ORIGINAL ARTICLE

Oman Medical Journal [2019], Vol. 34, No. 4: 313-321

HBV Transmission Risk Assessment in Healthcare Workers, Household and Sexual Contacts of HBV Infected Patients in the Southwest Region of Cameroon

Kukwah Anthony Tufon[1,2]*, Henry Dilonga Meriki[1,2,3], Tebit Emmanuel Kwenti[1,2,3,4], Nyeke James Tony[1,2], Ekeme Malika[2,3], Ayah Flora Bolimo[1,2], Youmbi Sylvain Kouanou[1], Theresa Nkuo-Akenji[5] and Damian Nota Anong[5]

[1]Department of Microbiology and Parasitology, University of Buea, Buea, Cameroon
[2]Diagnostic Laboratory, Buea Regional Hospital, Buea, Cameroon
[3]Department of Public Health and Hygiene, Faculty of Health Science, University of Buea, Buea, Cameroon
[4]Department of Medical Laboratory Science, Faculty of Health Science, University of Buea, Buea, Cameroon
[5]Department of Biological Science, Faculty of Science, University of Bamenda, Bamenda, Cameroon

ARTICLE INFO

Article history:
Received: 31 January 2018
Accepted: 14 January 2019

Online:
DOI 10.5001/omj.2019.62

Keywords:
Hepatitis B Virus Infection; Risk Factors; Healthcare Worker-Patient Transmission; Infection Transmission, Horizontal.

ABSTRACT

Objectives: Hepatitis B virus (HBV) is known to be highly transmissible via the body fluids of an infected person. We investigated the transmission risks, awareness, and prevalence among healthcare workers (HCWs), household contacts (HHCs), and sexual partners (SPs) of HBV infected individuals. ***Methods***: We conducted a cross-sectional study of HCWs, HBV infected individuals as well as their corresponding HHCs and SPs. Data related to some transmission risks and HBV awareness was obtained from each participant using a questionnaire. Blood samples were collected from each participant and tested for hepatitis B surface antigen (HBsAg), hepatitis B e-antigen, and anti-hepatitis B core (anti-HBc). HBV viral load measurement was done for the HBV infected participants. ***Results:*** A total of 596 participants were enrolled (127 HCWs, 128 HHCs, 138 SPs, and 203 HBV infected participants). HHCs (odds ratio (OR): 3.85, confidence interval (CI): 1.89–7.81), and SPs (OR: 3.04, CI: 1.51–6.17) were more associated with HBsAg/anti-HBc positivity compared to HCWs. Age, years spent with HBV infected partner, unprotected sex, and marriage were not identified as risk factors for HBV sexual transmission but cohabiting with an HBV infected SP was significantly (p = 0.005) associated with transmission (OR: 3.56, CI: 1.46–8.72). Female HHCs (OR: 2.48, CI: 1.06–5.80) and SPs (OR: 2.64, CI: 0.95–7.30) were more associated with HBsAg/anti-HBc positivity. The mean viral load (log IU) of HBV infected individuals (3.9±2.0) with HBsAg positive SPs was significantly higher than that of HBV infected individuals (2.8±1.0) with HBsAg negative SPs (p < 0.001). ***Conclusions:*** HHCs and SPs of HBV infected patients are more associated with HBV infection compared to HCWs. Horizontal transmission can as well be implicated among SPs since unprotected sex was not identified as a risk factor for transmission, but cohabitation was. Prompt management and preventive measures could be implemented if HHCs and SPs of HBV infected patients are identified, sensitized, and screened.

Hepatitis B virus (HBV) affects millions of people worldwide.[1] It is directly responsible for liver-related mortalities as a result of liver failure, cirrhosis, and hepatocellular carcinoma.[2–5] HBV infection remains a major global health problem despite several measures placed to curb transmission. It is approximately 100-times more transmissible than HIV and approximately 10-times more transmissible than hepatitis C virus (HCV)[6] although the three infections share similar transmission routes. The efforts to prevent HBV transmission among adolescents and adults are hindered by the increased frequency of initiation of high-risk behaviors.[7]

Transmission of HBV occurs when an uninfected person comes in contact with infected blood and/

*Corresponding author: drkapt@yahoo.com

or body fluids (e.g., semen, vaginal secretions, etc).[8] All persons with serological evidence of hepatitis B surface antigen (HBsAg) are infectious, but those who also have hepatitis B e-antigen (HBeAg) are more infectious because their blood most likely contains high titers of HBV.[9]

HBV is known to have varying routes of transmission with several identified occupational, behavioral, and demographic risk factors.[3,7] Some individuals who are at high risk of contracting the infection include healthcare workers (HCWs), household contacts (HHCs), and sexual partners (SPs) to HBV infected persons.[8,10]

Horizontal transmission is common among HHCs through the sharing of personal items and/or long-term close contact, which may lead to the transfer of body fluids from an infected to an uninfected person.

