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Patterns of hepatitis B prevalence and seroconversion in hemodialysis units from three continents: The DOPPS

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Patterns of hepatitis B prevalence and seroconversion in hemodialysis units from three continents: The DOPPS.

Background. Hepatitis B (HBV) historically has been a public health issue within hemodialysis units. This study estimates HBV prevalence and seroconversion rates across seven countries and investigates associations with facility level practice patterns.

Methods. The study sample was from the Dialysis Outcomes and Practice Patterns Study (DOPPS), a cross-sectional, prospective, observational study of adult hemodialysis patients randomly selected from 308 dialysis facilities in France, Germany, Italy, Spain, the United Kingdom, Japan, and the United States. Logistic regression was used to model the odds ratio (OR) of HBV prevalence, and Cox regression was used to model time from entry into the study to HBV seroconversion.

Results. In this sample, mean HBV facility prevalence was 3.0% with a median of 1.9%. The percentage of facilities with an HBV prevalence 0% to 5% was 78.5%. Adjusted HBV prevalence was higher in France, Germany, and Italy and lower in Japan and the United Kingdom. The majority of facilities (78.1%) had a seroconversion rate of 0 conversions per 100 patient-years. Presence of a protocol for HBV-infected patients was significantly associated with HBV seroconversion in the separate practice pattern model [risk ratio (RR) = 0.52, P = 0.03] and in the combined practice pattern model (RR = 0.44, P = 0.01).

Conclusion. There are differences in HBV prevalence and rate of seroconversion both at the country and the hemodialysis facility level. Presence of a protocol for HBV-infected patients was strongly and significantly associated with decreased risk for seroconversion. The observed variation suggests opportunities for improved HBV outcomes with further definition of optimal practice patterns at the facility level.

Key words: hepatitis B, infection control protocols, Dialysis Outcomes and Practice Patterns Study, seroconversion, vaccine.

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Hepatitis B virus (HBV) historically has been a critical infection issue within hemodialysis facilities. [1, 2] Considerable transmission of HBV can occur between hemodialysis patients and staff [3]. Hemodialysis patients are at increased risk for HBV infection because of the opportunity for exposure to HBV associated with the dialysis procedure. The reservoir of infection for potential transmission of HBV is greater in hemodialysis patients. After infection with HBV, hemodialysis patients are at greater risk of becoming chronic carriers than the general population [3–5]. Moreover, the conversion rate after vaccination is less for chronic hemodialysis patients than for the general population (50% to 80% vs. >95%) [6–10]. Although many patients with end-stage renal disease (ESRD) do not live long enough to develop HBV-related complications, increased risk of hepatocellular carcinoma and mortality associated with HBV is reported in the ESRD population [11–13]. HBV infection is also associated with greater morbidity and mortality in ESRD patients after they have received a renal transplant [14–20].

The hemodialysis and infectious disease communities have developed practice patterns and infection control measures designed to reduce HBV transmission. These include protocols for handling bodily fluids, isolation policies, the HBV vaccine, and use of erythropoietin [21–27]. However, HBV persists within hemodialysis units. Furthermore, there is observed variation in HBV prevalence and seroconversion between hemodialysis units. It is likely that facility-level practice patterns affect HBV transmission, even in the current environment of infection control measures.

Several country- and region-specific studies have looked at HBV prevalence and seroconversion in hemodialysis units [10, 23, 25, 26, 28–32]. Worldwide, uniformly collected statistics on prevalence and seroconversion of HBV in hemodialysis units do not exist. The

present study used data from the Dialysis Outcomes and Practice Patterns Study (DOPPS) to estimate HBV prevalence and seroconversion rates in seven countries and to investigate whether facility-level practice patterns were associated with HBV prevalence and seroconversion. The standardization of DOPPS data collection allows for direct comparison of HBV across hemodialysis facilities and across countries at a level of detail and power that has not previously been reported.

