Hepatitis C virus infection among multi-transfused patients and personnel in haemodialysis units in central Islamic Republic of Iran

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العدوى بفيروس الالتهاب الكبدي "سي" بين الذين تكرَّر نقل الدم لهم وبين العاملين في وحدات الدِّيال الدموي في وسط جمهورية إيران الإسلامية

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الخلاصة: قد أجرى الباحثون دراسة مستعرضة حول مدى انتشار فيروس الالتهاب الكبدي "سي" وعوامل الاختطار المرافقة له لدى 382 من أولئك الذين تكرَّر نقل الدم لهم، ولدى العاملين في وحدات الدِّيال الدموي في محافظة يَزْد في عام 2006. ومن بين مَنْ أُجري لهم تحرِّي أضداد فيروس الالتهاب الكبدي "سي" وجد الباحثون أن 50.6٪ من المصابين باضطرابات وراثية نزفية، و11.8٪ من المصابين بالثلاسيمية، و5.0٪ ممَّن يُجرون الدِّيال الدموي كانوا إيجابيّي المصل. وكان أكثر عوامل الاختطار المصاحبة للعدوى بفيروس الالتهاب الكبدي "سي" شيوعاً هو نقل الدم لأول مرة قبل عام 1996 (حين بدأ التحري لدماء المتبرعين). واتضح للباحثين أن واحداً من بين كل 52 من العاملين في وحدات الدِّيال الدموي مصاب بالعدوى بفيروس الالتهاب الكبدي "سي" (وكان من متعاطي المخدرات بطريق الحقن بالوريد). وقد كانت وسائل مكافحة العدوى سيئة في جميع المراكز. كما اتضح أن مرضى الاضطرابات النـزفية الوراثية من النمط الجيني الأول (65.0٪) هم الأغلبية، ويتلوهم مَنْ هم من النمط الجيني الثالث (35.0٪). وتُبَرْهن هذه النتائج على أن تحري دم المتبرعين واستخدام رُكازات العوامل بعد تعطيل الفيروسات فيها، تترافق بانخفاض اختطار للعدوى بفيروس الالتهاب الكبدي "سي" بين مَنْ يتكرَّر نقلُ الدم لهم.

ABSTRACT A cross-sectional study was made of the prevalence of HCV and associated risk factors in 382 multi-transfused patients and haemodialysis staff in Yadz province in 2006. Of those tested for anti-HCV antibodies, 50.6% of patients with inherited bleeding disorders, 11.8% with thalassaemia and 5.0% undergoing haemodialysis were seropositive. First transfusion before 1996 (when blood donor screening started) was the common risk factor associated with HCV infection. Only 1/52 haemodialysis staff members was HCV infected (an intravenous drug user). Infection control measures were poor in all centres. In patients with inherited bleeding disorders genotype 1 (65.0%) was the predominant followed by genotype 3 (35.0%). The results provide evidence that blood donor screening and use of virus-inactivated factor concentrates have lowered the risk of HCV infection among multi-transfused patients.

Infection par le virus de l'hépatite C chez des patients polytransfusés et le personnel d'unités d'hémodialyse dans le centre de la République islamique d'Iran

RÉSUMÉ Une étude transversale a été menée sur la prévalence du virus de l'hépatite C et les facteurs de risque associés chez 382 patients polytransfusés et le personnel d'unités d'hémodialyse dans la province de Yadz en 2006. Parmi les patients chez qui on a recherché des anticorps anti-VHC, 50,6 % d'entre eux présentaient des troubles héréditaires de la coagulation et 11,8 % étaient atteints de thalassémie ; 5,0 % des patients hémodialysés étaient séropositifs. Une première transfusion avant 1996 (date à laquelle le dépistage des donneurs de sang a débuté) représentait le facteur de risque le plus fréquemment associé à une infection par le virus de l'hépatite C. Seul un membre du personnel (consommateur de drogues injectables) des unités d'hémodialyse sur 52 était infecté par le virus de l'hépatite C. Les mesures de lutte contre l'infection étaient médiocres dans toutes les unités. Chez les patients atteints de troubles héréditaires de la coagulation, le génotype 1 prédominait (65,0 %), suivi par le génotype 3 (35,0 %). Les résultats prouvent que le dépistage des donneurs de sang et l'utilisation de concentrés de facteur de coagulation viro-inactivés ont contribué à réduire le risque d'infection par le virus de l'hépatite C chez les patients polytransfusés.

