

# Hepatitis C virus infection in asymptomatic male volunteer blood donors in Karachi, Pakistan

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**SUMMARY.** The objectives of this study were to assess the proportion of hepatitis C virus (HCV) reactors and to identify risk factors associated with HCV infection in volunteer blood donors in Karachi, Pakistan. Between 1 January 1998 and 31 December 2002, consecutive blood donations tested at two blood banks were used to assess the proportion of HCV sero-reactors donors. To evaluate the potential risk factors, a case-control study design was implemented to select cases and controls between 15 October 2001 and 15 March 2002. The overall seroprevalence of HCV in these blood donors was 1.8% (6349/35 1309). Trend analysis revealed a significant ( $P < 0.001$ ) linear increase in proportions of HCV-seropositive donors from 1998 to 2002. Final multivariate logistic regression model showed that the cases were more likely than controls to have reported past hospitalization or

to have received multiple injections. When a glass syringe was used to give therapeutic injections, it increased the adjusted odds of being HCV seropositive significantly more among cases than in controls and this relationship was stronger when injection was given by general medical practitioner than if the injection was given in hospital setting. Cases were more likely than controls to have reported sexual contact with multiple sexual partners. Primary prevention programmes focused on identified risk factors might help to curtail the spread of HCV infection in this community and in other similar settings in developing countries.

**Keywords:** asymptomatic volunteer blood donors, hepatitis C virus, Pakistan, prevalence, risk factors, trend analysis.

## INTRODUCTION

Infection with hepatitis C virus (HCV) may lead to disabling symptoms, cirrhosis and hepatocellular carcinoma [1,2], and reportedly account for a significant proportion of end-stage liver disease [3]. Approximately 3% of the world population (or about 170 million people) may be infected with HCV [4,5]. In healthier blood donors the incidence of HCV infection varies from 0.17 to 1.4% in US [6], and is 0.35% in UK [7]. However, in other parts of the world particularly in developing countries the incidence of HCV infection both in general population and blood donors may be much higher e.g. 2.1% in blood donors of Indonesia [8], 5.6% in Thailand [9] and 24.8% in Egypt [10]. Nonetheless, well-designed prevalence studies of general population are needed in many of these regions to arrive at a more accurate estimate of infection and disease [11].

Abbreviations: HCV, Hepatitis C virus; ELISA, enzyme-linked immunosorbent assay; CSW, commercial sex worker.

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Actual magnitude of HCV infection and contribution of the various factors for its transmission in the general population in Pakistan are largely unknown. In a community-based study in Punjab, Pakistan, 6.5% HCV seroprevalence was recorded [12], however, the generalizability of these results is limited because study sample was not representative and the study population had access to a particular network of health services. Other studies have shown that 43% cases of chronic liver disease, 18% cases of cirrhosis and 61% cases of hepatocellular carcinoma were HCV seropositive, suggesting a potentially high HCV prevalence in the general population in Pakistan [13,14].

Developed countries have successfully controlled HCV infection in general population mainly by interrupting some of the transmission links by the introduction of tests for surrogate HCV markers in blood [15]. However, because of the lack of universal and appropriate blood screening in developing countries, the risk of post-transfusion HCV infection is still unknown. Other parenteral routes implicated as the most likely routes for HCV transmission in these settings include unsafe injections; facial shave and armpits shave from barbers [12,14,16,17], and having lived with HCV seropositive family member [18,19], but these findings are yet to be verified.

Volunteer blood donors are generally considered to be the healthier segment of any community and the proportion of HCV seropositivity and risk factor(s) for HCV infection among them may possibly be considered a mirror reflection of the situation in the general population. Therefore, the objectives of this study were to estimate the proportion of HCV-seropositive donors and to identify the risk factors for HCV infection in male asymptomatic volunteer blood donors of Karachi.

## METHODS

### *Study design, setting and subjects*

This study was conducted at the two blood banks in Karachi; one at a tertiary care hospital in private sector (blood bank 1) and second belongs to a nongovernment organization (blood bank 2). Blood bank 1 receives blood donations as replacement from friends and relatives of inpatients requiring blood transfusions. Blood bank 2 caters the need of all those in Karachi who need blood transfusion including patients of leukaemia, haemophilia, thalassaemia and other blood-related diseases. Blood bank 2 also receives blood donations from volunteers on exchange basis. The HCV serological results of consecutive blood donations at blood bank 1 made between 1 January 1998 and 31 December 2002, and of blood donations at blood bank 2 made between 1 January 1999 and 31 December 2002 were available to assess the proportions of HCV sero-reactors donors. Both the blood banks use commercially available kits for enzyme-linked immunosorbent assay (ELISA-III) to detect anti-HCV antibodies and the results are interpreted essentially following the instructions of manufacturer.