The mechanism and possibility of HBV transmission among members of the same household/close contact remains unclear. This could be influenced by the following factors: viral load of the infected person, nature of the virus (intact or damaged) in body fluids, stage of the infection, the entry site of body fluid, and the immune status of the uninfected person.[11] Children who manage to bypass vertical transmission can still be at risk because they would still be subjected to long-term interpersonal contact with their infected mothers, which could lead to horizontal transmission of the disease.[12]

Sexual transmission is usually through unprotected vaginal, anal, or oral sex with an HBV infected person.[13] This happens to be the most common HBV transmission route in low endemic areas and developed countries.[11,14] SPs to HBV infected persons are at risk of contracting the infection via this route.

HCWs are directly or indirectly exposed to the infection due to the nature of their profession. Some medical procedures like dentistry, surgery, dialysis, close patient care, and analyzing potentially dangerous body fluids pose a risk if appropriate safety measures are not adhered to.[15,16] Needlestick injury or splashing of infected blood or body fluids are potential routes of transmission for HCWs.[17]

Understanding the HBV transmission risks among HCWs in Cameroon cannot be overemphasized as the prevalence in this group is 8.7%.[18] To the best of our knowledge, there is no published data on HBV prevalence among HHCs and SPs of HBV infected individuals in Cameroon even though these groups are subjected to obvious and possibly long-term contact with HBV infected persons. Moreover, there is higher risk of infection in an HBV endemic country like Cameroon. For these reasons, it is of public health importance to investigate the prevalence of the disease, assess transmission risks, awareness, and HBV knowledge among these groups so that effective measures can be implemented to reduce or eliminate the chances of transmission.

METHODS

The National Ethics Committee of Research for Human Health and the administrative authority of Buea Regional Hospital approved this study. Each participant signed an informed consent form before enrolment. The parents or guardians of children who took part in this study gave their approval and signed the consent form on behalf of their children. A counselor verbally explained the content of the consent form to those who could not read nor write.

This was a cross-sectional study that enrolled HCWs and HBV infected patients as well as their corresponding HHCs and SPs. The HBV infected participants were earlier identified and enrolled as described in a previous study.[19] They subsequently linked us to their SPs and HHCs.

This study was conducted at the Buea Regional Hospital, a secondary level multi-disciplinary reference hospital in the Southwest region of Cameroon.

The HCWs who participated in this study were nurses, doctors, and laboratory technicians working at the hospital for more than a year and who, to the best of their knowledge, do not live with and are not involved in any sexual relationship with an HBV infected person.

An eligible HHC was considered anybody living in the same house with an HBV infected person for more than six months, while an eligible SP was considered anybody who is or has been in a sexual relationship with an HBV infected person for more than six months.

The sample size was estimated using the formula described by Swinscow.[20]

$$n = \frac{Z^2 \times p\,(1\text{-}p)}{e^2}$$

$Z = 1.96$

p = prevalence of HBV infection among HCWs (calculated as 4.98%)[21]

e = error rate = 0.05

$$n = \frac{1.96^2\,(0.0498)\,(1\text{-}0.0498)}{0.05^2} = 72.7$$

We needed to enroll at least 73 HCWs for this study.

Chronic HBV patients enrolled in a previous study[19] at the Buea Regional Hospital between January 2016 and December 2017 linked us to their SPs and HHCs who were subsequently enrolled in this study. The high prevalence (8.0%) of HBV infection in the Southwest region of Cameroon[22] requires that we consider any HHC and/or SP of an HBV infected patient at risk of contracting the infection.

An interviewer-based standard questionnaire was administered to all participants to obtain demographic data as well as information on vaccine status, condom use, marital status, nature of relationship, present living condition, and the number of years spent with HBV infected individual (from HHCs and SPs). We also investigated the knowledge our participants had of HBV infection (nature of the disease, transmission routes, risk factors, and preventive measures). Participants were considered knowledgeable if they were able to answer 70% or more of these questions correctly.[23] The HCWs also provided us with additional information on their specialization, unit of work, and the number of years spent in service.

Blood (5 mL) was collected from each participant in EDTA tubes. The samples were centrifuged at 1000 g for 5 minutes to obtain plasma, which was used to test for HBsAg, anti-HBs, HBeAg, anti-HBe, and anti-hepatitis B core (anti-HBc) total using the HBV serologic profile kit (Blue Cross Bio-Medical Co.,Ltd, Beijing) as per the manufacturer's instruction.

The following results were used to consider current and past infections:

- Current infection: positive for HBsAg and anti-HBc
- Past infection: positive for anti-HBc only
- People with past and current infection: people positive for HBsAg and anti-HBc + people positive for anti-HBc only

Plasma from known HBV infected participants was shipped to Biocollections Worldwide (Miami, USA) for DNA extraction and viral load analysis.