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Introduction

HCV infection was identified as a health problem in the Islamic Republic of Iran in the mid 1990s, when anti-HCV antibodies were found in blood donors and high-risk groups such as multi-transfused patients and intravenous drug users. Studies on multi-transfused patients have reported an average HCV prevalence of 14% in patients subjected to haemodialysis [1–5], 50% in subjects with haemophilia [6–9] and 16% in thalassaemia patients [10]. Published reports about the distribution of HCV genotypes among Iranian haemophilia patients are also scarce [6]. Yet HCV genotypes have an important influence on the response to treatment, and data on the genotypes in subgroups of the population with a high prevalence of HCV can help clinicians to make better decisions about therapy.

There is not much information on non-transfusion related risk factors for HCV transmission among multi-transfused patients, the prevalence of HCV infection in staff members working in haemodialysis units or on the implementation of infection control strategies in haemodialysis centres in the Islamic Republic of Iran. Screening of blood donors for anti-HCV began in 1996. However, studies about the effect of this routine screening on the rate of HCV infection among multi-transfused patients are limited too [11,12]. This cross-sectional study of the epidemiological features of HCV infection in Yazd province in central the Islamic Republic of Iran was conducted among 3 high-risk groups (patients with inherited bleeding disorders, patients with thalassaemia and patients undergoing haemodialysis) and among the personnel of dialysis centres. Such data on HCV epidemiology in multi-transfused patients and among dialysis staff can elucidate the frequency of HCV spread via blood transfusion or nosocomial transmission and help to improve transfusion safety.

Methods

Study subjects

All patients with thalassaemia and inherited bleeding disorders were recruited at 3 hospitals in Yazd province (Shahid Rahnamoon, Shahid Sadoghi and Farokhi hospitals) from April to June 2006. In addition haemodialysis patients and staff members in all 9 dialysis centres at 8 different cities in the province of Yazd were recruited. Patients with thalassaemia, inherited bleeding disorders and renal failure requiring haemodialysis who had received 10 or more units of blood or components in at least 2 different transfusion events were included. Patients who were anti-HCV positive prior to the first blood transfusion, those unwilling to participate in this study and some others who did not provide a blood sample were excluded.

Of the total 382 subjects who participated in this study 77 had inherited bleeding disorders, 93 had thalassaemia (representing 83% of patients with inherited bleeding disorders and 98% of the thalassaemia population in Yadz province) and 160 had chronic renal failure and were undergoing haemodialysis (representing all dialysis patients). The remaining 52 were haemodialysis unit personnel.

Study subjects were invited to participate in this study via telephone and letters from the authorities of dialysis centres and the Association of Haemophilia and Thalassaemia in Yazd province. Informed consent was obtained from patients and in the case of minors it was taken from their parents. The protocol used was approved by the ethics committee of Tehran University of Medical Sciences.

Data collection

Each patient was interviewed by questionnaire to collect data on risk factors for HCV infection: demographic variables (age, sex), clinical history (type and severity of disease, type of thalassaemia, duration of dialysis, history of kidney transplantation) and blood transfusion history (number of transfusions, frequency of dialysis, date of first blood transfusion). Haemodialysis unit staff were interviewed for: demographic variables (age, sex, job description), employment history (duration of working in hospitals and in haemodialysis units) and occupational exposure to blood (ever experienced a needlestick/cut injury or mucous membrane exposure).

Data on haemodialysis staff/patient ratios and infection control measures were obtained by interviewing the staff, from thalassaemia centre records and from observations by trained observers. Data from haemodialysis environment were collected 3 times a day (in the morning, at noon and at night). All questionnaires were reviewed and validated by the epidemiologist at the Department of Epidemiology and Biostatistics in the School of Public Health.

Serological tests

Blood samples were collected from 382 patients and staff and immediately centrifuged. Plasmas were stored at –30 °C and –70 °C and transported in dry ice by airplane from Yazd to the HCV laboratory in the School of Public Health at Tehran University of Medical Sciences. All samples were tested for anti-HCV by a third generation enzyme-linked immunosorbent assay (ELISA) (Ortho HCV, version 3.0, Ortho-Clinical Diagnostics). Anti-HCV positive samples were tested by the confirmatory recombinant immunoblot assays (RIBA) (Chiron RIBA HCV 3.0 SIA, Chiron)

HCV genotyping

All anti-HCV positive samples from patients with inherited bleeding disorders and samples of 2 haemodialysis patients who were indeterminate by RIBA were submitted by RNA extraction. Nested polymerase chain reaction assay (PCR) was performed with primers complementary to the conserved area of the 5′UTR regions of the HCV genome as described by Stuyver et al. [13]. HCV

genotyping was determined by Versant HCV genotype assay (LiPA, Bayer).

Statistical analysis

Univariate and logistic regression analyses were performed using *Stata* software, version 8.0. The logistic regression model was used to adjust for the factors that were significant factors in the univariate analysis. *P*-values < 0.05 were considered statistically significant for patients with inherited bleeding disorders and thalassaemia and 0.10 for haemodialysis patients.

