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DEATH RISK IN MAINTENANCE HEMODIALYSIS PATIENTS WITH POSITIVE HEPATITIS-C VIRUS

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Abstract:
Objective: *To find out the effect of HCV on the mortality rate of maintenance hemodialysis patients.* ***Material and Methods:*** *A national database of 1364 CRF patients who underwent HCV antibody serology testing at least once per month during an interval of (October 2015 through November 2018) was analyzed. Measurements included third-generation HCV enzyme immunoassay and routine laboratory measurements.* ***Results:*** *In proportional hazards regressions, the mortality hazard ratio that was associated with HCV infection was 1.25 (95% confidence interval 1.12 to 1.39; P < 0.001). Mortality hazards were higher among incident (dialysis duration <6 mo) than prevalent HD patients. Subgroup analysed indicated that HCV was associated with higher all-cause and cardiovascular mortality across almost all clinical, demographic, and laboratory groups of patients.* ***Conclusion:*** *Regardless of its wide range of prevalence variation among various countries the associations between HCV infection and increased death risk in dialysis patients seem consistent.*
Keywords: Hemodialysis, HCV, Mortality

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INTRODUCTION:

Background: In maintenance hemodialysis patients, hepatitis C virus (HCV) infection is common and may be associated with poor clinical outcomes. Hepatitis C virus (HCV) is a significant problem for patients undergoing hemodialysis therapy. This situation has never been studied in DHQ Hospital Vehari, Pakistan. his study was conducted aiming to estimate the mortality of CRF patients with the HCV in DHQ Hospital Vehari.

Hepatitis C virus (HCV) infection is the most common cause of chronic liver disease in the world. Certain populations, including maintenance hemodialysis (MHD) patients, have a significantly higher prevalence of HCV infection, ranging from 5 to 25% or even higher, according to the recent literature . This population may serve as an exceptional model to study the impact of HCV infection on outcomes, especially because the short-term death risk is extremely high in MHD patients in the Pakistan , at least 20% annually . Several investigations have suggested that HCV infection is associated with higher mortality in this population , but these studies have been limited in size and selectivity, the largest comprising only 367 HCV-infected patients . Given that HCV-associated liver disease typically takes decades to become clinically manifest, a period of time much longer than the lifespan of most dialysis patients with a 5-yr survival of 60 to 70% , the liver disease related complications seem the unlikely link to the high death risk. Approximately half of all deaths in MHD patients are attributed to cardiovascular disease . To date, associations between traditional cardiovascular risk factors and death have not been observed in MHD patients but a strong association between elements of the malnutrition inflammation complex (or cachexia) syndrome (MICS) and poor clinical out- come has been observed . Because HCV infection is associated with increases in inflammatory markers and alterations in nutritional status in both the general population and dialysis patients and is related to poor survival in MHD patients, examining associations between HCV infection and death risk after adjustment for markers of MICS may better reveal the mechanisms that lead to mortality that is associated with HCV infection. Moreover, a larger study population allows more detailed examination of diverse subgroups and potential interactions.

We studied a large national database of MHD patients in the to examine the hypothesis that HCV antibody positive MHD patients have a higher risk for all-cause and cardiovascular mortality. We also examined whether HCV infected MHD patients have distinct demographic, clinical, and laboratory characteristics that can be used to screen for HCV infection.

MATERIALS AND METHODS:

Data from all individuals who had ESRD and underwent MHD treatment from October 2015 to November 2018 in DHQ Vehari outpatient dialysis facility were extracted and examined. The study was approved by the institutional review committees, and the requirement for written consent form for individually identifiable data was waived on the basis of the Standards for Privacy of Individually Identifiable Health Information.

For minimization of measurement variability, all repeated measures for obtained for up to 12 calendar quarters (q1 through q12) for each laboratory and clinical measure for each patient during the 3 years cohort period. MHD status was defined as HD treatment during at least 45 consecutive days. Dialysis vintage was defined as the duration of time between the first day of dialysis treatment and the first day that the patient entered the cohort. For preexisting (prevalent) MHD patients (i.e., dialysis vintage ≥6 mo), data from the first calendar quarter were used. For new (incident) patients (i.e., dialysis vintage < 6 mo), the baseline values each patient during any given calendar (i.e., during a 13-wk interval) were averaged, and the summary estimate was used in all models. Hence, average values were originated from the calendar quarter in which the patient had undergone MHD for at least 45 d at the start of the given calendar quarter.

