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Hepatitis B and C among Berlin dental personnel: incidence, risk factors, and effectiveness of barrier prevention measures

A. AMMON[1]*, P. A. REICHART[3], G. PAULI[2] AND L. R. PETERSEN[1,4]

[1] *Department of Infectious Disease Epidemiology, Robert Koch Institute, Berlin, Germany*
[2] *Department of Virology, Robert Koch Institute, Berlin, Germany*
[3] *Center for Dental Medicine of the University Clinic Charité, Berlin, Germany*
[4] *Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, USA*

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SUMMARY

A study of 215 Berlin dentists and 108 dental assistants recruited at the 1997 Berlin Dental Society meeting assessed their occupational risk of hepatitis B virus (HBV) and hepatitis C virus (HCV) infection, HBV vaccine coverage, and barrier prevention methods used. Among dentists, 7% (95% CI 4–11) and 0·5% (95% CI 0–3) had serological evidence of previous HBV and HCV infection, respectively. Similar figures for dental assistants were 1% (95% CI 0–5) and 0% (95% CI 0–4). Only 74% of dentists and 63% of dental assistants reported HBV vaccination. Approximately half always used gloves, eye glasses, or face masks. HBV unvaccinated dentists whose patients had HBV risk factors had a greater risk of HBV infection; those who always wore face masks were at lower risk (OR 0·2, 95% CI 0·02–0·98). These data indicate that among Berlin dentists, the HCV risk was lower than that of HBV and that face masks may have lowered the risk of HBV. The use of eye glasses or gloves did not appear to lower the risk of HBV acquisition in this population.

INTRODUCTION

Hepatitis B virus (HBV) infection has long been recognized as an occupational hazard among dentists [1–3]. Contemporary serological surveys have indicated that 10–30% of dentists have serological evidence of past or current HBV infection [4–7]. To decrease the risk of HBV infection, dental personnel have been recommended to receive immunization against HBV [8, 9] as well as to use barrier methods such as gloves to prevent blood-borne infections acquired during dental procedures [8].

By 1992, over 80% of US dentists and over 90% of British dentists and dental assistants reported HBV vaccination [10, 11]. The use of barrier methods has generally increased over time. A 1993 Canadian survey indicated that 95% of dentists used gloves and 83% used face masks. A similarly high use of gloves was noted among US dentists [12], although substantially lower rates of glove use were observed in Sweden [13] and Israel [14]. Nevertheless, the effectiveness of barrier methods to prevent hepatitis infection remains unproven [15, 16].

The few existing data regarding hepatitis C virus (HCV) acquisition among dentists suggest that they are at increased risk, although the risk appears to be lower than that for HBV. A 1992 study of North American dentists showed 21% of oral surgeons and 8% of general dentists had serological evidence of previous infection with HBV. The corresponding figures for HCV were 2% for oral surgeons and 0·7% for general dentists [4]. A study conducted from 1985

* Author for correspondence: Robert Koch Institute, Stesemannstr. 90–102, D-10963 Berlin, Germany.

through 1987 in New York City showed that 9% of oral surgeons and 2% of dentists had anti-HCV antibody [17].

We present the results of a 1997 survey of dental personnel in Berlin, Germany. The goals of this survey were to assess what proportion of dentists and dental assistants had serological evidence of previous HBV and HCV infection, what were their risk factors for exposure, what was their HBV vaccine coverage, and what was the frequency of use and effectiveness of barrier methods to prevent HBV infection.

METHODS

Study population and recruitment

Approximately 3400 dentists serve the 3·8 million inhabitants of Berlin, Germany. All working dentists belong to a single dental society (Berliner Zahnärztekammer). The study was a cross-sectional survey of dentists and dental assistants attending the 1997 annual meeting of the Berliner Zahnärztekammer held on 8 and 9 February. The January issue of the dental society newsletter announced the possibility of anonymous and free HBV and HCV testing to all meeting participants. Additional announcements were given at the time of meeting registration and before the scientific sessions. Although all meeting attendees could enrol in the study, the analysis was limited to Berlin dentists and dental assistants. The total number of Berlin dentists and dental assistants who attended the meeting could not be determined from the meeting records.

Data collection

At a special booth in the conference building, potential participants gave oral consent, completed a questionnaire, and had blood drawn for HBV and HCV serological testing. The questionnaires and blood samples were labelled with a study number which was also given to the study participants so that they could receive their test results by telephone. No list linking names with study numbers was made. The questionnaire covered demographics, professional characteristics (type, duration, quantity of practice; patient characteristics; procedures performed), protective barrier measures used during dental procedures, HBV vaccination status, occupational exposures to blood and saliva, and other personal risk factors for hepatitis, such as injection drug use. On request of the dental society, information about male homosexual contact was not gathered.