Results

Patients with inherited bleeding disorders

The characteristics of the 77 patients with inherited bleeding disorders are shown in Table 1. HCV antibody was found in 41 patients (53.3%) by ELISA. HCV antibody was confirmed in 38 patients and the results were indeterminate in 3 subjects. Of these 41 patients, 37 plasma samples were available and were tested for by RT-PCR. The prevalence of HCV infection was 78.3% (29/37). Among these 29 HCV-RNA-positive patients, 28 were anti-HCV positive and 1 was indeterminate. Thus 39/77 patients were anti-HCV or HCV-RNA positive, resulting in an overall prevalence of HCV infection of 50.6%.

Of the 20 patients who started transfusion of factor concentrates after 1998 and received single blood donor products before 1996, 2 (10.0%) were positive for HCV antibodies. Most patients (34/37, 91.9%) first transfused with factor concentrates before 1998 and single-donor blood products before 1996 were anti-HCV positive. None of the patients in the age group ≤ 10 years had HCV infection. The prevalence of HCV positivity was 47.9%, 66.7% and 73.7% in the age groups 11–20, 21–30 and ≥ 31 years respectively. Severity of disease, duration of treatment and first transfusion before 1996 showed a significant relationship with the risk of HCV infection by univariate analysis (Table 1). Variables that were significantly associated with HCV positivity by multivariate analysis were first transfusion before 1996 and severity of disease (Table 2).

HCV genotypes were determined in 20 of the HCV-RNA positive patients. The HCV genotypes in this group with inherited bleeding disorders were 1a in 13 patients (65.0%) and 3a in 7 patients (35.0%).

Thalassaemia patients

The characteristics of 93 thalassaemia patients are shown in Table 3. Anti-HCV was ELISA and RIBA positive in 11 (11.8%) of them.

None of the patients in the age group ≤ 10 years was anti-HCV positive (Table 3). The rate of seropositivity was 21.2% (11/52) among thalassaemia patients transfused before 1996, but all patients who started receiving transfusion after 1996 were anti-HCV negative (41/41). Transfusion before 1996, duration of treatment and number of blood transfusions were significantly associated with HCV positivity by univariate analysis (Table 3). Logistic regression analysis revealed that duration of treatment remained as a variable significantly associated with HCV positivity (Table 2).

Haemodialysis patients

Among 160 haemodialysis patients whose characteristics are shown in Table 4, 9 (4.4%) were seropositive by ELISA. Of them, 7 were subsequently confirmed as being positive by RIBA and 2 were indeterminate. Of 2 patients who were indeterminate, 1 was positive for HCV-RNA. Hence, the overall prevalence of HCV in haemodialysis patients was 8/160 (5.0%).

Analysis of risk factors showed that a previous history of kidney transplantation, duration of haemodialysis and transfusion before 1996 were significantly associated with HCV positivity by univariate analysis (Table 4). Haemodialysis patients transfused before 1996 had more than 6 times higher risk of infection than those who received blood transfusion after 1996 (17.7% seropositive versus 2.7%). Table 4 also shows patients under haemodialysis treatment longer than 24 months had 12 times higher risk than those with less than 24 months treatment (10.5% seropositive versus 0%). However, multivariate analysis revealed that only history of kidney transplantation and duration of haemodialysis were independently associated with anti-HCV positivity in this population (Table 2).

Of 33 patients who had never been transfused, 1 (3.0%) of them was anti-HCV positive and of 110 haemodialysis patients who started transfusion after 1996, 3 (2.7%) were anti-HCV positive.

The number of new HCV infections ($n = 4$) among haemodialysis patients in Yazd ($n = 160$) was low (Table 5).

Haemodialysis personnel

A total of 52 haemodialysis personnel were enrolled in this study: 27 were nurses, 12 nursing aids and 13 janitorial staff. They ranged in age from 23 to 55 years and included 21 males and 31 females. The mean length of working years in hospital and in haemodialysis units for personnel were 11.8 (SD 7.9) and 6.0 (2.1) years respectively. The mean haemodialysis patient:staff ratio was 3:1. The same haemodialysis staff took care of both HCV-positive and -negative patients. Data on staff members showed that 14 (26.9%) and 27 (51.9%) had ever splashed blood on their conjunctiva and/or had a history of needlestick or cut injury respectively.

HCV antibody was found in only 1 (1.9%) of the 52 haemodialysis staff, who was a male aged 25 years old and an intravenous drug user.