### *Case-control evaluation*

To evaluate the potential risk factors for HCV seropositivity, a case-control study design was implemented to select the participants from both the blood banks between 15 October 2001 and 15 March 2002. Both the blood banks admitted apparently healthy individuals for screening. Preliminary screening includes a personal interview with the donor and exclusion of those who admit to known risk factors for hepatitis B and C and human immunodeficiency virus infections. Particular emphasis is given to a history of jaundice in the last 5 years, previous blood transfusions and history of drug addiction.

### *Selection of cases and controls*

Eligible blood donors aged 18–64 years, and HCV seropositive were defined as cases and those who were HCV seronegative were taken as controls. Study subjects were contacted after obtaining their address and phone numbers

from records of respective blood banks and were explained about the objective and potential risks/benefits of the study.

### *Data collection and sample size*

A predesigned and pretested structured questionnaire was used to gather data regarding demographic and socioeconomic attributes, various potential parenteral exposures to blood or blood products and contact history with a case of hepatitis C. Questions concerning sexual activity covered the number of lifetime sexual partners, homosexuality and protective measures during sexual intercourse. For case-control phase of this study, we required 80 cases and 160 controls in a ratio of 1:2 to have a power of at least 80% at a significance level of 5%, and to relate with the outcome as case or control status of the subjects, most of the hypothesized risk factors having a prevalence of at least 3% in reference population with an odds ratio (OR) of minimum magnitude of 2.5 [20].

### *Data management and analysis*

Data were entered into Epi-Info (version 6.04; Center for Disease Control and Prevention, Atlanta, GA, USA). Statistical Package for Social Sciences (version 10.0; SPSS Inc., Chicago, IL, USA) was used to analyse the data. Proportions of HCV-seropositive donors by blood bank and year of donation were calculated. Chi-square analysis was carried out to assess the significance of the change in the linear trend in proportions of HCV sero-reactors donors over time. Descriptive statistics were computed for demographic variables both for cases and controls. To assess univariate associations between HCV seropositivity and hypothesized risk factors, ORs and their corresponding 95% confidence intervals (CIs) were calculated using simple logistic regression analysis. A final set of independent risk factors for HCV seropositivity among donors was derived by a backward stepwise-logistic regression analysis. All risk factors with a  $P \leq 0.2$  on univariate analyses were considered for inclusion in model. After arriving at main effects model, plausible interaction terms were also evaluated for inclusion in the model. The goodness-of-fit model was checked by Pearson chi-square test [21].

### *Ethics*

Consent for an interview was taken from each participant, and assured about the confidentiality of his information. After interview, a brief counselling session was held with each case and was referred to gastroenterologist for further advice. Controls were briefed about the known modes of HCV transmission. The institutional Ethics Review Committee approved the study protocol.

## RESULTS

*Prevalence of HCV seropositivity among blood donors*

From 1 January 1998 to 31 December 2002 at blood bank 1, 0.7% (555/75 752) donors were tested as HCV seropositive. Whereas, at blood bank 2, from 1 January 1999 to 31 December 2002, 2.1% (5794/27 5557) donors turned out to be HCV seropositive. The overall seroprevalence of HCV in these donors was 1.8% (6349/35 1309). Total donations by year and by blood bank and proportions of HCV sero-reactors are given in Table 1 and depicted in Fig 1. The proportion of HCV-seropositive donors were consistently higher at blood bank 2 than blood bank 1 across the study period. Trend analysis revealed that the proportion of HCV sero-

reactor donors significantly increased over time both at blood bank 1 ( $P < 0.001$ ) and blood bank 2 ( $P = 0.024$ ) and for combined data ( $P < 0.001$ ).