Laboratory testing

All serological tests for HBV and HCV were done using Abbott Laboratories (Wiesbaden, Germany) test kits according to the manufacturer's specifications. Antibodies to HCV were screened with the enzyme-linked immunosorbent assay (ELISA) using the Anti-HCV test kit. Although specimens reactive in the ELISA were to have been tested also by a recombinant immunoblot assay (RIBA), there was insufficient serum available from the single anti-HCV positive dentist identified in the survey for this to be done.

Serum samples were tested for anti-HBs using the AUSAB assay. Samples were considered positive when they were repeatedly reactive with a titre of $\geqslant 10$ IU/l. Anti-HBc antibodies were tested by the CORE test kit. Samples with a positive anti-HBc-antibody test result were tested with the HBsAg test kit.

Case definitions and data analysis

All persons with anti-HBc were considered to have had serological evidence of previous or current HBV infection. Anti-HBc-positive persons who also had HBsAg were labelled as HBV carriers. Persons with anti-HBs without anti-HBc were considered to have been immunized against HBV. According to this definition, some persons who were vaccinated after they had previously been infected would be counted as not having been vaccinated. Persons with neither anti-HBs nor anti-HBc were considered to be HBV-antibody negative. Persons with anti-HCV antibody were considered to have had serological evidence of previous or current HCV infection with HCV.

The incidence of HBV infection among dentists was estimated according to the following formula: the number of anti-HBc-positive dentists divided by sum of the total years in practice for those with neither anti-HBc nor anti-HBs (no serological evidence of previous infection nor vaccination) plus half the total years in practice for those anti-HBc positive. The corresponding formula for HCV was the number of anti-HCV-positive dentists divided by the sum of the total years in practice for those without anti-HCV plus half the total years in practice for those with anti-HCV.

To compare possible risk factors for HBV and HCV acquisition, the data were analysed in a case-control study format. For HBV, persons with evidence of previous or current infection with HBV (anti-HBc positive) were compared with those who were antibody negative (neither anti-HBs nor anti-HBc), and thus did not have serological evidence of previous HBV infection nor vaccination. Comparisons regarding the age of the participants or the frequency of patient contact were assessed using the Student's t-test. Differences in categorical variables were assessed using χ^2 and Fisher's exact tests where appropriate. Ninety-five percent confidence intervals for odds ratios were calculated according to the method of Cornfield and 95% confidence limits for simple proportions were calculated by an exact binomial method using EPI-INFO 6.02.

RESULTS

A total of 215 dentists and 108 dental assistants participated in the study. The demographic characteristics of the study sample are shown in Table 1. The gender and age distribution of the 215 enrolled dentists paralleled closely those of all 3429 dental society members (data not shown). Among the enrolled dentists, 14 (7%) (95% CI 4–11) had serological evidence of previous or current HBV infection and two (1%) were HBsAg positive; one (0·5%) (95% CI 0–3) had evidence of previous or current HCV infection (Table 2). Among the 85 dentists without serological evidence of previous HBV vaccination, 14 (16%; 95% CI 9–26) had serological evidence of previous or current HBV infection. The incidence of hepatitis B acquisition among the dentists (0·01 per person-year of practice [14/1298 practice-years]) was approximately 25 times higher than that for hepatitis C (0·0004 per person-year of practice [1/2645 practice-years]). The number of practice-years for hepatitis B was lower because dentists with serological evidence of previous HBV immunization were excluded from the HBV incidence density calculation. Among the 108 dental assistants, 1% (95% CI 0–5) had serological evidence of previous or current HBV infection and none (95% CI 0–4) with HCV.

To determine possible risk factors for HBV acquisition, the 14 dentists with serological evidence of previous or current HBV infection (anti-HBc) were compared to the 71 without HBV antibody. Neither group differed significantly ($P > 0·2$) by age, gender, nor by number of patients handled per day. Compared to HBV-antibody-negative dentists, dentists with serological evidence of previous or current HBV infection tended to have been more likely to have performed certain dental procedures or have patients at high risk for HBV themselves, although these differences were mostly not statistically significant (Table 3). Nevertheless, dentists with serological evidence of previous or current HBV infection were less likely to have used face masks (Table 3). Twenty-four dentists reported having received a previous blood transfusion; six of whom had serological evidence of previous or current HBV infection (three with reported transfusion dates before 1980). Only three dentists reported injection drug use; none had evidence of previous HBV infection. The single dentist with HCV antibody denied blood transfusion or injection drug use.

