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Conditional Probabilities of HBV markers among Health Care Workers in Public Hospitals in White Nile State, Sudan; 2013

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Abstract

Background: Health-care workers are having highest probability of being infected with HBV.

Objective: To determine conditional probability of sero-prevalence of hepatitis B virus markers among health care workers in White Nile State, Sudan.

Methods: A cross sectional study design with analytical approach was used. Three hundred eighty five health care workers were selected randomly. An interview was carried using a pre-tested questionnaire and five ml venous blood samples were consented. Blood samples were tested for Anti-HB core total, HBsAg and HBeAg. Conditional probabilities of being a carrier and highly infective were calculated regarding departments, occupation of HCWs, marital status and working duration in hospital.

Results: Out of the total study population, 230 (59.7%) were positive for anti-HB core total. Out of 230 HCWs, 62 (27.1%) were positive for HBsAg. Out of 62 HCWs, 29 (46.8%) were positive for HBeAg. In overall, 16% of study population was carriers and 7.5% were highly infective. HCWs in surgical and Obstetrics & gynaecology had 0.50 conditional probability of being carriers and highly infective. Laboratory technicians had 0.64 conditional probability of being carriers and highly infective. HCWs with working duration in hospitals up to 5 years had 0.63 probability of being carriers and highly infective.

Conclusion: Prevalence and conditional probabilities of HBV markers among health care worker in White Nile State were high. HCWs in Surgical and Obstetrics & gynaecology, Laboratory technicians and HCWs with working duration up to 5 years are carriers and highly infective. Periodical screening and vaccination of HCWs are recommended.

Keywords: HBV markers, HCWs, conditional probability, White Nile State, Sudan

1. Introduction

Globally; almost two billion were infected with hepatitis B virus (HBV). The infectivity of HBV is 50 to 100 times higher than HIV (WHO, 2012). Internationally; HBV is a leading cause of morbidity and mortality in the presence of the era of vaccines and antiviral treatment (Mahgoub, Candotti, El-Ekiaby, & Allain, 2011). Health-care workers are having the highest probability of being infected with HBV during medical career in health institutions (Deuffic-Burban, Delarocque-Astagneau, Abiteboul, Bouvet, & Yazdanpanah, 2011; Mele et al., 2001; De Schryver, Claesen, Meheus, van Sprundel, & François, 2011). The risk of catching infection varies between and in-between health institutions as well as at geographical areas for general population. The modalities of prevalence of HBV virus varies between countries. In Western Brazilian Amazon, the infection rate of HBV measured by hepatitis B core antibodies (anti-HBc) is 79.1% (Castilho Mda, Oliveira, Gimaque, Leão, & Braga, 2012). In Southern Iran; the infection with HBV (anti-HBc) and carrier rates (HBsAg) are 22.2% and 11% respectively (Mohammad et al., 2014). A high infectivity rate of 20% was reported in Bangkok presented by positive HBeAg (Luksamijarulkul, Maneesri, & Kittigul, 1995). An alarming HBV figures in sub-Saharan Africa are noticed where HBV infection is above 60% and the carrier rate is 8% (Parkin, Bray, Ferlay, & Pisani, 2005). The carrier rates ranged between 7%–40% in some African countries like Ethiopia, Nigeria, and Tanzania. The highest carrier

rates are found in Burundi, Central African Republic, and Uganda that ranged between 10%- 15% (de Lalla et al., 1990; Pawlotsky, Bélec, &Grésenguet, 1990; Pellizzer, Blè, &Zamperetti, 1994; Ejele & Ojule, 2004; Abebe et al., 2003).