Thirteen-week averaged post dialysis weight and baseline height were used to calculate the body mass index. The dosage of administered recombinant human erythropoietin was also calculated for each calendar quarter. Causes of death, reflecting the reported information in the Cause of Death form were obtained. Cardiovascular death was defined as death as a result of myocardial infarction, cardiac arrest, heart failure, cerebro vascular accident, and other cardiac causes. Infectious death was defined as death attributed to an infectious disease as the primary cause of death.

In addition to the presence or absence of diabetes, which was avail- able in the database, histories of tobacco smoking and preexisting comorbid conditions were obtained by Medical Evidence Form and categorized into 10 comorbid conditions: (1) Ischemic heart disease, (2) congestive heart failure, (3) status post cardiac arrest, (4) status post myocardial infarction, (5) pericarditis, (6) cardiac dysrhythmia, (7) cerebrovascular events, (8)

peripheral vascular disease, (9) chronic obstructive pulmonary disease, and (10) cancer.

Blood samples were drawn using uniform techniques and were transported to the DHQ Vehari Laboratory, typically within 24 h. All laboratory values were measured by automated and standardized methods in the Laboratory. Most laboratory values, including complete blood cell counts and hemoglobin and serum levels of urea nitrogen, creatinine, albumin, calcium, phosphorus, bicarbonate, and total iron-binding capacity (TIBC), were measured monthly. Serum ferritin was measured quarterly. Hemoglobin was measured weekly to biweekly in most patients. Kt/V was used to estimate dialysis dosage, and normalized protein equivalent of total nitrogen appearance, also known as normalized protein catabolic rate, an estimation of daily protein intake, was measured monthly as a measure of protein intake. Most blood samples were collected before dialysis with the exception of the post dialysis serum urea nitrogen, which was obtained to calculate urea kinetics. The HCV antibody status was examined using the third generation of the HCV enzyme immunoassay.

Statistical Analyses:

In addition to standard descriptive statistics, multiple logistic regression models were fitted to estimate odds ratios of HCV infection controlling for potentially confounding covariates. We examined whether the 3-yr survival rates were associated with HCV infection, which was assumed to be present both retrospectively and prospectively when at least one HCV EIA test was positive. For each analysis, three models were examined on the basis of the level of multivariate adjustment:

1. An unadjusted model that included mortality data, HCV antibody result (positive versus negative), and entry calendar quarter (q1 through q12).
2. Case mix–adjusted models that included all in 1 plus age, gender, diabetes and 10 preexisting comorbid states, history of tobacco smoking, categories of dialysis vintage (<6 mo, 6 mo to 2 yr, 2 to 5 yr, and ≥ 5 yr), marital status (married, single, divorced, widowed, and other or unknown), the standardized mortality ratio of the dialysis clinic during entry quarter, dialysis dosage as indicated by Kt/V (single pool), presence or absence of a dialysis catheter, and residual renal function during the entry quarter (i.e., urinary urea clearance).
3. MICS-adjusted models, which included all of the covariates in the case-mix model as well as 13 surrogates of nutritional status and inflammation, including BMI, the average dosage of rHuEPO, and 11 laboratory variables as surrogates of the nutritional state or inflammation, together also known as MICS, with known association with clinical outcomes in MHD patients (1) Normalized protein equivalent of total nitrogen appearance as an indicator of daily protein intake, (2) serum albumin, (3) serum TIBC, (4) serum ferritin, (5) serum creatinine, (6) serum phosphorus, (7) serum calcium, (8) serum bicarbonate, (9) peripheral white blood cell count, (10) lymphocyte percentage, and (11) hemoglobin.

Missing covariate data (< 2% for most laboratory and demographic variables and <18% for the 10 comorbid conditions) were imputed by the mean or median of the existing values as appropriate.

