UNIVERSITY OF GHANA

COLLEGE OF HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

ADHERENCE TO HEPATITIS B VIRUS INFECTION PREVENTION PROTOCOL AMONG HEALTH CARE WORKERS IN SELECTED PUBLIC HEALTH FACILITIES IN THE GREATER ACCRA REGION

BY

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DECLARATION

I, Ms. Vivian Efua Senoo make a declaration that, this thesis submitted to the University of Ghana for the award of a PhD. Degree was produced through my own determination with direction from Professor Francis Anto, Dr. Reginald Quansah and Dr. Anthony Danso-Appiah

I also affirm that this work has never been succumbed to any other organization for the award of a degree of any nature.

I make known that a lot of published and unpublished works belonging to other investigators have been studied and such materials have been appropriately and accurately acknowledged.

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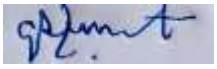
Date 20/08/2020 Signature… 

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DEDICATION

This work is dedicated to

Mr. Kennedy K.D. Dogbey

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ABSTRACT

Introduction: The World Health Organization global disease burden from sharp injuries revealed that 37% of Hepatitis B Virus (HBV) infections among Health Care Workers (HCWs) was as a result of occupational exposures to blood and body fluids. In Sub Saharan Africa alone, about 40-65% of HBV infections among HCWs occur as a result of percutaneous occupational exposures to contaminated blood and body fluids of patients. The prevalence of HBV among the Ghanaian population is high and occupational exposures to blood and body fluids that could potentially result in HBV infection is on a surge among HCWs. International health organizations have made recommendations regarding the prevention of occupational exposure and subsequent acquisition of HBV infection. In Ghana, the occupational health and safety policy guideline for the health sector was developed in accordance with international recommendations with the aim of providing policy direction towards efforts aimed at HCW protection from HBV. Seven years following the development and dissemination of the policy guideline, this present study was undertaken to access the level of adherence to preventive practices among HCWs in the Greater Accra Region.

Methods: A hospital based cross-sectional survey involving HCWs drawn from five health institutions in the Greater Accra Region was undertaken between January and April 2018. Stratified random sampling procedure was used to select 363 health care workers for the study. A structured pretested questionnaire was used to collect data from all consenting health care workers. Approximately 5 mls of venous blood was collected from all consenting HCWs and screened qualitatively for the presence of five serological markers of HBV. Enzyme Linked Immunosorbent Assay (ELISA) procedures were subsequently undertaken to detect IgM HBcAb and to quantify anti-HBs. Data were analyzed using SPSS version 20.0. Chi-square test or fisher's exact were performed

followed by binary logistic regression with level of significance set at <0.05. Analysis of variance procedure was undertaken following tests of normality and heterogeneity of variances to determine differences between overall adherence scores and post exposure prophylaxis knowledge. Adherence and knowledge scores were categorized into three levels namely: poor, intermediate and good using three interval scoring system of low (≤50%), intermediate (51-74%) and high (≥75-100%).

Results: Complete data were available for 340 out of 363 HCWs sampled for the study giving a response rate of 93.70%. Mean age, height and weight of participants were 34.55 years (SD ±7.68), 162.80cm (SD±7.83) and 72.55 kg **(**SD±13.83) respectively.

Overall HBV vaccination uptake was 60.9% (207/340) (95% CI= 55.7%-66.1%). Complete vaccination measured as adherence to 3 doses regimen was 46.8% (159/340). High risk perception (aOR= 4.0; 95% CI=1.3-12.5) and previous training in infection prevention (aOR= 2.8; 95% CI=1.1-7.5) were both seen to be significantly associated with adherence to receipt of three doses of HBV vaccine. Adherence to recommended vaccination schedule of 0, 1, 6 interval was intermediate 62.3% (159/207). Adherence to post vaccination serological testing was poor 21.3% (44/207) with HCWs working at regional hospital having the least odds of adhering to this vaccination component (aOR= 0.1; 95% CI=0.0-0.6). Overall vaccination adherence mean score was 53.46% (95% CI=49.86-57.05) with no statistically significant difference between the various cadre of staff (F=0.85; P=0.51). Adherence to overall HBV vaccination recommendation was extremely low in the population with 6.2% of the entire HCW population and 3.80% of vaccinated HCWs adhering completely. Post Exposure Prophylaxis (PEP) for HBV knowledge was generally poor (overall mean score was 47.85; 95% CI=44.35-51.35) with significant differences among HCW categories (F=3.11; P=0.010). Exposure reporting was good 76.3% (29/38) with significant difference between the various facility levels

(χ^2 =17.990; p=<0.001). All the components of PEP (Evaluation for eligibility for PEP, Timeliness of PEP initiation and post-PEP follow-up visits) were observed to have good level of adherence (adherence was >75%) except PEP usage that was intermediate with a coverage of 70% (7/10). The predominant HBV maker among the population was Anti-HBs; 57.4% (195/340) and the least was HBeAg; 1.5% (5/340). One third (123/340) of the HCWs were naïve to HBV. Lifetime exposure to HBV (Anti-HBc) prevalence was 8.2% (28/340) (95% CI= 5.0%-11.0%). Females had 4 times lower odds of being exposed to HBV (aOR=0.4; 95 % CI=0.1-0.9). HCWs without training in prevention of blood borne infections had almost three times higher odds of being exposed to HBV in their lifetime (aOR=2.6; 95 % CI=1.1-6.4). HCWs in lower level facilities also demonstrated two times higher odds of being exposed to HBV (uOR=2.1; 95 % CI=1.1 -4.7). The overall prevalence of current HBV infection (HBsAg) was 5.9 % (20/340) (95% CI =3%-8%). Prevalence was highest among males, orderlies and those working at CHPs facility.

Conclusions: The findings of this study suggest that despite the high susceptibility to HBV infection among the HCWs, adherence to recommendations regarding HBV vaccination and PEP usage are sub-optimal. Therefore, to avert the serious consequences of HBV infection among HCWs in the Greater Accra Region, immediate interventions are required from employers and all stakeholders. HCWs of all categories working at all the five levels of care would need support to promote adherence to pre and post exposure modalities against HBV infection. Apart from making vaccines and immunoglobulin available to HCWs, training in blood borne infections and programs targeted at increasing risk perception for HBV among HCWs could improve adherence and subsequently prevent new infections.

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LIST OF ABBREVIATIONS

Abbreviations	Meaning
Anti HBc	Hepatitis B Core Antibody
Anti -HBe	Hepatitis B Envelope Antibody
Anti-HBs	Hepatitis B Surface Antibody
aOR	Adjusted Odds Ratio
AIDS	Acquired Immune Deficiency Syndrome
AMA	Accra Metropolitan Assembly
BBIs	Blood Borne Infections
CDC	Centre for Disease Control and Prevention
CHPS	Community Based Health Planning Services
DHIMS	District Health Information Management System
DNA	Deoxyribonucleic Acid
EIA	Enzyme Immuno Assay
ELISA	Enzyme Linked Immunosorbent Assay
GHS	Ghana Health Service
GSS	Ghana Statistical Service
HBcAg	Hepatitis B Core Antigen
HBeAg	Hepatitis B E Antigen
HBIG	Hepatitis B Immunoglobulin
HBsAg	Hepatitis B Surface Antigen
HBV	Hepatitis B Virus
HCWs	Health Care Workers
HIV	Human Immuno-deficiency Virus
IgG anti-HBc	Immunoglobulin G to Hepatitis B Core Antibody
IgM anti-HBc	Immunoglobulin M to Hepatitis B Core Antibody
IPC	Infection Prevention and Control
NCIRS	National Center for Immunization Research and Surveillance
NSI	Needle Stick Injury
OR	Odds Ratio
PA	Physician Assistants
PEP	Post Exposure Prophylaxis
RDT	Rapid Diagnostic Test
SIP	Safe Injection Practices
uOR	Unadjusted Odds Ratio
USA	United States of America
WHO	World Health Organization

