HBc and HBsAg among Mount Scopus employees. Evidence for past or present HBV infection was established in 17.6% of 783 workers. Among the anti-HBc+ workers, 10.1% were HBsAg carriers (1.8% of all employees). Anti-HBs, tested only in anti-HBc+/HBsAg- subjects, was detected in 90 of 121 employees, indicating that the remaining 31 of 783 employees (4%) were anti-HBc+/HBsAg-/anti-HBs-. Prevalence of anti-HBc was found to be significantly ($\chi^2 = 7.27$, $p < 0.01$) higher in men (22.9%) than in women (14.9%), and profoundly ($\chi^2 = 16.62$, $p < 0.01$) associated with age (fig 1). Positive anti-HBc was detected in only 10 of 713 students (1.4%). This anti-HBc+ population consisted of nine of 392 medical students (2.3%), one of 121 nursing school students (0.8%), and none of 200 dental students.

Country of birth of employees was significantly associated with prevalence of anti-HBc (fig 2). The highest rate of anti-HBc+ (45.8%) was found among workers born in Morocco, and no evidence for HBV infection was found among workers born in north America or South Africa. For further analysis, the various places of birth were reduced to two main groups, and data were applied to a logistic regression model. Those groups with an anti-HBc+ prevalence rate of $> 20\%$ (those born in Morocco, Romania, the former USSR, and the Arab population) were classified as coming from an endemic area, and the remainder were classified as non-endemic. The logistic regression model highlights the impact of birth-

place on anti-HBc+ rates (table 3). Workers born in endemic areas had a 4.4-fold higher rate of positive anti-HBc than those born in non-endemic areas, controlling for age and sex. Independently, male sex or age ≥ 40 years showed twofold higher risk for HBV infection after controlling for the other variables. The possible interaction between origin and sex was tested by the logistic model and found to be non-significant. The possible interaction between sex and occupation could not be tested using the logistic model due to sex related traditional selection of occupation.

In assessing the rate of HBV infection in selected occupations, housekeepers were found to have the highest anti-HBc+ rate, after adjustment was made for age, sex, and place of birth (table 4). The impact of occupational exposure to HBV on housekeepers is evident through comparison of anti-HBc origin specific prevalences. Prevalence of anti-HBc in housekeepers born in endemic areas was 48% compared with 47% for those born in non-endemic areas (about half of the housekeepers were born in areas endemic for HBV, and both groups had a similar age distribution). Interestingly, department secretaries ranked second among the high risk groups whereas administration clerks ranked lowest.

To assess the impact of the workplace environment on the risk for HBV infection, data were gathered in selected departments of both hospitals and pooled in some cases. Table 5 describes the crude and adjusted prevalences of anti-HBc+, in selected departments ranked by prevalence.

Table 3 Logistic regression model: association of anti-HBc+ with selected variables

Variable	Categories	Odds ratio*	p Value
Age	≥ 40 / < 40	1.70	< 0.01
Sex	F/M	0.62	< 0.05
Origin	endemic/non-endemic	4.44	< 0.0001

*Odds ratio = anti-HBc rate ratio between the two categories tested in each variable, controlling for the other variables.

Table 4 Prevalence of anti-HBc by selected occupations (adjusted for age, sex, and origin by the indirect method)

Occupation	No tested	Anti-HBc + crude rate/100	Anti-HBc +	
			adjusted rate/100	(95% CI)
Housekeepers	39	46.2	32.4	(22.59–42.20)
Department secretaries	36	18.9	23.6	(10.40–36.80)
Nurses	297	16.7	17.2	(13.25–21.15)
Physicians	100	16.2	15.6	(9.28–21.92)
Laboratory workers	53	3.8	10.3	(4.23–16.43)
Administration clerks	34	5.9	7.8	(0–17.96)*

*The lower confidence bound turned out to be negative under normal approximation and is therefore replaced with 0.

Discussion

Hepatitis B virus infection is now well recognised as an occupational risk for medical personnel in those countries of the western world where HBV is not endemic.^{8 9 11 16 18 19} In such countries, candidates for hospital employment usually have a comparatively low anti-HBc rate as evidence for previous infection. By contrast, in countries of intermediate or high endemicity—the Mediterranean basin, Africa, or east Asia—medical employees may have acquired HBV through vertical or horizontal infection before beginning their employment in the medical professions. The purpose of our present study was to assess the risk for contracting HBV in medical personnel before and during their professional activity. The professional risk to acquire HBV was then calculated by controlling for country of birth, age, and sex in the population tested, assuming a similar environmental and non-occupational exposure in the different groups.

