http://www.senefro.org

© 2008 Órgano Oficial de la Sociedad Española de Nefrología

The seroprevalence of HCV in Patients Submitted to Hemodialysis and Health Professionals in the State of Minas Gerais, Southwest of Brazil

J. M. M. Oliveira Penido*, W. T. Caiaffa**, M. Guimarães Penido***, E. V. C. Caetano****, A. R. Carvalho****, A. F. Leite****, S. C. Faria****, I. V. Gomide****, A. A. B. Rosa****, M. G. M. G. Penido***** and R. Teixeira******

Department of Clinical Medicine of the Medicine Faculty of the Federal University of Minas Gerais. Brazil. Nephrology Unit of Belo Horizonte. **Department of Preventive and Social Medicine of the Medicine Faculty of the Federal University of MInas Gerais. Brazil. ***Nephrology Department of Santa Casa de Belo Horizonte. Minas Gerais. Brazil. ****Medicine Faculty of the Federal University of Minas Gerais. Brazil. *****Department of Pediatrics of the Medicine Faculty of the Federal University of Minas Gerais. Brazil. Nephrology Department of Santa Casa de Belo Horizonte. Minas Gerais. Brazil.****Department of Clinical Medicine of the Medicine Faculty of the Federal University of Minas Gerais. Brazil.*

Nefrología 2008; 28 **(2)** 178-185

SUMMARY

Patients with chronic renal failure (CRF) in hemodialysis (HD) programs comprise a risk group for acquisition of hepatitis C virus (HCV) infection. The objectives were to evaluate the seroprevalence of HCV in patients submitted to HD in State of Minas Gerais (MG), southest of Brazil; to correlate this seroprevalence with the time of treatment on HD; to investigate the anti-HCV seropositivity in health professionals, to investigate the existence of a correlation between mean HCV seroprevalence and the human development index (HDI). Patients from 66 healthcare units (HU) were studied using a validated questionnaire and considering the positive values of anti-HCV (Elisa III) tests performed in these units between january and december 2003. Results: *The majority of patients were male (56.2%), between 41 and 60 years old. The mean seroprevalence of HCV in the 66 healthcare units was 13 ± 9.5%; the three-monthly seroprevalence was below 20%, 15% and 10% in 75%, 50% and 40% of healthcare units, respectively. When the HU were grouped according to HCV seroprevalence into low (< 5%), medium (5-15%) and high seroprevalence (> 15%), 20% of the units have low, 42% medium and 37.5% were found to have high seroprevalence. No correlation was found between HDI and HCV seroprevalence (r = 0.42; p = 0.174) but in the regions in which the HDI was higher, HCV seroprevalence was also higher. There was a positive correlation between HCV seroprevalence and time on HD in 884 patients in the 4 HU (p < 0.001). The seroprevalence of HCV was investigated in 387 healthcare professionals (29%) working in 14 HU. They were divided into two groups according to their time of professional activity: < 10 y (G1) and >10 y (G2). In G1, there were no cases of anti-HCV seropositivity. In G2, 3 members of the staff were anti-HCV seropositive. The mean time of work of the seropositive staff in the HU was 15.6 years. The seroprevalence of HCV was 0.8% when all the healthcare professionals were taken into consideration. There was no statistically significant difference with respect to HCV seroprevalence between G1 and G2 with respect to the time of occupational exposure (p = 0.27).* Conclusion: *The seroprevalence of HCV in patients on HD in MG is 13 ± 9.5% and was < 10% in 40% of the HU; there was no statistically significant correlation between HDI and seroprevalence of HCV in the healthcare units evaluated; there was a statistically significant correlation between HCV seroprevalence and time of treatment on HD; HCV seroprevalence in the health professionals studied was 0.8% and similar to the literature.*

Key words: *Hepatitis C. Prevalence hepatitis C virus. Hemodialysis. Chronic renal failure.*

Correspondence: *Maria Goretti Penido*
Hospital das Clinicas da Faculdade de Medicina da UFMG
Rua Padre Rolim, 123/702
30130090 Belo Horizonte, MG
mariagorettipenido@yahoo.com.br

RESUMEN

Los pacientes con enfermedad renal crónica (ERC) en hemodiálisis (HD) constituyen un grupo expuesto al riesgo de adquirir una infección por el virus de la hepatitis C (HCV). Los objetivos de este estudio fueron la evaluación de la seroprevalencia de HCV en pacientes en HD en el Estado de Minas Gerais (MG), en el sudeste de Brasil, y la correlación de esa seroprevalencia con el tiempo de tratamiento en HD y con el Índice de Desarrollo Humano (IDH) regional, bien como la seroprevalencia del HCV en profesionales de la salud (PS) de HD. Se evaluaron pacientes de 66 Centros de Hemodiálisis (CH) a través de un cuestionario validado en el que se consideraron los valores positivos para anti-HCV (Elisa III) en el año de 2003. La mayoría eran hombres (56,2%) entre 41-60 años. La seroprevalencia media de HCV fue de 13 ± 9,5%. La seroprevalencia trimestral fue inferior a 20%, 15% y 10% en 75%, 50% y 40% de los CH, respectivamente. No hubo correlación entre el IDH y la seroprevalencia de HCV. Hubo correlación positiva entre seroprevalencia de HCV y tiempo en HD en 884 pacientes de cuatro CH (p < 0,001). La seroprevalencia de HCV fue in-

vestigada en 387 PS divididos en dos grupos de acuerdo con el tiempo de actividad; < 10 años (G1), > 10 años (G2). La seroprevalencia de HCV en los PS fue de 0,8%. No hubo diferencia de seroprevalencia de HCV entre G1 y G2 con respecto al tiempo de exposición ocupacional. Se concluyó que la seroprevalencia de HCV en pacientes en HD en MG fue del 13 ± 9,5% y < 10% en el 40% de los CH evaluados, no habiendo una correlación entre el IDH y la seroprevalencia del HCV. En cambio, hubo correlación positiva entre seroprevalencia del HCV y tiempo en HD, siendo que la seroprevalencia HCV en los PS fue del 0,8%.

Palabras clave: Hepatitis C. Seroprevalencia de la hepatitis C. Hemodiálisis. Enfermedad renal crónica.