Estimates of hepatitis B immunization coverage were obtained in two ways: via antibody testing and

Table 1. *Demographic and professional characteristics of the participants in the hepatitis study; Berlin, Germany, February 1997*

	Dentists ($n = 215$)		Dental assistants ($n = 108$)	
	*n**	(%)	*n**	(%)
Gender				
Male	103	(48)	2	(2)
Female	111	(52)	105	(97)
Age group (years)				
< 29	27	(13)	51	(47)
30–39	61	(28)	33	(31)
40–49	73	(34)	17	(16)
50–59	46	(21)	5	(5)
60–65	7	(3)	1	(1)
Practice setting				
Private practice	198	(92)	103	(95)
Clinic	13	(6)	2	(2)
Specialty (dentists)				
General dentist	201	(93)		
Dental surgeon	13	(6)		
Orthodontist	1	(< 1)		
Work activities (assistants)				
Administration			6	(6)
Assistant			55	(51)
Prophylaxis†			47	(44)

* The column totals vary slightly due to incomplete responses.

† Prophylaxis: prophylactic dental treatment for caries and peridontitis.

Table 2. *Antibodies to hepatitis B and C among Berlin dentists and dental assistants, February 1997*

			Dentists ($n = 215$)*		Dental assistants ($n = 108$)*	
			Positive	(%)	Positive	(%)
Hepatitis B	anti-HBc	anti-HBs				
Previous or current infection	+	±	14	(7)	1	(1)
HBsAg-positive			2		0	
Immunized	−	+	125	(58)	56	(52)
No antibody	−	−	71	(33)	43	(40)
Immunized (self report)			28		11	
Not immunized (self report)			41		30	
Immunized (self report)			160	(74)	68	(63)
Anti-HBs absent			28	(18)	11	(16)
Hepatitis C antibody			1	(0·5)	0	

* The column totals may vary slightly due to incomplete responses or lack of serum.

Table 3. *Possible risk factors for hepatitis B among dentists with previous or current infection with hepatitis B (anti-HBc positive) and among those without antibody to hepatitis B (with neither anti-HBc nor anti-HBs), Berlin, Germany, February 1997*

	Infection ($n = 14$)*		No antibody ($n = 71$)*				
	n	(%)	*n*	(%)	Odds ratio	95% CI	*P* value
Procedures†							
Endodontics	14	(100)	62	(90)	Undef.	–	0·60
Peridontics	11	(79)	46	(67)	1·8	0·4–11·2	0·53
Prophylaxis	14	(100)	59	(86)	Undef.	–	0·11
Tooth extraction	14	(100)	56	(81)	Undef.	–	0·20
Operative procedure	10	(71)	34	(49)	2·7	0·7–12·5	0·12
Patient characteristics‡							
Injection drug users	6	(43)	11	(18)	3·4	0·8–14·1	0·07
Homo- or bisexual men	11	(79)	35	(51)	3·6	0·8–21·3	0·06
HIV-positive/AIDS	7	(54)	19	(28)	3·0	0·8–11·9	0·10
Dialysis patients	10	(83)	24	(38)	8·3	1·5–82·3	0·004
Contact with blood/saliva†							
On skin	10	(83)	52	(78)	1·4	0·3–14·9	1·00
On mucous membranes	4	(36)	14	(27)	1·5	0·3–7·1	0·72
Penetrating through skin	3	(23)	8	(12)	2·3	0·3–11·5	0·37
Protective measures§							
Gloves	6	(43)	27	(41)	1·1	0·3–4·0	0·89
Glasses	7	(64)	40	(63)	1·1	0·2–5·4	1·00
Face mask	2	(15)	32	(49)	0·2	0·02–0·98	0·03

* Denominator totals vary due to incomplete responses.
† At least once per week compared to less than once per week.
‡ Ever compared to never. Don't know and no answers combined.
§ Always used compared to sometimes or never used.

via self-report on the questionnaire. Slightly over half of the study participants had serological evidence of previous immunization (Table 2). Among all participants, 74% of the dentists and 63% of the dental assistants reported having been immunized. Among the 41 anti-HBV-negative dentists who reported no

Table 4. *Protective measures against hepatitis B and C used by dentists and dental assistants, Berlin, February 1997*