*Characteristics of cases and controls*

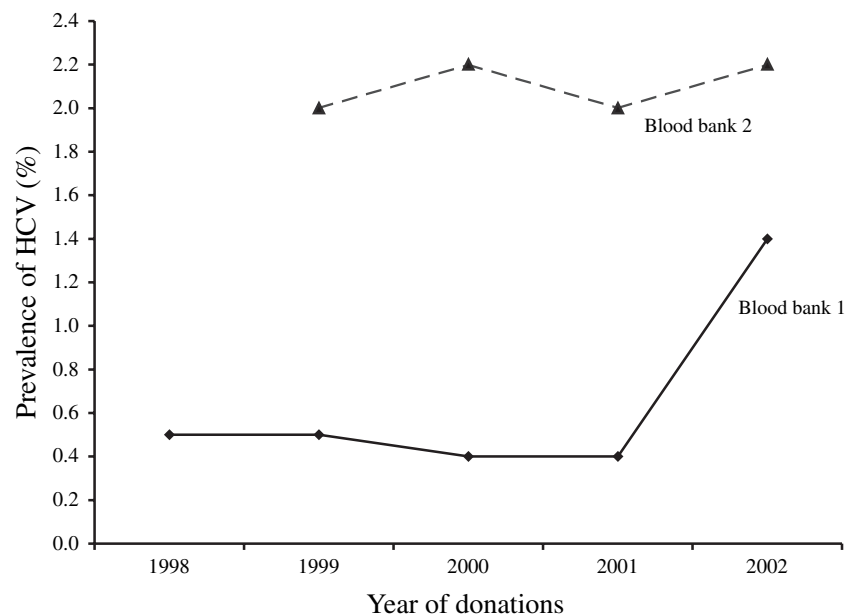
The distribution of various socio-demographic variables for 95 HCV seropositive cases and 391 HCV seronegative controls is represented in Table 2. About 83% of cases and 88% of controls were of 35 years of age or less. Forty per cent of cases and about 58% of controls belonged to Mohajir (Urdu-speaking) ethnicity, almost representing the composition of general population of Karachi. Eighty-five per cent of cases and 92% of controls have had only 10 or less years of schooling. For both cases and controls, the distributions of

**Table 1** Total blood donations and proportions of hepatitis C virus (HCV) seropositive donors at two large blood banks in Karachi, 1998–2002

Year of donation	Blood bank 1		Blood bank 2		Blood banks combined	
	Total donations	HCV positive (%)*	Total donations	HCV positive (%)**	Total donations	HCV seropositive (%)***
1998†	15068	75 (0.5)	–	–	15068	75 (0.5)
1999	14856	72 (0.4)	62566	1224 (2.0)	77422	1296 (1.6)
2000	15525	56 (0.4)	66486	1448 (2.2)	82011	1504 (1.8)
2001	15084	135 (0.9)	74154	1546 (2.1)	89238	1681 (1.9)
2002	15219	217 (1.4)	72351	1576 (2.2)	87570	1793 (2.1)
Total	75752	555 (0.7)	275557	5794 (2.1)	351309	6349 (1.8)

\* $\chi^2_{\text{trend}} = 107.14$  ( $P < 0.001$ ); \*\* $\chi^2_{\text{trend}} = 5.08$  ( $P = 0.024$ ); \*\*\* $\chi^2_{\text{trend}} = 108.21$  ( $P < 0.001$ ).

†Data for 1998 were not available for blood bank 2.



**Fig. 1** Sero-prevalence of hepatitis C virus (HCV) infection in volunteer blood donors assessed at two large blood banks, Karachi, Pakistan 1998–2002.

**Table 2** Characteristics of male volunteer blood donors defined as cases (HCV seropositive) or controls (HCV seronegative) enrolled from two large blood banks, Karachi, Pakistan

Variable	Cases [n = 95 (%)]	Controls [n = 391 (%)]
Age (completed years)		
15–25	32 (33.7)	212 (54.2)
26–35	47 (49.5)	133 (34.0)
>36	16 (16.8)	46 (11.8)
Ethnicity		
Mohajir	38 (40.0)	226 (57.8)
Punjabi	23 (24.2)	64 (16.4)
Pathan	15 (15.8)	32 (8.2)
Sindhi	8 (8.4)	28 (7.2)
Baloch and others	11 (11.6)	41 (10.4)
Education of the donor		
>10	40 (42.1)	232 (59.3)
≤10	42 (43.2)	129 (33.0)
Nil	13 (14.7)	30 (7.7)
Religion		
Muslim	90 (94.7)	372 (95.1)
Non-Muslim	5 (5.3)	19 (4.9)
Marital status		
Never married	38 (38.6)	220 (56.6)
Ever married	57 (61.4)	171 (43.4)
Profession		
Self employed	24 (25.3)	61 (15.7)
Service provider*	59 (62.0)	241 (61.6)
Health care professional†	3 (3.2)	11 (2.8)
Un-employed	9 (9.5)	78 (19.9)
Household income (Rupees/month)		
>15000	8 (8.4)	53 (13.6)
8001–15000	26 (27.4)	102 (26.1)
5001–8000	15 (15.8)	62 (15.9)
≤5000	34 (35.8)	97 (24.7)
Refused to answer	12 (12.6)	77 (19.7)
Number of times donated blood		
1	33 (34.7)	138 (35.3)
2	21 (22.1)	81 (20.7)
>2	41 (43.2)	172 (44.0)

\*Who provides services like labourer, driver, policeman, factory worker etc.

†Who deals with patients in hospitals and clinics or who handles patients specimen in laboratories, blood banks etc.

religion, marital status, profession, household income and number of blood donations in the past is given in Table 2.