INTRODUCTION AND OBJECTIVES

The World is facing a true epidemic of hepatitis C virus, which represents a big public health challenge in this millennium. Until 1998, 170 million people carried the HCV worldwide,[1,2] and in recent years 200 million or 3% of the world population is infected with this virus.[3,4] An estimation of the economic burden of chronic hepatitis C reveals an economic loss of about $600 million. It is calculated that between 2010 and 2019, this disease will originate a loss of about 1.83 millions of useful life, with an estimated economic loss of $54.2 billions.[5]

HCV infection is the main cause for chronic liver disease in HD patients. Patients with stage V chronic renal disease (CRD) on HD represent a risk group susceptible of acquiring this infection. The epidemiologic studies have shown that the incidence and seroprevalence of HCV infection in HD patients are declining in recent years.[6-8] However, and despite the public health policies adopted in developed and developing countries, the frequency of HCV seroprevalence in patients with stage V CRD on HD still is higher than in the general population.[7,9-12] In these patients, the main risk factors for acquiring the virus are frequent exposure to blood derivatives,[13] contaminated medical equipments, the number of years on dialysis therapy,[13,14] and the lack of adherence to the universal infection prevention and control measures.[10,15]

HCV seroprevalence in health care workers is three fold higher than that in workers in other industries. Thus, health care workers in dialysis centers are a special risk group for acquiring the virus.[16,17]

The Brazilian population-based studies on HCV seroprevalence still are scant. An HCV seroprevalence of 1.42% was shown in 1059 healthy individuals[18] and of 1.7% in 119 healthy individuals from an indigenous population.[19] In MG, there are no consistent data so far on HCV seroprevalence in the general population.

The goals of this study were: to evaluate the frequency of HCV seroprevalence in patients with stage V CRD on HD program in the hemodialysis centers of the State of MG in Southeast Brazil; to correlate this seroprevalence with the time on HD therapy; to investigate the HCV seroprevalence in health care workers of these hemodialysis centers; and to verify whether there exists a correlation between the average HCV seroprevalence of dialysis centers and HDI from the different regions of the State of MG.

PARTICIPANTS AND METHODS

Study design: This is a multicenter cross-sectional epidemiological study carried out in the period January to December of 2003 among the hemodialysis centers of the State of MG in the Southeast region of Brazil, where the health care status in relation to HCV infection was investigated among individuals with stage V CRD on HD program and among health care workers.

Subjects. Inclusion criteria: hemodialysis centers giving their consent to participate in the study on HCV seroprevalence with serological control by means of the anti-HCV ELISA III assay in HD patients and health care workers, by filling-up a validated questionnaire. After their consent, 66 (92%) hemodialysis centers out of a total of 72 were included into the study. Of the six centers excluded, one did not answer the questionnaire and five had not available the full monthly data on anti- HCV serology of the HD patients. Also included into the study were those hemodialysis centers starting their services in the year 2003 provided that they had solid data corresponding to the subsequent months during the study period. In these cases, the information taken into account was that from the time they started their services.

Methods: We applied a previously designed, tested, and validated questionnaire exclusively of the purpose of this study. The Health Secretary's Office of the State of MG (HSOSMG) offered its database for an eventual consultation. The HDI values were obtained from the Human Development Atlas.[20] The monthly HCV seroprevalence of the municipalities and geographical regions of the State of MG was calculated by dividing the number of patients with positive anti-HCV serology by the total number of patients submitted to HD per month at the hemodialysis centers. In order to calculate the frequency of HCV seroprevalence among health care workers we used the same methodology.

Measurements: The primary outcome variable was the serology of anti-HCV ELISA III antibodies performed monthly in CRD patients on HD at the hemodialysis centers included. The secondary outcomes variables were the demographical data of the patients: age, gender, etiology of renal disease, time on HD, serology of anti-HCV ELISA III antibodies among health care workers, frequency of HCV seroprevalence in the hemodialysis centers of the municipalities of one region and mean regional HDI.

Statistical analysis: The information gathered in the questionnaires was digitalized in a database developed with Microsoft Access version 2000 software. We established the mean annual HCV seroprevalence as the response variable. The descriptive data were obtained from the frequency of the characteristics of the different variables. In order to compare the mean regional HDI and the monthly average of the frequency of regional HCV seroprevalence, and continuous variables we used the Pearson's correlation coefficient (r). This coefficient provides the level of the strength of the linear relationship between two continuous variables, and varies from–1 to +1, including the naught value. The r^2 value is the proportion of the mean standard variation and that explained by x (or vice versa). The level of statistical significance was established at 0.05 with a statistical power of 80%.[21]

Ethical issues: The investigation project was approved by the Ethical and Investigation Committee of the Federal Uni-

Table I. HD patients distributed by age and gender, at december of 2003

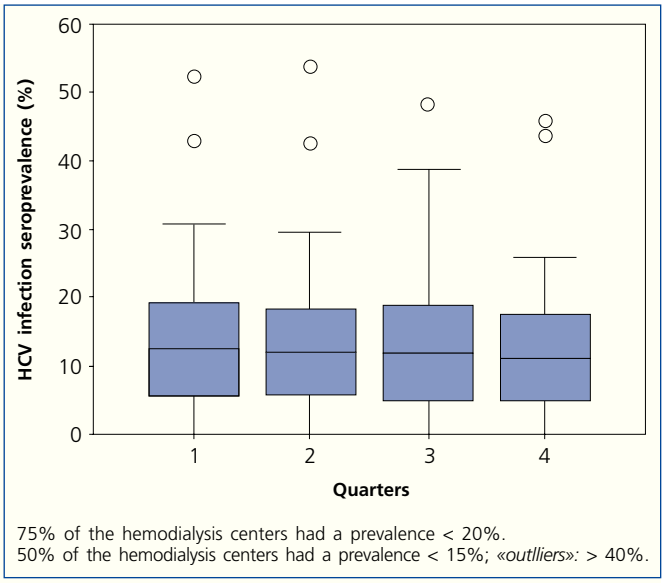
Age (years)	Males-n (%)	Females-n (%)
0-20	150 (3.5)	115 (3.5)
21-30	363 (8.5)	284 (8.5)
31-40	630 (14.5)	524 (15.5)
41-50	1,027 (24.0)	792 (24.0)
51-60	977 (23.0)	677 (20.0)
61-70	713 (16.5)	546 (16.5)
> 70	430 (10.0)	408 (12.0)
Total	4,290	3,346

versity of Minas Gerais (UFMG), complying with the 196/96 Resolution of the National Health Council, which establishes the rules for investigations on human beings.[22] Besides, we sent explanatory letters on the investigation project to the HSOSMG, the Brazilian Society of Nephrology (SBN), the National Association of Kidney Donors and Transplanted Patients (Associação Nacional dos Doadores e Transplantados Renais (DORETRANS), and to the hemodialysis centers of the State of MG.

