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The susceptibility of patients with type-2 diabetes to hepatitis C virus infection during long-term haemodialysis

Anil K. Saxena[a], *B. R. Panhotra*[b]

[a] Division of Nephrology, Post-graduate Department of Medicine, King Fahad Hospital and Tertiary Care Center, King Faisal University, Hofuf, Al-Hasa, Eastern Province, Saudi Arabia
[b] Department of Microbiology and Infection Control, King Fahad Hospital and Tertiary Care Center, King Faisal University, Hofuf, Al-Hasa, Eastern Province, Saudi Arabia

Summary

Background: Type-2 diabetes has emerged as the commonest cause of end stage renal disease (ESRD) requiring long-term haemodialysis (HD) that constitutes a high-risk environment for the transmission of hepatitis C virus (HCV). The likelihood of acquiring HCV infection in this rapidly growing population on HD conceivably vulnerable to viral infections has not been well studied. The present study aims to determine the susceptibility of the patients with type-2 diabetes to HCV infection in a HD unit with high HCV prevalence.

Methods: The records of 196 patients with ESRD enrolled on long-term HD at King Fahad Hospital and tertiary care centre, in Hofuf, Saudi Arabia, from November1995 to November 2000, were retrospectively reviewed. HCV prevalence, seroconversion rates, history of blood transfusion, and time on dialysis (time span since initiation of HD therapy) were recorded and compared between the group of patients with type-2 diabetes, and the non-diabetic group.

Results: The overall, HCV seroprevalence of 41.3% (81/196) and annual seroconversion rate of 8.26% were observed. Anti-HCV positivity was associated with longer time on dialysis.

Of the 196 patients 54 (27.5%) had type-2 diabetes mellitus and 142 (72.5%) were non-diabetics. Patients with type-2 diabetes recorded higher HCV prevalence (57.4% vs 35.2%), and annual seroconversion rates (11.48% vs 7.04%) after a shorter period on dialysis (32.6 vs 50.6 months), as compared to those of the non-diabetic group.

Conclusions: A significantly higher HCV prevalence [odds ratio (OR)-2.462, 95% CI (1.338–4.542)] and annual seroconversion rate [OR-2.483, 95% CI (1.241–4.946)] despite relatively shorter period on dialysis [OR-3.320, 95% CI (1.487–7.4810)] among patients with type-2 diabetes clearly point to the greater likelihood of their acquiring HCV infection even at an earlier stage than the non-diabetic patients, receiving treatment in a high prevalence HD unit.

Key words: HCV infection; type-2 diabetics; seroconversion; prevalence; haemodialysis

Introduction

The prevalence of hepatitis C virus (HCV) infection among end stage renal disease (ESRD) patients on haemodialysis (HD) is persistently higher than the general population. HCV infection is endemic in HD units worldwide, predominantly in the Middle Eastern countries [1, 2]. The burden of HCV disease is cumulative and heavy for immunocompromised patients on long-term HD in terms of development of chronic liver disease, cirrhosis and hepatocellular carcinoma along with the enormously increased cost of ESRD management [3].

Nosocomial transmission has been reported to be the principal mode of HCV infection in the modern hospital-based HD set-up [4, 5]. The obligatory requirement for a vascular access site and an extracorporeal blood circuit, may add to the risk of acquiring HCV infection through nosocomial transmission in a rapidly growing population of type-2 diabetics that has emerged as the most frequent cause of ESRD over the last three decades [6, 7]. Type-2 diabetes mellitus accounts for 20 to 50% of the patients on renal replacement therapy with almost 80% being managed with HD [8].

Data from the Second National Health and Nutrition Examination Survey (NHANES II) Mortality Study, USA, imply three times higher predisposition of adult diabetic patients to infec-

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tion-related mortality as compared to the non-diabetic population [9]. Sangiorgio et al. [10] recently reported the increased prevalence of HCV and HBV infections in type-2 diabetic patients as compared to the general population. However none of the studies have demonstrated that the patients with type-2 diabetes have a greater risk of acquiring HCV infection especially when they are dialysed in a high HCV prevalence unit.