RESULTS:

Because hepatitis serology tests are usually performed before a patient is accepted to an outpatient dialysis clinic for maintenance dialysis treatment, many patients with a previously documented HCV EIA result in outside facilities did not undergo repeat HCV EIA test in DHQ Hospital Vehari. In this study, we examined only HCV EIA tests that were performed in the DHQ Hospital Vehari Laboratory after a patient was admitted for MHD and only patients who remained under MHD treatment for at least 45 d. The original 3 years (October 2015 through November 2018) national database of all DHQ Hospital Vehari patients included 1364 individuals (source population) who had undergone MHD treatment for at least 45 d including 613 (45%) patients from the first calendar quarter and the rest from the subsequent 11 quarters. During each of the 12 calendar quarters, the presence of HCV antibody was examined in 4 to 9% of all MHD patients of the given calendar quarter using the EIA test in the DHQ Hospital Vehari Laboratory. Cumulatively, in 1364 MHD patients, or 16% of all DHQ Hospital Vehari MHD patients, including 572 (42%) from the first cohort quarter, at least one HCV EIA test was performed. Among these HCV-tested patients, 164 (12%) MHD patients had at least one positive HCV EIA test, including 48 patients with discordant results (i.e., at least one positive and one negative results). The remaining 1200 MHD patients had concordant HCV antibody negative results. Between 2015 and 2018, the annual prevalence of HCV EIA positivity among MHD patients whose HCV test was performed in DHQ Hospital Vehari Laboratory showed only small variations: 12.2% in 2016, 11.4% in 20116, 11.5% in 2017, and 11.1% in 2018.

Table 1 shows baseline demographic, clinical, and laboratory characteristics of the studied MHD patients during the baseline calendar quarter of the cohort. HCV-positive patients were on average 7 yr younger and more likely to be men than either the HCV-negative or the entire cohort population. Diabetes and cardiovascular diseases were less prevalent in HCV-infected patients, but death as a result of cardiovascular disease was only slightly less so. History of smoking and of HIV disease was at least twice as common in HCV-infected patients compared with other patients. Among laboratory parameters, serum albumin was slightly lower but TIBC and creatinine were higher in HCV-positive patients compared with HCV-negative patients. Serum levels of three routinely measured liver enzymes (aspartate aminotransferase [AST], lactate dehydrogenase, and alkaline phosphatase) were higher in HCV-infected patients, with AST almost twice as high in HCV-positive patients as in HCV-negative patients. Nevertheless the mean value in HCV-positive patients was 29 IU/L, which is still within the "normal" range of most commercial assays.With the use of logistic regressions, the association between demographic, clinical, and laboratory characteristics and HCV positivity was examined among all 1364 MHD patients whohad documented HCV EIA test results (Table 2). Younger age, single marital status, history of HIV disease, and tobacco smoking each were associated with at least two times higher odds of HCV positivity.

Table 1. Demographic, clinical, and laboratory characteristics 1364 MHD patients, including 164 patients HCV positive testing in the central laboratory and 1200 patients HCV negative who were tested for the presence of HCV antibody

Characteries	HCV Negative patients , n=1200	HCV Positive patients , n=164	P (Between the HCV Tested)
Age (year %)	61±16	54±13	<0.0001
> 65	44	21	<0.0001
Gender (% women)	47	35	<0.0001
Dialysis vintage <6 mo (%)	38	32	<0.0001
Cause of Death (%)			
Cardiovascular	55	50	<0.0001
Infactious	13	14	<0.0001
Preexisting comorbidities (%)			
Diabetes	48	38	<0.0001
HIV	1	4	<0.0001
Cancer	4	2	0.0006
Congestive heart failure	23	17	0.0005
IHD	17	8	<0.0001
Peripheral vascular disease	10	6	<0.0001
History of tobacco use	4	8	<0.0001
BMI (kg/m2)	26.4±6.4	25.6±5.6	<0.0001
nPCR or nPNA (g/kg/d)	1.00±0.25	0.98±0.25	<0.0001
Serum albumin (g/dl)	3.76±0.41	3.68±0.45	<0.0001
Creatinine (mg/dl)	8.8±3.3	9.9±3.6	<0.0001
Ferritin (ng/ml)	541±462	522±448	0.1
TIBC (mg/dl)	205±43	219±47	<0.0001
Bicarbonate (mEq/L)	21.8±2.9	21.8±2.9	<0.0001
Calcium (mg/dl)	9.3±0.7	9.1±0.8	<0.0001
Phosphorus mg/dl)	5.7±1.5	5.9±1.6	<0.0001
AST (IU/L)	18±15	29±26	<0.0001
LDH (IU/L)	189±56	196±68	<0.0001
Alkaline phosphatase (IU/L)	114±82	135±107	<0.0001
Blood hemoglobin (g/dl)	12.1±1.3	12.1±1.4	0.5
WBC count (per fl)	7.3±2.3	6.9±2.3	<0.0001
Lymphocyte (%of total WBC count)	21±8	23±8	<0.0001