METHODS

Data sources

This study used a sample of 8615 hemodialysis patients from the DOPPS, a cross-sectional, prospective, observational study involving a sample of adult hemodialysis patients randomly selected from 308 representative dialysis facilities in France, Germany, Italy, Spain, the United Kingdom, Japan, and the United States. Facilities in the United States entered the study in 1997, Europe in 1998, and Japan in 1999. This analysis used data gathered through spring 2001. Nationally representative samples were obtained using randomized patient selection, with ongoing longitudinal patient and facility data collection. The DOPPS sampling plan and study methods have been described elsewhere [33].

Classification of HBV status

Answers to the question, "Diagnosis of hepatitis B on or before the enrollment date? Yes/No/Suspected," were combined with serology results to define HBV classification. Patients were considered to have a clinical diagnosis of HBV if they answered "yes" to the above question. A case of HBV was defined as a patient who carried a clinical diagnosis of HBV or who was HBV surface antigen (HbsAg) positive at the time of entry into the study. After initial entry into the study, HBV status was queried every 4 months. An incident case of HBV infection was defined as seroconversion by a patient from HbsAg negative at the time of entry into the study to HbsAg positive in the reporting center during the study period.

Statistical methods

Demographics, comorbidity, and country analysis. The main outcome variables of interest were HBV prevalence and HBV seroconversion rates. Prevalence percentages represented a cross-section taken at the beginning of the study. HBV seroconversion rates were calculated as the number of conversions per 100 patient-years of observation. Independent variables included country, patient demographics (age, gender, and race), time on hemodialysis, alcohol or drug use in the past 12 months, and history of the following comorbid conditions: hepatitis C infection (HCV), prior renal transplant, coronary artery disease, congestive heart failure (CHF), cardiac disease other than CHF, hypertension, diabetes, cerebrovascular disease, peripheral vascular disease (PVD), cancer, human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), lung disease, neurologic disorders, psychiatric disease, and gastrointestinal bleed. Confidence intervals for unadjusted and adjusted prevalence and seroconversion measures of association were constructed for each country.

Practice pattern analysis. Associations among facility practice patterns and the facility prevalence of HBV infection were examined using logistic regression. Associations among facility practice patterns and time to HBV seroconversion were examined using Cox proportional hazards models. Practice patterns modeled as predictor variables included the following facility characteristics: protocol for HBV-infected patients, isolation of HBV-infected patients, isolation of HCV-infected patients, number of isolation stations (per station), patients per station (per one-unit increase), routine administration of HBV vaccine, number of highly trained staff (per 10% increase in highly trained staff), physician-patient interaction (hours/month), ratio of patient hours to direct patient staff hours, routine serologic screening for HBV, routine serologic screening for HCV, facility size, dialyzer reuse, and whether the hemodialysis facility treated acute patients. Highly trained staff members were defined as those who had received at least 2 years of formal nursing training. These models were also adjusted for the demographic characteristics and comorbidities listed above, as well as time since beginning of ESRD.

All models accounted for clustering at the facility level. For the logistic regression models, generalized estimating equations (GEE) were used to account for clustering at the facility level, assuming a compound symmetry covariance structure [34]. For the Cox regression models, the Sandwich Estimator was used to account for clustering at the facility level [35]. All analyses were performed using the SAS statistical package, version 8.2 (SAS Institute, Cary, NC, USA).

RESULTS

The initial sample included 8615 randomly selected hemodialysis patients. These patients were treated in 308 dialysis facilities. Table 1 (column 2) summarizes the demographic and comorbid characteristics of the patient sample. The mean and the median ages were 59.9 years and 62.0 years, respectively. African American patients comprised 17.4% of the sample and males 56.8%; 42% of the patients were over 65 years old. Two potential risk factors for HBV, drug and alcohol abuse, were noted in 3.0% and 1.7% of the sample, respectively.