Haemodialysis centres

The observations in haemodialysis centres showed that no dedicated areas, machines or personnel were used for

Table 1 Characteristics of patients with inherited bleeding disorders according to hepatitis C virus (HCV) antibody status, and univariate analysis of risk factors

Characteristic	Total	Anti-HCV positive		Anti-HCV negative		OR (95% CI)
	No.	No.	%	No.	%	
Total	77	38	49.4	39	50.6	
Sex						
Female	4	0	0.0	4	100.0	1
Male	73	38	52.1	35	47.9	2.09 (1.64–2.65)
Type of bleeding disorder						
Haemophilia A	46	24	52.2	22	47.8	
Haemophilia B	13	9	69.2	4	30.8	
Other[a]	18	5	27.8	13	72.2	
Severity of bleeding disorder[b]						
Mild/moderate (≥ 1%)	36	11	30.6	25	69.4	1
Severe (≤ 1%)	41	27	65.4	14	34.1	5.27 (1.87–11.7)[b]
Duration of treatment (months)						
≤ 120	25	2	8.0	23	92.0	1
≥ 120	52	36	69.2	16	30.8	25.9 (5.44–123)[b]
First transfusion						
Before 1996	54	37	68.5	17	31.5	1
After 1996	23	1	4.4	22	95.7	61.0 (7.38–507)[b]
	Mean (SD)	**Mean (SD)**		**Mean (SD)**		
Age (years)	21.9 (12.3)	28.1 (11.6)		15.9 (9.8)		
Duration of treatment (months)	205 (118)	267 (100)		145 (103)		

[a]*Inherited deficiency of coagulation factors V, VII, combined deficiency of factors V; and VIII, von Willebrand disease and Glanzmann´s thrombasthenia.*
[b]*Based on the level of biologically active coagulation factor.*
SD = standard deviation; OR = odds ratio; CI = confidence interval.

treatment of HCV infected patients. Items such as adhesive tape, blood pressure cuffs, scissors, clamps and stethoscopes were not shared between patients in 5/9 haemodialysis centres. The haemodialysis environment (dialysis beds, chairs and tables) was cleaned and disinfected between shifts in 3 of the centres. Machines were not cleaned externally between each shift but were disinfected internally between each shift in 4/9 haemodialysis centres. Dialysers were disposable and were never reused. The floor of the rooms was cleaned by disinfectant at the end of the day in all haemodialysis centres (Table 5).

Discussion

The present study has provided an opportunity to describe the epidemiological features of HCV infection in 3 different groups of multi-transfused patients and related health care workers from the same region of the Islamic Republic of Iran. The 3 groups allowed us to make a more comprehensive evaluation about the safety of the blood or blood products used with them. The study also demonstrates the HCV genotype distribution among patients with inherited bleeding disorders.

Patients with inherited bleeding disorders

Among the 3 high-risk groups studied, the prevalence of HCV antibody in patients with inherited bleeding disorders was highest (50.6%). HCV prevalence was lower than what was earlier reported for haemophilia patients from another province in the north of the country (Guilan), but was higher than in some Asian countries [14–16]. The lower prevalence of HCV in our patients compared with the study in Guilan province might be due to the higher number of patients classified as non-severe haemophilics (46.7%) and the higher proportion of patients who started transfusion after 1996 in Yazd province (32.4%).

The reason for subdividing our patients according to factor concentrate use before and after 1996 and 1998 was to detect the impact of this type of replacement therapy on HCV infection prevalence. HCV-positive patients in this population received 14-fold unsterilized clotting factors before 1998 and 2-fold single blood donor products before 1996 compared with HCV negative cases. Moreover, 10.0% of patients first transfused with factor concentrates after 1998 and receiving single blood products before 1996 were positive for HCV, while this rate was 91.9% for those patients starting transfusion with

Table 2 Logistic regression analysis of risk factors for anti-hepatitis C virus positivity in patients with inherited bleeding disorders, with thalassaemia or on haemodialysis

Variable	OR (95% CI)	*P*-value
Patients with inherited bleeding disorders		
Severity of bleeding disorder[a]		
Mild/moderate	1	< 0.001
Severe	6.13 (1.78–11.7)	
First blood transfusion		
Before 1996	1	0.004
After 1996	61.3 (6.90–542)	
Thalassaemia patients		
Duration of treatment (months)		
≤ 144	1	0.008
≥ 145	17.3 (2.10–142)	
Haemodialysis patients		
History of kidney transplantation		
Yes	1	0.019
No	8.20 (1.40–47.6)	
Duration of haemodialysis (months)		
≤ 24	1	0.068
≥ 25	7.90 (0.90–72.4)	

[a]Based on the level of biologically active coagulation factor.
OR = odds ratio; CI = confidence interval.

factor concentrates before 1998 and single-donor products before 1996. The findings suggest that non-virally inactivated factor concentrates could be considered as the main cause of HCV infection in this group in the Islamic Republic of Iran. A similar result has been described by others [6,17]. The prevalence of HCV fell from 91.9% in patients first transfused with unscreened blood before 1996 and non-virus-inactivated clotting factors before 1998 to 0% in those starting transfusion with screened blood and virus-inactivated clotting factors after 1996 and 1998 respectively. This indicates the value of routine screening for HCV and the use of efficiently inactivated factor concentrate in the Islamic Republic of Iran.