OPERATIONAL DEFINITION OF TERMS

Term	Description
Health Care Worker	A health professional having close contact with patients such that he/she is at risk of Hepatitis B Virus infection as a result of exposure to blood and body fluids. (Nurses/Midwives, Laboratory Staff, Physician Assistants, Anesthetics and Orderlies)
Complete Vaccination	Health Care Worker who had three doses or more of Hepatitis B Virus Vaccination.
Responder	Health Care Workers who has demonstrated serological evidence of Anti- HBs of ≥10mlU/mL following Hepatitis B Virus vaccination.
Levels of Care	Health facility levels ranging for Regional Hospital, District Hospital, Polyclinic, Health Center and CHPs (primary care).
(a) Lower level	CHPs, Health Centers and Polyclinics
(b) Higher level	District and Regional Hospitals
Vaccination Uptake	A health care worker receiving at least one dose or more of Hepatitis B Virus vaccine at any point in time in his/ her career.
Adherence to overall HBV Vaccination recommendation	1.Receiving HBV vaccine 2. Taking the recommended three (3) doses of the vaccine 3. Following the recommended dosage schedule. 4. Undertaking serological testing thereafter to confirm development of immunity
Adherence to Post Exposure Prophylaxis recommendation	Health care worker(1) reporting an exposure,(2) going thorough evaluation for PEP,(3) utilizing PEP within the first 48-72 hours (4) Complying with post PEP follow-ups
Current HBV Infection	The detection of Hepatitis B surface antigen in the blood of a participating HCW during the period of data collection.
Lifetime exposure	The detection of Hepatitis B core antibody in the blood of a participating HCW during the period of data collection.
Risk Perception	A health care worker admitting being at risk of HBV, knowing the consequences of HBV and admitting that the consequences are serious and that preventive modalities are beneficial to his/her health

CHAPTER ONE

INTRODUCTION

1.1 Background

Hepatitis B virus (HBV) infection is a liver infection and subsequent inflammation that is life-threatening and caused by HBV. Globally, the infection has been identified as the most common chronic infection afflicting humans (Trepo, Chan, & Lok, 2014). Current estimations revealed a global prevalence of 3.9% representing approximately 240 million infections (Razavi-Shearer et al., 2018; WHO, 2016). The infection is reported to result in chronicity and often lethal liver diseases, such as cirrhosis of the liver and also Hepatocellular carcinoma. HBV infection was therefore ranked among the most important health priorities worldwide. This infection has been identified as the tenth leading cause of death hence its inclusion in major public health priorities (Trepo et al., 2014). HBV control efforts started many decades ago, especially in 1982 when an effective and potent vaccine became available. Combating HBV infection by the year 2030 was outlined in the sustainable development goals. More so, in the year 2016, the World Health Assembly passed the Global Health Strategy on viral hepatitis and outlined specific strategies to reduce infections to less than one million by 2030 (WHO, 2016). The strategy under its intervention for impact emphasized childhood vaccination, prevention of perinatal transmission via birth doses and the use of immunoglobulins against HBV as important steps. The WHO also recognized the danger of HBV to Health Care Workers (HCWs) and under its infection prevention strategy emphasized the protection of HCWs as a priority for countries in the quest to eliminate the infection (WHO, 2016).

The inclusion of HCW protection in the global efforts to eradicate HBV infection is because, HBV infection, according to the Centers for Disease Control and Prevention

(CDC) (2013b), has for so many decades been recognized as an occupational risk for HCWs who by nature of their work are in close proximity with patients and their blood and body fluids.

1.2 The hepatitis B virus and the infection

Hepatitis B Virus was discovered accidentally by a noble peace prize winner, Dr. Baruch Blumberg and his peers in the 1960s when they originally sought out to identify and understand the link between genetic characteristics of individuals and their susceptibility to certain disorders such as cancers. They observed an unexpected reaction between the serum of a hemophilic patient who had multiple blood transfusions and the serum of an Australian Aborigine (Blumberg,1977; 2004). The protein responsible for the reaction was isolated and called the Australian antigen. Blumberg later suggested that the Australian antigen was linked to the post transfusion infections observed and therefore was directly associated with viral hepatitis (Gerlich, 2013). The name 'Australian Antigen' evolved to serum hepatitis antigen, Dane particle, and finally Hepatitis B Surface Antigen over the years (Trepo, 2014).

Hepatitis B virus upon entry into the body, attacks the liver cells which results in inflammation of the liver. The infection can be in both acute and chronic forms. It takes about 70 days for signs and symptoms of the infection to appear. The incubation period may as well vary from 30 to 180 days after viral entry (WHO, 2019). The occurrence of symptoms during the acute phase of the infection and the outcome depends on the age at infection. Infants and children are mostly asymptomatic compared to adults. It has also been observed that less than 1% of acute HBV infections in adults progresses to fulminant hepatitis (liver failure), which has a case fatality of over 80% (Trepo et al., 2014). Disease remission and recovery could be a favorable outcome for some individuals as they are

able to clear the infection and build natural immunity against the virus. Others with the infection could progress to a state of chronicity which is complicated with cirrhosis of the liver and hepatocellular carcinoma (WHO, 2019).

1.3 Epidemiology of hepatitis B virus infection

Hepatitis B virus (HBV) infection which is referred to as positivity to hepatitis B Surface Antigen (HBsAg) has a worldwide distribution. There are variations in the frequency of occurrence and distribution in respect to persons and geographical locations (Trepo et al., 2014). Over the last two decades global vaccination programme against HBV infection have contributed largely to the changing trends globally (Papastergiou et al., 2015; Wasley, Kruszon- Moran, et al., 2010; Zoulim and Durantel, 2015).

1.3.1 Distribution by sex.

Blumberg (1979) in his early research on HBV reported that in most population subgroups, there are more male chronic carriers of HBV infection than females. This observation was later attributed to the fact that females are more likely to produce neutralizing hepatitis B antibody (Anti-HBs) in response to HBV infection than males (Vierucci, London, Sutnick, & Ragazzini, 1972). Evidence from across few studies equally found statistically significant difference in prevalence in males and females therefore concluding that the male to female ratio in terms of HBV infection could be 2:1 (Khan et al., 2011; Kolou et al., 2017).

Chronic HBV infection appears to be frequent in men and advance more rapidly to fatal consequences in males than females (Baig, 2009; Wang et al., 2009; Yong-lin et al., 2012). There is evidence to support the fact that sex hormones (androgens and estrogen) and their equivalent receptors play significant roles in HBV infection progression and consequent

development of complications. Estrogen has a protective effect against HBV through the reduction in levels of HBV RNA transcription and inflammatory cytokines (Montella et al., 2015; Stroffolini et al., 2015).

1.3.2 Distribution of hepatitis B virus infection by age

Age is an important predictor of the clinical progression and determination of the outcome of HBV infection. Acute infections are severe in adults compared to children, however, infections in infants and preschool children carry much greater risks of chronicity and long term complications. This makes the age of acquisition of the infection very important. The outcome of acute forms of the infection is influenced by age of first encounter with the virus such that 95% of newborn, 20–30% of young ones who are under five years and less than 5% of adults progress to chronic HBV infections (Trepo et al., 2014).

Age category distribution of HBV infection has widely been studied with a lot of variations in results. One of the early studies by Baig (2009) reported that HBV infection is higher among people in their reproductive years and that the prevelence of chronic HBV infection is low in the extremes of age. A higher prevalence was reported among the 20-30 age categories by Kolou et al. (2017), confirming earlier observations.

