

Original Article

Staff Knowledge, Adherence to Infection Control Recommendations and Seroconversion Rates in Hemodialysis Centers in Khartoum

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Abstract

Introduction: We evaluated hemodialysis (HD) staff knowledge, adherence to infection control recommendations and seroconversion rates for hepatitis B virus (HBV) and hepatitis C virus (HCV) in 13 centers that continuously provided HD services in Khartoum State between June 2009 and November 2010.

Methods: The knowledge of 182 HD staff members was evaluated by a self-filled questionnaire. Relevant data were obtained from 1011 HD patients by direct interviews and record review. Adherence to infection control recommendations was evaluated by direct observation.

Results: HD staff members achieved a median score of 81% in knowledge evaluation (range 44-100%). Better scores were achieved by more experienced staff. We identified serious gaps in knowledge related to the environmental risk of viral transmission. Regular screening by enzyme-linked immunoassay (ELISA) was performed in 46% of centers. Only half susceptible patients were vaccinated against HBV. Staff dedicated for treatment of HBV positive patients were found in only 57% of centers that served such patients. Hand washing recommendations were strictly observed in 15% of centers, disinfection of HD stations between patients was strictly observed in 23% of centers, medications were prepared in a separate area in 8% of centers and delivered separately to each patient in none of the centers. There were 2.5 HCV seroconversions and 0.6 HBV seroconversions per 100 patient-years. Center characteristics that predicted HCV seroconversion were accommodation of HCV-positive patients in the same center, using ELISA for patient screening, and assigning more than 3 patients for one HD nurse.

Conclusion: There are serious gaps in HD staff knowledge and adherence to infection control recommendations. A structured training program for HD staff members is urgently required.

Keywords: Hemodialysis; HBV; HCV; Infection Control; Khartoum

The authors declared no conflict of interest

Introduction

Sudan belongs to the high endemicity areas of hepatitis B virus (HBV) infection, with the estimated prevalence of chronic HBV infection exceeding 8% [1]. There is paucity of published data on the prevalence of HCV and HBV infections in the general population in Sudan. In a report from a large maternity hospital in Khartoum, where sera were collected from pregnant women during a three-months period, the prevalences of HBV and HCV infections were 5.6% and 0.6% respectively [2]. In June 2009, there were 2858 prevalent hemodialysis (HD) patients in Sudan, 6.4% of whom were positive for HBV, 6.5% were positive for hepatitis C virus (HCV), and 0.7% were positive for both HBV and HCV [3]. Most of HBV positive patients were diagnosed before dialysis initiation, while most cases of HCV infection were acquired after starting dialysis.

Almost all cases of new HCV infections occurring in HD units can be traced to environmental contamination and noncompliance with standard infection control precautions [4, 5]. In a survey of a single center, 740 environmental surface samples were taken. Of these samples, 82 (11%) contained hemoglobin; 6 (7%) of those contained HCV-RNA. The rate of compliance with hand hygiene in the same center was 37%, and gloves were immediately removed after patient care in 33% of cases. A low ratio of nurses to patients and poor hand hygiene were independent predictors of the presence of hemoglobin on environmental surfaces [6].

In a report from central Brazil, a cohort of 360 patients who tested negative for anti-HCV was followed for an average of 24 months. The incidence of seroconversion

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was 4.6 per 1000 patient-months, ranging between 0-30 in different units. The unit where treatment was performed was identified as a risk factor for seroconversion (RR 42.4, $p < 0.05$). The three units with highest anti-HCV prevalence and incidence were identified as those that more frequently failed to apply control measures. Blood transfusion was associated with anti-HCV in the initial survey but was not important in incident cases [7].

In June 2009, we conducted a national survey of end stage renal disease (ESRD) patients in Sudan [3]. During that survey, we collected data from 1729 prevalent HD patients who were being dialyzed in 27 HD centers in Khartoum State, including sixteen private dialysis centers. Over the following months, almost all private HD centers were closed and their patient distributed to other centers, and six new governmental centers were opened. In November 2010, we conducted a cross-sectional survey of the thirteen HD centers that were still functioning from the original cohort. We evaluated HD staff knowledge about HBV and HCV in the HD setting and their adherence to recommended infection control measures. We also evaluated the seroconversion rates for both viruses in these centers between June 2009 and November 2010.