RESULTS

Descriptive study: By December of 2003, 7636 patients with stage V CRD were on a HD program in the 66 hemodialysis centers of the State of MG, Southeast Brazil. Of them, 4,290 (56.2%) were males and 3346 (43.8%) were females. About their age, 265 (3.5%) patients had 0-20 years, 647 (8.5%) 21-30 years, 1,154 (15.0%) 31-40 years, 1,819 (23.8%) 41-50 years, 1,654 (21.7%) 51-60 years, 1259 (16.5%) 61-70 years, and 838 (11.0%) more than 70 years. There was a preponderance of the male gender in all age groups (table I).

The most common etiologies of CRD were arterial hypertension (30%), chronic glomerulonephritis (24%), and diabetic nephropathy (20%). The sample loss was 10%. The mean number of patients in the six centers excluded (83 ± 29) was similar to the mean number of patients in the centers included (101 ± 59). There were no statistically significant differences (p = 0.46). The number of hemodialysis centers by each region of the State of MG and the quarterly seroprevalence results of HCV infection are shown in table II.



75% of the hemodialysis centers had a prevalence < 20%.
50% of the hemodialysis centers had a prevalence < 15%; «*outlliers*»: > 40%.

Figure 1. Quarterly HCV infection seroprevalence (%) in the hemodialysis centers of MG.

The mean quarterly seroprevalence of HCV infection in the State of MG was 13 ± 9%. The lowest HCV seroprevalence was found in the region of Vale do Jequitinhonha and the highest in the southeastern region of the State. The quarterly seroprevalence of HCV infection in the 66 hemodialysis centers of MG was lower than 20%, 15%, and 10% in 75%, 50%, and 40% of the hemodialysis centers, respectively, as shown in figure 1.

The 66 hemodialysis centers were pooled in five frequency intervals of HCV infection seroprevalence, considering the average HCV infection seroprevalence (≤ 10%, 11%-20%, 21%-30%, 31%-40%, and 41%-50%). Only two hemodialysis centers were included within the interval 41%-50%, being one in the Southeast region and the other one in the region of Triângulo do Norte. No hemodialysis centers were included in the interval 31%-40%, and 80% of the hemodialysis centers were included in the ≤ 20% interval. We also pooled the 66 hemodialysis centers by frequency of HCV infection seroprevalence in three categories: low HCV seroprevalence (<

Table II. Quarterly seroprevalence of HCV infection in the different regions of the State of MG (%)

Regions	Nº hemodialysis centers	Quarter 1	2	3	4
Center	21	12.05	11.71	11.88	11.36
Center-South	4	14.91	14.21	13.00	12.56
Vale do Jequitinhonha	1	0.00	0.00	0.00	2.40
North Leste	2	15.10	14.94	13.72	12.54
South Leste	2	17.34	17.40	16.98	17.24
Northwest	2	13.06	11.75	12.88	11.74
Northeast	2	12.53	13.07	11.60	9.68
North Minas	4	1.99	2.30	2.53	2.53
West	8	10.88	11.03	11.05	11.03
Southwest	3	21.15	21.11	19.91	19.45
South	9	10.90	11.00	10.42	9.65
North Triângulo	5	18.21	18.22	17.53	17.25
South Triângulo	3	17.52	16.63	15.52	14.85
Total in MG	66	13.14	12.96	12.64	12.10

Table III. Number of seropositive patients in four hemodialysis centers and time on HD

Hemodialysis centers	Patients > 10 years		Patients < 10 years		p	Total patients
	Seropositive	Total	Seropositive	Total		
8	4	11	2	73	0.002	84
15	18	32	20	217	< 0.001	249
17	2	12	2	142	0.03	154
18	24	47	19	350	< 0.001	397
Total	48	102	43	782		884
%	47			5.5		100

5%), intermediate HCV seroprevalence (5%-15%), and high HCV seroprevalence (> 15%). We observed that 20% of them were included in the low category, 42% in the intermediate, and 37.5% in the high HCV seroprevalence category, as proposed by Lombardi and coworkers in 1999.[23]

The time on dialysis therapy (in years) was significantly correlated with the HCV infection seroprevalence ($p < 0.001$), as shown by the evaluation of a population of 884 patients in four hemodialysis centers (table III).

We did not find a statistically significant correlation ($r = 0.42$; $p = 0.174$) between the average regional HDI and the mean monthly HCV infection seroprevalence in the municipalities of the same geographical region. However, in the regions were the HDI was the highest, we observed a trend towards a higher HCV infection seroprevalence (fig. 2).

HCV infection seroprevalence was investigated among 387 (29%) health care professionals working at 14 hemodialysis centers (19%) of the State of MG. The mean number of health care workers was 27 (7%) per hemodialysis center. The health care workers were distributed by the time working with HD: higher or lower than 10 years in groups G1 and G2, respectively. G1 comprised 159 health care workers (41%) and G2 228 health care workers (59%). In G1, the anti-HCV serology was negative in all, and in G2 three health care workers had anti-HCV seropositivity. The mean working time at hemodialysis centers for the seropositive health care workers was 15.6 years. Of the seropositive health care workers, one of them had an accident with contaminated material. The HCV seroprevalence in all health care workers was 0.8%, reaching 1.3% when we computed only those health care workers in G2. There were no statistically significant differences when analyzing the HCV infection seroprevalence between G1 and G2, taking into account the time of occupational exposure ($p = 0.27$). Among the health care workers of G2, the anti-HCV seropositivity was not correlated with transfusions with blood derivatives, tattoos, parenteral drug abuse (PDA), or *piercing* (table IV).