Univariate analyses (Table 3) showed that the distribution of age, ethnicity, education, marital status and profession were different between cases and controls ( $P \leq 0.05$ ). Of the risk factors considered, history of hospitalization, therapeutic

injections received in the past, intravenous drips received in the past, dental treatment, familial history of jaundice, death in the family with liver disease, going to barber for facial shave and piercing of body parts by potentially contaminated needles were strongly associated with HCV sero-status ( $P \leq 0.05$ ).

#### Multivariate logistic regression model of risk factors

Final multivariate model (Table 4) showed that the cases tended to be Mohajir (adjusted OR = 2.6; 95% CI: 1.4–5.1), and had no formal schooling (adjusted OR = 2.8; 95% CI: 1.3–6.5). Cases were more likely than controls to have reported past hospitalization once (adjusted OR = 2.3; 95% CI: 1.3–4.2) or more than once (adjusted OR = 7.7; 95% CI: 3.2–18.5). During the past 5 years, cases were significantly more likely than controls to have received 6–19 injections (adjusted OR = 3.3; 95% CI: 1.6–6.7) or 20 or more injections (adjusted OR = 6.8; 95% CI: 3.0–14.8). These aforementioned two risk factors expressed a dose–response relationship with HCV seropositivity. Use of glass syringe to give therapeutic injection increased the adjusted odds of being HCV seropositive significantly more among cases than in controls and this relationship was relatively stronger when injection was given by the general medical practitioner (adjusted OR = 5.0; 95% CI: 2.0–12.3) than if the injection was given in hospital setting (adjusted OR = 2.4; 95% CI: 1.1–5.5). Furthermore, cases were more likely than controls to have reported sexual contact with female other than his wife (adjusted OR = 2.5; 95% CI: 1.1–5.4) or with female commercial sex worker (CSW; adjusted OR = 3.1; 95% CI: 1.4–6.7).

#### DISCUSSION

In this study, HCV seroprevalence among asymptomatic blood donors at two blood banks was 1.8%, when stratified by blood bank, HCV seroprevalence among blood donors was 0.7% at blood bank 1 and 2.1% at blood bank 2. The overall proportion of HCV seropositivity among blood donors is relatively lower than the figures reported in some other developing countries: Indonesia, 2.1% [8], Saudi Arabia, 3.2% [22]; Brazil 2.9% [23], and substantially lower than 6.5% reported from Thailand [9]. HCV seroprevalence among blood donors in this study is slightly greater than the reported figures of 0.9–1.3% from Italy [24], 0.35% from UK [7] and 0.54% from US [25]. HCV prevalence in the US blood donors is significantly lower than corresponding estimates of 1.8% in the general population, reflecting the efficacy of donor risk factor exclusion policies [25,26]. Similar strategies of exclusion of donors on known risk factors history may play substantial role in reduction of post-transfusion HCV infection in recipients of blood transfusion in Pakistan and other aforementioned developing countries.

There was significant increase in the proportions of HCV-seropositive donors during 2001 and 2002 and more so at

**Table 3** Univariate analyses of putative risk factors for hepatitis C virus infection in a case-control study of asymptomatic volunteer blood donors from two large blood banks, Karachi, Pakistan