Methods

In November 2010, we conducted a cross-sectional survey of thirteen HD centers that continuously provided HD services in Khartoum State between June 2009 and November 2010. HD staff members working in these units were asked to provide data on the duration they spent working in HD centers and their vaccination status. They were also asked to respond to a set of 16 questions in true-and-false format related to various aspects of HBV and HCV infection, transmission and prevention in HD setting. One point was given for each correct answer, and the total score was recorded in percentage format.

We traced a cohort of 1011 patients who were being dialyzed in these centers in June 2009. After obtaining their consent, the researchers interviewed these patients during their HD sessions and reviewed their medical records. They collected data related to their current serology and vaccination status and whether they received blood transfusions or were dialyzed in other centers during the preceding period. Patients who received kidney transplants, those transferred to other centers and those who died during the interim period were also included in the analysis.

While interviewing patients, researchers observed the routine daily practice of the HD staff. These observations were then summarized in a structured data collection sheet for each HD center. The center's data collection sheets

listed twelve infection control recommendations, and the researcher indicated on a Likert-type scale whether the HD staff in the respective center practiced these recommendations; always, most of the time, sometimes, occasionally, or never.

Data were analyzed using SPSS version 19 and summarized as proportions, means and median values. Proportions were compared using Chi-squared test. Seroconversion rates were calculated by relating the total number of documented seroconversions to the duration of time spent collectively by patients in the same dialysis centers. Risk factors for seroconversion were evaluated using logistic regression analysis. P values less than 0.05 were considered statistically significant.

Results

The survey covered all thirteen governmental HD centers in Khartoum State that have been serving HD patients since June 2009 up to November 2010. Filled data collection sheets were returned from 182 staff members; 63.5% of whom were HD nurses, 25.4% were doctors and 11% were nurse assistants. Surveyed staff has been working in HD centers for a median duration of 24 months, with a minimum of 1 month and a maximum of 28 years. They had been graduated for a median duration of 60 months with a minimum of 6 months and a maximum of 31 years.

Staff knowledge about HBV and HCV

Questions exploring staff knowledge about HBV and HCV revealed gaps in certain aspects (Table 1). The median total score achieved by surveyed staff members was 81.3%, with a minimum score of 43.8% and a maximum score of 100%. Different HD centers appeared to have markedly different mean scores, with the best center achieving a mean score of 84.6% and the least center achieving a mean score of 66.4%. However, this variability was mainly allied with differences in staff experience. In some centers, more than 60% of the staff had been working in HD centers for less than one year. Staff members who have been working in HD centers for at least one year achieved significantly better score than those working for less than one year (79.6 ± 11 versus 72.2 ± 14 , $P = 0.0003$). They were also more likely to have received at least one dose of HBV vaccine (88.3% versus 62.5%, $P = 0.00$).

Prior screening for HBV and HCV was reported by 46.9% of surveyed staff. The majority (65.2%) has received three doses of HBV vaccine, 16% received 1-2 doses, and 18.8% were never vaccinated for HBV. Reasons cited by unvaccinated staff members for not receiving the vaccine were the non-provision of the vaccine by HD centers

Table 1: The proportion of HD staff members who were able to provide the correct answer for various questions related to HBV and HCV infection and transmission in HD setting

Num.	Question theme	Correct answers (%)
1	Infection with either HBV or HCV can lead to acute or chronic hepatitis	98.4
2	Chronic hepatitis caused by HBV or HCV can lead to liver cirrhosis or liver cancer	92.3
3	HBV and HCV are transmitted by blood and contaminated body fluids that penetrate the skin or mucous membranes	97.3
4	HCV is not transmitted through the HD machine, but through contaminated surfaces and equipment in the HD center	66.5
5	HBV can be transmitted from touching contaminated surfaces with no visible blood	69.2
6	HBV can survive on contaminated surfaces (like HD chairs and door knobs) for one week	53.8
7	HBV and HCV can be removed from contaminated surfaces by regular cleaning with disinfectants	88.5
8	HCV screening results can remain negative for several weeks after acquiring new infection, during which period the patient is infective	81.3
9	Vaccination against HBV is mandatory for everyone working in HD centers	98.4
10	Vaccination against HBV does not cause HBV infection	49.5
11	Vaccination against HBV does not cause screening results for HBV to become permanently positive	63.2
12	A healthy person who had been successfully vaccinated against HBV will not acquire the infection if he/she is exposed to a contaminated needle puncture	47.3
13	If a non-vaccinated person is exposed to a contaminated needle puncture, vaccination against HBV may not provide complete protection from infection	78.6
14	Vaccination against HBV is mandatory for every person who has chronic kidney disease	93.4
15	Chronic kidney disease patients achieve less immunity against HBV after vaccination than healthy persons	77.5
16	To improve the immunity that a chronic kidney disease patient gains from HBV vaccine, it should be offered before he/she becomes dialysis-dependent	93.4

(61.5%), lack of time (7.7%), belief that HBV infection was not prevalent (7.7%), lack of confidence in the effectiveness of the vaccine (7.7%), fear of screening result (3.8%), needle phobia (3.8%), and negligence (7.7%).