This is the first study on HCV-RNA prevalence and genotyping in this population in Yazd province. Some limited other studies of this kind have been performed in this and in another country [6,18]. The seroprevalence of HCV-RNA (78.3%) was higher than that observed in our previous study in Markazi province (68.0%), which could be explained by the fact that 43.4% of the patients in Markazi province were anti-HCV positive and a higher number of them had been treated with interferon and ribavirin. The HCV genotype prevalence and distribution identified in this study, with the predominance of genotype 1 (65.0%) followed by genotype 3 (35.0%), are different from previous studies in Markazi province and Isfahan city by this author (unpublished data). In Markazi province HCV genotype 1 was predominant (50.0%) followed by genotype 3 (18.2%), genotype 2 (4.5%) and mixed infections (genotypes 1 & 2, 1 & 3, 1 & 4 or 2 & 3) (27.3%). In Isfahan city genotypes 1 and 3 were common among haemophilia patients (both 45.5%) while and mixed infection (genotypes 1 & 3 & 6a) was identified in 9.0%. There are around 6000 haemophilia patients with nearly 50% anti-HCV antibody positive in the Islamic Republic of Iran [19]. These differences suggest that further studies are needed to determine the prevalence and distribution of HCV genotypes among patients with inherited disorders in different regions of the Islamic Republic of Iran.

Patients with thalassaemia

The seroprevalence of HCV in thalassaemia patients whose treatment is dependent on blood transfusion was 11.8%, twice that observed in the previous study in Markazi province (5.1%) but still lower than those in other Asian and Middle East countries [20–22]. The higher prevalence of HCV in this study in comparison with Markazi province could be due to different donor selection strategies, variations in HCV prevalence among the donor population and the higher mean duration of transfusion and mean number of blood units transfused by patients from Yazd.

The highest rate of HCV positivity was found in patients older than 21 years old. The finding was also observed by other authors [11,23]. It can be related to the longer time of treatment and transfusion at a time when blood was unscreened. A significant relationship between these 2 risk factors and HCV antibody positivity was identified by univariate analysis in this study. Iranian thalassaemia patients have only received blood provided locally and therefore this population is the best group to evaluate the effect of anti-HCV screening programmes on the prevalence of HCV in multi-transfused patients over time. The rates of HCV positivity among our patients transfused before and after 1996 were 21.2% and 0% respectively. This is in agreement with our previous study [6]. The findings showed that the most important risk factor for HCV infection among patients with thalassaemia in Yazd province was transfusion of blood before 1996, when blood screening for HCV was not implemented. The above result also documents the potential influence of the anti-HCV screening

Table 3 Characteristics of thalassaemia patients according to hepatitis C virus (HCV) antibody status, and univariate analysis of risk factors

Characteristic	Total	Anti-HCV positive		Anti-HCV negative		OR (95% CI)
	No.	No.	%	No.	%	
Total	93	11	11.8	82	88.2	
Sex						
Female	45	5	11.1	40	88.9	1
Male	48	6	12.5	42	87.5	1.01 (0.32–4.04)
Beta-thalassaemia						
Major	88	10	11.4	78	88.6	1
Intermediate	5	1	20.0	4	80.0	1.95 (0.20–19.2)
Duration of treatment (months)						
≤ 144	53	1	1.9	52	98.1	1
≥ 145	40	10	25.0	30	75.0	17.3 (2.11–142)
Total no. of transfusions (units)						
≤ 200	65	3	4.6	62	95.4	1
≥ 201	28	8	28.6	20	71.4	8.27 (1.10–34.2)
First blood transfusion						
Before 1996	52	11	21.2	41	78.8	1
After 1996	41	0	0.0	41	100.0	23.0 (1.30–403)
Age (years)						
≤ 10	39	0	0.0	39	100.0	
11–20	38	7	18.4	31	81.6	
≥ 21	16	4	25.0	12	75.0	
	Mean (SD)	**Mean (SD)**		**Mean (SD)**		
Age (years)	13.7 (8.9)	19.7 (3.4)		12.8 (9.1)		
Duration of transfusion (months)	139 (85)	208 (54)		129 (110)		
No. of transfusions	171 (124)	308 (146)		152.8 (110)		

SD = standard deviation; OR = odds ratio; CI = confidence interval.

programme on decreasing new HCV infection among thalassaemia patients in the Islamic Republic of Iran.