Table 1. Odds ratios (OR) for prevalence and risk ratio (RR) of seroconversion of hepatitis B (HBV) by patient characteristics[a]

Measure	Patients (%) or mean (SD)	OR for prevalence (*P* value)	Risk ratio for seroconversion (*P* value)
Age[b]	59.9 (14.7)	0.90 (0.03)	1.09 (0.28)
Race			
Non-African American	82.6	1.00 (ref)	1.00 (ref)
African American	17.4	1.28 (0.20)	1.26 (0.57)
Gender			
Male	56.8	1.41 (0.003)	0.92 (0.66)
Female	43.2	1.00 (ref)	1.00 (ref)
Time on ESRD	4.9 (5.4)	1.04 (0.04)	1.00 (0.99)
Comorbid conditions			
HCV	15.9	2.74 (<0.0001)	1.71 (0.03)
Prior Renal Transplant	6.8	1.09 (0.69)	0.73 (0.57)
PVD	21.3	0.77 (0.05)	0.51 (0.07)
HIV/AIDS	0.5	3.74 (0.0003)	2.66 (0.36)
Psychiatric disease	18.9	1.01 (0.96)	1.85 (0.05)
Dyspnea	19.8	0.72 (0.04)	1.13 (0.72)
CAD	36.0	1.20 (0.19)	0.86 (0.53)
CHF	29.6	1.03 (0.85)	0.85 (0.62)
Arrhythmia/other cardiac disease	33.2	1.27 (0.05)	0.78 (0.40)
HTN	73.2	1.07 (0.64)	1.06 (0.78)
Cerebrovascular disease	15.5	1.05 (0.76)	0.59 (0.08)
Diabetes	33.0	1.14 (0.34)	1.53 (0.09)
Lung disease	9.4	0.80 (0.23)	0.63 (0.47)
Cancer	8.3	1.12 (0.54)	0.82 (0.65)
Gastrointestinal bleeding	6.9	1.26 (0.24)	0.94 (0.91)
Neurologic disease	8.4	0.92 (0.65)	1.72 (0.13)
Recurrent cellulitis/gangrene	7.5	0.80 (0.38)	1.10 (0.87)
Substance abuse within past 12 months			
Drug	3.0	0.90 (0.74)	0.24 (0.18)
Alcohol	1.7	1.32 (0.36)	1.35 (0.58)

Abbreviations are: ESRD, end-stage renal disease; HCV, hepatitis C virus; PVD, peripheral vascular disease; HIV/AIDS, human immunodeficiency virus/acquired immunodeficiency disease; CAD, coronary artery disease; CHF, congestive heart failure; HTN, hypertension.

[a] Adjusted for age, gender, race, time on dialysis, alcohol use and drug abuse in the past 12 months, 15 comorbid conditions, and clustering effects

[b] OR and RR are given for increments of 10 years

HBV prevalence

Answers to the question "History of HBV?" were combined with serology results to define HBV classification. For 8433 out of 8615 patients (97.9%), the combination of answers gave a clear and unambiguous HBV classification of either HBV positive of HBV negative. For 107 patients, the question "History of HBV?" was answered "yes" and the patient was HbsAg negative. As HbsAg may disappear with convalescence, these patients were classified as HBV positive. There were 15 patients for whom "History of HBV?" was answered "suspected." For two of these patients HbsAb was positive, and the patients were classified HBV positive. For 12 of these patients HbsAg was negative, and the patients were classified HBV negative. For the remaining sole patient with a suspected history of HBV, HbsAg was unknown, and the patient was classified HBV positive. Sixty patients were missing both a response to "History of hepatitis B?" and missing the HbsAg serology. These patients were excluded from the analysis.