Data analysis was carried out using SPSS Statistics (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Data were presented as the number of cases, percentages, and mean±standard deviation. Categorical comparisons were performed using the Pearson's chi-square test or the Fisher's exact test (for two-by-two cells having values < 5). A two-sided p-value < 0.050 was considered significant. Adjusted odds ratio (OR) was performed for cases that recorded p-value < 0.050 in the crude OR.

RESULTS

A total of 596 participants were enrolled; 127 HCWs, 128 HHCs, 138 SPs, and 203 HBV infected participants. Their demographics are given in Table 1.

HHCs (OR = 3.85) and SPs (OR = 3.04) were more associated with HBsAg/anti-HBc positivity compared to HCWs and this proved to be statistically significant both with the crude and adjusted OR [Table 2].

Of the 138 SPs, 73 (52.9%) were aware of their partners status and 28 (20.3%) had taken the HBV

Table 1: Age and gender distribution of the study population.

Groups (n)	Mean age, years	Age range, years	Gender	n (%)
Healthcare workers (127)	33.3 ± 7.0	23–54	Female	92 (72.4)
			Male	35 (27.6)
Household contacts (128)	23.0 ± 15.6	5–65	Female	72 (56.3)
			Male	56 (43.8)
Sexual partners (138)	31.0 ± 6.7	19–45	Female	80 (58.0)
			Male	58 (42.0)
Hepatitis B virus infected participants (203)	39.5 ± 4.5	18–61	Female	77 (37.9)
			Male	126 (62.1)

Table 2: Comparison of risk of hepatitis B virus (HBV) transmission between healthcare workers, household contacts, and sexual partners.

Group	n	HBsAg status		Evidence of past + current infection		Risk estimate					
						Crude OR			Adjusted OR*		
		Negative	Positive	Negative	Positive	OR	95% CI	*p*-value	OR	95% CI	*p*-value
Household contacts, n (%)	128	110 (85.9)	18 (14.1)	92 (71.9)	36 (28.1)	1.10	0.65–1.90	0.710			
Sexual partners, n (%)	138	118 (85.5)	20 (14.5)	102 (73.9)	36 (26.1)	1					
Household contacts, n (%)	128	110 (85.9)	18 (14.1)	92 (71.9)	36 (28.1)	2.92	1.51–5.67	0.001	3.85	1.89–7.81	< 0.001
Healthcare workers, n (%)	127	121 (95.3)	6 (4.7)	112 (88.2)	15 (11.8)	1			1		
Sexual partners, n (%)	138	118 (85.5)	20 (14.5)	102 (73.9)	36 (26.1)	2.63	1.36–5.10	0.003	3.04	1.51–6.17	0.002
Healthcare workers, n (%)	127	121 (95.3)	6 (4.7)	112 (88.2)	15 (11.8)	1			1		

**Adjusted for age and sex.*
HBsAg: hepatitis B surface antigen; OR: odds ratio; CI: confidence interval.

vaccine. Of the 128 HHCs, only 19 (14.8%) were aware of the fact that they were living with an HBV infected person and 12 (9.4%) had taken the HBV vaccine. Forty-six (33.3%) SPs and 82 (64.1%) HHCs had little or no knowledge of HBV. All 127 HCWs knew about HBV infection and 50 (39.4%) had taken the vaccine. Probable evidence of past infection (positive for anti-HBc only) was recorded in 18 (14.1%) of the 128 HHCs, 16 (11.6%) of the 138 SPs, and nine (7.1%) of the 127 HCWs.

Female HHCs were significantly more associated with HBsAg/anti-HBc positivity even in the adjusted OR (OR = 2.48, CI: 1.06–5.80) [Table 3]. Among HHCs, 18 out of the 36 (50.0%) who showed evidence of past and current infection were siblings of HBV infected cases while 12 (33.3%) who showed evidence

Table 3: Characteristics of household contacts and transmission risk.

Household contacts (n)	HBsAg status, n (%)			Evidence of past + current infection, n (%)		Risk estimate			
						Crude OR		Adjusted OR	
	Negative	Positive	*p*-value	Negative	Positive	OR (95% CI)	*p*-value	OR (95%CI)	*p*-value
Gender									
Female (72)	62 (86.1)	10 (13.9)	0.950	46 (63.9)	26 (36.1)	2.60 (1.13–5.99)	0.023	2.48 (1.06–5.80)	0.036
Male (56)	48 (85.7)	8 (14.3)		46 (82.1)	10 (17.9)	1		1	
Age, years									
< 30 (98)	82 (83.7)	16 (16.3)	0.180	72 (73.5)	26 (26.5)	0.72 (0.30–1.75)	0.468		
≥ 30 (30)	28 (93.3)	2 (6.7)		20 (66.7)	10 (33.3)	1			
HBeAg status of infected case									
Negative (124)	106 (85.5)	18 (14.5)	0.410	90 (75.6)	34 (27.4)	0.38 (0.05–2.79)	0.320		
Positive (4)	4 (100)	0 (0.0)		2 (50.0)	2 (50.0)	1			
HBV vaccination									
No (116)	99 (85.3)	17 (14.7)	0.550	85 (73.3)	31 (26.7)	0.51 (0.15–1.73)	0.279		
Yes (12)	11 (91.7)	1 (8.3)		7 (58.3)	5 (41.7)	1			