Data are means ± SD for quantitative variables. P value compares hepatitis C virus (HCV) antibody–positive and –negative patients among those who had a documented HCV enzyme immunoassay (EIA) test. AST, aspartate aminotransferase; BMI, body mass index; LDH, lactate dehydrogenase; MHD, maintenance hemodialysis; nPCR, normalized protein catabolic rate; nPNA, normalized protein equivalent of total nitrogen appearance; TIBC, total iron-binding capacity; WBC, white blood cell.

Among laboratory measures, serum AST was the strongest predictor of HCV infection. Because the longer dialysis vintage could be associated with HCV infection, additional analysis of vintage were conducted. The relative prevalence for the logarithm of vintage (in dialysis months) was 1.36 (95% confidence interval 1.28 to 1.43; P 0.001). Upon further categorization of the dialysis vintage into seven groups (3 mo, 10 yr, and five groups in between) and using the 3- to 6-mo group as the reference, higher vintage groups 6 mo were incrementally associated with higher prev- alence of HCV infection across increasing vintage categories (Figure 1).

Table 2. Conditions associated with HCV antibody in 1364 MHD patients

Variable	Unadjusted		Case-Mix Adjusted		MICS Adjusted	
	OR (95%CI)	P	OR (95%CI)	P	OR (95%CI)	P
Age (10-yr increase)	0.77 (0.74 to 0.80)	<0.001	0.89 (0.85 to 0.93)	<0.001	0.87 (0.83 to 0.91)	<0.001
Age >65yr	0.32 (0.29 to 0.37)	<0.001	0.38 (0.31 to 0.46)	<0.001	0.39 (0.32 to 0.47)	<0.001
Marital status						
Married	1.00		1.00		1.00	
Divorced	1.76 (1.38 to 2.23)	<0.001	1.45 (1.13 to 1.87)	<0.001	1.37 (1.05 to 1.78)	0.02
Single	2.42 (2.10 to 2.80)	<0.001	1.71 (1.47 to 1.99)	<0.001	1.67 (1.42 to 1.96)	<0.001
Preexisting Comorbidities						
Diabetes	0.69 (0.62 to 0.77)	<0.001	0.81 (0.72 to 0.91)	<0.001	0.87 (0.77 to 0.99)	0.04
HIV	5.68 (3.87 to 8.32)	<0.001	3.60 (2.22 to 5.82)	<0.001	2.30 (1.37 to 3.85)	<0.001
IHD	0.52 (0.44 to 0.62)	<0.001	0.74 (0.6 to 0.90)	<0.001	0.73 (0.59 to 0.90)	<0.001
Tobacco smoking	2.58 (2.11 to 3.15)	<0.001	2.77 (2.23 to 3.45)	<0.001	2.35 (1.86 to 2.96)	<0.001
Hemodialysis dosage Kt/V (each 1-U increase	0.54 (0.46 to 0.65)	<0.001	0.74 (0.61 to 0.90)	<0.001	0.79 (0.64 to 0.99)	0.04
Liver enzymes						
AST (each 10-U/L increase)	1.49 (1.44 to 1.55)	<0.001	1.46 (1.41 to 1.53)	<0.001	1.35 (1.30 to 1.41)	<0.001
LDH(each 10-U/L increase)	1.03 (1.02 to 1.04)	<0.001	1.02 (1.01 to 1.03)	<0.001	1.01 (0.99 to 1.02)	0.1
Alkaline phosphatase (each 10-U/L increase)	1.02 (1.02 to 1.03)	<0.001	1.02 (1.01 to 1.03)	<0.001	1.01 (1.00 to 1.02)	<0.001

a' Odds ratios (OR) and 95% confidence intervals (CI) from multiple logistic regressions on HCV positivity among 13,664 tested patients. MICS, malnutrition-inflammation complex syndrome.

b' Compared with no comorbidity.

Among 1364 HCV-tested patients, 559 (41%) survived until the end of the cohort (November 30, 2018) 354 (26%) died; 25 (7%) underwent renal transplantation; and 354 (26%) were censored as a result of transfer to other facility, relocation, discontinuation of MHD, and other losses to follow-up.