Haemodialysis patients

This study represents the first report of HCV prevalence among haemodialysis patients and personnel in Yazd province. The prevalence of HCV antibody among haemodialysis patients in the present study (5.0%) was similar to that in Markazi province but lower than that reported from Europe and Saudi Arabia [24,25]. Implementation of anti-HCV screening assays and routine use of erythropoietin from 10 years ago are likely reasons for the low prevalence of HCV among haemodialysis patients in Yazd province.

An association between HCV infection and both duration of haemodialysis and a history of kidney transplantation was found by logistic regression and this is also reported in the literature [3,26]. The seropositive rate among haemodialysis patients transfused before 1996 was 17.7% compared with 2.7% in those receiving blood transfusion after 1996. Although this finding indicates the impact of blood screening in decreasing new cases of HCV infection, it also shows that new infections have occurred since 1996 and that other risk factors are involved.

Information from HCV infected haemodialysis patients who have been receiving screened blood or never been transfused showed that other variables which are classically associated with HCV infection were not important risk factors. The present study also revealed that the seropositive rate was 10.5% among patients under haemodialysis treatment longer than 24 months versus 1.0% for those with less than 24 months treatment. The results suggest that nosocomial transmission was a factor in HCV transmission among haemodialysis patients during the past 10 years. Subsequent molecular biology studies are needed to confirm the occurrence of nosocomial transmission in Yazd haemodialysis centres.

Haemodialysis personnel

The seroprevalence of HCV among personnel of haemodialysis centres in Yazd province was only 1.9% (1 case). This is similar to that reported from United States [27] but higher than other studies in Brazil and Saudi Arabia

Table 4 Characteristics of haemodialysis patients according to hepatitis C virus (HCV) antibody status, and univariate analysis of risk factors

Characteristic	Total	Anti-HCV positive		Anti-HCV negative		OR (95% CI)
	No.	No.	%	No.	%	
Total	160	7	4.4	153	95.6	
Sex						
Female	55	1	1.7	54	98.2	1
Male	105	6	5.7	99	94.3	3.27 (0.38–27.9)
History of blood transfusion						
Yes	127	6	4.7	121	95.3	1
No	33	1	3.0	32	97.0	1.59 (0.18–13.7)
First blood transfusion						
Never	33	1	3.0	32	97.0	1
Before 1996	17	3	17.7	14	82.3	6.90 (0.60–71.8)
After 1996	110	3	2.7	107	97.3	0.89 (0.09–8.90)
Duration of haemodialysis (months)						
≤ 24	103	1	1.0	102	99.0	1
≥ 25	57	6	10.5	51	89.5	12.0 (1.41–102)
History of kidney transplantation						
Yes	10	3	30.0	7	70.0	1
No	150	4	2.7	146	97.3	15.6 (2.92–83.8)
Number of dialyses (per week)						
1 or 2	51	3	5.9	48	94.1	1
3	109	4	3.7	105	96.3	0.61 (0.13–2.80)
	Mean (SD)	**Mean (SD)**		**Mean (SD)**		
Age (years)	57.0 (15.9)	47.6 (20.3)		57.4 (15.6)		
Duration of transfusion (months)	31 (38)	102 (81)		28 (31)		
No. of blood transfusions	7.7 (14.5)	34.7 (45.0)		6.5 (10.2)		

SD = standard deviation; OR = odds ratio; CI = confidence interval.

[28,29]. The anti-HCV positive staff member was an intravenous drug user and most likely had acquired HCV infection by this route. Although the remaining personnel were not regularly using gloves, and many of them had a history of needlestick and/or membrane exposure to patients' blood or other body fluids, all were HCV seronegative. This could be due to the low rate of HCV infection among the general population of Yazd province. The study therefore found no evidence for HCV as an occupational hazard to haemodialysis personnel. Nevertheless, educating haemodialysis personnel to adhere to standard infection control precautions is vital.

Haemodialysis centres

Data on infection control measures in 9 haemodialysis centres indicated that the 3 centres with the highest prevalence of HCV antibody were those which were not following standard infection control precautions. In these units, the same items were used repeatedly for different patients, cleaning and disinfection of equipment was insufficient and the use of gloves and hand-washing were not routine procedures. Similar findings were observed by studies in haemodialysis centres in other countries [30,31]. The remaining 6 haemodialysis centres with 0% anti-HCV prevalence also had poor adherence to standard haemodialysis unit precautions. The zero infection rate in these centres could be explained by the fact that they were new centres and may not have been admitting patients who were known anti-HCV positive, patients transferred from other haemodialysis centres, seropositive patients in transit or patients in the HCV immunological window between exposure to HCV and the appearance of detectable anti-HCV.