HBV: hepatitis B virus; HBsAg: hepatitis B surface antigen; HBeAg: hepatitis B e-antigen; OR: odds ratio; CI: confidence interval.

Table 4: Characteristics of sexual partners and transmission risks.

Sexual partners (n)	HBsAg status, n (%)			Evidence of past + current infection, n (%)		Risk estimate			
	Negative	Positive	*p*-value	Negative	Positive	Crude OR		Adjusted OR	
						OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Gender									
Female (80)	64 (80.0)	16 (20.0)	0.030	54 (67.5)	26 (32.5)	2.31 (1.01–5.29)	0.044	2.24 (0.95–7.30)	0.062
Male (58)	54 (93.1)	4 (6.9)		48 (82.8)	10 (17.2)	1		1	
Age, years							0.270		
< 30 (60)	49 (81.7)	11 (18.3)	0.370	42 (70.0)	18 (30.0)	1.53 (0.71–3.32)			
≥ 30 (78)	68 (87.2)	10 (12.8)		61 (78.2)	17 (21.8)	1			
Years spent with HBV infected partner									
≥ 5 (44)	36 (81.8)	8 (18.2)	0.400	34 (77.3)	10 (22.7)	0.77 (0.33–1.78)	0.540		
< 5 (94)	82 (87.2)	12 (12.8)		68 (72.3)	26 (27.7)	1			
Marital status									
Married (78)	68 (87.2)	10 (12.8)	0.530	54 (69.2)	24 (30.8)	1.78 (0.80–3.94)	0.156		
Single (60)	50 (83.3)	10 (16.7)		48 (80.0)	12 (20.0)	1			
Cohabiting with HBV infected partner									
Yes (68)	56 (82.4)	12 (17.6)	0.300	41 (60.3)	27 (39.7)	3.95 (1.73–9.04)	0.001	3.56 (1.46–8.72)	0.005
No (70)	62 (88.6)	8 (11.4)		60 (85.7)	10 (14.3)	1		1	
Condom use									
No (76)	66 (86.8)	10 (13.2)	0.550	56 (73.7)	20 (26.3)	0.63 (0.23–1.71)	0.361		
At times (40)	34 (85.0)	6 (15.0)	0.740	32 (80.0)	8 (20.0)	0.44 (0.14–1.40)	0.160		
Always (22)	18 (81.8)	4 (18.2)		14 (63.6)	8 (36.4)	1			
HBV vaccination									
No (110)	90 (81.8)	20 (18.2)	0.020	84 (76.4)	26 (23.6)	0.56 (0.23–1.56)	0.198		
Yes (28)	28 (100)	0 (0.0)		18 (64.3)	10 (35.7)	1			

HBV:hepatitis B virus; HBsAg: hepatitis B surface antigen; OR: odds ratio; CI: confidence interval.

of past and current infection were offspring of infected cases.

Female SPs were significantly more associated with the infection compared to male SPs, and this proved to be statistically significant only with the crude OR (OR = 2.31, CI: 1.01–5.29) [Table 4]. SPs who were cohabiting with their corresponding HBV infected SPs were significantly more associated with infection (OR = 3.95, CI: 1.73–9.04) compared to SPs who were not cohabiting [Table 4]. Seventeen (21.8%) of the married SPs admitted that they were not living with their spouses. Age, number of years spent with infected SP, and marital status did not show any statistically significant difference.

Among the 127 enrolled HCWs, 62 were nurses, 41 were medical doctors, and 24 were laboratory technicians. Six HCWs tested positive for HBsAg, and they were all nurses working in the medical (2), surgical (1), emergency (2), and maternity (1) wards. HCWs who had been working for more than

Table 5: Characteristics of healthcare workers and transmission risks.