1.3.3 Distribution by place

HBV infection has regional and geographical differences and the level of endemicity directly reflects the major mode of transmission in that particular region. The infection rate is categorized worldwide into three namely; (1) high, (2) intermediate and low (3) endemicities. The age at the time of acquiring the infection is the criteria for describing the endemicity of the disease in a particular geographical area (Hou, Liu, & Gu, 2005;

Shepard, Simard, Finelli, Fiore, & Bell, 2006). A global map showing the global distribution of the chronic form of HBV infection is shown in Figure.1.1 below.

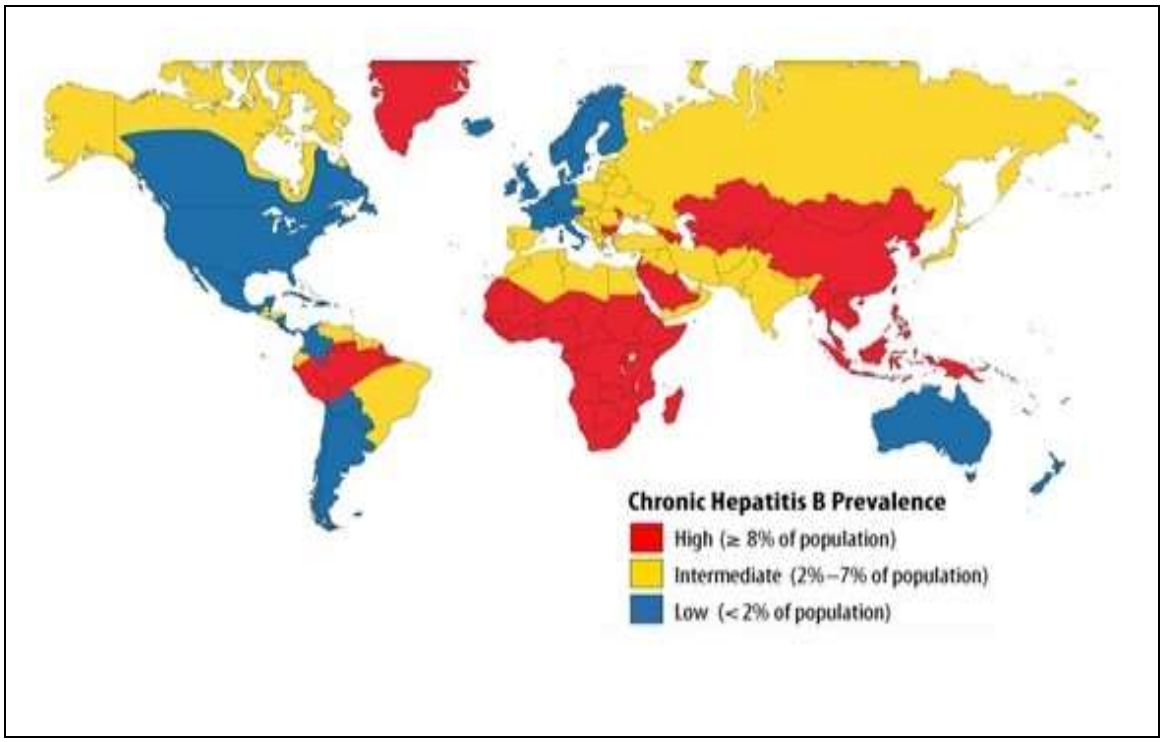

Figure 1.1: Global hepatitis B prevalence map.

Source: CDC 2010

1.3.3.1 High endemic areas

HBV infection is hyper endemic in developing countries with larger proportions in areas such as Southeast Asia, China, West Sub-saharan Africa and the Amazon Basin, where at least over 8% of the population are HBV chronic carriers (Locarnini, Hatzakis, Chen, & Lok, 2015). In these areas, it is estimated that close to 70–95% of the population have ever encountered the infection and possess past or present serological evidence of HBV infection. Most infections in these regions occur during infancy or early childhood with asymptomatic presentations resulting in limited evidence of acute infections (Hou et al., 2005; Zampino et al., 2015).

1.3.3.2 Intermediate endemic areas (low and high intermediate zones)

Hepatitis B seropositivity is moderately endemic in parts of Eastern and Southern Europe, the Middle East, Japan, and part of South America. The intermediate transmission zone is further classified into low and high intermediate regions. Regions with low intermediate prevalence have HBsAg positivity ranging from 2% to 4.9%, whilst a rate of 5% to 7% represents high intermediate infection transmission zones respectively (Locarnini et al., 2015). It is estimated that in such regions, between 10–60% of the population have evidence of present or past HBV infection, and between 2% to 7% of the total population are chronic carriers. Acute infections related to HBV are common in these areas because many infections occur in adolescence and adulthood. These geographical regions are characterized with mixed transmissions occurring in infancy, childhood and adulthood (Hou et al., 2005).

1.3.3.3 Low endemic areas

The endemicity of HBV is low in most developed areas, such as North America, Northern and Western Europe and Australia. In these regions, 5–7% of the population have serological evidence of past or present HBV infection with 0.5–2% of the population remaining chronic carriers. Majority of the infections recorded in these regions occur in the youth and adolescent populations as well as high risk groups where high risk behaviors such as injection drug use, risky sexual practices, frequent blood transfusions and hemodialysis predispose them to the infection (Hou et al., 2005; Shepard et al., 2006; Wasley, Kruszon-moran, et al., 2010). Table 1.1 gives a summary of chronic HBV prevalence in the three regions of the world.

Table 1.1: Summary of worldwide distribution of HBV endemicity

	Endemic Zones	Carrier State	Evidence of lifetime exposure HBV	Predominant Mode of Transmission
1	High	≥ 8%-20%	70-95%	Vertical (perinatal) & Horizontal
2	Intermediate	2% -7%	10-60%	Sexual & Horizontal & Parenteral
3	Low	<2%	5-7%	Sexual & Parenteral

Source: Van Damme et al, 1998; Hou et al., 2005; Shepheard et al., 2006

1.4 Phases or types of hepatitis B virus infection

Hepatitis B virus infection produces a wide variety of acute and chronic manifestations ranging from asymptomatic infections without jaundice, to fulminating infections that can result in death (Damme et al., 1998).

1.4.1 Acute infection

This is the stage of a newly acquired infection that is less than 6 months from the time of exposure. Generally, immunoglobulin to Hepatitis B Core Antibody of the M class (HBcAb IgM) is positive in individuals with acute infections and therefore its presence as the only marker or in combination with HBsAg provides the basis for diagnosing acute infections (Krajden, McNabb, & Petric, 2005). The occurrence of manifestations and signs at this phase of the infection is largely dependent on the age at which the individual acquires the infection. Infants and children in most instances remain asymptomatic, however, about 70% and 30% of the adults with the infection present with subclinical anicteric and icteric hepatitis respectively. Signs and symptoms in this group of people become evident from 1-4 months following exposure and viral entry. At least 1% of adults in this category would develop fulminant Hepatitis which is a fatal form of the infection

and records a fatality rate of 80% in the absence of a liver transplantation procedure (Liang, 2009; Trepo et al., 2014).

1.4.2 Chronic infection

Chronic HBV is the type of infection that persists beyond 6 months. This refers to the persistence of Hepatitis B Surface Antigen (HBsAg) in the serum of the infected individual for more than 6 months with a negative test to total antibody of the M class (Anti-HBc IgM). The risk of developing chronic disease is highly dependent on the age of first exposure to the virus such that the younger the individual at the time of infection, the higher the risk of developing chronic infection (Hepatitis B Foundation, 2018; Trepo et al., 2014).

This type of infection is common in sub-Saharan Africa, Asia and China where the complications of chronicity are subsequently high. According to Hepatitis B Foundation (2018), Song and Kim, (2016), about 5-10% of acutely infected adults, 5% of children who are five (5) years and 90% of infants infected during the neonatal period would all become chronically infected with HBV, and develop chronic disease with diversity in severity.