Table 3 shows the unadjusted (crude) death rates among incident and prevalent HCV-positive and HCV- negative

patients during the first 100 d of the MHD cohort. The unadjusted
mortality ratio among incident patients was incrementally increased from 1.15 to 1.84 over time.

Table 3. Unadjusted death rates among HCV+ and HCV- patients during the first 1000 d of the MHD cohort

Variable	Cohort Day					
	1	200	400	600	800	1000
Incident patients (vintage ≤6 mo)						
all HCV+ patients	64	59	53	48	41	34
dead HCV+ patients (% death)	0	5(7.8)	6(10.16)	5(9.43)	7(14.58)	7(17.07)
all HCV- patients	400	371	341	317	291	266
dead HCV- patients (% death)	0	29(7.25)	30(8.08)	24(7.1)	26(8.2)	25(8.59)
Mortality ratio HCV+/HCV-	NA	0.17	0.20	0.20	0.27	0.28
Prevalent patients (vintage ≥ 6 mo)						
all HCV+ patients	164	154	145	134	124	113
dead HCV+ patients (% death)	0	10(6.0)	10(6.49)	11(7.58)	10(7.46)	11(8.87)
all HCV- patients	1200	1127	1059	982	908	827
dead HCV- patients (% death)	0	73((6.08)	68((6.03)	77(7.53)	74(7.53)	81(8.92)
Mortality ratio HCV+/HCV-	NA	0.13	0.14	0.14	0.13	0.13

A stronger association between HCV infection and mortality was observed in incident patients compared with prevalent patients. Figure 3 shows hazard ratios of all-cause and cardiovascular death in various subgroups of MHD patients. All cause and cardiovascular death hazards are similar, although confidence intervals are wider for cardiovascular hazards as a result of smaller death numbers.

DISCUSSION:

In 1364 MHD patients who underwent the HCV EIA test and whose outcomes were observed over 3 years, 12% showed a positive HCV antibody at least once. In logistic regressions that adjusted for demographic and clinical characteristics and available surrogates of malnutrition and inflammation, predictors of HCV included younger age, male gender, unmarried status, HIV positivity, and smoking history. The longer an MHD patient underwent HD since the start of dialysis treatment, the higher was the prevalence of HCV infection. HCV infection was associated with both all cause and cardiovascular mortality among MHD patients. This association was stronger in incident than in prevalent MHD patients, which may underscore the effect of survival bias in the prevalent MHD patient cohort, many members of which had died before the start of the study. The association between HCV infection and mortality seemed consistent among various subgroups of MHD patients and independent of cause of death. HCV infection is much more common among MHD patients compared with the general population . Even though the prevalence of positive HCV serology is said to be de- creasing to levels of the pre dialysis patient population, (8) this study indicates a prevalence of 12% among those whose HCV antibody status was screened in one laboratory via the EIA during the 2015 to 2018 period. Although a selection bias might exist in choosing MHD patients for the HCV screening, we believe that most patients who never had any HCV EIA tests are most likely those who had a negative HCV test result at baseline performed in a non–DHQ Hospital Vehari facility or before the intercept of the 3-yr cohort. Our foregoing assertion is supported by the finding that most demographic, clinical, and laboratory features, including liver enzymes, were very similar among the 1200 HCV antibody–negative.

The striking discrepancy in prevalence of HCV infection between MHD patients and the general population may not be necessarily related to the renal disease, because HCV infection seems more common in MHD patients compared with those who undergo peritoneal dialysis, a renal replacement therapy with less blood exposure. Other studies have indicated increasing prevalence of HCV infection with greater duration of MHD treatment and continuing incidence of new HCV infections in MHD patients, suggesting that infection control efforts in dialysis centers may be insufficient. Consistent with the latter findings, our study also showed that dialysis treatment vintage was associated with higher HCV infection prevalence (see Figure 1). Although this may be related to more cumulative risk of exposure to infectious sources over time, the possibility of a cohort effect should also be considered (i.e., patients whose dialysis treatment started in previous years had higher risk

for HCV infection as a result of less stringent HCV infection control measures in the past).