Healthcare workers (n)	HBsAg status, n (%)			Evidence of past + current infection, n (%)		Risk estimate			
						Crude OR		Adjusted OR*	
	Negative	Positive	*p*-value	Negative	Positive	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Gender							0.594		
Female (92)	88 (95.7)	4 (4.3)	0.670	82 (89.1)	10 (10.9)	0.73 (0.23–2.32)			
Male (35)	33 (94.3)	2 (5.7)		30 (85.7)	5 (14.3)	1			
Age, years							0.141		
< 30 (41)	4 (100)	0 (0.0)	0.180	39 (95.1)	2 (4.9)	0.29 (0.06–1.34)			
≥ 30 (86)	80 (93.0)	6 (7.0)		73 (84.9)	13 (15.1)	1			
Specialty							0.074 0.313		
Nurse (62)	57 (91.9)	5 (8.1)	0.530	48 (77.4)	14 (22.6)	6.71 (0.83–54.17)			
Lab technician (41)	41 (100)	0 (0.0)	0.310	41 (100)	0 (0.0)	0.19 (0.01–4.82)			
Doctor (24)	23 (95.8)	1 (4.2)		23 (95.8)	1 (4.2)	1			
Years in service									
≥ 10 (69)	64 (92.8)	5 (7.2)	0.180	57 (82.8)	12 (17.4)	3.84 (1.03–14.29)	0.044	2.01 (1.12–10.19)	0.185
< 10 (58)	57 (98.3)	1 (1.7)		55 (94.8)	3 (5.2)	1		1	
HBV vaccination									
No (77)	71 (92.2)	6 (7.8)	0.080	63 (81.8)	14 (18.2)	10.89 (0.38–85.68)	0.005	4.72 (0.56–39.70)	0.153
Yes (50)	50 (100)	0 (0.0)		49 (98.0)	1 (2.0)	1			

HBV: hepatitis B virus; HBsAg: hepatitis B surface antigen; OR: odds ratio; CI: confidence interval.

10 years and those who had not been vaccinated against HBV were more associated with HBsAg/anti-HBc positivity although this did not prove to be statistically significant in the adjusted OR [Table 5].

The lowest and highest viral loads for HBV infected cases who had an HBsAg positive SP were 664 IU/mL (2.82 in log IU) and 277 124 060 IU/mL (8.36 in log IU), respectively. The lowest and highest viral loads for HBV infected cases who recorded at least one HBsAg positive HHC were 2 233 IU/mL (3.35 in log IU) and 302 111 IU/mL (5.48 in log IU), respectively. The mean viral load (log IU) of HBV infected individuals (3.9±2.0) with HBsAg positive SPs was significantly higher than that of HBV infected individuals (2.8±1.0) with HBsAg negative SPs ($p < 0.001$) [Table 6].

DISCUSSION

Due to the already established risky nature of their profession, HCWs practice a lot of safety precautions when dealing directly with patients or patient samples. Some of these precautions include: (1) understanding the disease and knowing their limits when taking care of a patient, (2) always wearing personal protective equipments on duty, (3) always disinfecting work areas and sterilizing reusable working materials after use, (4) ensuring that biohazard waste materials are properly disposed or incinerated, and (5) getting vaccinated against the infection. The proper implementation of all these safety precautions by HCWs technically reduces their chances of contracting an infection. HCWs were the most vaccinated (39.4%) high risk group in this study. Most SPs and HHCs

Table 6: Comparing household contacts and sexual partners hepatitis B virus (HBV) status with the mean viral loads of their corresponding HBV infected contacts.

High risk groups (n)	Mean viral load (log IU) comparison of the corresponding HBV infected participants		
	Mean ± SD	95% CI	*p*-value
Household contacts			
HBsAg status (current infection)			0.816
Positive (18)	2.0 ± 1.6	-0.90–1.15	
Negative (110)	2.1 ± 2.1		
Evidence of current and past infection			0.108
Positive (36)	2.6 ± 2.1	-0.14–1.39	
Negative (92)	1.9 ± 1.9		
Sexual partners			
HBsAg status (current infection)			< 0.001
Positive (20)	3.9 ± 2.0	0.57–1.77	
Negative (118)	2.8 ± 1.0		
Evidence of current and past infection			< 0.001
Positive (36)	3.6 ± 1.7	0.48–1.45	
Negative (102)	2.7 ± 1.0		

SD: statndard deviation; CI: confidence interval; HBsAg: hepatitis B surface antigen.

interact with their HBV infected contacts without any form of precaution, and this could be because they do not know much about HBV infection. Our study and others[24] have shown that people living with HBV infected individuals have very poor or little knowledge of HBV infection. Some are also not aware of the fact that they are living with an infected person, and some do not know that they are classified as high-risk when it comes to contracting HBV infection. Their high level of ignorance could be the reason why most SPs and HHCs are not vaccinated and this, of course, justifies why they are more associated with HBsAg/anti-HBc positivity compared to HCWs. Although this has been proven to influence transmission in previous studies,[25,26] HCWs work unit could not be addressed in our study because the nurses admitted that their units of work are not permanent and can be changed whenever the hospital administration deems it necessary.