Table 1 (column 3) provides the odds ratio (OR) for HBV prevalence, as predicted by the demographic and comorbid characteristics of the sample. Younger age was significantly associated with prior HBV infection. Prevalence was 10% lower per 10 years older age ($P = 0.03$). Male gender was associated with a 41% higher risk for prevalence of HBV. Infection with HCV was strongly and significantly associated with HBV prevalence [adjusted odds ratio (AOR) = 2.74, $P < 0.0001$]. HBV was significantly less prevalent in those patients with PVD (AOR = 0.77, $P = 0.05$) and significantly more prevalent in those patients with HIV/AIDS (AOR = 3.74, $P = 0.0003$). Substance abuse as reported by the patient during the 12 months prior to data collection was not significantly associated with HBV prevalence.

Table 2 provides HBV prevalence percentages by country, after adjustment for age, gender, race, and time of ESRD. Adjusted HBV prevalence was higher in France, Germany, and Italy, and lower in Japan, Spain, and the United Kingdom.

The pattern of prevalence of HBV by interval of time of ESRD is shown in Figure 1. Prevalence of HBV was lowest among patients who had been treated with hemodialysis for 0 to 5 years and then increased as years since onset of ESRD increased. Time on ESRD therapy was significantly associated with HBV prevalence, with a 4% higher odds ratio of HBV prevalence per year of ESRD (Table 1) (AOR = 1.04, $P = 0.04$).

Table 2. Prevalence and seroconversion rates, by country[a]

Country	Unadjusted prevalence %	Adjusted prevalence[a] %, *95% CI*	Unadjusted seroconversions/ 100 patient-years	Adjusted seroconversions/ 100 patient-years[a] *95% CI*
France	5.0 (3.2, 6.8)	3.7 (2.9, 4.7)	0.9 (0.6, 1.4)	1.0 (0.4, 3.1)
Germany	5.2 (3.3, 7.1)	4.6 (3.6, 5.8)	1.1 (0.9, 1.3)	1.8 (0.6, 4.9)
Italy	6.6 (4.5, 8.7)	4.3 (3.4, 5.4)	0.5 (0.3, 0.9)	0.5 (0.1, 1.6)
Japan	3.3 (2.5, 4.1)	2.1 (1.6, 2.6)	1.2 (1.0, 1.4)	1.0 (0.4, 2.8)
Spain	3.1 (1.6, 4.6)	2.1 (1.6, 2.7)	0.7 (0.4, 1.1)	0.7 (0.2, 2.1)
United Kingdom	0.0 (—, —)	0.0 (—, —)	0.4 (0.1, 1.1)	0.5 (0.1, 2.3)
United States	2.8 (2.3, 3.3)	2.4 (2.1, 2.7)	0.4 (0.3, 0.5)	0.4 (0.2, 0.6)
Overall	3.3	—	0.7	—

[a] Adjusted for age, gender, race, time on dialysis, hepatitis C virus (HCV), previous transplantation, alcohol use, and drug abuse in the past 12 months

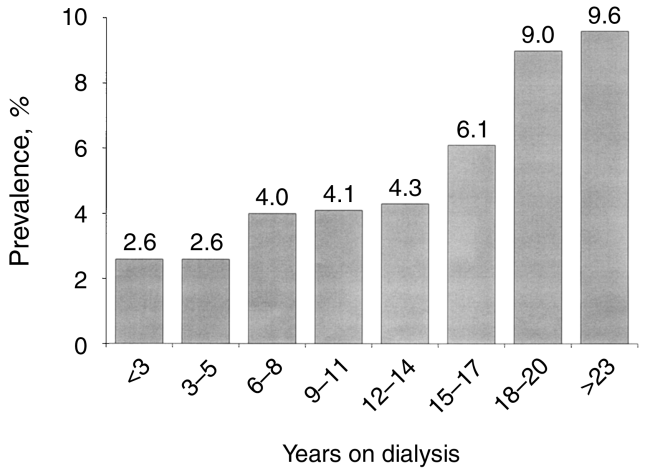

Fig. 1. Variation in hepatitis B virus (HBV) prevalence by patient's time on dialysis. The mean time on ESRD was 4.9 years, with a SD of 5.4 years.