Because the mortality rate is 21% per year . Hence, our estimates of HCV-associated mortality may be conservative (i.e. the true association between HCV infection and short-term risk for death in MHD patients may indeed be higher than that observed in prevalent cohorts). However, a cohort effect may also have led to these contrasts. Future studies are needed to examine these hypotheses.In our investigation, as in others, the EIA was assumed as the reference standard of the HCV infection, and HCV-positive status was assumed to hold both prospectively and retrospectively when at least one EIA test was positive. These assumptions may not be correct if seroconversion occurred during the cohort time. Indeed, in 48 (3%) patients of our cohort, discrep- ant results were noticed, indicating lack of certainty about HCV infection status. Furthermore, EIA testing may underestimate HCV prevalence in dialysis patients, some of whom may not develop anti HCV antibody at least in early stages of HCV infection as a result of relative state of immune deficiency. Molecular-based assays that detect HCV RNA, such as PCR and transcription-mediated amplification, are somewhat more sensitive diagnostic tests and may pick up additional HCV- infected patients . Hence, it is likely that the true prevalence of the HCV infection in our population is higher than that detected by the EIA test; misclassification of a small proportion of EIA-negative but HCV-infected patients may have intro- duced some bias in our estimates, most likely toward the null. Our study indicated that HCV infection is more common among younger MHD patients.

A key finding in our study was the higher short-term all- cause and cardiovascular mortality rate among virtually all subgroups of HCV-infected MHD patients. At least four other dialysis cohorts have exhibited an association of HCV with mortality (7–10), but all were of relatively limited size, and their findings may have not been applicable to the larger population of patients. Our original hypothesis that this association could be due to MICS in HCV-positive patients was only partially confirmed, because serum albumin, a surrogate of visceral protein, was lower, but TIBC and creatinine, other nutritional surrogates, were paradoxically higher in HCV-infected patients compared with HCV-negative individuals. However, direct markers of inflammation and MICS, such as proinflammatory cytokines, were not available in our cohort. After adjustment for 13 available surrogates of MICS, the association between HCV infection and mortality was reduced in some subpopulations, which may indicate that MICS is either a confounder or may be at least partially in the causal pathway. Hence, at least among some MHD patients, HCV may be associated with poor survival and higher short-term cardiovascular death through yet to be determined factors such as MICS.

Our study confirms some of the results that we recently reported from analyzing a limited number of patients of the same cohort. The latter study, however, included only 367

HCV-infected patients, was limited to the baseline calendar quarter and only 2 yr of follow-up, did not include time- dependent repeated measures, lacked information on history of comorbidity and smoking, and did not include subgroup analyses because of small sample size. A limitation of this study is potential misclassification of the cause of death as cardiovascular. Hence, all-cause death may be a more reliable outcome than cause-specific mortality. Another limitation of our analysis is that it is based on a 3-yr period of the cohort, rather than longitudinal follow-ups over many years. Nonetheless, our results indicate that even short-term all-cause and cause-specific mortality is high in HCV-infected MHD patients. More elaborate and sensitive HCV detection tests such as molecular tests were not used in our study, because such methods are substantially more costly and usually not used as screening tests. However, all laboratory measurements are performed in one single facility, and most data are means of several measures. Hence, measurement variability is minimized.

Perspective

Despite reported reductions in the prevalence of HCV infection in dialysis populations in such countries as Spain (8), Italy (12), and Greece (33), which have HCV prevalence much higher than those in the PAKISTAN, the HCV infection rate among DHQ Hospital Vehari dialysis patients does not seem to have changed considerably. Regardless of its wide range of prevalence variation among various countries, the associations between HCV infection and increased death risk in dialysis patients seem consistent (7–12). Because dialysis patients have an exceptionally high short-term mortality, it is less likely that the HCV-associated death risk is due to such long-term HCV complications as liver disease. Inflammation associated with chronic infections (17–19) may contribute to the increased death risk in these

individuals. The currently conservative approach to HCV-infected dialysis patients (not treating them unless they have active liver pathology) may need to be revisited in light of findings that link HCV infection to short-term death. More diligent efforts to prevent infection in dialysis clinics may be warranted. Our results may have implications not only in the management of HCV infection in dialysis patients but in many other individuals without renal failure. More studies are needed to verify the true prevalence of HCV infection in the 21st century among dialysis patients in various countries using newer molecular testing to understand better the natural course of HCV infection and its link to short-term mortality and to evaluate the effectiveness of current and future anti-HCV treatment modalities in improving clinical outcome in dialysis patient.

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