The length of time spent with an HBV infected person may also influence transmission. HHCs and SPs have longer and more frequent contact with their respective HBV infected contacts compared to HCWs who get in contact with infected patients occasionally.

HHCs recorded the highest prevalence of HBV infection among all the risk groups studied. Another study recorded a similar percentage (30.1%) for HBV prevalence among HHCs of HBsAg positive persons.[27] Horizontal transmission of HBV infection has several different paths that can be implicated, and this makes it difficult to guess how the infection was transmitted for any given case. Other bodily fluids, like saliva and tears, have also been shown to carry the virus.[11]

HBV sexual transmission is common[28] and the primary risk factor associated with this is unprotected sex with an HBV infected partner (heterosexual or homosexual). Thirty-six (26.1%) SPs in our study had evidence of past and/or current HBV infection. Female sex was identified as a risk factor associated with sexual transmission. In heterosexual relationships, uninfected women are at a higher risk of contracting HBV from an HBsAg positive male partner than the reverse. This is because women are on the receiving end of semen, which greatly increases their risk of infection during unprotected sex.[29] Although about 84% of SPs admitted that they had unprotected sex with their infected partners at least once (considering those who said they did not use condoms at all and those who said they use it occasionally), unprotected sex was not identified as a risk factor for HBV transmission. This is not in line with the findings of other studies[30] in other parts of the world.

Marriage was not significantly associated with HBV sexual transmission but cohabiting with an HBV SP was. Pre-marital screening may account for the fact that being married to an HBV infected person was not identified as a risk factor in our study. HBsAg screening before marriage increases the couples awareness and, as a result, appropriate protective measures (e.g., vaccination, limited contact with partner's bodily fluids) are taken if one person is HBsAg positive. The fact that some married people admitted not living in the same town or together with their spouse could also account for the reason why we did not identify marriage as a risk factor. Identifying cohabitation with an infected SP as a risk factor for HBV transmission led us to one big question: were these cases infected via sexual transmission? Cohabitation with an HBV

infected SP over a long time also predisposes you to the horizontal transmission route of HBV,[31] so it is possible that some of these cases contracted the infection via this route. In addition, the fact that unprotected sex was not identified as a risk factor for sexual transmission in our study further indicates that the chances of horizontal transmission here cannot be overlooked. Another study carried out in the Southwest region of Cameroon revealed that HBV sexual transmission is not a significant/predominant route of transmission[32] as seen in America and Europe where men who have sex with men are more common and could be a risk factor.[30,33,34] The type of sex (oral, vaginal, or anal) and timing (e.g., having sex with a woman on her menses) can also influence sexual transmission.[29] Unfortunately, our study was not designed to go into all these details.

Generally, keeping human factors aside, the transmission of HBV may also depend on some viral factors like the HBeAg status, virus integrity, and the HBV viral load of the infected person.[11] Some studies talk about initiating HBV antiviral therapy for HBsAg positive pregnant women with viral loads as high as 10^6–10^8 copies/mL to reduce the risk of perinatal transmission.[35,36] Research conducted in Ghana showed that HBsAg positive pregnant women with a viral load ≥ 1×10^4 IU/mL had a higher chance of perinatally transmitting HBV to their infants compared with those with viral loads < 1×10^4 IU/mL.[37] Our study showed that the mean viral load of HBV infected cases who had HBsAg positive SPs was significantly higher than those with HBsAg negative SPs. The lowest viral load for an HBV infected person with an HBsAg positive SPs was 664 IU/mL while that of an HBV infected person with at least one HBsAg positive HHC was 2233 IU/mL. The HBV infected cases that had HBsAg negative SPs/HHCs recorded viral loads as low as undetectable. Although this information does not give us a cut-off level of viral load to guarantee transmission (more research needs to be done on this subject), it tells us that transmission is seemingly more evident for cases with elevated viral loads. However, other factors may also need to be considered before any conclusion. Firstly, the kind of activities or how much contact an uninfected person has with the infected person may influence transmission. Secondly, we measured viral load only once and maybe the time factor here influenced our findings in one way or the other because the fact that someone has a low or undetectable viral load at the time of testing does not mean that was the case some months/years before. Thirdly, we were not able to determine who was infected first. The fact that you got to know your HBV status before your sexual partner/household contact does not mean you contracted it first.

Our study measured viral loads only for the HBsAg positive cases who linked us to their partners/contacts. No viral load test was done for partners/contacts who eventually had an HBsAg positive result in the course of the study. Some of these limitations probably accounts for the reason why most studies done to relate HBV DNA levels and transmission possibilities have been with regards to perinatal transmission only.[35–38]

CONCLUSION

HHCs and SPs to HBV patients are less knowledgeable and at greater risk of contracting the infection compared to HCWs. Horizontal transmission can as well be implicated among SPs given that the majority of them with serological evidence of past and current infection were cohabiting with their respective HBV infected partners and unprotected sex was not identified as a risk factor for sexual transmission. Increased sensitization and prompt screening of all HHCs and SPs of already identified HBV infected patients should be encouraged to help identify infected cases early enough and implement management and preventive measures.