1.5 Hepatitis B virus transmission

Apart from chimpanzees, the known natural hosts for HBV are humans (Barker et al., 1973; Weiland, 2015). The virus is known to be transmitted through exposure principally to infected blood and other vehicles including body fluids such as semen and vaginal fluids. Additionally, HBV has been isolated in saliva, tears, sweat, urine and breastmilk. There is however, limited evidence to show that transmission through some of these body

fluids are likely especially when no visible blood is present and this has generated a lot of arguments and controversies among infectious disease experts. Blood therefore, becomes the principal but most important vehicle for transmission of HBV infection (Aljarbou, 2013; Hou et al., 2005; Nelson, Jamieson, & Murphy, 2014; Maclachlan &Cowie, 2015). Four major modes of transmission have been identified in HBV infection and this is dependent also on the epidemiologic pattern of the disease in a particular geographical area. These four modes of transmission are: vertical, horizontal, sexual and percutaneous or per mucous transmissions. These transmission forms have been described in the next four sessions.

1.5.1 Vertical or mother to child transmission

Perinatal or vertical transmission of HBV is defined as positivity to HBsAg and HBV Deoxyribonucleic acid (DNA), 6-12 months of life of an infant born to a HBV infected mother. Studies in the area of HBV transmission suggest that this form of transmission may occur during the embryonic stage or trans-placentally. Intrapartum transmission which is strongly correlated with the duration of the first stage of labour has also been largely cited (Schweitzer, 1975). Trans-placental transmission is the predominant mode of HBV transmission in areas of high HBV prevalence (high endemic areas) and hence, it is an important indicator for estimating the prevalence of HBV infection in a specific geographical region of the world (Aljarbou, 2013; WHO, 2016). The risk of perinatal transmission is reported to be higher in mothers who are both reactive to HBsAg and Hepatitis B E antigen (HBeAg). According to Eke, Onyire, & Amadi (2016), it is estimated that approximately 90% of the HBeAg seropositive mothers with a high viral load transmit the infection to their babies compared to 10%-20% frequency of transmission in HBeAg seronegative mothers. Controversies exist around the issue of

HBV transmission via breastfeeding, however, research evidence put forward by Beasley, Shiao, Stevens and Meng, (1975) suggested no evidence for a relationship between breastfeeding and subsequent development of HBV antigenæmia in the babies born to HBV infected mothers.

1.5.2 Sexual transmission

Sexual contact together with vertical transmission of HBV account for the majority of HBV infections worldwide. HBV, being a sexually transmitted infection has been thoroughly researched and documented. The infection can be efficiently transmitted sexually during both heterosexual and male homosexual contacts (Inoue & Tanaka, 2016). The virus exchange is through semen and vaginal fluid during sexual intercourse, hence its classification into the category of sexually transmitted infections. Persons with chronic HBV infection are the major reservoirs for transmission, however, any individual positive to hepatitis B envelope antigen (HBeAg) may potentially be a source of infection (Lama et al., 2010; Shepard et al., 2006). Sexual transmission of HBV is a source of infection in all areas of the world, especially in areas of low endemicity (Hou et al., 2005).

1.5.3 Horizontal transmission

This is the mode of acquisition of HBV that occurs without any apparent sexual and perinatal exposures. It has been identified as playing a major role in the spread of the infection among close household contacts even though the mechanism of horizontal transmission among household contacts is associated with many controversies (Gupta, Gupta, Joshi, & Singh, 2008; Komatsu, Inui, & Fujisawa, 2016). Based on the HBsAg detection rate, HBV DNA level and animal experiments, saliva, and tears have been implicated in the transmission of HBV through household and close contacts. It has also

been reported that sweating may be another uncommon form of transmitting HBV infection (Bereket-Yücel, 2007). Heiberg and Hogh (2012) also suggested that sharing personal care items such as tooth brush among family members, and close contacts provide a vehicle for transmission through non intact skin or mucous membranes. Urine and faeces do not appear to cause horizontal infection nevertheless, the roles of the remaining body fluids remain controversial (Komatsu, Inui, & Fujisawa, 2016). In general, horizontal transmission appears to be the less efficient mode of transmission of the virus compared to the other routes described (Li, Hou, & Cao, 2015).

1.5.4 Percutaneous and per-mucosal transmission

These two modes of transmission are possible when there is a direct transfer of HBV from an infected person to another through exposure to contaminated blood and body fluids directly through the skin and mucous membranes. The transfer of the virus could occur through cuts, abrasions and splashes on mucous membranes of the body (Hou et al., 2005). Mechanisms identified under these modes of transmission include the use of unsafe blood and blood products in transfusion procedures, sharp injuries from contaminated objects as seen among injection drug users, and unsterile surgical procedures such as surgical or dental procedures. Cultural practices such as body scarification, circumcision as well as tattoo procedures have all been implicated (Hou et al., 2005). Transmission of HBV infection in the health care setting is said to be principally by percutaneous exposures followed by per-mucous exposures. This is evident in patient to HCW and HCW to patient transmissions (Viral Hepatitis Prevention Board, 2005). In the presence of HBeAg, HBV is most likely to be transmitted following a percutaneous exposure or direct inoculation with infected blood and other body fluids. The risk associated with this mode of

transmission could be as high as 30% (American Academy of Orthopaedic Surgeons, 2012).

1.5.4.1 Transmission in the health care setting.

Hepatitis B infections through the routes described above have declined in occurrence following the implementation of prevention and control strategies globally. However, health care associated infections are still considered as issues of great concern in both developed and under developed countries (Maclachlan & Cowie, 2015; Thompson, Perz, Moorman, & Holmberg, 2009). Transmission of HBV infection in health care settings can occur in three forms, namely; (1) Patient to patient, (2) Patient to HCW and (3) HCW to patients. However, the transmissions between patient to patient as well as patient to HCW are the two most important forms of transmission of HBV and other blood borne infections in the hospital setting (Viral Hepatitis Prevention Board, 2005). Figure 1.2 below illustrates the interrelationship between patients and HCWs in HBV transmission in the health care setting.