The present study was designed to determine the vulnerability of type-2 diabetic patients on long-term HD, to HCV infection in terms of prevalence and annual seroconversion rates in relation to period on dialysis, with non-diabetic ESRD patients as a reference population.

Patients and methods

This retrospective cohort study comprised of the review of the records of 196 patients with diverse aetiologies of ESRD enrolled for long-term HD from November 7th 1995 to November 6th 2000 at King Fahad Hospital and tertiary care centre, Al-Hasa, Saudi Arabia. There were 99 males and 97 females. The mean age of the patients was 47.8 ± 14.9 years (range 14–84 years). Patients with type-2 diabetes represented 27.55% (54/196) of the HD cohort whereas the remaining, 72.45% (142/196) with diverse aetiologies for ESRD, formed the non-diabetic cohort (Table 1). Of all 54 type-2 diabetic patients, 68.5 % (37/54) were non-insulin requiring (NIRDM) and 31.5% (17/54) were insulin requiring (IRDM).

Factors such as period on dialysis, blood transfusions, surgical interventions (eg, creation of an arteriovenous fistula, herniorrhaphy, appendicectomy, gynaecological surgery and surgical treatment of complicated skin wounds and diabetic feet) and invasive procedures (eg, gastrointestinal endoscopies, and cystoscopies) performed during the 6 months preceding HCV seroconversion, were also recorded and statistically compared, between the diabetic and non-diabetic cohorts.

Intravenous drug abuse (IVDA), tattooing and promiscuous sexual behaviour, frequently implicated in the transmission of HCV infection in HD units elsewhere, are practically non-existent in the ethnic population of Al-Hasa region of Saudi Arabia.

These ESRD patients were dialysed two or three times per week through disposable single-use high-flux dialyser membranes (Polysulphone, Bellco, Mirandola, Italy; Polyacrylonitrile, Filtrat 10 AN 69, Hospal, Meyzieu, France.) and blood lines.

HCV positive and HCV negative patients were dialysed in a common space exclusive of any partition between them whereas the patients with HBV infection were strictly isolated as per CDC guidelines [11]. Male and female patients were dialysed in separate rooms

There was no specific assignment of HD staff nurses regarding serological status of patients to HCV during this period. The patient/nursing staff ratio was 3:1 with the same staff nurse taking care of HCV positive and HCV negative patients at the same time but, with strict enforcement of universal infection control precautions.

Infection control precautions

Strict adherence to universal precautions for infection control as recommended by CDC was practised routinely, regardless of HCV or HBV serological status [11, 12]. All staff members taking care of HD patients wore gowns, masks, gloves and protective eyewear while preparing, performing and terminating dialysis. Gloves were changed after each patient manipulation, and hands were washed between each patient. Meticulous cleaning and disinfecting of environmental surfaces at each dialysis station was done before all dialysis sessions, and waste generated was disposed off in an incinerator, in accordance with Saudi regulations governing medical waste.

Only single dose-single use vials (pre-filled syringes) of recombinant human erythropoietin injections (EPREX-epoetin alpha, CILAG AG International, Zug, Switzerland) were used; however, multidose vials of heparin (required to prevent coagulation of blood in extracorporeal circulation during HD) and subcutaneous insulin (for insulin requiring type-2 diabetics- IRDM), were allotted, labelled and used solely for the same patient.

Table 1

Aetiological diagnosis and anti-HCV positivity (prevalence) in the study population on long-term haemodialysis (n = 196).