Studies in Sudan and Yemen have shown that the prevalence of HBV carrier among HCWs was 6% and 9.9% respectively (Elmukashfi, Ibrahim, Elkhidir, Bashir, & Elkarim, 2012; Shidrawi, Ali, Ahmad, Dayton, & Murray-Lyon, 2004). A community base study in Gezira State, Central Sudan resulted in HBV infection and carrier rates as 47.5% and 6.9% respectively (World Health Organization, 1996; Mudawi et al., 2007; McCarthy, el-Tigani, Khalid, & Hyams, 1994; Hatim, 2008). The infection rate of HBV in Sudan ranged from 47%-78%, and the carrier rate from 6.8%–26% (Hatim, 2008). Sudan is one of the countries that are highly endemic of HBV where almost all age groups are at risk (Elduma & Saeed, 2006). HBV is the main cause of hepatocellular carcinoma and it is the second cause of acute liver failure in Sudan (Elduma & Saeed, 2006). An HIV survey in eastern part of Sudan showed 68% of at risk population has positive test for HBV markers (McCarthy et al., 1989). The prevalence of HBV carrier in Gezira State among blood donors and laboratory staff was 17.3% and 12.1% respectively (Elshafie, 1992). This is triggering the attention about HBV situation in low and middle income countries including Sudan where resources are limited and the health system has insufficient measures of infection control (Hussain, Patrick, & Shams, 2010). However; the probability of being HBV carrier among health care workers in White Nile State stimulates the stakeholders at local health system to strengthen the preventive measures. The objective of the study is to determine the conditional probability of sero-prevalence of hepatitis B virus infectivity markers among health care workers in Public Hospitals in White Nile State, Sudan and to estimate each conditional probability at different departments in the hospitals, among occupation of HCWs, their marital status and the working duration in the hospitals.

2. Materials and Methods

The study was a cross sectional design with analytical approach using conditional probability. White Nile State is the study area. It is one of 18 states of Sudan. It has an area of 3041 km^2 and a population of 1,188,707 distributed in eight localities.

The study population was health care staff working in 23 Public Hospitals in the State. The eligible health care worker (HCW) was that working in the hospital for at least 45 days or more. The total number of HCWs in the State was 1808.

The sample size was 391 CHWs that determined by the binomial formula for cross sectional studies (Charan & Biswas, 2013):

$$\mathrm{n} = \frac{z^2 pq}{d^2} * deff$$

Where;

n= Desired sample size, z= is the confidence coefficient =1.96

p= the prevalence rate selected at 15%. The rationale is that, White Nile State is bordered by South Sudan in the southern part of the country and central states from the northern. The prevalence of carriers with positive hepatitis B surface antigen (HBsAg) ranged between 6.8% in central Sudan to 26% in southern Sudan (Hatim MY Mudawi, 2008). Therefore the average prevalence of HBsAg was considered as benchmark for calculation of the sample size.

q= (1 –p)

d = is the acceptable marginal errorat 0.05, deff is the design effect of the stratification that equal 2.

Finally; none response rate was 0.02% (six respondents) resulted in target sample size 385.

2.1 Selection of Sample and Data Collection

Thirteen hospitals were selected by probability proportional to size from the total hospital in the State. In each hospital, the departments were categorized to strata depending on the three levels of hazards. The resulting strata were considered as primary sampling units (PSU). The HCWs were selected randomly from PSU at each hospital.

The sample of HCWs was divided proportionately among different PSU. Participants were selected randomly within each PSU. Tools and methods of data collection composed of interview using a pre-tested questionnaire and withdrawal of five ml of venous blood samples. The blood samples were managed by separation of sera and storage at -20° centigrade.

Anti-HB core total in the sera was tested by ELISA. Thereafter; positive anti-HB core total samples were screened

for HBsAg followed by testing positive HBsAg specimens for HBeAg. We did not screen anti-HB core negative persons for HBsAg. The conditional probabilities of being a carrier and infective were calculated regarding departments, occupation of the HCWs, marital status and working duration in the hospital.

2.2 Data Analysis

Data was processed and analyzed by SPSS software version 20. Conditional probability was calculated manually using Bayesian analysis formula below:

$$\Pr(A_i / B_j) = \Pr \frac{(A_i \cap B_j)}{\Pr(B_j)} = \Pr(A_i) * \frac{\Pr(B_j / A_i)}{\Pr(B_j)} \quad (3)$$

Chi square test at 95% CL was used to test HBV markers at different departments in the hospitals, occupation of HCWs, marital status and the working duration in the hospitals.