DISCUSSION

Chronic hepatitis C produces a big impact on morbidity and mortality of patients with CRD on HD.[24,25] HD patients are particularly susceptible to HCV infection, which may be attributed to nosocomial transmission and immune impairments characteristic of this specific group.[26,27] The prevalence studies are particularly useful to guide the decision-making process on diagnostic screening and to help during strategic planning of the preventive and therapeutic actions. For these reasons, the knowledge on the reality of HCV infection seroprevalence in hemodialysis centers in the State of MG was the main goal of this study and it will surely contribute to strict adoption of preventi-

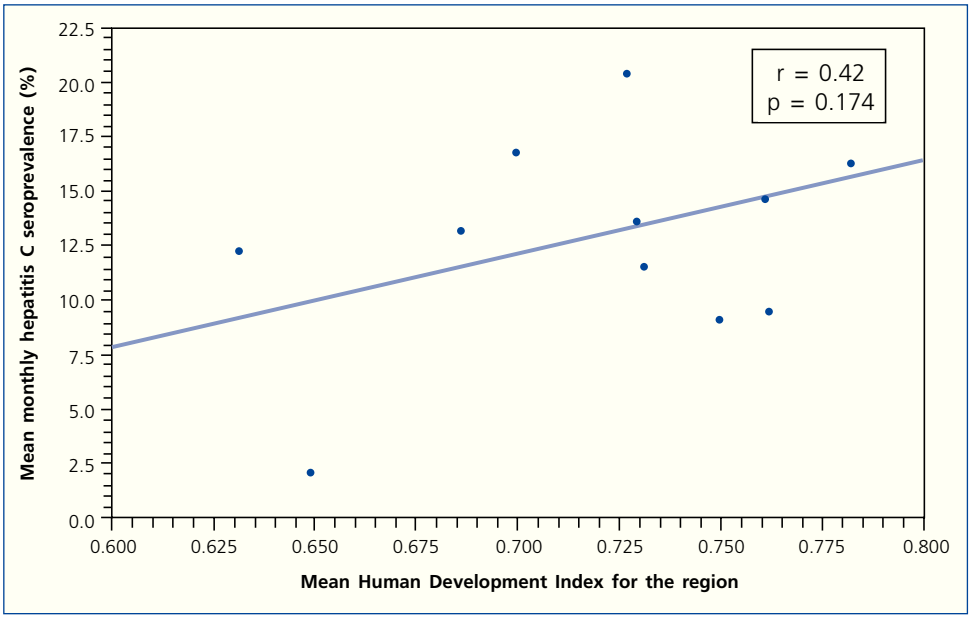


Figure 2. Dispersion between the HDI and mean HCV infection seroprevalence media in the different regions of MG.

Table IV. Anti HCV seropositivity among health care professionals at hemodialysis centers of the State of MG

Numerical identification of the hemodialysis center	HCV seroprevalence at the hemodialysis centers (%)	NOHCW	NOHCW HCV (+)	THCW HCV (+) years	NOHCW > 10 years G2	NOHCW < 10 years G1
18	10.2	65	1	22	50	15
10	22.3	61	0		47	14
17	3.1	31	0		10	21
13	12.2	35	1	13	29	6
15	16.5	35	0		30	5
12	5.0	16	1	12	7	9
08	12.0	26	0		14	12
63	11.0	10	0		6	4
62	12.2	18	0		14	4
37	25.8	20	0		13	7
34	18.0	17	0		5	12
35	50.0	13	0		3	10
32	23.8	22	0		0	22
57	3.3	18	0		0	18
		387	3	Media: 15.6	228	159

NOHCW: total number health care workers at each hemodialysis center; NOHCW HCV (+): number of Anti-HCV positive health care workers; THCW HCV (+): working time (years) for two seropositive health care workers; NOHCW > 10 years: number of health care workers with working time longer than 10 years; NOHCW < 10 years: number of health care workers with working time shorter than 10 years.

ve and infection control measures, as well as the reduction of the high seroprevalence of this disease.

In order to carry out epidemiologic studies a representative sample is required. In the State of MG there are 72 hemodialysis centers distributed in their 13 geographical regions, and all of them were called to participate. However, hemodialysis patients from 66 hemodialysis centers comprised the population-based sample. The exclusion of six centers did not compromise the results, considering that most of them were included in the investigation, which made possible to obtain a representative sample of the population of chronic renal patients on HD in the State of MG. The data on hepatitis C seroprevalence were obtained from 7636 patients. The high number of patients together with having including into the study hemodialysis centers from the whole State, shows that the results found are representative of HCV infection seroprevalence in the hemodialysis centers of MG, and from an epidemiological viewpoint they reflect the current situation of hepatitis C seroprevalence among HD patients of the State of MG, southeast region of Brazil.

The average hepatitis C seroprevalence found was 13%. The monthly and quarterly assessment of anti-HCV serology in the hemodialysis centers of MG for the year 2003 showed that there was no increase in the frequency of HCV seroprevalence. These data are in agreement with the national scientific literature, as has been reported by Romão Junior and coworkers in 2004 for the entire country.[28] Similarly, these data are similar to those described in other countries, such as those by Geerlings and coworkers[29] and Jadoul and coworkers.[8] According to these authors, the adoption of serologic assays in the cases of hepatitis C in blood manipulating centers and hemodialysis centers, together with prevention and infection control measures at these centers led to a decrease in HCV infection seroprevalence among HD patients.[8,29]

A predominance of the male gender was observed in all age groups, most of them aged 40-60 years, the results being similar to previous descriptions.[28,30-32] It is known that age and gender do not correlate with a greater risk for HCV transmission;[10,11,25,33] However, in HD patients this may be different considering that there is a preponderance of the male gender among end-stage CRD patients.[28,30-32]

The main etiologies for CRD found were arterial hypertension (30%), followed by chronic glomerulonephritis (24%) and diabetes mellitus-associated nephropathy (20%). These data are similar to previous descriptions for MG,[30,34] Brazil,[28,32] the United States,[31] and other countries.[35] However, this datum should be cautiously analyzed since the etiology of end-stage renal disease is unknown in a big proportion of CRD patients, as has been observed in 10% of the population starting on HD in MG in the year 1995.[30]