Aetiological diagnosis of ESRD	Patients n (%)	Anti-HCV positivity (prevalence)	
		n	%
DN	54 (27.55)	31	57.4
CGN	45 (22.96)	19	42.2
CPN	18 (9.18)	5	27.7
SCN	8 (4.08)	5	62.5
ADPKD	10 (5.10)	2	20.0
LN	18 (9.18)	4	22.2
AN	4 (2.04)	1	25.0
MCD	3 (1.53)	1	33.3
VUR	3 (1.53)	1	33.3
UN	33 (16.83)	12	36.3
Total	196	81	41.3

Abbreviations: DN = Diabetic nephropathy, CGN = Chronic glomerulonephritis, CPN = Chronic pyelonephritis, SCN = Sickle cell nephropathy, ADPKD = Autosomal dominant polycystic kidney disease, LN = Lupus nephritis, AN = Analgesic nephropathy, MCD = Medullary cystic disease, VUR = Vesico-ureteric reflux, UN = Unknown

Disinfection of haemodialysis machines

The HD machines (Hospal Integra™, Meyzieu, France), were disinfected after each patient (HCV positive or negative) with hot water and chemicals (Puristeril and sodium hypochlorite). Chemical disinfection, as per instructions of the manufacturers, involved using 0.1% per-acetic acid (Puristeril® 340, Fresinius AG, Homburg, Germany) and running the machine at 85 °C for 35 minutes after each dialysis session. After the chemical disinfection, hot water, at 80–90 °C, was run at a high flow rate for 60 minutes. This procedure was performed at the end of the day on every machine in preparation for the next day's work, while disinfection of the dialysate circuit was performed with sodium hypochlorite (<0.3 ppm) after each individual session. External, disposable venous and arterial pressure transducer filters were also changed and discarded between each patient treatment after single use.

Detection of HCV infection

Blood samples were collected from all patients on the date of their enrolment in the unit and subsequently every three months for analysis for HCV infection. The serum samples were stored at –20 °C until analysis for anti HCV antibodies by second-generation enzyme linked immunosorbant assay (ELISA-2) using Murex version III kits (Murex Biotech Ltd, Dartford, UK) was done. All the anti HCV positive samples were confirmed by recombinant Immunoblot assay, CHIRON-RIBA-HCV 3.0 (Ortho Clinical diagnostics, Raritan, NJ, USA). Seroconversion rates were calculated at the end of each year by recording the percentage of new cases per year.

In addition to patients, all personnel (renal physicians, staff nurses and HD technicians) were tested annually for anti HCV/HBV and liver enzymes. Blood and blood products used for transfusion were acquired from voluntary donors and screened for anti-HCV with ELISA-2.

Statistical analyses

The statistical package for social sciences, SPSS version 10.1 (SPSS, Chicago, IL) was used for data processing. The value p <0.05 (two sided) was used as a cut-off level for statistical significance. The Chi-square test was used to assess the difference between proportions of anti-HCV positive patients in the two groups (with type-2 diabetes and non-diabetics). The Student t-test was used to compare the means of two quantitative variables. Mantel-Haenszel odds ratios (ORs) and their 95% confidence intervals (CIs) were used to investigate the association between the seroconversion rates and selected risk factors. Significantly associated variables with the risk of acquiring HCV infection in the univariate analysis were excluded in a multivariate logistic regression model.

Since the duration of follow-up was not uniform, the prognostic significance of anti-HCV positivity in the two patients groups – with type-2 diabetes, including NIRDM and IRDM subgroups and non-diabetics – was tested by cumulative survival analysis at the main time points (HCV serology at the beginning of HD – the study entry and the time of becoming anti-HCV positive). The cumulative survival curves were obtained by the Kaplan Meier survival method. The equality of the survival curves was assessed by the Cox proportional hazard test.

Results

All ESRD patients had been on HD for a mean period on dialysis of 66.5 ± 10.5 months (range 4–142 months).

Factors affecting HCV positivity are listed in the table 2. Of 196 ESRD patients, 81 (41.3%) including 49 males and 32 females were found to be

Table 2

Determinants of HCV seroconversion in the haemodialysis cohort (n = 196) (univariate analysis,1995–2000).