	Dentists ($n = 215$)*		Dental assistants ($n = 108$)*	
Measure taken	*n*	(%)	*n*	(%)
Patient history type†				
Written	146	(68)	84	(78)
Oral	26	(12)	3	(3)
Written and oral	28	(13)	5	(5)
None	13	(6)	9	(8)
Patient history frequency†				
At the first visit	118	(62)	52	(60)
At certain intervals	60	(32)	31	(36)
At each visit	11	(6)	4	(5)
Protective gloves				
Always	111	(54)	57	(57)
Sometimes	92	(45)	39	(39)
Never	1	(0·5)	4	(4)
Protective eye glasses				
Always	124	(58)	35	(33)
Sometimes	69	(32)	43	(41)
Never	21	(10)	27	(26)
Face mask				
Always	107	(50)	51	(50)
Sometimes	96	(45)	44	(43)
Never	10	(5)	8	(8)

* Denominator totals vary due to incomplete responses.
† History of risk factors for hepatitis B and C infection. For dental assistants, the type and frequency of patient history information was for the practice or clinic in which they worked.

previous immunization, the principal reasons stated for not having been vaccinated were concern over vaccine safety (27%), the vaccination was not offered (27%), did not get around to obtaining it (22%), and that HBV is not so serious (17%). Among the 30 corresponding dental assistants, the principle reasons stated for not being vaccinated were that the vaccination was not offered (37%) and concern over vaccine safety (17%).

Over 90% of the dentists reported that they obtain from their patients a risk factor history for hepatitis B and C, mostly by written means and mostly only at the first visit (Table 4). A similar proportion of the dental assistants reported that this history was obtained in the clinic in which they worked (Table 4). Approximately half of the dentists and dental assistants reported consistent use of protective gloves, glasses, or face masks (Table 4).

DISCUSSION

Our results suggest that occupational transmission of HCV in dental settings occurs sometimes, but not frequently [4]. The finding that less than one percent of Berlin dentists had anti-HCV was consistent with prevalences of less than two percent found among general dentists in Taiwan [18] and North America [4, 17]. In comparison, among the Berlin dentists, the incidence density for HCV per practice-year was approximately 25 times lower than that for HBV.

HBV vaccine coverage was suboptimal among the Berlin dental personnel surveyed, with approximately one-quarter of the Berlin dentists and one-third of the assistants reporting not having been vaccinated. The proportion with serological evidence of HBV vaccination was even lower, presumably due to loss of antibody following complete or partial vaccination failure to produce anti-HBs or due to inaccurate self-reporting. The self-reported HBV vaccination coverage among Berlin dentists was lower than that observed in North America [10, 19] and the United Kingdom [11]. Similar to other studies, dentists had higher coverage levels than assistants [11, 19, 20].

Among the Berlin dentists without serological evidence of previous HBV vaccination, 16% had serological evidence of previous or current HBV infection, indicating that the contemporary risk of HBV acquisition remains high and similar to that observed in earlier North American studies [2–4, 10, 15, 17]. This continuing high risk could be in part due to inconsistent use of or ineffectiveness of recommended barrier prevention measures to prevent transmission of blood-borne infections. Among the Berlin dentists, the odds of previous or current HBV infection did not differ according to the consistent use of gloves or eye glasses, suggesting that these modalities had limited or no efficacy. However, the odds of previous or current HBV infection for dentists who regularly wore face masks were one-fifth of those who used them irregularly or not at all. Unfortunately, there are few other comparison data about the efficacy of barrier prevention measures. Two studies conducted during the 1980s showed no relationship between the use of gloves, face masks, or eye protection and previous HBV infection [15, 16]. However, in one study, so few dentists used face masks that the power to detect a protective effect was low [16].

The conclusion that face masks may have reduced the risk of HBV infection must be interpreted with

some caution as the small number of previously HBV-infected dentists precluded a multivariate analysis to examine potential confounding factors. Nevertheless, the fact that only the use of face masks, but neither gloves nor eye glasses, had an apparent protective effect suggests that this finding was not merely due to general attention toward preventive measures or other general practice characteristics. In addition, this study only had an approximately 50% power to detect a fourfold reduction in the odds of previous infection by gloves or eye glasses. Nevertheless, the fact that the point estimates of the odds ratios were 1·1 would suggest that no significant effect would have been found even with a much larger sample size.

Two general limitations of the study must be considered when interpreting the results. Although the demographic characteristics of our study sample resembled that of all Berlin dentists, the voluntary nature of the study may have introduced selection bias. In addition, Berlin has the highest incidence of AIDS in Germany [21], suggesting that a disproportionately high number of men who have sex with men and injection drug users live in Berlin. Because both of these behaviours are also risk factors for HBV, Berlin dentists may have a higher proportion of patients with HBV infection.