Regional studies in Brazil[32] and in other Latin-American countries[36] have placed and pointed out chronic glomerulonephritis as one of the main etiologies for CRD. Among glomerulopathies, it is known that focal and segmentary glomerulosclerosis (FSGS) and membranous-proliferative glomerulonephritis (MPGN) are among the ones most frequently leading to CRD.[32] MPGN has the peculiarity of being associated to infections with Schistosoma mansonii, streptococci, and hepatitis B and C viruses.[15,32] These characteristics contribute to the fact that MPGN is a common histological type in our setting, by contrast to what has been observed in other countries.[32] Despite the fact that arterial hypertension and diabetes mellitus represent the leading causes of end-stage CRD,[31,35] we should take into account that the outbreaks of prevalent infectious diseases occurring in Brazil account for a big proportion of the cases progressing to end-stage CRD.[37,38] Anyhow, in recent years the etiologic profile of CRD has changed both in Brazil and in other Latin-American countries.[36,38] The absence of histological confirmation, the characteristic silent progression of the glomerular damage after the initial insult, and the lack of an appropriate planning for the follow-up of patients at the pre-dialysis period are the main barriers precluding the

knowledge on the true etiology of advanced chronic renal disease worldwide.[38]

The number of patients maintained on HD in Brazil represents the fourth biggest casuistic worldwide, only surpassed by those from the United Stated, Japan, and Germany.[28] Most of this population in Brazil concentrates in the southeastern region, where the State of MG is located. The mean HCV infection seroprevalence for the 66 hemodialysis centers studied was 13% ± 9.5%, with a variation of 0%-50%. In just one hemodialysis center the HCV seroprevalence was 0%. This isolated and atypical event was attributed to the fact that this was a new center not contemplating the admission of anti-HCV positive patients («old cases»), seropositive patients in transit, patients during the «immunological window» due to the anti-HCV serological assay, or contaminated patients not detected during the study. A higher HCV seroprevalence also occurred in only one hemodialysis center and, according to some reports, several patients admitted for therapy came from other hemodialysis centers in the State of MG and other states due to budget-limiting issues of the Unique Health Care System (UHCS).

Another hemodialysis center started its activity in February of 2003 so that, for the purpose of this study, the monthly HCV seroprevalence from February to December of 2003 was considered. It is interesting to observe that this is a newly created hemodialysis center with an initial seroprevalence of 2.2%, and with an annual mean of 2.6%. This fact may be attributed to admission of seropositive patients coming from other hemodialysis centers from the same region with a mean seroprevalence of 18.5%.

By pooling the 66 hemodialysis centers into five frequency intervals of HCV seroprevalence it was observed that 80% of them were included in the seroprevalence frequency interval of ≤ 20%, and only two were in the 41%-50% interval. In 1999, Lombardi and coworkers, in Italy, used a similar way of pooling their data, and they found rates and variations very similar to those found in our study.[23]

Time on HD therapy is an important individual and independent risk factor for acquiring HCV infection, the estimation being 10% per year.[10,39] The multiple contamination opportunities to which the population of HD uremic patients are exposed are the main reason to explain this high sero-conversion index. There is, however, a significant change in the risk factors for acquiring HCV infection currently. Until 1992, the highest risk factor for catching the virus infection in hemodialysis centers was blood transfusion together with the unavailability of erythropoietin for managing CRD-associated anemia. Recently, this picture began changing, and nowadays the main HCV infection route in hemodialysis centers is nosocomial transmission.[10] About the HCV transmission according to time of exposure to HD, we could infer a higher HCV seroprevalence among the oldest hemodialysis centers due to the higher risk for contamination. In fact, this study identified a number of HCV seropositive HD patients attending for more than a decade hemodialysis centers that have been working for more than 20 years. It is likely that these patients may have got infected as a result of blood transfusions, which were commonly performed at that time. From an epidemiological perspective, these are the so-called «old cases», which may have an impact when calculating the seroprevalence rates in this kind of studies. On the other hand, a lower HCV infection seroprevalence is expected in those hemodialysis centers that have been working between five and ten years. However, admission of old seropositive patients transferred from other hemodialysis centers to the newest ones may have contributed, at least in part, to alter the HCV seroprevalence rate in these newest centers. It is important to highlight that an investigation on the incidence of HCV infection in hemodialysis centers was not among the objectives of our study.

Most of the hemodialysis centers had an HCV seroprevalence < 20%, and when the centers were categorized into low, intermediate-, and high-seroprevalence groups, there was a predominance of the intermediate-seroprevalence group (5-15%).

We also observed stability in HCV seroprevalence rates during the study period, and there were no new hepatitis C cases recorded. Similar results have been reported in Brazil [28,40] and other countries.[7,16,41-43]

In Italy, a positive correlation was reported between high seroprevalence and high incidence of HCV infection.[23] The authors found an HCV incidence rate of 0.40% in those hemodialysis centers with a seroprevalence up to 20% and an incidence rate of 0.94%-1.77% in those centers with a seroprevalence of 40%-50%. The reasons for these higher seroconversion indexes were blood transfusions (13.6%), violation of the universal precaution rules (17%), and surgical procedures (8.5%). In 54.2% of the cases, the causes could not be determined. It is important to highlight that HCV transmission in HD centers may occur even in the absence of known risk factors. Another study reported that there are approximately 10%-50% seropositive patients in whom no risk factors are identified.[10] This is one of the main arguments supporting nosocomial transmission of HCV, associated to procedures such as frequent venous puncturing and sharing equipment in hemodialysis centers. In addition, we should not underestimate the possibility for HD patients of acquiring the infection in the community or due to other risk factors (intravenous drug abuse).[10] Some authors suggest that the homogeneity of HCV genotypes in infected patients from a same HD service strengthens the hypothesis of nosocomial transmission.[10,15,44,45] However, this hypothesis requires careful evaluation given the greater worldwide distribution of genotype 1, and thus the greater chance of getting infected with the most prevalent genotype within a give region. In Brazil, the most common one is genotype 1, followed by genotype 3.[46,47] Among other potential factors cited for nosocomial HCV transmission are re-use of capillaries, contamination of HD machines surfaces, as well as other equipment such as items shared by the patients during the HD procedures.[10,48,49]