Variables †	Anti-HCV serology		OR	CI_{95}	P
	Positive	Negative			
Patients, No., Total (%)	81/196 (41.3)	115/196(58.7)			
Age (years), Mean ± SD	51.2 ± 18.4	44.5 ± 11.05	1.405	0.728–1.717	0.351
Gender, No., Total (%)					
Male	49/81(60.5)	50/115(43.5)	1.991	0.073–3.703	0.008
Female	32/81(39.5)	65/115(56.5)	0.502	0.270–0.932	0.280
Period on dialysis (months) Mean ± SD	41.6 ± 10.95	25.05 ± 10.1	2.690	1.256–5.793	0.009
No. of units of blood Transfused Mean ± SD	9.6 ± 3.5	7.9 ± 5			
Surgical interventions No., Total (%)	9/81 (11.25)	14/115(12.17)	0.902	0.338–2.372	0.998
Invasive procedures No., Total (%)	14/81(17.28)	22/115 (19.0)	0.749	0.333–1.631	0.533
Diabetes type-2 No., Total (%)					
Yes	31/54(57.4)	23/54(42.6)	3.214	1.279–8.184	0.011
No	50/142(35.2)	92/142(64.8)	0.295	0.176–0.495	0.241

† Intravenous drug abuse (IVDA), tattooing and promiscuous sexual behaviour, were not observed in the population of Al-Hasa region of Eastern Province of Saudi Arabia.
Abbreviations: OR-odds ratio, CI_{95}- 95% confidence interval, SD-Standard deviation

anti-HCV positive. More males (60.5%, 49/81) than the females (39.5%, 32/81) were anti-HCV positive and the difference was statistically significant (95% CI, 0.073–3.703, P <0.008). A higher mean period on dialysis (41.6 ± 10.95 months) was noted among HCV positive patients than those of anti-HCV negative patients (25.05 ± 10.1 months). This difference in the period on dialysis between the two groups was statistically significant (95% CI, 1.256–5.793, P <0.009).

The number of units of blood transfused between anti-HCV positive and, anti-HCV negative cohorts were, comparable (9.6 ± 3.5 vs 7.9 ± 5 units).

The other factors analysed: age, number of units of transfused, along with the surgical interventions and the invasive procedures (performed in the preceding six months) were comparable between the anti-HCV positive and HCV negative groups.

Of 196 patients, 54 (27.5%) were type-2 diabetics and 142 (72.5%) were non-diabetics.

More patients in the cohort with type-2 diabetes mellitus (57.4%, 31/54) were anti-HCV positive than those in the non-diabetic cohort (35.2 %, 50/142). This difference was statistically significant (95% CI, 1.338–4.542, P <0.003 (Table 2). However, the mean period on dialysis recorded in anti-HCV positive patients with type-2 diabetes, was shorter ((32.6 ± 12.4 months) than that observed in anti-HCV positive non-diabetic patients (50.6 ± 9.5 months). This difference in the period on dialysis between the two groups was also statistically significant (95% CI, 1.487–7.481, P <0.003).

The variable invasive procedures (performed during preceding 6 months), showed more than a

Table 3

Determinants of HCV seroconversion between type-2 diabetic (n = 54) and non-diabetic (n = 142) cohorts on haemodialysis (univariate analysis, 1995–2000).

Variables †	Anti-HCV positive patients		OR	CI_{95}	P
	Type-2 diabetics	Non-diabetics			
Patients No., Total (%)	31/54 (57.4)	50/142(35.2)	2.483	1 .241–4.946	0.008
Age (years) Mean ± SD	52.8 ± 18.6	49.6 ± 18.3	1.161	0.597–2.258	0.752
Gender No., Total (%)					
Male	32/54(59.3)	67/142(47.2)	1.652	0.587–4.695	0.414
Female	22/54(40.7)	75/142(52.8)	0.606	0.213–1.705	0.404
Period on dialysis (months) Mean ± SD	32.6 ± 12.4	50.6 ± 9.5	3.320	1.487–7.481	0.003
No. of units of blood Transfused Mean ± SD	8.6 ± 5	10.6 ± 4	1.391	0.424–4.546	0.737
Surgical interventions No., Total (%)	3/31 (9.6)	6/50(12.0)	0.786	0.141–3.947	0.100
Invasive procedures No., Total (%)	7/31(22.6)	7/50 (14.0)	2.551	0.691–9.621	0.196
HCV prevalence (%)	57.4	35.2	2.462	1.338–4.542	0.003
Seroconversions/year Mean (%)	6.02 (11.48)	10.0(7.04)	2.483	1.241–4.946	0.008