Application of Bayesian Analysis

Bayesian analysis was used to predict the conditional probability where the prior probability of HBV infection was calculated manually to reflect the acquisition of additional information about carrier and high infectivity rates as posterior probabilities.

3. Results

The study population composed of 154 males (40%). Regarding age, 30.9% were in the age group 27–36 years, 20.0% in the age group 47–56 years and 13.2% in the age group 57 and more. The married HCWs constitute 60% of the sample and 39% were single.

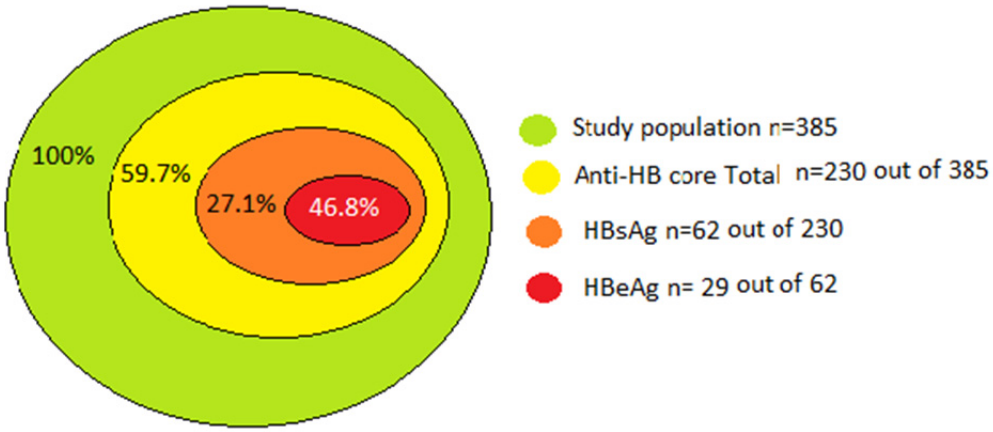

Figure 1.Prevalence of HBV markers among HCWs in hospitals in White Nile State 2013

Out of the total study population, 230 (59.7%) were positive for anti-HB core total. Out of 230 HCWs, 62 (27.1%) were positive for HBsAg. Out of 62 HCWs, 29 (46.8%) were positive for HBeAg that were highly infective. In overall, 16% of study population was carriers and 7.5% were highly infective. (Figure 1)

Table 1. Distribution of HBV carriers by HCWs characteristics given that a HCW is positive for anti-HB core total in White Nile State, Sudan; 2013

HCWs characteristics		+ve anti-HB core total $\Pr(B_j)$ N=230	Joint Probability. $A_i \cap B_j$	Conditional Probability. $\Pr(A_i / B_j)$	P-Value*
Departments	Surgery	0.59	0.10	0.17	0.001
	Obstetrics & gynaecology.	0.58	0.16	0.27	0.001
	Dentistry[¥]	0.430	0.0	0.0	.008
	Pharmacy	0.46	0.10	0.20	0.004
	Non-surgical and non-pharmaceutical	0.62	0.18	0.29	0.001
	TOTAL	0.60	0.16	0.27	0.001
Occupation	Doctor	0.63	0.22	0.34	0.001
	Pharmacist	0.50	0.08	0.17	0.002
	Nurse	0.68	0.15	0.22	0.001
	Nurse midwife	0.53	0.07	0.13	0.001
	Midwife not nurse	0.70	0.10	0.14	0.007
	Lab technician.	0.55	0.22	0.41	0.001
	Labour	0.53	0.14	0.27	0.001
	Operation assistant.	0.64	0.18	0.29	0.004
	TOTAL	0.60	0.16	0.27	0.001
Marital status	Married	0.54	0.15	0.27	0.001
	Single	0.67	0.19	0.29	0.001
	Widow[#]	0.545	0.00	0.00	.001
	Divorce	0.67	0.11	0.17	0.011
	TOTAL	0.60	0.16	0.27	0.001
Duration of work	Less than 1 year	0.70	0.15	0.22	0.001
	1-2 years	0.66	0.20	0.30	0.001
	Up to 5 years	0.60	0.21	0.36	0.001
	Up to 10 years	0.53	0.15	0.27	0.001
	Up to 20 years	0.59	0.18	0.31	0.001
	More than 20 years	0.55	0.09	0.17	0.001
	TOTAL	0.60	0.16	0.27	0.001

