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Risk factors for bloodborne viral hepatitis in healthcare workers of Pakistan: a population based case–control study

Zulfikar A Gorar,[1] Zahid A Butt,[2] Imrana Aziz[3]

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[1]Health Services Academy, Chak Shahzad, Islamabad, Pakistan
[2]Department of Public Health, Pakistan Institute of Ophthalmology, Al-Shifa Trust Eye Hospital, Rawalpindi, Pakistan
[3]Department of General Surgery, Dow University of Health Sciences, Karachi, Pakistan

Correspondence to
Dr Zulfikar Gorar;
zulfikar.gorar@hsa.edu.pk

ABSTRACT

Objectives: A high prevalence of viral hepatitis B and C was found among healthcare workers during a province-wide screening in Sindh Province, Pakistan. A follow-up study was undertaken to identify risk factors for this high prevalence in healthcare workers.

Design: Population based case–control design.

Setting: Public sector healthcare facilities in a rural district of Pakistan.

Participants: Healthcare workers who were screened for hepatitis B surface antigen (HBsAg) and hepatitis C virus (HCV) antibodies. 178 healthcare workers employed at the public sector clinics and hospitals of the district were approached, of which 14 refused to participate. Cases had detectable serum antibodies against HCV and the presence of HBsAg. Healthcare workers non-reactive to HCV antibodies and with no HBsAg were controls. These were matched in a ratio of 1:1.

Outcome measure: Detectable serum HBsAg and HCV antibody titer were taken as outcome. OR for various exposures was calculated; those with p<0.25 were entered in a multivariate logistic regression model to find out significant predictors.

Results: Needle stick injury (OR=6; CI_{95} 1.4 to 23), recapping the needle (OR=5.7; CI_{95} 1.1 to 28), wound care at accident and emergency of a hospital (OR=5.5; CI_{95} 1 to 28), female gender (OR=3.4; CI_{95} 1 to 12) and more than 10 years of formal education (OR=0.25; CI_{95} 0.07 to 0.8) were associated with hepatitis C. Hepatitis B was found to be associated with trying to bend or break a needle after use (OR=4.9; CI_{95} 1 to 24).

Conclusions: Healthcare workers in Pakistan are at additional risk of exposure to bloodborne pathogens. Bi-dimensional risk factors present at individual and broader health systems levels are responsible. Occupational safety, health trainings and redesigning of the curriculum for allied health professionals are required.

Strengths and limitations of this study

- Research was conducted by interviewing health workers at multiple clinics and hospitals in a district based primary healthcare delivery system; hence, results can be generalised for other similar settings in Sindh, Pakistan.
- This study was a follow-up of province-wide screening; hence, we could not enrol the incident cases of hepatitis B or C.
- The number of participants involved in surgery or dental procedures was small, which could have resulted in non-significant associations for these important risk factors.
- Recall bias cannot be ignored when mentioning different exposures.

INTRODUCTION

Healthcare workers (HCWs) around the world are at additional risk for acquiring bloodborne pathogens (BBP) like hepatitis B virus (HBV), hepatitis C virus (HCV) and HIV when compared to any other occupational group.[1] This is usually due to the unique nature of their occupation which involves working with exposure prone procedures during healthcare delivery. An exposure that might place HCWs at risk for BBP is defined as a percutaneous injury (eg, a needle stick or cut with a sharp object) or contact of the mucous membrane or non-intact skin (eg, exposed skin, ie, chapped, abraded or afflicted with dermatitis) with blood, tissue or other body fluids that are potentially infectious.[2] The risk of developing serological evidence of hepatitis B is high (32–67%) when blood is both hepatitis B surface antigens (HBsAg) and envelop antigen (HBeAg) positive. It reduces (23–37%) with HBsAg-positive but HBeAg-negative blood.[2] The average risk of seroconversion for an HCW after sustaining a sharp injury caused by a hepatitis C contaminated instrument is reported to be as high as 10%.[3]