Although HCV seroprevalence rates among HD patients still are higher than in the general population,[50] the studies show a trend towards a decrease in hepatitis C prevalence and incidence rates in hemodialysis centers, in recent years.[28,41,43,51] This was attributed to the adoption of effective preventive and nosocomial transmission control measures, a decreased number in blood transfusions, and the implementation of serological screening assays in blood-manipulating centers and hemodialysis centers. Anti-HCV serological screening assays in blood-manipulating centers, which are mandatory in Brazil

since 1993, represent the main reason explaining the significant decrease in horizontal transmission of HCV. The implementation of these assays is mandatory in hemodialysis centers since 1996.[51,52]

The HDI is a general measurement of human development and it does not comprise all aspects related with development,[20] although it is a more complete and realistic index than the *per capita* gross domestic product, which only considers the economical dimension of development. According to the classification of the United Nations Development Program (UNDP),[53] the State of MG lies among the regions of intermediate human development (HDI: 0.5-0.8). In the State of MG, hemodialysis centers are located at strategic municipalities and structured so as being able to obtain the resources necessary for implementing high-complexity health care services. The HDI in these municipalities is about 0.7, and the seroprevalence rates found were variable. In other words, there was no association between the HDI and the mean HCV seroprevalence in these municipalities ($r = 0.42$; $p = 0.174$), although there was a trend towards a correlation. An interesting observation is having found significant HCV seroprevalence rates in regions with high HDI. The possible explanation for this might be the concentration of most of the old hemodialysis centers in those regions having the highest HDI, and with a higher number of seropositive patients attributed to «old cases».

The risk for accidental contamination from needle sticking among health care workers is estimated to be 0%-3%, reaching a maximum of 10% in the case that the source of contamination has a positive viremia detected by means of molecular biology.[54-56] Another study estimates a risk of 0.7% among non-exposed health care workers[57] and up to 2% among exposed health care workers.[55] The anti-HCV seroprevalence was investigated in 387 (29%) health care professionals working in 14 hemodialysis centers (19%) of the State of MG. The health care workers were divided into two groups —G1 and G2— based on the time of professional activity in HD being lower or higher than 10 years, respectively. The results show that, on average, each hemodialysis center has 27 health care workers. One hundred and fifty-nine (41%) were included in G1 and none of them was seropositive. G2 comprised 228 health care workers (59%) with three seropositive ones. The average professional activity time for the three positive health care workers was 15.6 years. The risk factor in one case was an accident with contaminated material. In the remaining two, no risk factors were identified. The HCV seroprevalence, considering all health care workers in G1 and G2 was 0.8%, and 1.3% for health care workers in G2. The HCV seroprevalence among the health care professionals in this study, although not being a risk measurement, is similar to that described in other investigations. En 1995, the HCV seroprevalence observed among health care workers from 16% of the hemodialysis centers of the United States was 2%, with variations from 0% to 10%.[41] In the year 2000, Fabrizi and coworkers investigated the HCV seroprevalence among 20,091 health care workers in the United States; 349 (1.7%) tested positive.[17]

We did not observe a significant difference in HCV seroprevalence in relation to the time of occupational exposure between workers in G1 and G2 ($p = 0.27$). So, the duration of occupation in health care workers of the hemodialysis centers was not associated with an increase in HCV seroprevalence among them. Assessing the risk for HCV transmission from the patients to the health care workers during their activity at the hemodialysis centers was not an objective in our study.

To conclude, this study shows that HCV seroprevalence among HD patients in MG is higher than that in the general population, although lower than in previous years, and similar to that described in European countries and in the United States of America; the HCV seroprevalence varies among the hemodialysis centers from a same municipality and among hemodialysis centers from different regions of the State of MG; the time on HD was associated with higher HCV seroprevalence; we did not observe a quarterly increase in HCV seroprevalence in the hemodialysis centers during the study period; there was no correlation between the regional HDI and HCV seroprevalence; the trend towards a higher HCV seroprevalence at sites with higher HDI may be explained by the existence of older hemodialysis centers in these regions; the anti-HCV seroprevalence among health care workers is similar to that described in other studies.

REFERENCES

1. Centers for Disease Control and Prevention. Recommendations for preventing transmissions of infections among chronic hemodialysis patients. *MMWR Morb Mortal Wkly Rept:* Recommendations and Reports, Atlanta, v. 50, n.RR-5, pp. 1-43, Apr. 2001. disponível em: <http:/www.cdc.gov/mmwr/PDF/rr/rr5050.pdf>
2. World Health Organization. Global surveillance and control of hepatitis C. *J Viral Hepatitis* 1999; 6: 35-47.
3. Wasley A, Alter MJ. Epidemiology of hepatitis C: geographic differences and temporal trends. *Semin Liver Dis* 2000; 20 (1): 1-16.
4. Terrez-Speziale AM. Hepatitis C: historia natural y estado actual de su manejo. *Rev Med Patol Clin* 2003; 50: 179-189.
5. Wong JB, Mcquillan GM, Mchutchison JG, Poynard T. Estimating future hepatitis C morbidity, mortality, and costs in the United States. *Am J Public Health* 2000; 90 (10): 1562-1569.
6. Saab S, Brezina M, Gitnick G, Martin P, Yee HF Jr. Hepatitis C *screening* strategies in hemodialysis patients. *Am J Kidney Dis* 2001; 38: 91-97.
7. Tokars JI, Frank M, Alter MJ, Arduino MJ. National surveillance of dialysis-associated diseases in the United States, 2000. *Semin Dial* 2002; 15 (3): 162-171.
8. Jadoul M, Poignet JL, Geddes C, Locatelli F, Medin C, Krajewska M, Barril G, Scheuermann E, Sonkondi S, Goubau P. HCV Collaborative Group. The changing epidemiology of hepatitis C virus infection in hemodialysis: European multicentre study. *Nefhrol Dial Transplant* 2004; 19 (4): 904-909.
9. García-Valdecasas J, Bernal C, García F, Leyva A, Cerezo S. Epidemiological factors involved in hepatitis C virus infection in patients with renal disease. *Nephrol Dial Transplant* 1995; 10 (6): 81-82.
10. Fabrizi F, Poordad FF, Martin P. Hepatitis C infection and the patient with end-stage renal disease. *Hepatology* 2002; 36 (1): 3-10.
11. Busek SU, Baba EH, Tavares Filho HA, Pimenta L, Salomão A, Correa-Oliveira R, Oliveira GC. Hepatitis C and hepatitis B virus infection in different hemodialysis units in Belo Horizonte, Minas Gerais, Brazil. *Mem Inst Oswaldo Cruz* 2002; 97 (6): 775-778.
12. Bergman S, Accortt N, Turner A, Glaze J. Hepatitis C infection is acquired pre-ESRD. *Am J Kidney Dis* 2005; 45 (4): 684-689.
13. Natov SN, Lau JY, Bouthot BA, Murthy BV, Ruthazer R, Schmid CH, Levey AS, Pereira BJ. Serologic and virologic profiles of hepatitis C infection in renal transplant candidates. New England Organ Bank Hepatitis C Study Group. *Am J Kidney Dis* 1998; 31 (6): 920-927.
14. Furusyo N, Hayashi J, Kakuda K, Ariyama I, Kanamoto-Tanaka Y, Shimizu C, Etoh Y. Acute hepatitis among japanese hemodialysis patients: a prospective study 9 year study. *Am Gastroenterol* 2001; 96: 1593-1600.
15. Meyers CM, Seeff LB, Stehman-Breen CO, Hoofnagle JH. Hepatitis C and renal disease: an update. *Am J Kidney Dis* 2003; 42 (4): 631-657.