3.1 Hospital Departments' Factor

Three dentists were not carriers but positive for anti-HB core total.

The conditional probability of being positive for HBsAg and positive for anti-HB core total was significantly found in 27% of HCWs in Obstetrics & gynaecology department. Other departments including non-surgical and non- pharmaceutical had a significant conditional probability of 0.29. Surgical department had shown the least conditional probability of 0.17. (Table 1)

3.2 Occupation Factor

The highest conditional probability of being a carrier and positive for anti-HB core total was found among laboratory technicians, 0.41 followed by doctors, operation assistants and labours, 0.34, 0.29 and 0.27 respectively, P-value 0.001. The least conditional probability was among nurse midwives and non-nurse midwives, 0.13 and

0.14 respectively, P-value 0.001 and 0.007. (Table 1)

3.3 Marital Status Factor

Six widows were positive anti-HB core total but not carriers. The conditional probability of being a carrier and positive for anti-HB core total was 0.27 and 0.29 among married and single HCWs respectively, P-value 0.001. (Table 1)

3.4 Working Duration Factor

The highest conditional probability of being a carrier and positive anti-HB core total was 0.36 among HCWs with up to 5 years working duration in the hospitals, P-value 0.001. The working duration of 10 years and 20 years have conditional probabilities of 0.27 and 0.31 respectively, P-value 0.001. (Table 1)

Table 2. Distribution of HBV highly infective rate by HCWs characteristics given that a HCW is positive for HBsAg in White Nile State, Sudan; 2013

HCWs characteristics		+ve HBsAg $\Pr(B_j)$ N=62	Joint Probability. $A_i \cap B_j$	Conditional Probability. $\Pr(A_i / B_j)$	P-Value*
Department	Surgery	0.10	0.05	0.50	0.001
	Obstetrics & gynaecology.	0.18	0.08	0.50	0.001
	Dentistry[¥]	0.0	0.0	0.0	
	Pharmacy[#]	0.1	0.0	0.0	.004
	Non-surgical and non-pharmaceutical	0.19	0.08	0.43	0.001
	TOTAL	0.17	0.33	0.43	0.001
Occupation	Doctor	0.22	0.12	0.54	0.001
	Pharmacist[#]	0.083	0.00	0.00	.002
	Nurse	0.15	0.03	0.19	0.001
	Nurse midwife[¥]	0.150	0.028	0.187	.000
	Midwife not nurse[#]	0.067	0.067	1.0	.001
	Lab technician.	0.22	0.14	0.64	0.001
	Labour	0.14	0.08	0.59	0.001
	Operation assistant.	0.18	0.09	0.50	0.027
	TOTAL	0.16	0.08	0.47	0.001
Marital status	Married	0.15	0.07	0.44	0.001
	Single	0.20	0.10	0.48	0.001
	Widow [#]	0.00	0.00	0.00	D
	Divorce[¥]	0.111	0.111	1.0	.011
	TOTAL	0.16	0.08	0.47	0.001
Duration of work	Less than 1 year	0.15	0.07	0.44	0.001
	1-2 years	0.20	0.10	0.50	0.001
	Up to 5 years	0.21	0.13	0.63	0.001
	Up to 10 years	0.15	0.07	0.45	0.001
	Up to 20 years	0.18	0.06	0.31	0.001
	More than 20 years	0.10	0.04	0.42	0.001
	TOTAL	0.16	0.08	0.47	0.001