Pakistan has a moderately high prevalence of hepatitis in the general population[4] (hepatitis C: 4.9% and hepatitis B: 2.5%), but the prevalence of viral hepatitis C is steadily rising in rural Pakistan.[5] In 2007–2008, the Ministry of Health Pakistan, under

its National Programme for Prevention and Control of Hepatitis, undertook the screening of HCWs in the southern province of Sindh; an HCW was defined as any category of employee working in the healthcare delivery at public sector health outlets. Altogether, 11 670 HCWs were screened in the whole province; during this exercise, a standard laboratory procedure was adopted whereby blood of the consenting HCW was drawn at the workplace, centrifuged at the spot and brought back to the central pathology laboratory on the same day in cold chain. Temperature was maintained between 2°C–8°C. Serum was analysed in the third generation ELISA using BIORAD and J&J USA Kits. Out of the total screened in the province, 851 (7.29%) were HBsAg reactive and 713 (6.16%) were HCV antibodyreactive.[6] These figures are high when compared with other reported national or international figures. Other studies from Pakistan have reported HCV prevalence in HCWs from 5.2% (±0.63) to 5.6%;[7 8] for hepatitis B, the estimates vary between 3.25% (±1.2%) and 9%.[9]. [10] The high prevalence of hepatitis B and C among Pakistani HCWs can potentially reduce workforce productivity,[11] compromise patient safety and affect the health system performance at large.

In order to identify risk factors for the high prevalence of hepatitis in Sindh Province as compared to national and international reports, we identified a cohort of HCWs at district Jamshoro of Sindh province having serum antibodies against HCV and the presence of HBsAg. District Jamshoro was selected due to its very high prevalence of HBsAg (24%) and antibodies against hepatitis C (11.7%) when compared with other districts.

MATERIALS AND METHODS

The study was conducted from February 2012 to May 2012 as a follow-up of Government sponsored province wide, generalised screening of HCWs in 2007–2008. To identify work-related risk factors for the high prevalence hepatitis B and C, we used a prevalent case–control design to establish significant risk factors and make recommendations for health services management. Presence of HBsAg and antibodies against HCV in blood was taken as outcome. ***Definition and identification***: Cases were HCWs with documented evidence of antibodies against HCV and the presence of HBsAg.[12] Control subjects were those HCWs who did not have detectable serum antibody titre against hepatitis C or the presence of HBsAg. Assuming a common workplace poses a similar set of risk factors; for each case, one control from the same clinic or workplace was selected. Further matching was done between various cadres of health workers; for example, a nurse and operation theatre assistant was matched against their own cadre. We identified needle stick injury (NSI) to health workers as an exposure; published evidence reports NSI incidence in Sindh between 45% and 85%.[13–16] These studies have largely been undertaken at tertiary hospitals with a high volume of patients. Health facilities in our area of study were predominantly primary and secondary care hospitals of a district with less patient load. A sample of 77 cases was calculated by assuming an exposure rate of 40% among controls, a two tailed significance level of 5% and a power level of 90% at an OR of 2. The statistical formula used to determine the number of study participants in each group is as follows[i]:

$$\left(\{\mu\sqrt{([\pi_1(1-\pi_1)+\pi 2(1-\pi_2)+v\sqrt{2\pi(1-\pi)}\})}\right)^2/(\pi_2-\pi_1)^2$$

To account for potential refusals, we raised the sample size to 90 in the case group and 90 in the control group. ***Sampling technique***: District health authorities maintained a database of 657 screened HCWs, of which 227 were reported as reactive. Reactive subjects were taken as cases and non-reactive cases were taken as controls. Sampling of cases and controls was done by the simple random sampling method from the database. For every case, a control was selected from the same hospital. Cases and controls were approached at the workplace for a detailed interview. Informed consent was taken. ***Questionnaire:*** The following information was obtained by interviewing each case and control on a pretested questionnaire (A) involvement in exposure prone procedures at healthcare settings—surgery, working in blood banks, handling infectious waste at a pathology laboratory, major dental procedures; (B) practices of safe injection delivery—using a separate tray for syringes, use of gloves, recapping the needles, use of sharp containers; (C) miscellaneous risk factors—family member with hepatitis, receiving blood transfusion, vaccination, post-traumatic suturing, education, number of years served. Since past exposure was being measured, recall bias was identified as an important bias and multiple checks in the questionnaire were used along with in-built triangulation. ***Statistical analysis***: Data were entered into SPSS V.20 for analysis. A description of baseline characters of the two groups is provided. Although routes of blood transmission are shared by the two viruses, the risk of transmission for a similar exposure is disproportionally greater for hepatitis B than for hepatitis C, we report the two viruses separately as pooling HCV and HBV infection is not epidemiologically appropriate. A crude estimation of association was obtained by calculating unadjusted OR and 95% CI. This was done by univariate logistics regression. Exposures with OR having $p \leq 0.25$ were entered in a binary logistic regression model. The final model was based on statistical significance and biological plausibility.