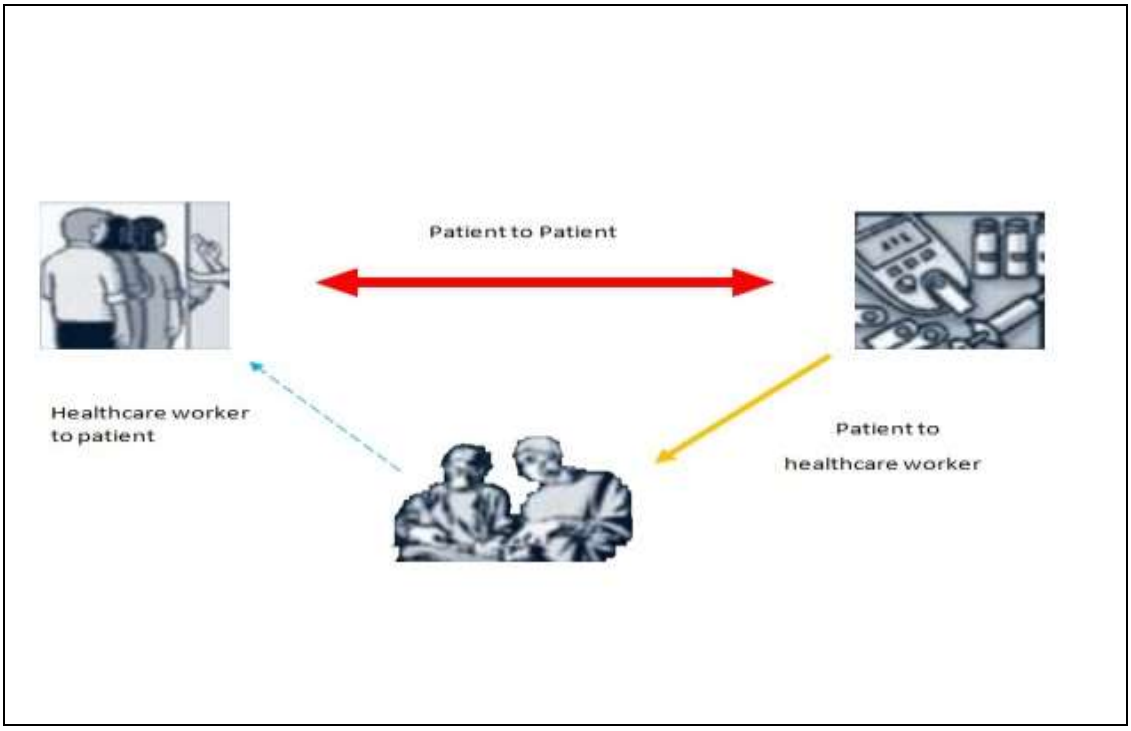

Figure 1.2: Diagram showing possible transmission routes of HBV infection in the health care setting

Source: CDC 2013

Three main routes of HBV transmission are predominant in the healthcare settings. These include; (1) Needle Stick Injuries (NSIs) resulting in direct inoculation of infected blood or body fluids (percutaneous); (2) direct contact with non-intact skin or mucous membrane with infected blood or body fluid (per mucous), and finally; (3) indirect contact with contaminated surface with non-intact skin or mucous membranes (Viral Hepatitis Prevention Board, 2005). HCWs represent one of the largest susceptible groups for HBV infection. Transmission of HBV in this population is predominantly through percutaneous or per mucosal exposures. Transmission of HBV infection to HCWs is reported to largely depend on the positivity to HBeAg and viral load of the source patient. Other determinants include the degree of contact, the type of body fluids involved in the exposure among many others (Kashyap, Tiwari, & Prakash, 2018). Globally, estimates are available to show that there is continuous exposure of HCWs through injuries sustained via medical devices and sharp objects within the health care setting which predispose HCWs to HBV

infections (Prüss-Ustün, Rapiti, & Hutin, 2005). For example, Prüss-Ustün et al (2005), estimated that three million HCWs globally experience stressful life events of NSSIs from objects contaminated with HBV each year.

1.6 Prevention of hepatitis B virus infection

1.6.1 Primary prevention

Prevention of HBV infection is critical in the control of the infection and its associated morbidity and mortality. The goal of HBV primary prevention is to prevent the transmission of the infection to others who are not infected. Prevention through immunization is considered the most cost effective strategy in preventing and eliminating the infection globally. A plasma derived vaccine was produced nearly three decades ago and was replaced with a safer and equally effective recombinant type in the year 1986 (Buynak et al.,1976; Valenzuela, Medina, Rutter, Ammerer, & Hall, 1982). The recombinant vaccine with its immunoglobulin when effectively used in active and passive immunization, is able to prevent 90-95% of HBV infections (Beasley et al., 1983). Prevention of HBV is more effective than drug therapy. This is because despite the progress made in the development of antiviral drugs, a complete cure for the infection is still not available. This makes prevention of HBV infection by immunization the most cost effective strategy in eliminating HBV-related diseases among the general population and at risk populations including HCWs (Chang & Chen, 2015).

Other preventive strategies that have yielded good results among the general population include screening of blood and blood products, sterilization of medical care items and equipment and avoidance of risky sexual and behavioral risk factors (Chang et al., 2015).

According to the WHO (2011), the use of occupational safety measures including standard precautions practices which entail recognizing all blood and body fluid as being potentially infected with HBV has also been identified as a primary prevention modality to prevent HBV infection among HCWs who are at high risk of the infection.

1.6.2 Secondary prevention

The goal of secondary prevention of HBV infection is to achieve early diagnosis and treatment of the infection with the aim of delaying or entirely preventing the occurrence of complications and death associated with the infection (Seto, Lo, Pawlotsky, & Yuen, 2018). Antiretroviral drugs are available for the treatment of HBV infection. Research evidence shows that the risk of liver cancer and death can be reduced with early enrollment into care and timely initiation of treatment (i.e. before complications develop) (WHO, 2011). Oral nucleoside or nucleotide analogues (entecavir, tenovofir disoproxil fumerate and tenofovir alafenamide) are the forms of treatment recommended globally. These agents achieve a substantial virological suppression in many patients and therefore reduce the incidence of complications of cirrhosis and cancer (Seto, Lo, Pawlotsky, & Yuen, 2018). Subcutaneous injection of pegylated interferon alfa for one (1) year remains the first line therapy in patients with chronic HBV infection (Aryal, 2018). However, its unfavorable side effects and the low likelihood of viral suppression after treatment cessation makes it an unpopular choice of treatment compared to nucleotide analogues (Dusheiko, 2013).

1.6.3 Tertiary prevention

This level of prevention targets individuals with chronic HBV infection. The goal of tertiary prevention in HBV infection is to improve the quality of life of affected people and to reduce to the minimum the symptoms of the chronic form of the infection and its associated complications (Seto, Lo, Pawlotsky, & Yuen, 2018). Their management largely focuses on effective treatment of disease symptoms and limiting disease progression, complications and disabilities, including the management of lifestyle behaviors that may contribute to the worsening of the chronic form of the infection (National Viral Hepatitis Roundtable, 2008).

1.7 Statement of the problem

Hepatitis B virus (HBV) infection has long been recognized as an occupational risk for Health Care Workers (HCWs) who come into close contact with infected individuals and their body fluids (CDC, 2013). HCWs are known to have a risk of two to four times higher than the general population (Byrne, 1966; Singhal, Bora and Singh, 2009; Tatsilong et al., 2016). It has also been estimated that 37% of all HBV infections in HCWs are as a result of occupational exposures to blood and body fluids via needle stick and sharp injuries and exposures to mucous membranes (Prüss-Ustün, Rapiti, & Hutin, 2005).

A meta-analysis of 65 studies from 21 countries in Africa estimated a pooled lifetime and 12 months exposure to HBV to be 65.7% and 48.0% respectively (Auta et al., 2017) among HCWs. In Ghana however, from the year 2015 to 2018, exposures to blood and body fluids in three hospitals were 13.5%, 28.9% and 83% (Babanawo et al., 2018; Lori, McCullagh, Krueger, & Oteng, 2015; Tetteh et al., 2015). These exposures have the potential of resulting in HBV infections in the absence of preventive measures given that 40-60% of all HBV infections in HCWs in developing countries are as a result of

percutaneous exposures resulting from injuries sustained within the health facility environment (Prüss-üstün et al., 2003). The infection in HCWs is associated with liver cirrhosis, hepatocellular carcinoma and even death with huge psychological and physiological effect on the affected HCW as well as economic burden on the health care system as a whole (Coppola et al., 2016; Trepo, Chan and Lok, 2014; Zampino et al., 2015).

HBV is completely preventable. The WHO has recommended the use of three-dose HBV vaccine at 0, 1, 6 months interval followed with post vaccination serological testing as well as the use of immunoglobulin (HBIG) in the form of pre and post exposure prophylaxis respectively. These recommendations are known to effectively provide seroprotection and avert the acquisition of HBV infection in 90-95% of individuals (Azami et al., 2017; Kim et al., 1997;Walayat et al., 2015).