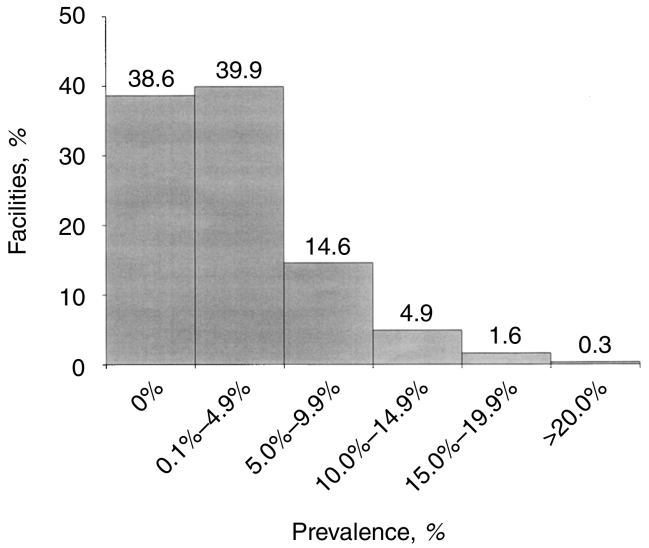

Fig. 2. Distribution of hepatitis B virus (HBV) prevalence by facility. Mean HBV prevalence was 3.1%, with a median of 2.0%. The percentage of facilities with an HBV prevalence of 0% to 5% was 77%.

Figure 2 shows the distribution of HBV prevalence across dialysis facilities. In the 308 facilities studied, the mean HBV prevalence was 3.1% with a median of 2.0%. The majority of facilities (78.5%) had HBV prevalence between 0% and 5%. Only 6.8% of facilities had HBV prevalence greater than 10%.

HBV seroconversion

Table 1 (column 4) provides the risk ratio (RR) of HBV seroconversion for a variety of demographic characteristics and comorbid conditions. Seroconversion was not significantly associated with any of the following factors: age, African American race, male gender, or time of ESRD by year. Infection with HCV was strongly and significantly associated with higher risk of seroconversion (AOR = 1.71, $P = 0.03$). Substance abuse as reported by the patient during the 12 months prior to data collection was not significantly associated with HBV seroconversion.

Table 2 provides HBV seroconversion rates by country, after adjustment for age, gender, race, time on dialysis, and 10 facility practice patterns. The RR for adjusted HBV seroconversion rates ranged from 0.4 to 1.8 seroconversions/100 patient-years.

Figure 3 shows the facility distribution of HBV seroconversion rates. Overall HBV seroconversion rate was 0.78 events per 100 patient-years. The majority of facilities (78.1%) had a seroconversion rate of 0 conversions per 100 patient-years.

Practice patterns and facility characteristics

Several practice patterns were evaluated for their association with HBV prevalence and seroconversion, as shown in Table 3. Results are shown for separate models (each practice pattern modeled separately) and combined models (all practice patterns included in the model simultaneously). All models were adjusted for patient characteristics. One practice pattern was significantly associated with HBV prevalence in the models with a single practice pattern. HBV prevalence was higher in facilities with an increase in the ratio of patients to dialysis stations (OR = 1.09, $P = 0.03$). There was also an association

Table 3. Associations among practice patterns and outcomes[a]