RESULTS

A total of 178 participants (89 cases and 89 controls) working at various public sector primary and secondary

[i]π_1=Proportion of control exposed, π_2=Proportion of cases exposed, calculated from $\pi_2 = \pi_1\ OR/1+\pi_1\ (OR-1)$, $\pi=\pi_1 + \pi_2/2$

Table 1 Baseline characteristics of the respondents

Variables	Cases=81 n (%)	Controls=83 n (%)
Age in years		
15–25	0	2 (2.4)
26–35	16 (19.7)	22 (26.5)
36–45	26 (32)	35 (42)
46–55	37 (45.6)	24 (29)
56–65	2 (2.4)	0
Gender		
Male	53 (65.4)	60 (72)
Female	28 (34.5)	23 (28)
Education		
Graduation	9 (11)	13 (15.6)
Intermediate	2 (2.46)	7 (8.43)
Matriculation	24 (29.6)	34 (41)
Primary	27 (33.3)	18 (21.6)
Technical education	3 (3.7)	1 (1.2)
No formal education	16 (19.7)	10 (12.4)
Seropositivity		
Hepatitis B positive	47 (58)	0
Hepatitis C positive	34 (42)	0
Hepatitis negative	0	83 (100)
Exposures		
Involved in major surgeries	7 (8.64)	6 (7.2)
Dental procedure of any kind	1 (1.2)	2 (2.4)
Handling infectious material in lab	8 (9.8)	4 (4.8)
Internal instrumentation	3 (3.7)	0
Minor skin surgery	2 (2.46)	7 (8.4)
Worked in blood bank	3 (3.7)	4 (4.8)
Injection delivery of any kind	45 (55.5)	51 (61.4)
Vaccinated for hepatitis B	50 (61.7)	59 (71)
Underwent dental extraction	34 (42)	28 (31.3)
Received blood transfusion	8 (9.8)	3 (3.6)
Any family member with HBV	3 (3.7)	6 (7.2)
Any family member with HCV	5 (6.1)	2 (2.4)
Needle stick injury	47 (58)	24 (28.9)
Treated at A&E of hospital	70 (51)	67 (49)

A&E, accidents and emergency; HBV, hepatitis B virus; HCV, hepatitis C virus.

healthcare hospitals spread across Jamshoro district were approached for an interview. The refusal rate was 7.8% (14). Two-thirds (68.9%) of respondents were males, one-third (35%) were educated up to the 10th grade and 16% had no formal education and were mostly working as janitorial staff. The baseline characteristics are given in table 1 below. In our study, 53.8% of staff reported having NSI in the past 6 months. The staff category reporting the frequency of events in order from highest to lowest is as follows: operation theatre staff (85.7%), vaccinators[ii] (66.7%), obstetric staff (57%), lady health workers[ii] (55.3%) and doctors (40%). In the univariate analysis, we found NSI to be associated with hepatitis. Cases who had reported NSIs were more prone to contracting hepatitis C (OR=4.39, CI_{95} 1.5 to 12.5) as compared to controls. Cases involved in handling of infectious waste in the pathology laboratory were at increased risk of contracting hepatitis B (OR=2.7, CI_{95} 0.9 to 8.3). HCWs working in surgeries were at 1.7 times increased risk of getting hepatitis C (CI_{95} 0.62 to 5); on the other hand, they were less likely to get hepatitis B (OR=0.58, CI_{95} 0.2 to 1.8). This is because 80% of these are vaccinated against hepatitis B. HCWs having knowledge about unsafe injections as modes of spread for hepatitis B and C were 2.4 times more likely to use sharp disposal boxes. Use of sharp disposal boxes was found to be protective against hepatitis B (OR=0.25, CI_{95} 0.089 to 0.699). Those who were ever treated for small wounds at the accidents and emergency (A&E) department of a public sector hospital were more likely to have hepatitis when compared to controls who were not treated (OR=2.26, CI_{95} 1 to 5.2). Cases were more likely to have another family member suffering from hepatitis as compared to controls (OR=2.6, CI_{95} 0.4 to 14). Blood transfusion was a risk factor (OR=2.9, CI_{95} 0.75 to 11.9) for contracting disease; the risk of hepatitis B appears to be slightly higher (OR = 2.1, CI_{95} 0.61 to 7.3) when compared to the risk for hepatitis C (OR=1.6, CI_{95} 0.39 to 6.3). Univariate analysis shows protective effects against both infections when formal education is 10 years or more; however, in the multivariate model, education emerges as a significant predictor for hepatitis C only (OR=0.25, CI_{95} 0.07 to 0.8). Vaccination against hepatitis B was also protective against hepatitis B (OR=0.229, CI_{95} 0.1 to 0.48) (table 2). In the final multivariate model for hepatitis B, bending or breaking of the needle puts an HCW at 4.9 times higher risk (CI_{95} 1 to 24) (table 3A). Strong predictors of hepatitis C in the final multivariate model are NSI, attempt to recap the needle after use, more than 10 years of education, being treated at the A&E department of a hospital and female gender (table 3B).