Poor adherence to HBV preventive recommendation has been reported among HCW populations especially in other African countries where vaccination coverages of as low as 13.4% and 24.7% have been reported (Auta, Adewuyi, Kureh, Onoviran, & Adeloye, 2018). The poor uptake is also associated with HCWs failing to adhere to the three doses regimen at the recommended 0,1,6 months interval of administration (Auta, Adewuyi, Kureh, Onoviran, & Adeloye, 2018).

Individual HCW factors and prevailing conditions in the health facility environment have been implicated for the poor adherence. Since the year 2010, Ghana has successfully integrated the recommendation regarding HCW protection from HBV into its Occupational Health and Safety Policy for the health sector with the aim of providing policy direction towards promoting optimal adherence among HCWs. However, lttle is known about the level of adherence to the recommendations regarding HBV prevention among Ghanaian HCWs.

This study was therefore designed to investigate the level of adherence to HBV infection prevention recommendations by HCWs in the Greater Accra Region given the fact that HCWs in Ghana are increasingly being exposed to blood and body fluids.

1.8 Justification for study

The risk of transmission of blood borne pathogens in the health care setting is dependent on a number of factors, and the risk of transmission is known to be greater for HBV than for Human Immunodeficiency Virus (HIV) and others (Hu, Kane, & Heymann, 1991), hence HBV transmission and prevention in the health care setting is an area worth investigating.

In Ghana, a lot of works have been done in the area of HBV infection with participants being largely blood donors, pregnant women and to a lesser extent, community members. There is limited research on HCWs in that regard. The prevalence and distribution of serological markers of HBV among HCWs had not been previously explored. Only one study which is closely related to this present study was done among nurses only in the northern sector of Ghana where self-reported vaccination coverage was used to estimate the number of health care workers protected from HBV (Konlan, Aarah-Bapuah, Kombat, & Wuffele, 2016) in this present study I used serology to determine level of seroprotection against HBV among six (6) different categories of HCWs.

Poor adherence to recommendations regarding HBV prevention at both the individual HCW and health facility levels are detrimental to efforts directed at eliminating HBV infection among HCWs and could compromise the occupational health and safety of HCWs hence the importance of this research work.

This study in the end has been able to document the prevalence of HBV infection and the distribution of HBV markers among six categories of HCWs as well as to determine the

practices regarding HBV vaccination and Post Exposure Prophylaxis (PEP) utilization in comparison to what has been outlined in the Occupational Health and Safety Policy of the Ghana Health Service. The study provided baseline information to compare future trends regarding HBV infection and its prevention among HCWs in Ghana.

1.9 Research questions

1. What is the level of adherence to the Hepatitis B virus infection prevention protocol?
2. What factors are associated with adherence to the Hepatitis B virus infection prevention protocol?
3. What is the distribution of hepatitis B virus markers and what factors are associated with HBcAb and HBsAg positivity among health care workers in the Greater Accra Region?
4. What is the level of seroprotection against Hepatitis B virus among vaccinated health care workers in the Greater Accra Region?

1.10 General objective

To determine the level of adherence to the Hepatitis B virus infection prevention protocol and associated factors among Health Care Workers in selected public health facilities in the Greater Accra Region.

1.10.1 Specific objectives:

1. To determine the level of adherence to the various components of the Hepatitis B virus infection prevention protocol:

A. The proportion of health care workers adhering to: three doses of the Hepatitis B Virus vaccination, 0, 1, & 6 months schedule and post vaccination serological testing.

B. The proportion of health care workers adhering to: reporting of exposures (most recent in <12 months), undergoing evaluation, timely post exposure prophylaxis usage and attendance of 6 months follow up-visits.

2. To determine factors associated with adherence to the various components of the Hepatitis B virus infection prevention protocol.
3. To assess the distribution of hepatitis B viral markers and factors associated with HBcAb and HBsAg acquisition among health care workers in the Greater Accra Region.
4. To determine the level of seroprotection and associated factors among vaccinated health care workers.

1.11 The framework of the study

The conceptual framework in Figure 1.3 shows five main components (3 determinants and 2 outcome components). HBV transmission and subsequent acquisition among HCWs is complex due to the fact that there are other modes of acquiring HBV infection apart from being a HCW (Hu et al., 1991).

This present study conceptualized that sociodemographic variables, perceived risk or feeling of susceptibility to HBV infection as well as health facility environmental factors can all influence the HCW's choices of adhering to HBV prevention practices and ultimately influence the chances of occupationally acquiring HBV infection.

Specifically, HCWs' unique characteristics such as sex, age, educational level, job category, unit of work, and training in prevention of HBV infection are personal factors which have been shown to influence the uptake and subsequent adherence to preventive

practices through diverse mechanisms (HBV vaccination and PEP usage) (Fortunato, Tafuri, Cozza, Martinelli, & Prato, 2015; Zheng et al., 2015).

The effect of sociodemographic variables on health behavior have been widely studied. Sex and age have been shown to have a significant influence on how HCWs perceive risk for health events and how ready they are to take up preventive actions to prevent negative health outcomes. For example elderly individuals and females have been reported to have positive attitudes towards healthy practices compared to younger people and men (Bonem, Ellsworth, & Gonzalez, 2015; Kim, Park, & Kang, 2018).

It is widely known that good risk perception or feeling of vulnerability to health threats is positively associated with individual's decision to adhere to prevention modalities. For instance, individuals with high risk perception have been observed to be highly motivated to vaccinate and practice PEP optimally (Morowatishaifabad, Zare Sakhvidi, Gholianavval, Masoudi Boroujeni, & Alavijeh, 2015).

Research has also shown that, external health facility factors such as free vaccination programmes, availability of logistics and policies within the work environment of the HCW can trigger a preventive actions and promote HCWs decision to take up measures to protect themselves from HBV infection (Fortunato et al., 2015;Nowalk, Lim, Raymund, Bialor, & Zimmerman, 2013; Zheng et al., 2015).

When all the determining factors interact in a positive way, to ensure good adherence to vaccination and PEP protocol, there is the possibility that HCWs would be protected from HBV infection and its associated morbidity and mortality.

Table 1.2 presents the summary of the components as described in the conceptual framework. Additionally, Figure 1.3 illustrates the conceptual framework of the study.

Table 1.2: Components of the conceptual framework

Components of the Framework	Explanation of the component	Terminology applied in the study
Perceived susceptibility	A person's belief that he is at risk of acquiring the infection and that the infection is associated with very serious consequences.	Risk perception for HBV infection among HCWs
Sociodemographic Factors	Personal attributes that can promote the uptake of preventive behavior	Demographic factors such as age, sex, cadre, educational status, Infection Prevention and Control (IPC) training, facility type etc.
Health facility Factors	Environmental or external factors that promote risk perception and motivate an individual to take up a preventive behavior	Health facility factor such as the availability of protocols, policies, programmes, logistics (immunoglobulins & vaccines) for proper implementation of the preventive practices at the individual level.
Hepatitis B virus infection prevention steps	Positive preventive behavior in complete accordance with what is recommended for HCWs.	Adherence to HBV: (1)Vaccination uptake (2) 3 doses Vaccination at 0,1,6 and post vaccination testing (a) Exposure Reporting (b) Evaluation (c) PEP use (d) timeliness of PEP (e) Post PEP follow-up
HBV Status	HBV exposure, infection, protection, naive	The presence or absence of HBV viral serological markers