This study has several important implications for public health policy. First, despite a continuing high risk of HBV infection and the existence of long-standing recommendations for routine HBV vaccination, vaccine coverage among dentists and dental assistants cannot be assumed to be adequate. Second, the finding of a lower risk of HBV acquisition among dentists who routinely used face masks should reinforce their routine use. Finally, given the high costs of gloves [12] and their apparent lack of efficacy in preventing HBV infection in this and two previous studies [15, 16] dictates further evaluation as to the cost-effectiveness of their routine use in dentistry. However, this cost-effectiveness evaluation has to take into account the potential for prevention of other blood-borne viruses, particularly HIV.

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REFERENCES

1. Feldman RE, Schiff ER. Hepatitis in dental professionals. JAMA 1975; **232**: 1228–30.
2. Smith JL, Maynard JE, Berquiest KR. Comparative risk of hepatitis B among physicians and dentists. J Infect Dis 1976; **133**: 705–6.
3. Mosley JW, Edwards VM, Casey G, Redeker A, White E. Hepatitis B virus infection in dentists. NEJM 1975; **293**: 729–34.
4. Thomas DL, Gruninger SE, Siew C, Joy ED, Quinn TC. Occupational risk of hepatitis C infections among general dentists and oral surgeons in North America. Am J Med 1996; **100**: 41–5.
5. Siew C, Gruninger SE, Mitchell EW, Burrell KH. Survey of hepatitis B exposure and vaccination in volunteer dentists. J Am Dental Assoc 1987; **114**: 457–9.
6. Noble MA, Mathias RG, Gibson GB, Epstein JB. Hepatitis B and HIV infections in dental professionals: effectiveness of infection control practices. J Can Dent Assoc 1991; **57**: 55–8.
7. Reichart PA, Bommerer M, Lange W, Koch M. Kein Nachweis von Antikörpern gegen HIV-1 bei Berliner Zahnärzten. Zahnärztliche Mitteilungen 1988; **7**: 749–53.
8. Centers for Disease Control and Prevention. Recommended infection-control practices for dentistry, 1993. MMWR 1993; **42**: 1–11.
9. Robert Koch-Institut. Impfempfehlungen der Ständigen Impfkommission (STIKO). Epidemiol Bull 1997; **15**: 97–108.
10. Cleveland JL, Siew C, Lockwood SA, Gruninger SE, Gooch BF, Shapiro CN. Hepatitis B vaccination and infection among U.S. dentists, 1983–1992. J Am Dent Assoc 1996; **127**: 1385–92.
11. Scully C, Griffiths M, Levers H, Blake C, Chartres L. The control of cross-infection in UK clinical dentistry in the 1990s: immunization against hepatitis B. Br Dent J 1993; **174**: 29–31.
12. Nash KD. How infection control procedures are affecting dental practice today. J Am Dental Assoc 1992; **123**: 67–73.
13. Hellegran K. Use of gloves among dentists in Sweden – a 3-year follow-up study. Swed Dent J 1994; **18**: 9–14.
14. Trieger N, Schlesinger N, Kaufman E, Mann J. Israeli dentists: a survey of infection control office practices and care of medically compromised patients. Spec Care Dentist 1993; **13**: 117–21.
15. Noble MA, Mathias RG, Gibson GB, Epstein JB. Hepatitis B and HIV infections in dental professionals: effectiveness of infection control procedures. J Can Dent Assoc 1991; **57**: 55–8.
16. Reingold AL, Kane MA, Hightower AW. Failure of gloves and other protective devices to prevent transmission of hepatitis B virus to oral surgeons. JAMA 1988; **259**: 2558–60.
17. Klein RS, Freeman, Taylor RE, Stevens CE. Occupational risk for hepatitis C virus infection among New York City dentists. Lancet 1991; **338**: 1539–42.

18. Kwo MY, Hahn LJ, Hong CY, Kao JH, Chen DS. Low prevalence of hepatitis C virus among dentists in Taiwan. J Med Virol 1993; **40**: 10–3.
19. McCarthy GM, MacDonald JK. A comparison of infection control practices of different groups of oral specialists and general dental practitioners. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998; **85**: 47–51.
20. McCarthy GM, MacDonald JK. Improved compliance with recommended infection control practices in the dental office between 1994 and 1995. Am J Infect Control 1998; **26**: 24–8.
21. Hamouda O, Nießing W, Voß L. AIDS/HIV 1996. Bericht zur epidemiologischen Situation in der Bundesrepublik Deutschland. Berlin, Germany: Robert Koch-Institut, 1997, Report No. 17/1997.