Variables	HCV sero-positive [n = 95 (%)]	HCV sero-negative [n = 391 (%)]	OR	95% CI
<b>Age (completed years)</b>				
15–25	32 (33.7)	212 (54.2)	1.0	–
26–35	47 (49.5)	133 (34.0)	2.3	1.4, 3.6
>36	16 (16.8)	46 (11.8)	2.3	1.2, 4.5
<b>Ethnicity</b>				
Mohajir	38 (40.0)	226 (57.8)	1.0	–
Punjabi	23 (24.2)	64 (16.4)	2.1	1.2–3.8
Pathan	15 (15.8)	32 (8.2)	2.8	1.4–5.6
Sindhi	8 (8.4)	28 (7.2)	1.7	0.7–4.0
Baloch and others	11 (11.6)	41 (10.4)	1.6	0.8–3.4
<b>Education of the donor</b>				
>10	40 (42.1)	232 (59.3)	1.0	–
≤10	42 (43.2)	129 (33.0)	1.9	1.2–3.1
0	13 (14.7)	30 (7.7)	2.5	1.2–5.2
<b>Marital status</b>				
Never married	38 (38.6)	220 (56.6)	1.0	–
Ever married	57 (61.4)	171 (43.4)	2.0	1.3–3.1
<b>History of hospital admission</b>				
0	56 (58.9)	292 (74.7)	1.0	–
1	28 (29.5)	82 (21.0)	1.8	1.1–3.0
>1	11 (11.6)	17 (4.3)	3.3	1.5–7.6
<b>Percutaneous injury treatment</b>				
No history of injury	54 (57.4)	248 (63.4)	1.0	–
Consulted with doctor	35 (36.4)	113 (28.9)	1.4	0.8–2.3
Consulted with others	6 (6.2)	30 (7.7)	0.9	0.4–2.3
<b>Death in a family because of liver disease</b>				
No	84 (88.4)	371 (94.9)	1.0	–
Yes	11 (11.6)	20 (5.1)	2.4	1.1–5.3
<b>Living with a family member when he/she had jaundice</b>				
No history of jaundice in family	54 (56.8)	286 (73.1)	1.0	–
Living	3 (3.2)	10 (2.6)	1.6	0.4–6.0
Not living	38 (40.0)	95 (24.3)	2.1	1.3–3.4
<b>Relationship with a family member who had a history of jaundice</b>				
No history of jaundice in a family	54 (56.8)	286 (73.2)	1.0	–
Distant relatives	7 (7.4)	11 (2.8)	3.4	1.3–9.0
Immediate relative	34 (35.8)	94 (24.0)	2.0	1.1–3.1
<b>History of dental treatment</b>				
Never had dental treatment	61 (64.2)	270 (69.1)	1.0	–
Treated by dentist	25 (26.3)	117 (29.9)	0.9	0.6–1.6
Treated by others	9 (9.5)	4 (1.0)	10.0	3.0–33.3
<b>Last injection received (completed months)</b>				
Never received	4 (4.2)	86 (22.0)	1.0	–
≥6	36 (37.9)	190 (48.6)	4.1	1.4–11.6
<6	55 (57.9)	115 (29.4)	10.2	3.5–29.3
<b>Injections received in last 1 year</b>				
0	28 (29.5)	240 (61.4)	1.0	–
1	11 (11.6)	31 (7.9)	3.0	1.3–6.7
2–5	20 (21.1)	82 (21.0)	2.1	1.1–3.9
≥6	36 (37.8)	38 (9.7)	8.1	4.4–14.8

Table 3 Continued

Variables	HCV sero-positive [n = 95 (%)]	HCV sero-negative [n = 391 (%)]	OR	95% CI
Injections received in 5 years				
0	18 (18.9)	168 (43.0)	1.0	-
1-5	19 (20.0)	127 (32.5)	1.4	0.7-2.7
6-19	30 (31.6)	76 (19.4)	3.7	1.9-7.0
≥20	28 (29.5)	20 (5.1)	13.1	6.1-27.7
Injections received in 10 years				
0	63 (66.3)	243 (62.1)	1.0	-
1-10	12 (12.6)	111 (28.4)	0.4	0.2-0.8
>10	20 (21.1)	37 (9.5)	2.1	1.1-3.9
Type of syringe used and place from where last injection was received				
Never had injection	8 (8.4)	131 (33.5)	1.0	-
From hospital with a glass syringe	3 (3.2)	9 (2.3)	5.4	1.2-24.1
From GP with a plastic syringe	57 (60.0)	210 (53.7)	4.4	2.1-10.0
From GP with a glass syringe	27 (28.4)	41 (10.5)	10.8	4.5-25.5
Drip received from				
Never had drip	29 (30.5)	233 (59.6)	1.0	-
Hospital	23 (24.2)	74 (18.9)	2.5	1.4-4.5
GP's and others	43 (45.3)	84 (21.5)	4.1	2.4-7.0
No. of drips received in last 1 year				
0	75 (78.9)	360 (92.1)	1.0	-
1	7 (7.4)	23 (5.9)	1.5	0.6-3.5
≥2	13 (13.7)	8 (2.0)	7.8	
No. of drips received in last 5 years				
0	53 (55.8)	300 (76.7)	1.0	-
1-4	31 (32.6)	81 (20.7)	2.2	1.3-3.6
≥5	11 (11.6)	10 (2.6)	6.2	2.5-15.4
No. of drips received in last 10 years				
0	43 (45.3)	256 (65.4)	1.0	-
1-4	31 (32.6)	114 (29.2)	1.6	1.0-2.7
≥5	21 (22.1)	21 (5.4)	6.0	3.0-11.8
Ear pierced				
No	90 (94.4)	369 (94.4)	1.0	-
Yes	5 (5.6)	22 (5.6)	0.9	0.3-2.5
Tattoo on the body				
No	88 (92.6)	371 (94.9)	1.0	-
Yes	7 (7.4)	20 (5.1)	0.7	0.3-1.7
Handle blood/blood products				
No	95 (95.0)	383 (98.0)	1.0	-
Yes	5 (5.0)	8 (2.0)	2.1	0.6-7.1
Handle used syringes				
No	92 (96.8)	381 (97.4)	1.0	-
Yes	3 (3.2)	10 (2.6)	1.2	0.3-4.6
Shaving from barber				
No	22 (23.2)	156 (39.9)	1.0	-
Yes	73 (76.8)	235 (60.1)	2.2	1.3-3.7
Frequency of going to barber				
Never	22 (23.2)	156 (39.9)	1.0	-
Daily	2 (2.1)	26 (6.6)	0.5	0.1-2.5
Once a week	27 (28.4)	67 (17.2)	2.9	1.5-5.3
More than once a week	44 (46.3)	142 (36.3)	2.2	1.3-3.8