Half of the seropositive patients in our study acquired HCV infection after 1996 and were not infected by blood transfusion. The finding suggests that nosocomial transmission of HCV, presumably associated with violation of universal precaution rules, has occurred in Yazd haemodialysis centres. In the survey by Grethe et al. on haemodialysis patients who had not received blood

Table 5 Evaluation of infection control measures in the 9 haemodialysis centres in Yazd province

Control practices	Haemodialysis unit								
	1	2	3	4	5	6	7	8	9
Disinfection of dialysis machine between patients	–	–	+	–	+	+	–	–	+
Using disposable gloves	+	–	+	+	+	+	+	+	–
Changing gloves and washing hands between patients	–	–	–	–	–	–	+	–	–
Using individual supplies and medications	–	+	+	+	–	–	–	+	+
Medication preparation area located in a separated room	–	+	–	–	–	–	–	–	–
Cleaning and disinfection of nondisposable instruments and haemodialysis environment between shifts	–	–	–	–	–	+	+	–	+
Haemodialysis staff/patient ratio	18/73	6/19	3/4	4/10	3/13	4/14	4/6	3/7	7/14
Using disposable single-use dialyser membranes	+	+	+	+	+	+	+	+	+
Prevalence of HCV (%)	6.9 (5/73)	0	0	0	9.6 (1/13)	14.3 (2/14)	0	0	0
No. of new HCV cases after 1996	2/73	0	0	0	0	2/14	0	0	0

HCV = hepatitis C virus.

during the previous 2 years, nosocomial transmission was recognized as an important cause of HCV spread in haemodialysis units [32]. The low number of cases of new HCV infection (4/160) in Yazd haemodialysis patients over the past decade could be due to the low anti-HCV prevalence (5.0%) in haemodialysis patients of this province. A strong correlation between prevalence and incidence was also observed by Petrosillo et al. [33] and Pujol et al. [34].

Conclusion

The results of this study provide evidence that strategies such as screening of blood donors, use of virus-inactivated factor concentrates, better selection of volunteers and improvement in education for health care workers have contributed to much lower HCV infection prevalence in Iranian transfused patients.

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References

1. Amir-Mohtashami Z, Jaafari Shakib A, Toorchi-roodsari H. Seroprevalence of hepatitis C and risk factors in hemodialysis patients in Guilan province, Iran *Payesh*, 2003, 4:291–295 [in Farsi].
2. Alavian SM et al. Prevalence of hepatitis C virus infection and related risk factors among Iranian haemodialysis patients. *Nephrology*, 2003, 8:256–260.
3. Samimi-Rad K et al. Virus infection and hcv genotypes of hemodialysis patients. *Iranian Journal of Public Health*, 2008, 37:146–152.
4. Taziki O, Espahbodi F. Prevalence of hepatitis C virus infection in hemodialysis patients. *Saudi Journal of Kidney Diseases and Transplantation*, 2008, 19:475–478.
5. Assarehzadegan MA et al. Prevalence of hepatitis C and B infection and HC V genotypes among hemodialysis patients in Khuzestan province, Southwest Iran. *Saudi Journal of Kidney Diseases and Transplantation*, 2009, 20:681–684.
6. Samimi-Rad K, Shahbaz B. Hepatitis C virus genotypes among patients with thalassemia and inherited bleeding disorders in Markazi province, Iran. *Haemophilia*, 2007, 13:156–163.
7. Hariri MM et al. Prevalence of hepatitis B, C and HIV markers in thalassemic and hemophilic patients in Isfahan, 2004. *Blood. The Scientific Journal of Iranian Blood Transfusion Organization Research Center*, 2006, 2:201–204 [in Farsi].
8. Torabi SE et al. Prevalence of hepatitis B, C and HIV in hemophiliac patients of East Azarbaijan in 2004. *Blood. The Scientific Journal of Iranian Blood Transfusion Organization Research Center*, 2006, 2(Suppl. 7):291-299 [in Farsi].
9. Sharifi-Mood B et al. Hepatitis B and C virus infections in patients with hemophilia in Zahedan, southeast Iran. *Saudi Medical Journal*, 2007, 28:1516–1519.
10. Abolghasemi H et al. Thalassemia in Iran: epidemiology, prevention, and management. *Journal of Pediatric Hematology/Oncology*, 2007, 29:233–238.
11. Mirmomen S et al. Epidemiology of hepatitis B, hepatitis C, and human immunodeficiency virus infections in patients with beta-thalassemia in Iran: a multicenter study. *Archives of Iranian Medicine*, 2006, 9:319–323.