16. Tokars JI, Miller ER, Alter MJ, Arduino MJ. National surveillance of dialysis associated diseases in the United States, 1995. *ASAIO J* 1998; 44 (1): 98-107.
17. Fabrizi F, Bunnapradist S, Lun J, Nefhrol GHI, Martin P. Kinetics of hepatitis C virus during hemodialysis: novel perspectives. *J Nephrol* 2003; 16 (4): 467-475.
18. Focaccia R, Da Conceição OJ, Sette HJR, Sabino E, Bassit L, Nitrini DR, Lomar AV, Lorenzo R, Vieira De Souza F, Kiffer CR, Santos EB, Gonzales MP, Sáez-Alquezar A, Riscal JR, Fischer D. Estimated Prevalence of Viral Hepatitis in the General Population of the Municipality of São Paulo, Measured by a Serologic Survey of a Stratified, Randomized and Residence-Based Population. *Braz J Infect Dis* 1998; 2 (6): 269-284.
19. Ferrari JO, Ferreira MU, Tanaka A, Mizokami M. The seroprevalence of hepatitis B and C in an Amerindian population in the southwestern Brazilian Amazon. *Rev Soc Bras Med Trop* 1999; 32 (3): 299-302.
20. Atlas do Desenvolvimento Humano do Brasil [Homepage na Internet] Brasília: Instituto Brasileiro de Geografia e Estatística — IBGE; c 1991-2000 [atualizada em 2000; acesso em 22/04/07] Disponível em: http://www.fjp.gov.br/produtos/cees/idh/atlas_idh.php.
21. Bergmaschi DP, Souza JMP, Braga PE. Introdução à Bioestatística. São Paulo, 2005. [Material de apoio Didático de Curso de Atualização do Programa de Verão da Faculdade de Saúde Pública da Universidade de São Paulo]. Disponível em: http://www.fsp.usp.br/~denisepb/bioverao 2005 apostila.pdf. Acesso em 23/08/07.
22. Resolução 196 do Conselho Nacional de Saúde, 1996. Homepage na Internet. Brasília [Acesso em 18/08/2007] Ministério da Saúde do Brasil, Disponível em: http://http://www.conselho.saude.gov.br/ .
23. Lombardi M, Cerrai T, Geatti S, Negroni S, Pertusini L, Pegoraro M, Di Lullo G. Results of a national epidemiological investigation of HCV infection in dialysis patients (Survey by the Italian Branch of EDTNA/ERCA) *J Nephro* 1999; 12: 322-327.
24. Cheney CP, Chopra S, Graham C. Hepatitis C. *Infect Dis Clin North Am* 2000; 14 (3): 633-667.
25. Lauer GM, Walker BD. Hepatitis C virus infection. *N Engl J Med* 2001; 345 (1): 41-52.
26. Giacchino F, Alloatti S, Quarello F, Bosticardo GM, Giraudo G, Piccoli G. The immunological state in chronic renal insufficiency. *Int J Artif Organs* 1982; 5 (4): 237-242.
27. Barros MT, Romão Junior JE. Resposta Imunológica na Uremia. En: Cruz, Jenner. Atualidades em Nefrologia. São Paulo: Sarvier, 1996. v 4, cap. 30, pp. 230-240.
28. Romão Junior JE, Pinto SWL, Canziani ME, Praxedes JN, Santello JL, Moreira JCM. Censo SBN 2002: informações epidemiológicas das unidades de diálise do Brasil. *J Bras Nefrol* 2003; 25 (4): 187-198.
29. Geerlings W, Tufveson G, Ehrich JH, Jones EH, Landais P, Loirat C, Mallick NP, Margreiter R, Raine AE, Salmela K. Report on management of renal failure in Europe XXIII. *Neprhol Dial Transplant* 1994; 9: S6-S25.
30. Penido JMMO, Soares NA, Salazar HM, Ferreira Filho S, Magela G. Estudo Epidemiológico dos pacientes renais crônicos em tratamento dialítico no Estado de Minas Gerais em 1994 e 1995. *J Bras Nefrol* 1996; 18 (3): 137-137.
31. US Renal Data System. USRDS 1999. Annual Date Report. Atlas of End-Stage Renal Disease in the United States, National Institutes of Health. National Institutes of Diabetes and Digestive and Kidney Disease, Bethesda; 1999.
32. Sesso R. Inquérito epidemiológico em unidades de diálise do Brasil. *J Bras Nefrol* 2000; 22 (2): 23-26.
33. Dotta MA, Chequer H, Pereira JPM, Schimitt VM, Krug L, Saitovitch D. Métodos molecular e imunológico no diagnóstico da hepatite C em pacientes em hemodiálise. *J Bras Nefrol* 2003; 25: 86-94.
34. Oliveira MP. Diagnóstico da hepatite C em portadores de insuficiência renal crônica em hemodiálise: qual a melhor estratégia? Belo Horizonte: Faculdade de Medicina da Universidade Federal de Minas Gerais, 2005. 107 p. (Dissertação, Mestrado em Gastroenterologia).
35. El Nahas AM. & Bello AK. Chronic kidney Diseases: the global challenge. *Lancet* 2005; 365: 331-340.
36. Sociedad Latnoamericana de Nefrologia e Hipertensión. Informe del año 2001. Incluye datos de los años 1991 a1999. Registro Latinoamericano de diálises e transplante renal. Disponível em: <http://www.slanh.org/registro. Acesso em 18/04/06.