1.11.1 Conceptual framework of the Study

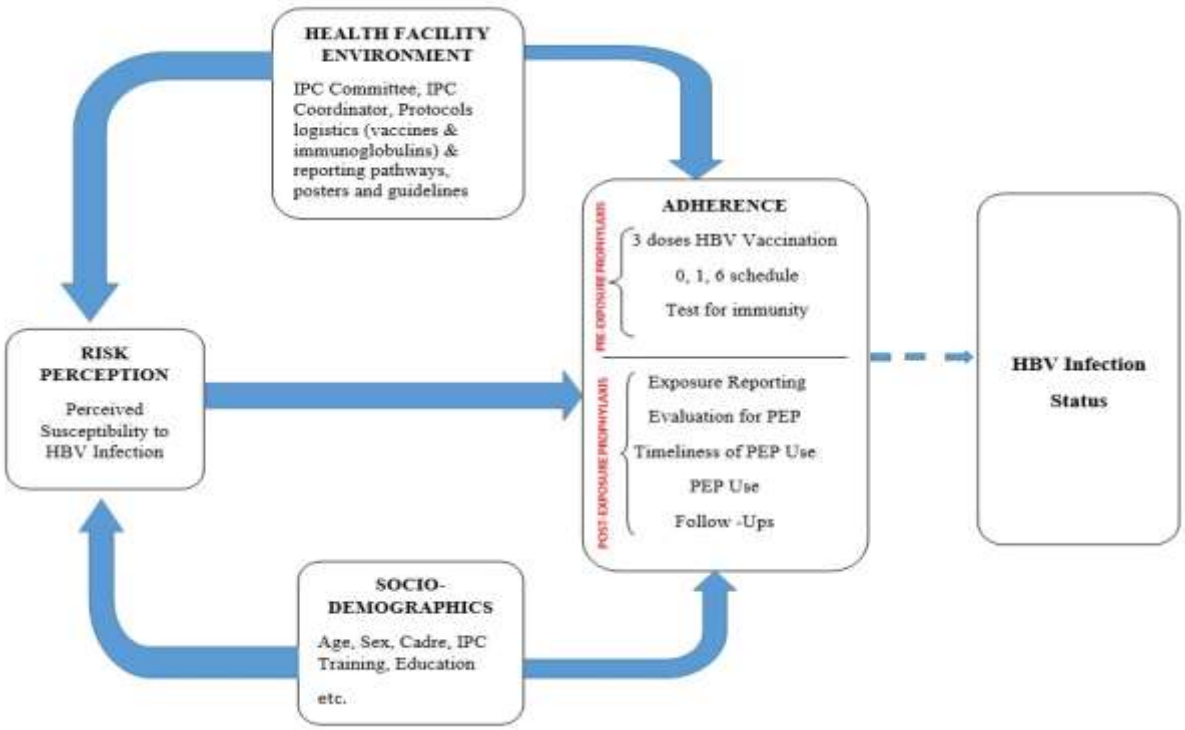

Figure 1. 3: Conceptual Framework showing HCW internal factors, health facility factors and how these factors contribute to adherence to HBV prevention among HCWs (Adapted from Anderson et al.,1995 and Rosentock et al.,1974)

1.12 Summary of chapter one

Hepatitis B virus (HBV) infection is an infection and subsequent inflammation of the liver tissues which is caused by a virus called the hepatitis B virus. The infection could present in both acute and chronic forms of which, fulminant hepatitis, liver cancer and cirrhosis are the major complications of the infection. It is transmitted vertically, horizontally as well as through sexual contact. Enough evidence is now available to support the fact that HBV infection could be transmitted through sweat and saliva although blood remains the principal vehicle for transmission. The possibility of HBV infection being transmitted via broken skin and mucous membranes provides the basis for its recognition as a hospital associated infection and a huge occupational health hazard to Health Care Workers (HCWs) all over the world.

There is a marked variation in the distribution of HBV infection globally with the infection rate being categorized worldwide into 3 levels of endemicity. Africa and the Pacific Regions of the world have the highest prevalence of the chronic form of the infection and in such areas, vertical transmission remains the predominant route of transmission. The infection over many decades have been found to be predominant in males and individuals within the reproductive years.

Prevention is achieved through 3 levels. Firstly through primary prevention strategies aimed at protecting uninfected individuals from infections through the use of pre-exposure and post exposure prophylaxis in the form of HBV vaccination and use of immunoglobulin. Secondary prevention seeks to identify individuals infected with the virus with the aim of initiating treatment to considerably reduce the morbidity and mortality associated with HBV infection. The goal of tertiary prevention in HBV infection is to improve the quality of life of affected people and to reduce to minimum the symptoms of the chronic form of the infection.

1.13 Organization of the thesis

This thesis is subdivided into six chapters with the first chapter being the introductory chapter presented information on HBV infection in terms of its epidemiology, the statement of the problem, justification for the conduct of the study as well as the conceptual framework on which the study was built. In addition, the research questions and objectives that the study sought to address were outlined.

The second chapter positions this present study in existing body of knowledge and literature available on HBV infection and implementation of preventive practices. The prevalence of the infection was described from global level to HCW population level. Literature was also reviewed regarding the coverage of preventive practices and determining factors with the aim of providing intuition to understand the level of adherence to recommended practices among HCWs regarding HBV prevention.

Chapter three gave a detailed description of the methods utilized in the study. In this chapter, the design and setting, as well as the population of interest were described. Additionally, the chapter described the laboratory tools and devices, laboratory procedures undertaken coupled with ethical issues that were considered whilst conducting the study.

Chapter four presents the results obtained after analyzing the data. It also illustrated the interpretations of research outcomes or results in line with the objectives of the study. Chapter Five discussed the key findings of the study. The strengths and limitations were equally elaborated under this chapter. Chapter six which is the last chapter of the thesis presented the summary and conclusions as well as recommendations made based on the research findings.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature obtained from existing research works which were published in international journals as well as country-specific online databases. This review was guided principally by the objectives outlined for the study as well as the theoretical framework of the study. Related literature was retrieved from electronic databases including PubMed, Science Direct, Google Scholar, CINAHL, and JSTOR among many others. Reference list search approach was also undertaken. In the search procedures, key terms were combined in most cases in order to restrict the search results to only articles that were relevant to the study.

The major search terms used for this review include: (1) hepatitis B virus infection and health care workers, (2) hepatitis virus infection prevention and health care workers, (3) vaccination and post exposure prophylaxis and health care worker, (4) serological markers and hepatitis B infection, (5) facility/hospital and hepatitis B infection prevention and others.

2.1.1 Hepatitis B virus infection, a public health issue

Hepatitis B Virus (HBV) infection is a major global public health problem due to its worldwide distribution as well as its potential for long term complications including liver cirrhosis, hepatocellular carcinoma and end stage liver disease (Tsochatzis, Bosch, & Burroughs, 2014).

Despite global efforts to eradicate the infection among the population, HBV infection largely remains a devastating cause of morbidity which is associated with close to 30%

and 53% of the global prevalence of liver cirrhosis and hepatocellular carcinoma respectively (Papastergiou et al., 2015).

HBV infection is an international public health issue that is highly comparable to other major communicable diseases such as Human Immunodeficiency Virus, malaria and tuberculosis (Stanaway et al., 2016). The global burden of disease study identified HBV as one of the leading causes of mortality and as such suggested that HBV is a top health priority (Stanaway et al., 2016). Despite the huge burden of the infection on the general population, it has been largely neglected and ignored as a human health and development priority until very recently (WHO, 2016a).

2.2 Prevalence of hepatitis B infection

2.2.1 Global prevalence

There is significant heterogeneity in available literature on the global prevalence of HBV infection. Ott and his colleagues in 2012 using a systematic review approach estimated the global prevalence for the years 1990 and 2005 to be 4.2 % (223 million) and 3.7 % (240 million) respectively. The outcome of their review suggested a decline in global prevalence which was attributed largely to the global infant vaccination programme. In the year 2015, it was estimated that 257 million people were living with the chronic form of HBV infection globally with a huge burden on Africa and Western Pacific Regions where a greater proportion of infected individuals lack access to life-saving testing and treatment services (WHO, 2017). In the same year, a systematic review and meta-analysis of HBsAg prevalence studies from 161 countries estimated the pooled global prevalence of HBV to be 3.61% representing 248 million chronic carriers. This study also identified Africa and Western Pacific Regions as being regions most affected (Schweitzer, Horn, Mikolajczyk, Krause, & Ott, 2015). Another related modeling study in 2016 utilized data

from 120 countries and estimated the global prevalence of HBV to be 3.9% representing close to 291 million infections. This modeling estimate found 21 countries including China, India and Nigeria to have contributed over 80% to the global burden of HBV infections (Razavi-Shearer et al., 2018). The dynamics observed with the global burden of HBV is said to have resulted from the effective implementation of global vaccination against the infection which has resulted in a considerable decrease in HBV burden and associated morbidity and mortality (Ott et al., 2012a; Zoulim and Durantel, 2015).