Adherence to infection control measures

Regular screening for HD patients was performed every 3 months by 84.6% in centers and every 6 months in 15.4%. Enzyme-linked immunoassay (ELISA) was the usual screening method in only six centers (46%). The remaining centers screened patients by rapid immunochromatography testing (ICT) and confirmed positive results by ELISA. Only one center (8.3%)

monitored ALT levels. Only 49% of HBV susceptible patients reported being vaccinated against HBV. No center monitored anti-HBs levels or offered annual booster doses of HBV vaccine for patients with suboptimal levels.

Seven centers (53.8%) provided dialysis for HBV positive patients; a separate room was used for HBV positive patients in six of these centers, while the seventh center relied on a partition within the general ward to separate these patients. In four centers (57%), separate staff was dedicated for HBV positive patients.

Eight centers (61.5%) provided dialysis for HCV positive patients; a separate room and dedicated staff

Table 2: The proportion of surveyed HD centers in which staff members were observed to be strictly adherent to the specified infection control recommendations

Num.	Infection control recommendation	Strictly adherent centers (%)
1	Staff members should always wear gloves when connecting patients	84.6
2	Staff members should always wear gloves when disconnecting patients	84.6
3	Staff members should always wear gloves when handling the blood lines	38.5
4	Staff members should always wear gloves while changing dressings	30.8
5	Hands should always be washed after gloves are removed, between patient contacts, and after touching contaminated items	15.4
6	The surfaces of HD machines and patients' chairs should always be cleaned and disinfected between patients	23.1
7	Items taken to a patient's dialysis station should be cleaned and disinfected before using them for other patients	23.1
8	Items taken to a patient's dialysis station that cannot be disinfected (e.g. adhesive tape) should be dedicated only for that patient	7.7
9	Medications should be prepared in a room or area separated from the patient treatment area and designated only for medications	7.7
10	Medications should be delivered separately to each patient and common carts should not be used to distribute medications	0
11	Staff members should not eat, drink, or smoke in the dialysis treatment area	38.5
12	Staff members should wear protective clothing when performing procedures during which spattering of blood might occur	15.4

were assigned for HCV positive patients in four of these centers (50%). All centers used dedicated HD machines for HCV positive patients.

Gloves were readily available in all centers. A hand washing basin was available in 85% of surveyed HD wards and safe waste-disposal bins were readily available in 77%. A separate room was available for preparing medication (e.g. heparin) in only 8% of surveyed HD centers. A separate room for staff rest was available in 77%. Adherence to recommended infection control measures was generally inadequate in surveyed HD centers (Table 2).

Seroconversion rates

Follow up data were available for 918 patients who were HCV negative at baseline and 927 patients who were HBsAg negative at base line. At the end of the follow up period, there were 2.5 HCV seroconversions per 100 patient-years and 0.6 HBV seroconversions per 100 patient-years.

Centers that catered only for HCV negative patients had a HCV seroconversion rate of 0.6 seroconversions per 100 patient-years. The rate of HCV seroconversion in centers that provided dialysis service to HCV positive patients was 3.5 seroconversions per 100 patient-years. In addition to dedicating special chairs for HCV positive patients, four centers segregated HCV positive patients in a separate room. In fact, these centers had a higher seroconversion rate for HCV than centers that dialyzed them in the general dialysis ward (4.3 versus 2.1 seroconversions per 100 patient-years) (Table 3).

Center characteristics that predicted HCV seroconversion were provision of dialysis for HCV-positive patients, using ELISA for patient screening, and assigning more than 3 patients for one HD nurse (Table 4).