3.5 Hospital Departments' Factor

There was no highly infective HCW or a carrier for HBV in dentistry department.Only one pharmacist was highly infective and a carrier. The conditional probability of being highly infective and carrier in Surgery and Obstetrics & Gynaecology departments was 0.50, P-value 0.001. The conditional probability of highly infective and carrier in non-surgical and non- pharmaceutical departments was 0.43, P-value 0.001. Only one pharmacist was highly infective and a carrier. There neither highly infective HCW nor a carrier for HBV in dentistry department. (Table 2)

3.6 Occupation Factor

Only one pharmacist and one non- nurse midwife were carriers but not highly infective.Only one nurse midwife was a carrier and highly infective. The conditional probability of being highly infective and a carrier was 0.64 among laboratory technicians, 0.59 among labours, 0.54 among doctors and 0.50 among operation assistants, P-value 0.001. The least conditional probability was found among nurses, 0.19, P-value 0.001. Only one pharmacist and one non- nurse midwife were carriers but not highly infective and one nurse midwife was a carrier and highly infective. (Table 2)

3.7 Marital Status Factor

There were no carriers among widows.Only one divorced HCW was a carrier and highly infective. The conditional probability of married and single HCWs that were highly infective and carriers was 0.44 and 0.48 respectively-value 0.001. There were no carriers among widows and only one divorced HCW was highly infective and a carrier. (Table 2)

3.8 Working Duration Factor

The conditional probability of being highly infective and a carrier was the highest regarding working duration up to 5 years, 0.63, P-value 0.001. The overall conditional probability for infectivity and carries regarding working duration was significantly high, 0.47, P-value 0.001. (Table 2)

4. Discussion

Bayesian analysis was used to predict the rate of carrier/high profile of infectivity given additional information about the HCWs working in health institutions at White Nile State.

In this study, 59.7% of the study population was positive for anti-HB core total and 27.1% was positive for HBsAg. This result is high than a study carried out in Khartoum State for blood samples of donors where positive anti-HB core and positive HBsAg were 36% and 11% respectively (Mahgoub et al., 2011). The study among donors is selective and purposive compared to our study where sampling procedure infers the prevalence of HBV markers for White Nile State. The State has free population movement from South Sudan where prevalence of HBV is high (Hatim, 2008).

Among positive HBsAg HCWs in White Nile State, 46.8% were highly infective (positive HBeAg). This marker is an important estimate from an epidemiological point of view (Ott, Stevens, & Wiersma, 2012).

In our study, laboratory technicians, labours, doctors and operation assistants were having the highest conditional probabilities of being carries and highly infective. This is supported by a study in tertiary hospital in Uganda (Abdhalah, Ziraba, Bwogi, Namale, Wainaina, & Mayanja-Kizza, 2010). In this study, the conditional probabilities infectivity of HCWs regarding working duration was high that could be due to chronicity rather than current HBV infection (Abdhalah et al., 2010).

Unmarried and married HCWs in White Nile State were found to have high probability of HBV infectivity. This is supported by a study that found in Nigeria that showed high rates of HBsAg among illiterate, unmarried pregnant women attending ante natal care (Pennap, Osanga, & Ubam, 2011). In our study, surgical departments have the highest conditional probabilities of HBV infectivity. This reflects a serious gap in the policy of protection against HBV (Willis, Wortley, Wang, Jacques-Carroll, & Zhang, 2009).

5. Conclusion

Prevalence and conditional probabilities of HBV markers among health care worker in White Nile State were high. HCWs in Surgical and Obstetrics & gynaecology, Laboratory technicians and HCWs with working duration up to 5 years are carriers and highly infective. Periodical screening and vaccination of HCWs are recommended.

Competing Interests Statement

The authors declare that there is no conflict of interests regarding the publication of this paper.

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