Practice pattern	Prevalence OR		Seroconversion RR[b]	
	Separate model (*P* value)	Combined model (*P* value)	Separate model (*P* value)	Combined model (*P* value)
Protocol for hepatitis B virus-infected patients *yes/no*	1.20 (0.46)	1.16 (0.53)	0.52 (0.03)[c]	0.44 (0.01)[c]
Isolate hepatitis B virus patients %	1.51 (0.06)	1.58 (0.047)[c]	0.77 (0.41)	0.78 (0.52)
Isolate hepatitis C virus patients %	1.20 (0.48)	0.82 (0.52)	0.60 (0.28)	0.53 (0.29)
Number of isolation stations *per station*	1.06 (0.22)	1.02 (0.71)	0.96 (0.56)	1.00 (0.98)
Patients/station *per 1 unit increase*	1.09 (0.03)[c]	1.11 (0.01)[c]	0.96 (0.56)	0.91 (0.28)
Hepatitis B virus vaccine routinely administered *yes/no*	0.71 (0.09)	0.80 (0.30)	2.58 (0.02)[c]	11.2 (0.007)[d]
Highly trained staff[e] *per 10%*[f]	0.92 (0.13)	0.91 (0.12)	1.41 (0.73)	1.03 (0.70)
Physician patient interaction *min/month*	1.00 (0.27)	1.00 (0.31)	1.00 (0.46)	1.00 (0.26)
Patient hours/direct patient staff hours	0.94 (0.69)	0.94 (0.70)	0.91 (0.54)	0.92 (0.63)
Routine screening for hepatitis B virus *yes/no*	1.33 (0.32)	1.44 (0.23)	1.01 (0.97)	0.76 (0.45)
Routine screening for hepatitis C virus *yes/no*	0.93 (0.71)	0.83 (0.30)	1.19 (0.55)	1.14 (0.71)
Facility treats acute patients *yes/no*	1.24 (0.24)	1.26 (0.26)	1.04 (0.90)	1.07 (0.83)
Facility size *per 10 patients*	1.01 (0.23)	1.00 (0.99)	0.99 (0.53)	0.99 (0.71)
Dialyzer reuse[g]	0.74 (0.19)	0.74 (0.52)	1.15 (0.74)	1.06 (0.91)

[a] Adjusted for age, gender, race, time on dialysis, comorbid conditions, history of drug use, history of alcohol use, presence of hepatitis C virus at the patient level, history of renal transplantation, hospital-based facility, and country of residence
[b] Also adjusted for facility prevalence of HBV
[c] $P < 0.05$
[d] $P < 0.01$
[e] Highly trained staff is defined as at least 2 years of formal nursing training
[f] For freestanding units only
[g] Model included only the three countries in DOPPS that reuse: the United States, Spain, and the United Kingdom

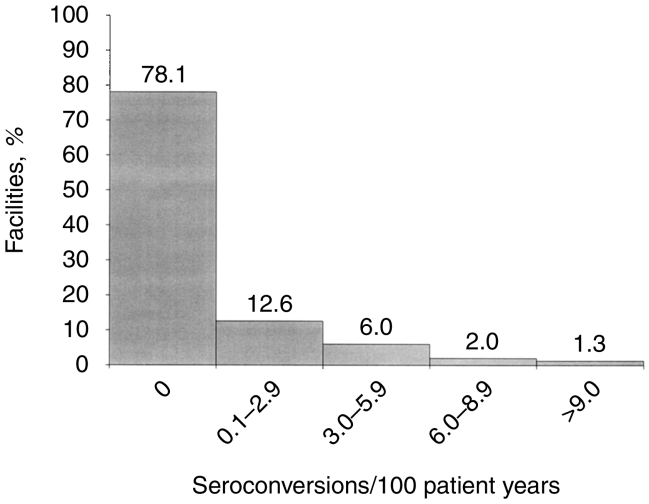

Fig. 3. Distribution of hepatitis B virus (HBV) seroconversion rates by facility. In 78.1% of facilities, the mean seroconversion rate was 0 seroconversions per 100 patient-years.

between increased HBV prevalence and isolation of patients infected with HBV (OR = 1.51, $P = 0.06$). Two practice patterns were significant in the model that included all practice patterns: isolating HBV patients (OR = 1.58, $P = 0.047$), and ratio of patients per station, with an AOR of 1.11 for each additional patient dialyzing at a hemodialysis station ($P = 0.01$).