Discussion

This survey revealed serious gaps in HD staff knowledge about HBV and HCV transmission within HD centers. This reflects the lack of a structured training curriculum for new HD staff members in Sudan. New staff members

Table 3: HCV and HBV seroconversion rates in different HD centers in Khartoum State

HD center	Follow-up patient-months	Strategy for HCV positive patients	Screening method	Patient nurse ratio	Baseline prevalence (%)		seroconversion rate (per 100 patient-year)	
					HCV	HBV	HCV	HBV
1	1401	-	ELISA	3.1	0	0.9	0.9	1.0
2	640	-	ELISA	3.0	0	9.4	1.9	0.0
3	462	-	ELISA	3.3	0	0	0.0	0.0
4	247	-	ELISA	3.3	0	0	0.0	0.0
5	691	-	ICT	3.0	0	0	0.0	1.8
6	995	Separate ward	ELISA	2.9	16.2	0	5.8	0.0
7	430	Separate ward	ELISA	3.0	9.1	12.1	3.0	0.0
8	2161	Separate ward	ICT	3.7	13.4	14.8	6.3	0.0
9	2121	Separate ward	ICT	2.8	22.5	20.3	1.5	2.3
10	1232	Separate machines	ICT	3.0	7.4	0	3.2	0.0
11	1307	Separate machines	ICT	5.7	5.0	9.9	2.0	0.0
12	668	Separate machines	ICT	2.3	7.5	0	0.0	2.0
13	538	Separate machines	ICT	3.3	4.1	2.0	0.0	0.0

Table 4: Risk factors for HCV seroconversion identified by logistic regression analysis in the study population (N=918)

Risk factor	Odds ratio	P value	95% confidence interval
Center provides dialysis for HCV-positive patients*	73	0.01	3.2 – 1656
Center uses ELISA for screening*	15	0.02	1.5 – 146
Center assigns more than 3 patients for one nurse*	12	0.03	1.2 – 123
Male gender	3.2	0.1	0.7 – 15
Receiving dialysis in a different HD center	2.8	0.1	0.8 – 10
Blood transfusion during follow-up period	1.2	0.8	0.3 – 4.9
Age	1.0	0.7	0.99 – 1.04

* statistically significant

are generally trained by senior staff, and in the busy working environment of HD wards priority is naturally given to the teaching of skills. This is not sufficient for the adult learner, who needs to understand the logic behind a recommended act. If a staff member fully understands that HCV and HBV transmission in the dialysis ward mainly occurs through environmental contamination, he/she would probably be keener to follow the recommended infection control procedures. The staff turn-over rate is also high. Almost 25% of surveyed staff had been working in HD centers for less than one year. This would constitute a heavy training burden for senior staff, and may indicate that new staff members are being trained by relatively inexperienced ones.

Misconceptions about HBV vaccine were common among surveyed staff. Half the staff thought that the vaccine itself can sometimes cause HBV infection. Half the staff was not aware of the fact that successful vaccination offers virtually complete protection against HBV. This is unfortunate, since HBV vaccine is the first and currently the only vaccine against a major human cancer, with an outstanding record of safety and efficacy [1]. Some of the unvaccinated staff expressed their concern about the need for screening. This should not be an obstacle to vaccination since hepatitis B vaccination does no harm to HBV-immune or HBV-infected individuals. It should be the responsibility of HD centers to provide hepatitis B vaccine for their staff. Individuals who are not

HBV-immune should probably not be allowed to work in the high risk HD environment.

Hemodialysis patients are at high risk of acquiring HBV infection. Hepatitis B vaccination efficacy in reducing this risk is well documented [4]. Unfortunately, only half surveyed patients were vaccinated against HBV. Unlike healthy individuals, the kidney failure patient is not fully protected against HBV unless he/she maintains a protective anti-HBs titer. Therefore, annual monitoring for anti-HBs levels is indicated, and a booster dose of the vaccine should be administered to susceptible patients if necessary.

This survey identified another serious defect in the management of HBV susceptible individuals. Nurses who cared for HBsAg positive patients were required to care for HBV susceptible patients during the same shift in four centers. Moreover, HBV susceptible patients were allowed to socialize with HBsAg positive patients while receiving their HD treatment. This demonstrates the general tendency to underestimate the risk of transmission through contaminated hands, surfaces and equipment in the dialysis environment.