DISCUSSION

Bloodborne viral hepatitis is on the rise in Pakistan, and HCWs are at increased risk of contracting disease. At the individual level, this risk has two dimensions, in the first dimension, HCWs are performing hazardous and unsafe injection delivery practices and in the second they seek care as a patient in a system with lax infection control regulations. At a broader level of health system operations, this is due to quality issues in healthcare delivery. We found (1) NSI, (2) attempts at recapping the needle after use, (3) more than 10 years of formal education, (4) female gender and (5) getting wound care at the A&E department of a hospital to be significantly associated with bloodborne hepatitis among the HCWs of Jamshoro.

Nearly 80% of the hepatitis infections in health workers of the WHO-EMRO subregion D are attributed

[ii]LHWs and vaccinators are the outreach primary health care staff engaged in immunizations.

Table 2 Univariate logistic regression analysis with unadjusted OR for variables associated with viral hepatitis among healthcare workers of district Jamshoro, Sindh Province, Pakistan

	Hepatitis B			Hepatitis C		
Variables	Unadjusted OR	CI_{95}	p Value	Unadjusted OR	CI_{95}	p Value
Exposure prone procedures						
Needle stick injury	2.0	0.93 to 4.6	0.07	4.39	1.65 to 11.6	0.003
Handling infectious waste	2.75	0.9 to 8.3	0.07	0.6	0.13 to 2.88	0.53
Surgery	0.58	0.18 to 1.8	0.36	1.7	0.62 to 5	0.28
Safe injection practices						
Recap needle after use	1.2	0.36 to 4.4	0.7	3	0.92 to 9.9	0.06
Move around with uncapped needle	2.8	0.53 to 14.7	0.2	1.4	0.24 to 8.1	0.7
Use of sharp disposal container	0.25	0.09 to 0.7	0.008	0.78	0.25 to 2.4	0.66
Factors outside workplace						
Hepatitis B vaccination	0.2	0.11 to 0.5	<0.000	–	–	–
More than 10 years of educations	0.6	0.29 to 1.1	0.1	0.5	0.23 to 1.1	0.08
Female gender	0.9	0.43 to 1.9	0.8	1.7	0.8 to 3.8	0.15
Family member with hepatitis	0.7	0.14 to 3.5	0.7	3	0.65 to 14.5	0.15
Treated at A&E of hospital	1.2	0.56 to 2.7	0.6	2.26	1 to 5.2	0.05
Received blood transfusion	2.1	0.61 to 7.3	0.23	1.6	0.39 to 6.3	0.5
Staff category						
Lady health worker	0.6	0.28 to 1.5	0.3	1.9	0.87 to 4.5	0.1
Operation theatre staff	0.7	0.14 to 3.4	0.6	2	0.47 to 8.44	0.3
Sanitary workers	1.2	0.36 to 4.4	0.7	0.7	0.15 to 3.5	0.7
Outreach vaccination staff	1.7	0.58 to 5.2	0.3	1	0.25 to 3.5	0.9
Labour room staff	1.9	0.41 to 8.9	0.4	1.5	0.29 to 8.4	0.6
Doctors	1.6	0.27 to 10.2	0.6	1	0.1 to 8	0.9
Ward servants	1.2	0.62 to 2.5	0.5	1.2	0.59 to 2.7	0.5
Support staff	1.4	0.45 to 4.5	0.5	2.3	0.7 to 7.4	0.1

A&E, accidents and emergency.

to sharp injuries.[1] The frequency of NSI reported in our study is lower than that reported from Egypt (64%) by Talaat *et al*.[17] Those who have had an NSI in the past 6 months were six times more likely to have serological evidence of antibodies against hepatitis C. Moro *et al*[18] reported a NSI frequency of 13 NSI / worker / 100 years among immunisation clinic staff of Dominican Republic, findings from our study are higher than reported by Moro. Low emphasis on safe injection practices during in-service trainings can be a contributory factor. These trainings are reported to be erratic, unplanned and heavily dependent on donor funding. In order to increase the low vaccination coverage, task shifting is done and additional staff whose primary job is not immunisation are trained.[19] This additional staff is usually given 7–10 days hands-on training with little or no emphasis on the injection safety and sharp injuries expected to occur while delivering any injection, thus predisposing them to NSI. Non-physician healthcare providers in rural areas have a 1.98 times higher risk of having a sharp injury.[20] Our results are consistent with these findings by Janjua *et al*. Recapping of needles is a known risk factor for exposure to blood and body fluids in HCWs.[21] This practice leads to high NSI incidence