† Intravenous drug abuse (IVDA), tattooing and promiscuous sexual behaviour, were not observed in ethnic population of Al-Hasa region of Eastern Province of Saudi Arabia.
Abbreviations: OR – odds ratio, CI_{95} – 95% confidence interval, SD – standard deviation

Figure 1

Mean HCV prevalence and seroconversion rates in Non-diabetic and Type-2 diabetic (NIRDM & IRDM) patient groups on long-term HD. NIRDM – non insulin requiring diabetes mellitus, IRDM – insulin requiring diabetes mellitus.

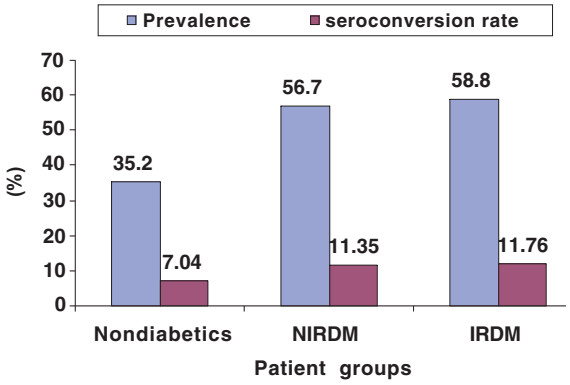
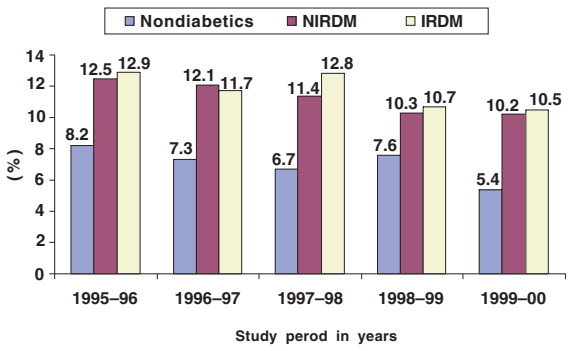


Figure 2

Annual HCV seroconversion rates in non-diabetic and Type-2 diabetic (NIRDM & IRDM) patient groups on long-term HD. NIRDM – non insulin requiring diabetes mellitus, IRDM – insulin requiring diabetes mellitus.



twofold risk (OR-2.551) for the acquisition of HCV infection (although this was not statistically significant – 95% CI, 0.691–9.621, *P*-0.196) among type-2 diabetic patients in comparison to the non-diabetic patients on HD.

The other variables such as age, gender, number of units of blood transfusion and surgical procedures (performed during preceding six months), did not show any significant statistical relationship with the anti-HCV positivity between the two cohorts.

A higher annual seroconversion rate was recorded among type-2 diabetics (11.48% per year) in comparison to non-diabetics on HD (7.04% per year) and this difference was statistically significant (95% CI, 1.241–4.946, *P* <0.008) (Table 3).

Further analysis of the subgroups of type-2 diabetes mellitus – NIRDM and IRDM, with respect to the factors affecting HCV infection in patients on long-term HD – showed no statistically significant difference in the mean anti-HCV prevalence (56.7 vs 58.8%, *P*-0.776) and annual seroconversion rates (11.35 vs 11.76%, *P*-0.972) between the two subgroups (Table 4 and Fig. 1 and 2).

Of the three potential determinants (period on dialysis, invasive procedures and diabetes type-2 status) that showed more than a twofold risk for the acquisition of HCV infection and/or a statistically significant association in univariate analysis

Table 4

Determinants of HCV seroconversion between the two subgroups of patients with type-2 diabetes mellitus -NIRDM (n = 37) and IRDM (n = 17) on haemodialysis (univariate analysis,1995–2000).