Table 3 Continued

Variables	HCV sero-positive [n = 95 (%)]	HCV sero-negative [n = 391 (%)]	OR	95% CI
History of sexual contact				
No history of sexual contact	198 (50.6)	28 (29.5)	1.0	–
No history of sexual contact other than wife	143 (36.6)	34 (35.8)	1.6	0.9–2.9
History of sexual contact other than wife but not with a CSW	31 (7.9)	15 (15.8)	3.4	1.6–7.1
History of sexual contact with a CSW and/or others	19 (4.9)	18 (18.9)	6.7	3.1–14.3

CI, confidence interval; CSW, commercial sex worker; OR, odds ratio; GP, general practitioner.

blood bank 1. This increase may be either because of cumulative experience of personnel in performing ELISA in the respective laboratories and/or indeed it may be representing an increase in HCV seroprevalence in general population. We are not aware of any reliable published data on the HCV prevalence and/or incidence in general population of Pakistan or populations in similar settings in the region for comparison purpose. Further evidence is thus required to verify these findings.

Of the demographic variables, ethnicity was strongly related with HCV seropositivity. Compared with Mohajir, Punjabi were more likely to be cases in this study. However, similar pair-wise evaluation of Sindhi, Pathan, Baloch/others with Mohajir ethnic status did not reveal any significant differences in adjusted odds of HCV seropositivity. The ethnic differences in HCV seropositivity have also been previously reported [27]. In addition, compared with controls, cases were more likely to have no formal schooling in this study. The independent associations of these two demographic variables i.e. ethnicity and education with HCV sero-status of the donors appear to be suggestive of involvement of social or environmental rather than biological susceptibility of HCV infection.

Sexual intercourse with female other than wife or sexual contact with CSW was associated with elevated adjusted odds of HCV seropositivity among cases compared with controls. HCV transmission through sexual exposure to an infected contact has been postulated [28], but not widely accepted, and considered to be an inefficient route for HCV transmission [29,30]. However, some other studies in blood donors have revealed that sex with an intravenous drug user [31], sex with recipient of a blood transfusion or with a partner having history of sexually transmitted diseases as independent predictors of HCV sero-status among blood donors [27]. We could not ascertain risk factor profile of sex partners of our study participants, and this aspect needs further evaluation.

This study showed significant independent associations between HCV seropositivity among blood donors and past hospitalization, number of therapeutic injection received in

past 5 years and setting wherein last therapeutic injections received along with the type of syringe used. These results corroborate the findings of previous studies reported from Netherlands [32,33], wherein 92% of the donors reported to have a risk factor of parenteral exposure. The results of some relatively recent studies from other developed countries have revealed different sets of risk factors for acquisition of HCV infection among blood donors including previous blood transfusion, previous intravenous drug use, tattooing, have lived in closed institution (i.e. prison or juvenile detention), sex with intravenous drug user [27,31,34], or being health care worker [34]. In our study, two cases and five controls reportedly have had the prior history of blood transfusion and this variable was not significantly associated with HCV sero-status in univariate analysis. Therefore, these findings showed that epidemiology of HCV seropositivity among blood donors in Pakistan and perhaps in other developing countries in the region is slightly different from what has been reported from developed countries. Similar to the results of Dutch study [33], health care settings appear to be main source of spread of HCV infection in Pakistan. These findings flagged the need for the enforcement of strict infection control measures at both public and private health care settings to prevent the nosocomial exposure to HCV and other blood-borne pathogens. Public health education and strict infection control measures in health care settings seemed to have nearly eliminated nosocomial HCV transmission in developed countries. Such strategies if followed with same rigor are likely to be successful in Pakistan and other developing countries.