In the present study, 17.6% of all employees at Hadassah Mount Scopus hospital had evidence for past or present HBV infection as determined by positive anti-HBc tests. This figure is similar to data obtained in studies conducted in other countries^{8 9 11 16 18 19} where HBV is less endemic in the general population than in Israel.²⁰ Furthermore, as

also shown by Hadler *et al*¹⁶ using a linear logistic regression model, we found a higher rate of HBV markers among male hospital employees. Among the study population in Jerusalem, male predominance was found for some specialised hospital occupations (physicians and housekeepers), whereas female predominance was shown for nurses, laboratory technicians, and departmental secretaries. A multi-variable analysis that could have separated the effects of sex and occupation was not possible due to the small sample size in each occupation and the strong dependence between defined occupations and sex. We therefore pooled the data for nurses and physicians born in countries not endemic for HBV and analysed the association between HBV infection and sex in two age groups (<40 years and ≥40 years). No difference was seen in the risk to contract HBV between men and women among these hospital employees, where 10% of men and 10.1% of women below the age of 40 were anti-HBc+, as compared with 16.5% and 17.4% respectively in the over 40 age group. The lowest prevalence of anti-HBc+ was found in employees below 30 years of age (11.3%), whereas in those aged 60 or over, 31% showed evidence for past or present HBV infection. The increase in prevalence of HBV with advancing age correlates with the increased duration of occupation

Table 5 Prevalence of anti-HBc by selected department (adjusted for age, sex, and origin by the indirect method)

Occupation	No tested	Anti-HBc + crude rate/100	Anti-HBc +	
			adjusted rate/100	(95% CI)
Clinical biochemistry (EK)	23	28.0	36.5	(21.25–51.80)
Haemodialysis (EK)†	29	24.1	31.8	(14.88–48.68)
Haematology/Oncology‡	75	24.0	28.3	(17.45–39.85)
Blood bank (EK)	20	20.0	28.2	(7.08–49.30)
Clinical biochemistry (MS)	20	15.3	18.2	(6.99–29.38)
Blood bank (MS)	11	9.1	15.0	(0–42.58)*
Surgery	462	22.1	20.9	(17.64–24.15)
Intensive care/anaesthesia‡	223	13.5	16.6	(11.53–21.72)
Internal medicine/pediatrics‡	371	15.6	16.0	(12.58–19.45)
Pathology‡	24	20.8	16.4	(4.91–27.86)
Dental clinic (EK)†	124	12.1	12.2	(6.77–17.61)
Administration (MS)§	61	10.1	9.6	(1.92–17.20)

*The lower confidence bound turned out to be negative under normal approximation and is therefore replaced with 0 (zero).

†Exists in EK only.

‡EK and MS.

§Examined in MS only.

EK = Ein Karem; MS = Mount Scopus.

in the hospital. These two variables showed a high correlation (Pearson's correlation coefficient 0.7, $p < 0.0001$). The increase in prevalence of anti-HBc with advancing age may be explained by continuous accumulation of years of exposure to HBV, by a cohort effect, or by both.

The effect of exposure to HBV on prevalence of anti-HBc was reported by Denes *et al* who showed an accelerated phase of rising antibodies to the hepatitis B virus surface antigen in physicians who had recently entered practice.¹¹ Similar findings were seen in the present survey, where medical students had an anti-HBc+ prevalence of only 2.3%, whereas a pooled sample of 248 physicians (born in countries where HBV is not endemic) showed an accelerated rise in anti-HBc prevalence that was directly proportional to increase in age. In this group, anti-HBc+ prevalences of 9.8%, 12.9%, and 21.1% were shown for the age groups 30–39, 40–49, and 50–59 respectively. Similar findings were seen in a group of 799 nurses (data not shown). One exception was dentists and their assistants: none of the 200 dental students tested was found to be anti-HBc+, and only 9% of dentists had evidence for HBV infection; there was no correlation with age.