12. Alavian SM et al. The efficacy of blood donor screening in reducing the incidence of hepatitis C virus infection among thalassemic patients in Iran. *Transfusion Today*, 2002, 53:3–4.
13. Stuyver L et al. Second-generation line probe assay for hepatitis C virus genotyping. *Journal of Clinical Microbiology*, 1996, 34:2259–2266.
14. Mansour-Ghanaei F et al. Prevalence of hepatitis B and C seromarkers and abnormal liver function tests among hemophiliacs in Guilan (northern province of Iran). *Medical Science Monitor*, 2002, 8:CR797–CR800.
15. Ghosh K et al. Transfusion transmitted diseases in haemophilics from western India. *Indian Journal of Medical Research*, 2000, 112:61–64.
16. Nakata S et al. Hepatitis C and B virus infections in populations at low or high risk in Ho Chi Minh and Hanoi, Vietnam. *Journal of Gastroenterology and Hepatology*, 1994, 9:416–419.
17. Al-Kubaisy WA, Al-Naib KT, Habib MA. Prevalence of HCV/HIV co-infection among haemophilia patients in Baghdad. *Eastern Mediterranean Health Journal*, 2006, 12:264–269.
18. Maor Y et al. Hepatitis C at the Israeli national hemophilia center. *Haemophilia*, 2006, 12:68–74.
19. Rezvan. H, et al. Transfusion-transmitted infections among multitransfused patients in Iran: a review. *Transfusion Medicine*, 2007, 17: 425–433.
20. Al-Kubaisy WA, Al-Naib KT, Habib M. Seroprevalence of hepatitis C virus specific antibodies among Iraqi children with thalassaemia. *Eastern Mediterranean Health Journal*, 2006, 12:204–210.
21. Al-Sheyyab M, Batieha A, El-Khateeb M. The prevalence of hepatitis B, hepatitis C and human immune deficiency virus markers in multi-transfused patients. *Journal of Tropical Pediatrics*, 2001, 47:239–242.
22. Marwaha RK et al. Seroprevalence of hepatitis C and B virus in multiply transfused beta-thalassemics: results from a thalassemic day care unit in north India. *Vox Sanguinis*, 2003, 85:119–120.
23. Ramia S et al. Hepatitis-C-virus genotypes and hepatitis-G-virus infection in Lebanese thalassaemics. *Annals of Tropical Medicine and Parasitology*, 2002, 96:197–202.
24. Jadoul M et al. The changing epidemiology of hepatitis C virus (HCV) infection in haemodialysis: European multicentre study. *Nephrology, Dialysis, Transplantation*, 2004, 19:904–909.
25. Huraib S et al. High prevalence of and risk factors for hepatitis C in haemodialysis patients in Saudi Arabia: a need for new dialysis strategies. *Nephrology, Dialysis, Transplantation*, 1995, 10:470–474.
26. Bdour S. Hepatitis C virus infection in Jordanian haemodialysis units: serological diagnosis and genotyping. *Journal of Medical Microbiology*, 2002, 51:700–704.
27. Fabrizi F et al. Kinetics of hepatitis C virus load during hemodialysis: novel perspectives. *Journal of Nephrology*, 2003, 16:467–475.
28. Oliveira Penido JM et al. Seroprevalencia del virus de la hepatitis C en pacientes en hemodialisis y en profesionales de la salud en el Estado de Minas Gerais, region Sudeste de Brasil. [The seroprevalence of HCV in patients submitted to hemodialysis and health professionals in the State of Minas Gerais, southwest of Brazil]. *Nefrologia*, 2008, 28:178–185.
29. Saxena AK, Panhotra BR. The vulnerability of middle-aged and elderly patients to hepatitis C virus infection in a high-prevalence hospital-based hemodialysis setting. *Journal of the American Geriatrics Society*, 2004, 52:242–246.
30. Arenas Jimenez MD, Sanchez-Paya J. Standard precautions in haemodialysis--the gap between theory and practice. *Nephrology, Dialysis, Transplantation*, 1999, 14:823–825.
31. Santos MA, Souto FJ. Infection by the hepatitis C virus in chronic renal failure patients undergoing hemodialysis in Mato Grosso state, central Brazil: a cohort study. *BMC Public Health*, 2007, 7:32.
32. Grethe S et al. Molecular epidemiology of an outbreak of HCV in a hemodialysis unit: direct sequencing of HCV-HVR1 as an appropriate tool for phylogenetic analysis. *Journal of Medical Virology*, 2000, 60:152–158.
33. Petrosillo N et al. Prevalence of infected patients and understaffing have a role in hepatitis C virus transmission in dialysis. *American Journal of Kidney Diseases*, 2001, 37:1004–1010.
34. Pujol FH et al. High incidence of hepatitis C virus infection in hemodialysis patients in units with high prevalence. *Journal of Clinical Microbiology*, 1996, 34:1633–1636.