Variables †	Anti-HCV positive patients with type-2 diabetes mellitus		OR	CI_{95}	P
	NIRDM	IRDM			
Patients No., Total (%)	21/37 (56.7)	10/17(58.8)	0.919	1 .243–3.410	1.000
Age (years), Mean ± SD	48.6 ± 14.8	53.6 ± 15.3	0.819	0.453–1.480	0 .751
Gender, No., Total (%)					
Male	20/37(54.0)	9/17(52.9)	1.046	1.285–3.835	1.000
Female	17/37(45.9)	8/17(47.1)	0.956	1.261–3.512	1.000
Period on dialysis (months) Mean ± SD	42.9 ± 11.6	47.2 ± 9.7	1.195	0.482–2.972	0.833
No. of units of blood Transfused Mean ± SD	9.8 ±3.5	8.6± 5	1.286	0.574–2.515	0.727
Surgical interventions No., Total (%)	2/20 (10.0)	1/11(9.1)	1.111	0.472–2.658	0.954
Invasive procedures No., Total (%)	4/20(20.0)	3/11 (27.2)	0.667	0.472–1.190	0.186
HCV prevalence (%)	56.7	58.8	0.884	0.486–1.610	0.775
Seroconversions/year Mean (%)	4.2 (11.35)	2.0 (11.76)	0.833	0.216–1.816	0.972

† Intravenous drug abuse (IVDA), tattooing and promiscuous sexual behaviour, were not observed in ethnic population of Al-Hasa region of Eastern Province of Saudi Arabia.
Abbreviations: NIRDM – non insulin requiring diabetes mellitus, IRDM – insulin requiring diabetes mellitus, OR – odds ratio, CI95 – 95% confidence interval, SD – standard deviation

Figure 3

Kaplan Meier cumulative survival curves demonstrating the probability of HCV seroconversions in non-diabetic and Type-2 diabetic (NIRDM & IRDM) patient groups on long-term HD. NIRDM – non insulin requiring diabetes mellitus, IRDM – insulin requiring diabetes mellitus, HR – hazard ratio.

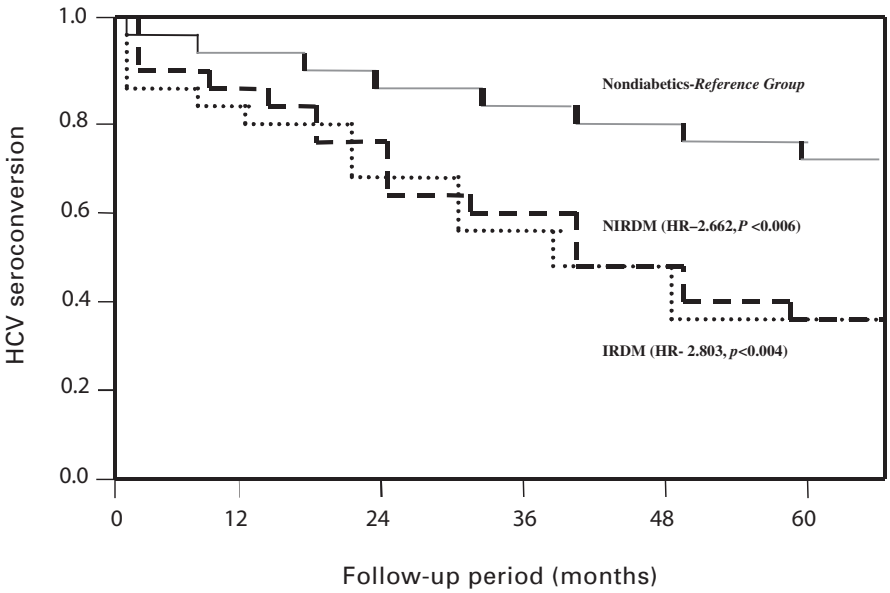


Table 5

Determinants of the HCV seroconversion by Multivariate analysis (1995–2000).

Determinants †	MLR ORs*	CI_{95}
Period on dialysis (months)	4.3	1.383–15.541
Invasive procedures	1.7	0.448–1.921
Type-2-diabetes status	9.8	2.663–32.924

† Intravenous drug abuse (IVDA), tattooing and promiscuous sexual behaviour, were not observed in ethnic population of Al-Hasa region of Eastern Province of Saudi Arabia.