Certain limitations of this study should be considered in interpreting the results. Importantly, recall bias – an inherent characteristic of a case-control design might have been introduced in measurement of some of the variables, especially in responses to questions regarding past history of injections and drips received. However, we tried to minimize the recall bias by using standard questionnaire for both cases and controls [20]. Any bias that might have occurred must be nondifferential, thus yielded conservative estimates of

**Table 4** Multivariate logistic regression model of risk factors associated with hepatitis C virus infection on asymptomatic volunteer blood donors in a case-control study, Karachi, Pakistan

Variables	Adjusted OR	95% CI
<b>Ethnicity</b>		
Mohajir	1.0	–
Punjabi	2.6	1.4–5.1
Pathan	2.2	1.0–4.9
Sindhi	1.6	0.6–4.5
Baloch and others	1.5	0.7–3.2
<b>Education of the donor</b>		
>10	1.0	–
≤10	1.6	0.9–2.8
0	2.8	1.3–6.5
<b>History of hospital admission</b>		
0	1.0	–
1	2.3	1.3–4.2
>1	7.7	3.2–18.5
<b>Number of therapeutic injection received in last 5 years</b>		
0	1.0	–
1–5	1.5	0.7–3.2
6–19	3.3	1.6–6.7
≥20	6.8	3.0–14.8
<b>Type of syringe used and place from where last injection was received</b>		
Never had injection	1.0	–
From GP with a plastic syringe	3.9	0.9–16.5
From hospital with a glass syringe	2.4	1.1–5.5
From GP with a glass syringe	5.0	2.0–12.3
<b>History of sexual contact</b>		
No history of sexual contact	1.0	–
No history of sexual contact other than wife	1.0	0.6–1.8
History of sexual contact other than wife but not with a CSW	2.5	1.1–5.4
History of sexual contact with a CSW and/or others	3.1	1.4–6.7

CI, confidence interval; CSW, commercial sex worker; OR, odds ratio; GP, general practitioner.

observed relationships. In addition, care needs to be exercised to draw inferences about cause-and-effect relationship of identified risk factors and HCV sero-status of subjects because of the nature of study design.

In conclusion, primary prevention programme focused on identified risk factors may help curtail the spread of HCV infection in this and other similar settings in developing countries. In addition, there is an immediate need of devel-

oping locally relevant guidelines for counselling and further management of HCV-seropositive donors.

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#### REFERENCES

- 1 Tong MJ, El-Farra NS, Reikes AR *et al.* Clinical outcomes after transfusions-associated hepatitis C. *N Engl J Med* 1995; 332: 1463–1466.
- 2 DiBisceglie AM, Goodman ZD, Ishak KG *et al.* Long-term clinical and histopathological follow-up of chronic post-transfusion hepatitis. *Hepatology* 1991; 14: 969–974.
- 3 Thomas DL, Astemborski J, Rai RM *et al.* The natural history of hepatitis C virus infection: host viral and environmental factors. *JAMA* 2000; 284: 450–456.
- 4 World Health Organization. Hepatitis C: global prevalence. *Weekly Epidemiol Rec* 1997; 72: 341–344.
- 5 Mast EE, Alter MJ, Margolis HS. Strategies to prevent and control hepatitis B and C virus infections: a global perspective. *Vaccine* 1999; 17: 1730–1733.
- 6 Alter MJ, Kruszon-Moran D, Nainan OV *et al.* The prevalence of hepatitis C virus infection in the United States, 1988 through 1994. *N Engl J Med* 1999; 341: 556–562.
- 7 Mutimer DJ, Harrison RF, O'Donnel KB, Shaw J *et al.* Hepatitis C virus infection in the asymptomatic British Blood donors. *J Viral Hepat* 1995; 2: 47–53.
- 8 Sulaiman HA, Julitasari Sie A, Rustam M *et al.* Prevalence of hepatitis B and C viruses in healthy Indonesian blood donors. *Tran R Soc Trop Med Hyg* 1995; 89: 167–170.
- 9 Songsivilai S, Jinathongthai S, Wongsena W, Tiangpityakorn C, Dharakul T. High prevalence of hepatitis C infection among blood donors in northeastern Thailand. *Am J Trop Med Hyg* 1997; 57: 66–69.
- 10 Arthur RR, Hassan NF, Abdallah MY *et al.* Hepatitis C antibody prevalence in blood donors in different governrates in Egypt. *Tran R Soc Trop Med Hyg* 1997; 91: 271–274.
- 11 World Health Organization. Global surveillance and control of hepatitis C. Report of a WHO consultation organized in collaboration with the viral hepatitis prevention board, Antwerp, Belgium. *J Viral Hepatitis* 1999; 6: 35–47.
- 12 Luby SP, Qamruddin K, Shah AA *et al.* The relationship between therapeutic injections and high prevalence of hepatitis C infection in Hafizabad, Pakistan. *Epidemiol Infect* 1997; 119: 349–356.
- 13 Tong CY, Khan R, Beeching NJ *et al.* The occurrence of hepatitis B and C viruses in Pakistani patient with chronic liver disease and hepatocellular carcinoma. *Epidemiol Infect* 1996; 117: 327–332.
- 14 Bari A, Akhtar S, Rahbar MH, Luby SP. Risk factors for hepatitis C virus infection in male adults in Rawalpindi-