Disclosure
The authors declared no conflicts of interest. No funding was received for this study.

Acknowledgements
We would like to acknowledge the assistance we had from the administrators of the Buea Regional Hospital which made this work possible. We wish to thank all the participants who accepted to be a part of this study. Special thanks go to Biocollections Worldwide Miami in USA for performing HBV viral load analysis.

REFERENCES

1. WHO. Hepatitis B. 2017 [cited 2018 Jan 8]. Available from: http://www.who.int/mediacentre/factsheets/fs204/en/.
2. Nwokediuko SC. Chronic hepatitis B: management challenges in resource-poor countries. Hepat Mon 2011 Oct;11(10):786-793.
3. WHO. Guidelines for the prevention, care and treatment of persons with chronic hepatitis B infection. 2015 [cited

2016 Mar 6]. Available from: http://apps.who.int/iris/bitstream/10665/154590/1/9789241549059_eng.pdf?ua=1&ua=1.

4. WHO. Hepatitis B. Emergencies preparedness, response. 2002 [cited 2016 Mar 6]. Available from: http://www.who.int/emc.
5. Lavanchy D. Hepatitis B virus epidemiology, disease burden, treatment, and current and emerging prevention and control measures. J Viral Hepat 2004 Mar;11(2):97-107.
6. CDC. Recommendations for preventing transmission of human immunodeficiency virus and hepatitis B virus to patients during exposure-prone invasive procedures. MMWR Morb Mortal Wkly Rep 1991;40(8):1-9.
7. Mast EE, Weinbaum CM, Fiore AE, Alter MJ, Bell BP, Finelli L, et al. A comprehensive immunization strategy to eliminate transmission of hepatitis B virus infection in the United States. MMWR: Reccommendations of the Advisory Committee on Immunization Practices (ACIP) Part II: immunization of adults. 2006;55(RR-16):1-33.
8. CDC. Hepatitis B FAQs for the public | division of viral hepatitis | CDC. 2016 [cited 2018 Jan 9]. Available from: https://www.cdc.gov/hepatitis/hbv/bfaq.htm.
9. Nguyen MH, Keeffe EB. Are hepatitis B e antigen (HBeAg)-positive chronic hepatitis B and HBeAg-negative chronic hepatitis B distinct diseases? Clin Infect Dis 2008 Nov 15;47(10):1312-1314.
10. Memon AR, Shafique K, Memon A, Draz AU, Rauf MU, Afsar S. Hepatitis B and C prevalence among the high risk groups of Pakistani population. A cross sectional study. Arch Public Health 2012 Apr 26;70(1):9.
11. Komatsu H, Inui A, Fujisawa T. The role of body fluids in the horizontal transmission of hepatitis B virus via household/close contact. Eur Med J 2016;1(1):67-75.
12. Amiri SS, Soleimani MJ, Hasanjani MR. Possible sources for transmission of hepatitis B virus infection in 80 children in Babol, North of Iran. Casp J Intern Med 2010;1(2):50-52.
13. Villeneuve JP. The natural history of chronic hepatitis B virus infection. J Clin Virol 2005 Dec;34(Suppl 1):S139-S142.
14. Atkins M, Nolan M. Sexual transmission of hepatitis B. Curr Opin Infect Dis 2005 Feb;18(1):67-72.
15. Kohn WG, Collins AS, Cleveland JL, Harte JA, Eklund KJ, Malvitz DM. Guidelines for infection control in dental health-care settings --- 2003. Morb Mortal Wkly Rep 2003;52(17):1-61.
16. Beltrami EM, Williams IT, Shapiro CN, Chamberland ME. Risk and management of blood-borne infections in health care workers. Clin Microbiol Rev 2000 Jul;13(3):385-407.
17. Foley M, Leyden A. American nurses association independent study module, needlestick safety and prevention. Sótt þann 2003;1–33. [cited 2018 Jan 9]. Available from: https://www.who.int/occupational_health/activities/1anaism.pdf.
18. Bilounga Ndongo C, Eteki L, Siedner M, Mbaye R, Chen J, Ntone R, et al. Prevalence and vaccination coverage of hepatitis B among healthcare workers in Cameroon: A national seroprevalence survey. J Viral Hepat 2018 Dec;25(12):1582-1587.
19. Tufon KA, Anong DN, Meriki HD, Georges TD, Maurice M, Kouanou YS, et al. Characterization and assessment of HBV chronically infected patients: Identification of those eligible for treatment in the South West region of Cameroon. PLoS One 2018;13(9):e0203312.