* Multiple logistic regression (MLR) odds ratios (ORs) and 95% confidence intervals (CIs) adjusted for the variables having ORs >2 (ie, period on dialysis, invasive procedures type-2 diabetes status) at univariate analysis of anti-HCV positive patients among Type-2 diabetic and non-diabetic cohorts on haemodialysis, as shown in Table 3.

(Table 3) only two (period on dialysis and diabetes type-2 status) maintained their effect in the multiple logistic regression model after adjustment of the remaining potential confounders (Table 5).

Kaplan Meier survival curves were drawn showing relationship between the HCV seroconversion among the patients of two groups – with type-2 diabetes (including NIRDM and IRDM) and non-diabetics. The follow-up time period was expressed in months. Survival data with Cox regression model and estimated hazard ratios (HR) for these patients groups are shown in Fig. 3.

None of the haemodialysis personnel was tested positive for HCV/HBV at any stage of the study.

Discussion

The HCV seroprevalence of 41.3% observed in this study is comparable to the 43.2% reported from the Al-Hasa region of Saudi Arabia [13]. However, it is much lower than 72.3% reported from the Western Province and 68% in a multicentre epidemiological study carried out in Saudi Arabia [2, 14]. Such wide variations in the prevalence of HCV infection among HD units within the same country are well recognised [15].

Repeated blood transfusions are no longer considered a major risk factor for the transmission of HCV. Due to routine HCV screening through highly sensitive tests (ELISA anti-HCV) for blood donors, the risk of post transfusion HCV infection is currently less than 1/100,000 units [16]. As the number of units of blood transfused between the anti-HCV positive and anti-HCV negative groups in this study was comparable (9.6 ± 3.5 vs. 7.9 ± 5 units) and the prevalence of anti-HCV antibody among blood donors in this region is only 0.67% [17] – significantly lower than the 41.3% overall HCV prevalence in the HD unit, the transmission of HCV infection within the dialysis unit through means other than blood transfusion is highly probable.

Data based on the recent molecular biological studies support nosocomial transmission of HCV infection within the HD units [4, 5, 18]. It often occurs through blood contaminated gloves and hands of HD staff nurses, dialysis equipment, dialyser and blood line surfaces, and the use of reprocessed dialysers [2, 19, 20]. Presence of HCV-RNA in the "hand washings" of nurses dialysing HCV positive as well as negative patients has been demonstrated in a recent clinico-virological study from the Middle East [20]. Sharing HD machines and reprocessing of dialysers for reuse have also been reported to play a role in the transmission of HCV infection [19]. Although the passage of HCV through intact dialyser membrane seems unlikely as viral particles have a size much larger (35 nm in diameter) than the pore of even the most permeable membrane, the disruption of the membrane integrity while reprocessing the dialysers could possibly permit the passage of virus into the blood compartment [21, 22]. In addition, outbreaks of HCV transmission have been reported in HD units, due to failure to strictly enforce standard infection control measures such as failure to change gloves between the patients while performing HD treatments [23].

Sharing of multidose heparin and saline vials between the patients with and without HCV infection, being dialysed on the same shift – has been reported to play a role in the nosocomial transmission of HCV infection [24, 25].

Period on dialysis has been considered a potent predictor of HCV infection risk: the chances of acquiring HCV infection are much higher after a decade of HD, with a reported predictable risk of 10% per year [26]. A significant association between period on dialysis and anti-HCV positivity was recorded in the present study which is consistent with the findings reported earlier [26, 27]. Patients with a period on dialysis of 41.6 ± 10.95 months carried significantly higher risk (P <0.009) of acquiring HCV infection than those with a period on dialysis of 25.05 ± 10.1 months.

Although an overall seroconversion rate of 8.26% per year observed in this study is comparable to the seroconversion rates of 7–9%, reported from other HD centres in Saudi Arabia and elsewhere [2, 28]; the seroconversion rate of >5% per year and the prevalence rate of >20% in the present study, remains the primary concern [28].