More than half surveyed centers relied on rapid immunochromatography technique (ICT) for patient screening and performed it every three months. This doesn't conform to the Center for Disease Control and Prevention [4] or Kidney Disease Improving Global Outcomes (KDIGO) [5] guidelines. In a cross-sectional epidemiological study of two populations of 1,200 potential blood donors in rural Cambodia and Vietnam the prevalence rates of HBsAg, anti-HBc and anti-HCV as established by enzyme immunoassay (EIA) tests were compared to rapid test outcomes. The actual rapid test demonstrated high specificity for all three test categories as claimed by the manufacturer. The observed test sensitivity was significantly lower than that claimed by the manufacturer: 86.5% for HBsAg, 86.6% for anti-HBc, and 76.4% for anti-HCV. There were large and significant variations in test performance between the two countries, especially for HBsAg detection. The authors concluded that rapid tests may be useful screening tools in blood transfusion services in low-resource settings, but tests should be carefully validated locally before being used for screening purposes since test performance varies by location [8]. To compensate for the higher cost of EIA, it may be suitable to reduce the frequency of viral screening for HD patients to biannual screening as recommended by guidelines [4, 5].

Seroconversion rates were 2.5 HCV seroconversions per 100 patient-years and 0.6 HBV seroconversions per 100 patient-years. These figures are similar to those reported by DOPPS study which evaluated 308 representative

dialysis facilities in France, Germany, Italy, Spain, the United Kingdom, Japan, and the United States. In the DOPPS study, the adjusted HCV and HBV seroconversion rates were 1.2-3.9 and 0.4-1.8 seroconversions per 100 patient-years, respectively [9, 10].

It is quite possible that our figures underestimate the true incidence of seroconversion because most centers relied on ICT for screening rather than ELISA. In fact, being dialyzed in a center that uses ELISA for regular patient screening was one of the predictors of HCV seroconversion in this study.

HCV seroconversion was documented in almost all centers that cared for anti-HCV positive patients. Centers that provided dialysis only for anti-HCV negative patients had a much lower seroconversion rate (0.6 versus 3.5 seroconversions per 100 patient years) although adherence to infection control measures was poor in both groups of centers. This is expected because HCV infected patients represents the reservoir of the infective agent within the dialysis ward. Even centers that segregated anti-HCV positive patients in a separate room were not able to eliminate transmission. This demonstrates that segregation is not an alternative to hygienic practices.

Adherence to the recommended infection control measures is not only meant for the prevention of viral hepatitis. Bacteremia resulting from hemodialysis catheters and arterio-venous fistulae infections are associated with significant morbidity, mortality and costs. This can be effectively reduced by simple hygienic measures such as hand washing between patient contacts. These hygienic measures are also important for staff safety.

The alarmingly low adherence to hand washing recommendations in this study is a common problem. In a survey that included 420 HD staff members from 45 HD facilities in the USA, only 36% reported «always following recommended hand hygiene and glove use practices» [11]. In another study, one person observed the health care staff in each of nine different dialysis units, during 495 randomly distributed 30 min observation periods that covered all steps of a HD session (connection, dialysis and disconnection). Gloves were actually used on 92.9% of the occasions when it was indicated. Hands were washed only 35.6% of the time after patient contact, and only 13.8% of the time before patient contact. The personnel's knowledge of patients' infectious status did not modify their adherence to hand hygiene practices [12]. This is an area where a targeted educational program is clearly needed. The provision of alcohol-based hand cleansers in the vicinity of each HD station may also help improve hand hygiene practices in HD units.

A higher patient-nurse ratio in this study was significantly associated with a higher risk of HCV seroconversion. Overburdening nurses with patient care is likely to result in less adherence to recommended safety procedures. In the above mentioned study, poor adherence to hand washing was associated with the number of shifts per HD unit per day and with higher patient-to-nurse ratios [12]. Another study from a large HD center in KSA evaluated patients that were assigned to HD groups of varying patient-to-nurse ratios: group I, 2:1; group II, 3:1, and group III, 4:1. Group I had the lowest HCV prevalence and annual seroconversion rates (26.8% and 5.3%, respectively), followed by group II (43.6% and 8.7%, respectively); group III had the highest HCV prevalence and seroconversion rates (71.8% and 14.4%, respectively) [13]. Most centers in the current study assigned each nurse with three patients at maximum during a HD shift, and this appears to be a reasonable limit. Understaffing can have a negative impact on patient safety and should not be tolerated in the highly demanding working environment of HD centers.

Conclusion

There are serious gaps in knowledge about HBV and HCV infections in the dialysis setting among surveyed HD staff members. Adherence to many aspects of recommended infection control measures is also inadequate. Higher rates of HCV seroconversion were noted in HD centers with higher patient-nurse ratios. A structured training program for HD staff members is urgently required to improve performance and reduce seroconversion rates.

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