20. Swinscow TD, Campbell MV. Statistics at square one. I. Tabulation of data. 10th ed. British Medical Journal; 2002. p. 18-23.
21. Ngekeng S, Chichom-Mefire A, Nde P, Nsagha D, Nkuigue A, Tiogouo K, et al. Hepatitis B prevalence, knowledge and occupational factors among health care workers in fako division, south west region Cameroon. Microbiol Res J Int 2018;23(4):1-9.
22. Bigna JJ, Amougou MA, Asangbeh SL, Kenne AM, Noumegni SR, Ngo-Malabo ET, et al. Seroprevalence of hepatitis B virus infection in Cameroon: a systematic review and meta-analysis. BMJ Open 2017 Jun 30;7(6):e015298.
23. Abdela A, Woldu B, Haile K, Mathewos B, Deressa T. Assessment of knowledge, attitudes and practices toward prevention of hepatitis B virus infection among students of medicine and health sciences in Northwest Ethiopia. BMC Res Notes 2016 Aug;9(1):410.
24. Frambo AA, Atashili J, Fon PN, Ndumbe PM. Prevalence of HBsAg and knowledge about hepatitis B in pregnancy in the Buea Health District, Cameroon: a cross-sectional study. BMC Res Notes 2014 Jun 25;7:394.
25. Schillie S, Murphy TV, Sawyer M, Ly K, Hughes E, Jiles R, et al; Centers for Disease Control and Prevention (CDC). CDC guidance for evaluating health-care personnel for hepatitis B virus protection and for administering postexposure management. MMWR Recomm Rep 2013 Dec;62(RR-10):1-19.
26. Kosgeroglu N, Ayranci U, Vardareli E, Dincer S. Occupational exposure to hepatitis infection among Turkish nurses: frequency of needle exposure, sharps injuries and vaccination. Epidemiol Infect 2004 Jan;132(1):27-33.
27. Ashraf H, Alam NH, Rothermundt C, Brooks A, Bardhan P, Hossain L, et al. Prevalence and risk factors of hepatitis B and C virus infections in an impoverished urban community in Dhaka, Bangladesh. BMC Infect Dis 2010 Dec 15;10:208.
28. Shepard CW, Simard EP, Finelli L, Fiore AE, Bell BP. Hepatitis B virus infection: epidemiology and vaccination. Epidemiol Rev 2006 Jun 1;28(1):112-125.
29. Hepatitis B foundation. If hepatitis B is sexually transmitted, how come my partner isn't infected? 2017 [cited 2017 Dec 7]. Available from: http://www.hepb.org/blog/hepatitis-b-sexually-transmitted-come-partner-isnt-infected/.
30. Inoue T, Tanaka Y. Hepatitis B virus and its sexually transmitted infection - an update. Microb cell (Graz, Austria) 2016 Sep 5;3(9):420-437.
31. Martinson FEA, Weigle KA, Royce RA, Weber DJ, Suchindran CM, Lemon SM. Risk factors for horizontal transmission of hepatitis B virus in a rural district in Ghana. Am J Epidemiol 1998;147(5):478-487.
32. Shevell L, Meriki HD, Cho-Ngwa F, Fuller C. Epidemiology of human immunodeficiency virus-1 and hepatitis B virus co-infection and risk factors for acquiring these infections in the Fako division of Southwest Cameroon. BMC Public Health 2015 Dec 17;15(1):1066.
33. del Rio C. Despite advances, HBV infection remains common among MSM. NEJM J Watch 2015 Nov 2. 2015 [cited 2017 Dec 7]. Available from: https://www.jwatch.org/na39306/2015/11/02/despite-advances-hbv-infection-remains-common-among-msm.
34. Franco E, Bagnato B, Marino MG, Meleleo C, Serino L, Zaratti L. Hepatitis B: epidemiology and prevention in developing countries. World J Hepatol 2012 Mar 27;4(3):74-80.
35. Belopolskaya M, Avrutin V, Firsov S, Yakovlev A. HBsAg level and hepatitis B viral load correlation with focus on pregnancy. Ann Gastroenterol 2015;28(3):379-384.
36. Borgia G, Carleo MA, Gaeta GB, Gentile I. Hepatitis B in pregnancy. World J Gastroenterol. 2012 Sep 14;18(34):4677-4683.
37. Candotti D, Danso K, Allain J-P. Maternofetal transmission of hepatitis B virus genotype E in Ghana, west Africa. J Gen Virol 2007 Oct 1;88(10):2686-2695.
38. Tran TT. Management of hepatitis B in pregnancy: weighing the options. Cleve Clin J Med 2009 May 1;76(Suppl 3):S25-S29.