Several studies have demonstrated increased

frequency of HCV infection among patients with type-2 diabetes, in comparison to either general population or blood donors [10, 29, 30]. However, none of these studies have demonstrated that type-2 diabetic patients while on HD have a greater risk of HCV infection. In fact, the striking relationship between the higher HCV seroprevalence and seroconversion rates with, paradoxically lower period on dialysis in the patients with type-2 diabetes is the finding of particular interest in the present study. As the prolonged period on dialysis facilitates the nosocomial transmission of HCV conceivably by increasing the time-span of exposure of patients to a high-risk HD environment; the acquisition of anti-HCV positivity after a relatively shorter period on dialysis could clearly be an expression of the increased vulnerability of the type-2 diabetic patients to HCV infection.

When the odds of HCV seroconversions developing over a 5-year follow-up period were estimated using Kaplan-Meier survival curves (fig. 3), patients with type-2 diabetes in the subgroups NIRDM and IRDM had a significantly higher probability of seroconversions than the non-diabetic group, with hazard ratios of 2.662 (P <0.006) and 2.803(P <0.004), respectively. However, no significant difference in the mean HCV seroprevalence and annual seroconversion rates between the patients with NIRDM and IRDM was observed in this study suggesting that the patients with IRDM were at no extra-risk of developing HCV infection when compared to those with NIRDM during long-term HD.

Patients with type-2 diabetes on long-term HD suffer from impaired immune defence mechanisms [31]. In addition their advancing age and under-nourishment particularly related to uraemia and HD treatment make them more susceptible to infections [32–36]. Uraemia and associated inflammation induced by dialysers can cause oxidative stress and activation, apoptosis and reduction in the number of T-cells leading to defects in cell mediated immunity [34–36]. Further defects in the antigen presenting cells (APCs) and antigen-specific activation of T-cells can lead to immune incompetence for viral infections among type-2 diabetic patients [10, 29, 30, 33].

Thus, the outcome of this study suggests that type-2 diabetics, comprising more than a quarter of the HD cohort, carry a much greater risk of HCV infection, conceivably through nosocomial transmission than the non-diabetic patients while receiving long-term HD treatment in high prevalence hospital-based units. The rigorous application of universal precautions as per recommendations of CDC and possibly the strict isolation of anti-HCV positive patients may be helpful in effective prevention of transmission of HCV infection among type-2 diabetic patients on HD [37, 38]. Nevertheless, multicentre molecular follow-up studies with larger sample size, are required to corroborate these observations and to formulate appropriate strategies for type-2 diabetic patients on HD, accordingly.

Correspondence:
Anil K. Saxena, MD
Division of Nephrology
Post-graduate Department of Medicine
King Fahad Hospital and Tertiary Care Center
King Faisal University
Hofuf, Al-Hasa-31982
Eastern Province, Saudi Arabia

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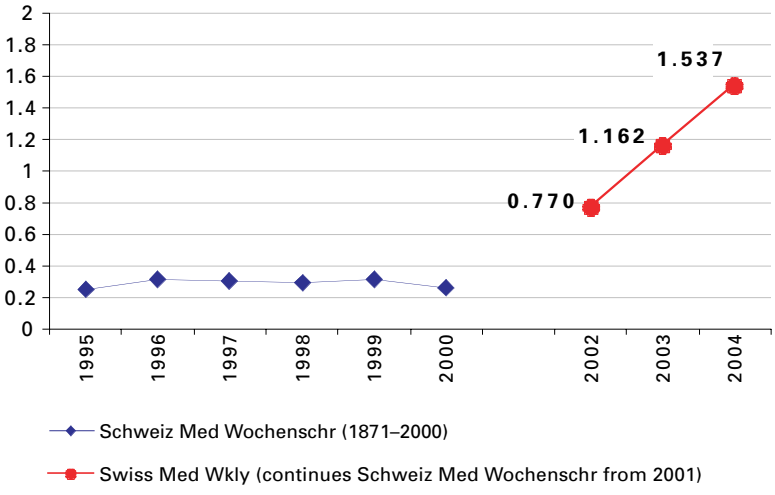

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