In the models for HBV seroconversion that examined a single practice pattern, two practice patterns reached a level of significance: presence of a protocol for HBV-infected patients (RR = 0.52, $P = 0.03$) and routine administration of HBV vaccine (RR = 2.58, $P = 0.02$). Both of these practice patterns retained significance in the models that included all practice patterns: protocol for HBV-infected patients (RR = 0.44, $P = 0.01$), and routine administration of HBV vaccine (RR = 11.2, $P = 0.007$). Dialyzer reuse was not significantly associated with HBV seroconversion.

DISCUSSION

This prospective study estimated HBV prevalence and seroconversion rates in hemodialysis units in seven countries and evaluated associations between facility level practice patterns and HBV prevalence and seroconversion. The observed results indicate that HBV persisted even in the current environment of infection control measures. Furthermore, this analysis of DOPPS data demonstrates variation in HBV outcomes by patient characteristics (Table 1), by country (Table 2), and by hemodialysis facility practice patterns (Table 3). The DOPPS estimates of HBV prevalence by country do not contradict published reports that prevalence of HBV among hemodialysis patients is relatively higher in Italy and lower in Japan [26, 27]. It is possible that the differences we observed reflect differences in the underlying prevalence rate of HBV infection in the general population in these countries. Selection of patients to alternative renal replacement therapies is also possible. The United Kingdom treats a greater proportion of chronic dialysis patients with peritoneal dialysis. It is possible that patients in the United Kingdom with prior HBV infection are preferentially treated by peritoneal dialysis.

The DOPPS study did not evaluate HBV prevalence and seroconversion in developing countries, where studies have shown HBV infection rates are much higher [29–32].

The positive association between HBV prevalence and years on hemodialysis (Fig. 1) has been found previously. Albertoni et al [10] reported a sharp increase in HbsAg carriers in patients with 10 years or more of hemodialysis, a finding they attributed to a cohort effect. Our study, using data from 1997 through 1999, finds evidence for a cohort effect during a similar time period. DOPPS data demonstrate a markedly higher HBV prevalence in patients with 18 years or more of hemodialysis. The positive association between HBV prevalence and years of hemodialysis has several possible explanations. Older patients on dialysis started treatment before routine implementation of such practice patterns as donor blood screens for HbsAg, vaccination of ESRD patients against HBV, universal precautions, and use of erythropoietin. Although less likely, it is possible that patients who have undergone hemodialysis for a longer period of time have a longer time at risk for exposure to HBV than those patients who have been on hemodialysis for a shorter amount of time.

The significantly decreased risk for seroconversion associated with facilities reporting a protocol for patients infected with HBV is one of the strongest findings of this analysis (Table 3). Use of a protocol for control of HBV infection has proven crucial. The first reports of success in limiting HBV infection were from the United Kingdom after a "prevention and control program" was started in hemodialysis units in 1970 [36]. Also in 1970, in response to an outbreak of hepatitis in Edinburgh, Scotland, physicians initiated a specific set of infection control measures that effectively ended the outbreak [37]. In 1977, the Centers for Disease Control and Prevention (CDC) in the United States issued a set of recommendations for control of HBV in hemodialysis units [22]. The original recommendations were effective and most are still in place [38].

However, even in the current environment, in which infection control protocols have been established for over a decade, our analysis found large and significant differences in HBV outcomes associated with facility-level practice patterns. In this study, units that identified themselves as having a protocol for HBV-infected patients had a strongly and significantly decreased association with HBV seroconversion. This striking finding suggests that facility-level practice patterns related to HBV outcomes still exist, over and above those recommended by the CDC and other country-specific infection control agencies. Limitations of data collection did not allow for more detailed investigation of facility-specific protocols for HBV-infected patients. Those units that identified themselves as having such a protocol may have had specific clinical routines related to handwashing, use of gloves, or placement of patients and machines that minimized the spread of HBV. It is likely that further definition of optimal practice patterns and protocols at the facility level will yield opportunities for improved HBV control.