37. Pinto dos Santos J, Loureiro A, Cendoroglo M, Pereira BJG. Impact of dialysis room and reuse strategies on the incidence of HCV infection in HD units. *Nephrol Dial Transplant* 1996; 11: 2017-2022.
38. Zatz R, Romão Junior JE, Noronha IL. Nephrology in Latin America, with special emphasis on Brazil. *Kidney Int Suppl* 2003; 83: S131-134.
39. Hinrichsen H, Leimenstoll G, Stegen G, Schrader H, Folsch UR, Schmidt WE. PHV Study Group. Prevalence and risk factors of hepatitis C virus infection in haemodialysis patients: a multicentre study in 2,796 patients. *Gut* 2002; 51 (3): 429-433.
40. Carneiro MA, Martins RM, Teles SA, Silva SA, Lopes CL, Cardoso DD, Vanderborght BO, Yoshida CF. Hepatitis C prevalence and risk factors in hemodialysis patients in Central Brazil: a survey by polymerase chain reaction and serological methods. *Mem Inst Oswaldo Cruz* 2001; 96 (6): 765-769.
41. Tokars JI, Miller ER, Alter MJ, Ardduino MJ. National surveillance of dialysis-associated diseases in the United States, 1997. *Semin Dial* 2000; 13 (2): 75-85.
42. Tokars JI, Finelli L, Alter MJ, Arduino MJ. National surveillance of dialysis-associated diseases in the United States, 2001. *Semin Dial* 2004; 17 (4): 310-319.
43. Espinosa M, Martín-Malo A, Ojeda R, Santamara R, Soriano S, Aguera M, Aljama P. Marked reduction in the prevalence of hepatitis C virus infection in hemodialysis patients: causes and consequences. *Am J Kidney Dis* 2004; 43 (4): 685-689.
44. Caramelo C, Navas S, Alberola ML, Bermejillo T, Reyero A, Carreno V. Evidence against transmission of hepatitis C virus through hemodialysis ultrafiltrate and peritoneal fluid. *Nephron* 1994; 66 (4): 470-473.
45. Carithers RL Jr. Hepatitis C and renal failure. *Am J Med* 1999; 107 (6B): 90S-94S.
46. Oliveira GC, Carmo RA, Rocha MOC. Hepatitis C vírus genotypes in hemophiliacs in the state of Minas Gerais, Brasil. *Transfusion* 1999; 39: 1194-1199.
47. Busek S, Oliveira GC. Molecular epidemiology of the hepatitis C virus in Brasil. *Gen Molec Res* 2003; 2: 117-123.
48. Allander T, Medin C, Jacobson S, Grillner L, Persson MA. Hepatitis C transmission in a hemodialysis unit: molecular evidence for spread of virus among patients not sharing equipment. *J Med Virol* 1994; 43 (4): 415-419.
49. Fabrizi F, Martin P. Hepatitis C virus infection in dialysis: an emerging clinical reality. *Int J Artif Organs* 2001; 24 (3): 123-130.
50. Fabrizi F, Poordad FF, Martin P. Hepatitis C infection and the patient with end-stage renal disease. *Hepatology* 2002; 36 (1): 3-10.
51. Carneiro MA, Teles SA, Díaz MA, Ferreira RC, Naghettine AV, Silva SA, Lampe E, Yoshida CF, Martins RM. Decline of hepatitis C infection in hemodialysis patients in Central Brazil: a ten years of surveillance. *Mem Inst Oswaldo Cruz* 2005; 100 (4): 345-349.
52. Brasil. Ministério da Saúde.Gabinete Do Ministro. Portaria n° 2042 de 11 de outubro de 1996. Estabelece o Regulamento Técnico para O funcionamento dos Serviços De Terapia Renal Substitutiva e as normas para o cadastramento desses estabelecimentos junto ao Sistema Único de Saúde. Diário Oficial da União, Brasília, 14 de outubro de 1996.
53. Brasil. Programa das Nações Unidas para o Desenvolvimento (PNUD) Desenvolvimento humano e IDH, Disponível em: http://www.pnud.org.br/idh/. Acesso em 16/08/07.
54. Mitsui T, Iwano K, Masuko K, Yamazaki C, Okamoto H, Tsuda F, Tanaka T, Mishiro S. Hepatitis C virus infection in medical personnel after needlestick accident. *Hepatology* 1992; 16 (5):1109-1114.
55. Germanaud J, Causse X, Dhumeaux D. Transmission of hepatitis C by accidental needlestick injuries. Evaluation of the risk. *Presse Med* 1994; 23 (23): 1078-1082.
56. Thomas DL, Astemborski J, Rai RM, Anania FA, Schaeffer M, Galai N, Nolt K, Nelson KE, Strathdee SA, Johnson L, Laeyendecker O, Boitnott J, Wilson LE, Vlahov D. The natural history of hepatitis C virus infection: host, viral, and environmental factors. *JAMA* 2000; 284 (4): 450-456.
57. Struve J, Aronsson B, Frenning B, Forsgren M, Weiland O. Prevalence of antibodies against hepatitis C virus infection among health care workers in Stockholm. *Scand J Gastroentero* 1994; 29 (4): 360-362.