Table 3 Multivariable logistic regression analysis of risk factors associated with transmission of hepatitis among healthcare workers in District Jamshoro, Sindh Province, Pakistan

Variable	Adjusted OR	CI_{95}	p Value
(A) Hepatitis B			
Hepatitis B vaccination*	0.108	0.03 to 0.3	<0.000
Bending or breaking needle by hand	4.9	1 to 24	0.04
(B) Hepatitis C			
Needle stick injury	6	1.4 to 23	0.012
Recap needle after use	5.7	1.1 to 28	0.03
More than 10 years of educations	0.25	0.07 to 0.8	0.02
Treated at A&E of hospital	5.5	1 to 28	0.03
Female gender	3.4	1 to 12	0.04

*OR is calculated with hepatitis B seropositivity as outcome.
A&E, accidents and emergency.

and we found HCWs performing hazardous injection practices of (A) bending or breaking the needle and (b) trying to recap the needle to have 4.9 and 5.7 times increased risk of presence of HBsAg and antibodies against hepatitis C in their blood. The number of years worked in the health services is a known risk factor for hepatitis,[22 23] but we did not find it significant.

Health workers having more than 10 years of formal education are less likely to have hepatitis C antibodies. Yousufzai has also reported years of education as predictors of sharp injury.[24] The reasons for this phenomenon are twofold, due to the increased awareness of hazardous procedures and due to educational criteria for recruitment of certain staff categories. Staff with less than 10 years education are usually recruited for the service cadre dealing with exposure prone procedures. No association was found between formal education years and hepatitis B.

Universal hepatitis B vaccination of healthcare staff in Sindh Province was started in 2001 and reinforced in 2006. However, vaccine uptake was 70%; this finding is consistent with other data from Pakistan.[25–28] In our study, a small subset of (20%) HCWs who were vaccinated against hepatitis B vaccine also had HBsAg in their blood. Hepatitis B vaccine confers an immunity level >10 mIU/mL of anti-HBsAg antibodies for at least 10 years; hence, this inconsistent finding can be due to exposure of this group to HBV prior to vaccination. Our study is not conclusive on this and separate research is needed. However, incomplete vaccination is not altogether a developing country phenomenon; 22% of all the transplant surgeons in the USA were short of three dose hepatitis B vaccines.[28]

An HCW who has received wound care or stitches at the A&E department of a hospital has a 5.5 times higher risk of having antibodies against hepatitis C. This risk is not a consequence of occupation but depicts the general condition of infection control at the hospitals and outpatient departments where patients with minor injuries are being sutured. Karmochkine used a case–control design among prevalent cases of hepatitis C and identified wound care as a non-parenteral risk factor with an OR of 10.1.[29]

The National Hepatitis B and C prevalence survey of Pakistan reported a considerably higher prevalence of hepatitis C in the female gender from 0 to 39 years of age[26] when compared with the male gender. In a multivariate model, we also found the female gender to be associated with hepatitis C among health workers of Jamshoro (OR 3.4, CI_{95}= 1 to 12). A majority of female HCWs are lady health workers involved in immunisation and were given inadequate training for injection delivery.

CONCLUSION

HCWs of Jamshoro district in Sindh Province are at additional risk of contracting hepatitis B and C. Risk factors exist at two levels: at the individual level, determinants like education, gender, injection safety practices and uptake of vaccination are significantly associated. Infection control practices at the outpatient and A&E departments are also associated at the organisational level. The work environment of an HCW cannot be 100% risk free, but in times of emerging and re-emerging infections, Pakistan needs a health workforce which is aware about the occupational hazards and can take standard precautionary measures while performing risk prone procedures.

Public sector healthcare employees in Pakistan work in an environment where guidelines and continuous education opportunities on risk prone procedures and infection control are minimal. Two interventions can provide quick gains in reducing the transmission of disease: (1) interventions of ongoing NSI surveillance; organised and structured training on occupational exposure to blood body fluid prevention and (2) universal vaccination of HCWs before induction in service.

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Patient consent Obtained.

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