- Islamabad, Pakistan. *Trop Med Int Health* 2001; 6(9): 732–738.
- 15 Alter MJ. Epidemiology of hepatitis C in the West. *Semin Liver Dis* 1995; 15: 5–14.
  - 16 Kahn AJ, Luby SP, Fikree F *et al*. Unsafe injections and the transmission of hepatitis B and C in a periurban community in Pakistan. *Bull World Health Org* 2000; 78: 956–963.
  - 17 Usman HR, Akhtar S, Rahbar MH, Hamid S, Moattar T, Luby SP. Injections in health care settings: a risk factor for acute hepatitis B virus infection in Karachi, Pakistan. *Epidemiol Infect* 2003; 130: 293–300.
  - 18 Pasha O, Luby SP, Khan AJ, Shah SA, McCormick JB, Fisher-Hoch SP. Household members of hepatitis C virus-infected people in Hafizabad, Pakistan: infections by injections from health care providers. *Epidemiol Infect* 1999; 123: 515–518.
  - 19 Akhtar S, Moattar T, Rahbar MH, Azam I, Salman A. Prevalence and risk factors for intrafamilial transmission of hepatitis C virus in Karachi, Pakistan. *J Viral Hepat* 2002; 9: 309–314.
  - 20 Schlesselman JJ, Stolley PD. *Case-control Studies, Design, Conduct, Analysis*. New York: Oxford University Press, 1982.
  - 21 Hosmer DW Jr, Lemeshow S. *Applied Logistic Regression*. New York: John Wiley & Sons, 1989: 307.
  - 22 Abdelaal M, Rowbottom D, Zawawi T, Scott T, Gilpin C. Epidemiology of hepatitis: a study of male blood donors in Saudi Arabia. *Transfusion* 1994; 34: 135–137.
  - 23 Patino-Sarcinelli F, Hyman J, Camacho LAB, Linhares DB, Azevedo JG. Prevalence and risk factors for hepatitis C antibodies in volunteer blood donors in Brazil. *Transfusion* 1994; 34: 138–141.
  - 24 Lai ME, Mazzoleni AP, Farci P *et al*. Markers of hepatitis C virus infection in Sardinian blood donors: relationship with alanine aminotransferase levels. *J Med Virol* 1993; 41: 282–288.
  - 25 Wang B, Schreiber GB, Glynn SA *et al*. Prevalence of transfusion-transmissible viral infections in first-time US blood donors by donation site. *Transfusion* 2003; 43(6): 705–712.
  - 26 Glynn SA, Kleinman SH, Schreiber GB *et al*. Trends in incidence and prevalence of major transfusion-transmissible viral infections in United States blood donors, 1991 to 1996. *JAMA* 2000; 284: 229–350.
  - 27 Murphy EL, Bryzman SM, Glynn SA *et al*. Risk factors for hepatitis C virus infection in United States blood donors. *Hepatology* 2000; 31: 756–762.
  - 28 Alter MJ, Hadler SC, Judson FN *et al*. Risk factors for acute non-A, non-B hepatitis in the United States and association with HCV infection. *JAMA* 1990; 254: 2231–2235.
  - 29 Eyster ME, Alter HJ, Aledort LM *et al*. Heterosexual co-transmission of hepatitis C virus (HCV) and human immunodeficiency virus (HIV). *Ann Intern Med* 1991; 115: 764–768.
  - 30 Tong MJ, Lai PPC, Hwang S *et al*. Evaluation of sexual transmission in patients with chronic hepatitis C infection. *Clin Diag Virol* 1995; 3: 39–47.
  - 31 Delage G, Rivard C, Chiavetta J *et al*. Risk factors for acquisition of hepatitis C virus infection in blood donors: result of a case-control study. *Gastroenterology* 1999; 116: 893–899.
  - 32 Van der Poel CL, Cuyppers HTM, Reesink HW *et al*. Confirmation of hepatitis C virus infection by new four antigen recombinant immunoblot assay. *Lancet* 1991; 337: 317–319.
  - 33 Van der Poel C, Cuyppers H, Reesink H *et al*. Risk factors in hepatitis C virus-infected blood donors. *Transfusion* 1991; 31: 777–779.
  - 34 Neal KR, Jones DA, Killey D *et al*. Risk factors for hepatitis C virus infection. a case-control study of blood donors in the Trent Region (UK). *Epidemiol Infect* 1994; 112: 595–601.