A possibility exists, however, that the rising prevalence of anti-HBc with increasing age among the tested population may be partially attributed to a cohort effect. To date, there is a greater awareness among medical employees, and especially among physicians, nurses, and laboratory technicians, of the risk of contracting HBV, hepatitis C virus, and human immunodeficiency viruses.¹⁸ In Sweden, the introduction of strict safety procedures in hospitals led to a significant decrease in the incidence of acute HBV infection among medical personnel.⁶ The higher prevalence among older employees in our study population may therefore be attributed to HBV infection contracted several decades earlier. Indeed, possible support for such a cohort effect was shown by comparing the prevalence of anti-HBc among the employees in the clinical biochemistry departments of the two Hadassah hospitals. In Ein Kerem, the anti-HBc rate, adjusted for age, sex, and country of birth, was twice as high as the adjusted rate at Mount Scopus. Interestingly, many of the employees of Ein Kerem began their employment 30–40 years ago when safety precautions to prevent HBV infection were practically non-existent, whereas the Mount Scopus hospital has been in operation only from the mid-1970s (with mostly younger employees), when safety regulations against HBV had already been introduced.

The implementation of screening for HBV and immunisation strategies in Israeli hospitals deserves special attention, in as much as unlike the situation in many western countries, Israel is in an area of intermediate endemicity for HBV, meaning that at all

times, an estimated 3–5% of the patients in hospital are asymptomatic HBsAg carriers. Moreover, about 50% of hospital employees in Israel are not native born: many of them immigrated from countries where HBV is endemic, such as north Africa, the Mediterranean basin, and Middle East countries. Indeed, 46% of employees born in Morocco, 41% of employees born in the former USSR, and 34% of the Arab employees of the two hospitals had evidence for past or present HBV infection. The significant differences in prevalence of HBV markers among different ethnic groups in Israel²⁰ as well as in the United States^{9,16,17} has been known for over a decade. The question was raised as to whether the occupational risk for contracting HBV is also as high in an environment with such prevalent background infection with HBV (before commencement of employment), in comparison with western countries. It has been shown in the present study that the risk for contracting HBV during the professional lifetime of medical employees in Jerusalem is indeed substantial after adjustment for country of birth, age, and sex. It was therefore not surprising to discover that physicians and nurses working in haemodialysis and haematology/oncology, and laboratory technicians working in clinical biochemistry and in the blood bank had anti-HBc prevalences of 32%, 28%, 27%, and 24% respectively after such adjustments. By contrast, the lowest prevalence of anti-HBc was found among the administrative personnel, where only 8% were anti-HBc+. One finding, concerning two risk groups among hospital employees who until this time had not been given proper attention was unexpected: housekeepers and departmental secretaries had exceptionally high prevalence of anti-HBc (32% and 24% respectively). In fact, housekeepers are often injured by non-protected needles and discarded medical instruments negligently thrown into the waste, and departmental secretaries in both hospitals handle test tubes containing blood without using protective gloves. These two groups of employees had the highest prevalence for anti-HBc after adjustment for ethnic background, age, and sex, and they are, unfortunately, also less aware of the risk of contracting HBV in the hospital environment.

Finally, the present study has clearly shown that HBV infection is a serious hazard to hospital employees in Israel. It is therefore mandatory to protect this population: (1) by offering them an active immunisation programme against HBV, which has in fact been implemented before the submission of this study for publication. It is advised that all new candidates for employment in Israeli hospitals, who were born in countries endemic for HBV (such as north Africa, the Middle East, the former USSR, and Romania), should be screened for anti-HBc before immunisation, as 20–50% may be exempt from vaccination due to previous infection with HBV.

Candidates born elsewhere should be immunised without any pre-vaccination screening. (2) The currently recommended guidelines for needle and sharps disposal, and the use of gloves when handling potentially contaminated material, should be enforced more vigorously by the hospitals, clinics, and laboratories around the country.

The present study was only partially funded. We are therefore very grateful to the following colleagues who have contributed appreciably to the carrying out of this study by volunteering their "free time": B Adler, R Adler, D Avraham, M Avitzur, M Barkali, R Brazis, N Daudi, N Ferber, T Fink, D Galili, Y Grinbaum, S Gutkin, E Kafri, N Kellman, T Kushnir, N Mani, T Perlstein, S Shraga, A Tubul, and E Weinstein. We also thank Professor J Kark for his critical review.

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Accepted 16 December 1991

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