A key component of past and present infection control protocols is segregation of HbsAg-positive patients and their equipment. In this study, practice patterns related to patient isolation were linked with HBV prevalence and seroconversion (Table 3). The association between isolation of patients infected with HBV and increased prevalence of HBV may indicate the response of hemodialysis units to a higher HBV prevalence in their dialysis population. Dialysis centers with a high prevalence of HBV may have been more likely to have had a protocol that included isolation of patients infected with HBV. Success of such protocols may be reflected in the 22% decreased RR for seroconversion associated with isolation of patients infected with HBV, although this result did not achieve significance.

This analysis found an association between RR for HBV seroconversion and routine administration of HBV vaccine in both the univariate and the multivariate models. The reason for increased RR for HBV seroconversion associated with routine administration of HBV vaccine is not clear. Recent outbreaks of HBV have been linked to several practice patterns, including failure to routinely screen patients for HbsAg [39]. Currently, the CDC recommends routine HBV screening and vaccination [38]. One explanation for the association between vaccine administration and RR for seroconversion is that those units with a high rate of new HBV infection are more likely to vaccinate their patients in an effort to control HBV spread than units with a lower rate of new HBV infection.

This analysis evaluated associations between staffing practice patterns at the hemodialysis facility level and HBV outcomes. No clear association was found between physician interaction time with hemodialysis patients per month and HBV prevalence or seroconversion. Once an infection protocol is in place, it is largely the day-to-day responsibility of the nurses and technicians at the hemodialysis facility to carry out that protocol. Application of the protocol would then be independent of the presence of a physician at the hemodialysis facility. The decrease in HBV prevalence and seroconversion associated with an increase in the ratio of patient hours to direct patient staff hours was both small and not significant. The only practice pattern related to staffing that approached statististical significance in this analysis was a decreased risk for HBV prevalence in free-standing hemodialysis units with an increased number of highly trained staff (at least 2 years of formal nursing training).

An increase in highly trained staff was not associated with decreased HBV seroconversion.

One of the most striking differences in practice patterns among countries was the high level of dialyzer reuse within the United States. DOPPS results did not find a significant association between dialyzer reuse and RR for HBV seroconversion, a finding consistent with the results of other investigators [40, 41]. However, many hemodialysis centers choose not to reuse dialyzers from HbsAg-positive patients because handling of these dialyzers may place staff at risk for infection [38].

This prospective, observational study was designed to identify associations and so is less useful for rejecting a lack of association. A sample size of 308 hemodialysis units may not provide sufficient power to reject the null hypothesis of no association between certain practice patterns and HBV prevalence and seroconversion. For example, a significant association between isolation of HBV-positive patients and decreased RR for HBV seroconversion is biologically and clinically plausible, but not demonstrated in our study. Although our analysis did not demonstrate this association, we cannot confidently reject the null hypothesis of no association between isolation of HBV-positive patients and decreased RR for HBV seroconversion.

Community exposure to HBV may vary by country and by hemodialysis unit, so it is a potential confounder. Data collection for the DOPPS did not include detailed questions related to several potential community exposures. However, our analyses did attempt to adjust for potential confounding by community sources by adjusting all models for patient-reported drug and alcohol abuse in the 12 months prior to data collection and by adjusting all models for country.

Infection control within the chronic hemodialysis population has focused on HBV. Protocols to minimize HBV transmission have been in place in hemodialysis units for many years. Even so, our analysis found large and significant differences in HBV outcomes associated with facility-level practice patterns. Presence of a protocol for HBV-infected patients, as reported by individual hemodialysis units, was strongly and significantly associated with decreased risk for seroconversion. The observed variation suggests that further clarification of optimal practice patterns at the facility level may indicate opportunities for improved HBV control.

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