2.2.2 Prevalence in Africa

In Africa, HBV infection is highly endemic and the HBV infection associated disease burden is high. The lifetime risk of HBV infection has been estimated to be over 60% and more than 8% of the population remain chronic HBV carriers who are at risk of progressive complications (Howell, Ladep, Lemoine, Thursz, & Taylor-Robinson., 2014).

A systematic review and meta-analysis of 396 studies across the world reported that chronic HBV was most common in the sub-Saharan Region of Africa with the western part of the sub-Sahara having the highest age specific prevalence in the world in 1990 (Ott et al., 2012a). The findings from the review confirmed variation between and across countries in the sub region. Countries such as Nigeria, Burkina Faso, Namibia, Cameroon and Gabon have been known to have recorded prevalence of >8% in various population groups whereas Ivory Coast, Liberia, Sierra Leone and Senegal are considered as being areas of intermediate endemicity with rates ranging from 2%-8%. Northern African countries including Egypt, Morocco, Tunisia and Algeria have also shown lower rates of infection and therefore belong to low endemic zones with rates falling below < 2% (Kramvis, 2014; Zampino et al., 2015).

Many studies done in the African settings obtained higher prevalence of the infection in rural settings compared to urban areas. This was largely attributed to the traditional practices of childhood circumcision, tribal scarification, as well as poorer sanitary conditions which are all high risk practices for HBV acquisition (Papastergiou et al., 2015). For example, a higher prevalence of HBV infection was identified among populations of women of child bearing age living in rural communities with lower family income and lower educational status in Africa (Zhang et al., 2013).

2.2.3 Prevalence in Ghana

Ghana, a country located geographically within the sub-Saharan Africa belongs to the hyper endemic zone of HBV infection. A nationwide prevalence of HBV infection is not yet available, however, reports emerging from various studies undertaken by researchers among diverse population groups in the country in most instances revealed prevalence that were high enough to maintain Ghana in the hyper endemic category. Specifically, a recent estimate from a meta-analysis and systematic review of 30 prevalence studies across the ten regions of Ghana obtained a pooled prevalence of 12.3% (Ofori-Asenso & Agyeman, 2016).

The contribution of Ghana to the global burden was recently revealed in a modeling estimate and meta-analysis performed in 2015. Ghana was ranked 14th among 21 countries contributing to 80% of infections to the global HBV burden (Razavi-Shearer et al., 2018).

Majority of studies in the various geographical zones in Ghana were conducted mainly among blood donors and other vulnerable populations including pregnant women. All these studies being cross-sectional and retrospective in design with mainly purposive

sampling revealed high prevalence of the infection with variations in the prevalence in the three geographical belts of the country. Specifically, a study from Tamale representing the northern sector of Ghana reported prevalence of 10.79% and 11.56% among voluntary and replacement blood donors respectively (Dongdem et al., 2012).

A retrospective study of data on prospective donors at Kintampo which is located within the middle belt of the country even though revealed a declining prevalence of 11.0%, 9.6% and 8.2% in 2010, 2011, and 2012 respectively indicating decline over three years, it still estimated an overall prevalence or an average prevalence of 9.6% (Walana, Hokey, & Ahiaba., 2014). Osei, Lokpo and Agboli (2017) also estimated a prevalence of 7.5% among prospective donors in the southern part of the country. Comparing the prevalence from the three belts, HBV infection frequency was lower in the southern part compared to the northern and middle belts of Ghana.

Hepatitis B Virus infection among special populations in Ghana have also been reported to be high. For example, among Human Immune-Deficiency Virus (HIV) infected individuals, a systematic review and meta-analysis of 12 studies estimated a pooled prevalence of 13.6% (Agyeman & Ofori-Asenso, 2016). Table 2.1 below shows a summary of HBV prevalence studies undertaken from 2011 to 2019.

Table 2.1 (a) Prevalence of HBV infection in Ghana: summary of prevalence surveys conducted in Ghana (2011-2019)

Author(s)	Objectives	Population	Research Design	Outcome/ Main Finding	Conclusion and Recommendations
Adoba et al. (2015)	To determine the prevalence of HBV and HCV among Barbers in Obuasi	200 Barbers conveniently sampled	Cross-sectional workplace study	HBV and HCV prevalence was 14.5% and 0.5%	High prevalence of HBV and poor knowledge of HBV and HCV. Urgent education of this population is recommended.
Agyeman et al. (2016)	To determine HIV/HBV co-infection prevalence rate among Ghanaians.	12 studies across 7 regions in Ghana.	A systematic review and Meta-analysis. Published literature from 1999-2016	The prevalence of HIV/HBV co-infection in Ghana was estimated as 13.6% (95% CI: 10.2-16.8).	One out of 7 HIV infected individuals is co infected with HBV. Preventive interventions and strategic policy directions are needed to improve management strategies for HBV infection and (ART) implementation.
Amidu et al. (2012)	To determine the relative sero-prevalence of HBV infection in three suburbs	783 subjects in three densely populated suburbs in Kumasi	Cross-sectional study	Overall prevalence 8.68% with variations in prevalence of the three suburbs	Local prevalence of HBV may vary widely even in closely related communities
Anabire et al. (2019)	To evaluate the prevalence of malaria and HBV by comparing RDT(Rapid Diagnostic Tests)and PCR (Polymerase Chain Reactions) outcomes	2071 Ante natal clinical attendees	Cross-sectional study	HBV prevalence was 7.9% and 7.5% for RDT and PCR respectively	Socio-economic status did not influence the prevalence of HBV mono infections among pregnant women
Dongdem et al. (2012)	To estimate the prevalence of HBV Infection among blood donors in Ghana.	6462 Replacement and voluntary donors	Cross-sectional Descriptive study	HBV prevalence was 11.59% and 10.79% among replacement and voluntary donors respectively.	HBV infection was high among blood donors. Infection was sex, age category and donor type dependent.
Ephraim et al. (2014)	To examined the prevalence of HBV and HCV infection among Type 2 diabetics	110 Type two Diabetic patients	Randomized Cross-sectional Hospital based study	The sero-prevalence of HBV was 5.5% and was higher than that of HCV in Type 2 Diabetic Mellitus patients.	Type 2 Diabeties Mellitus patient require protective measures like prophylaxis, to reduce the risk of HBV infection and its consequences.

Table 2.1 (b) Prevalence of HBV infection in Ghana: summary of prevalence surveys conducted in Ghana (2011-2019)

Author(s)	Objectives	Population	Research Design	Outcome/ Main Finding	Conclusion and Recommendations
Luuse et al. (2017)	To determine the sero-prevalence of HBs antigen (Ag) and HBeAg among pregnant women in the Ho municipality.	208 Pregnant women Attending ANC clinic	Cross-sectional study	Prevalence rate of 2.4% was estimated With HBeAg being 40%	Volta region in Ghana is among the areas of lower HBV prevalence. To sustain and improve on the current rate, routine screening of pregnant women in all health facilities in the country is required
Nkrumah , et al. (2011)	To investigate the prevalence of Hepatitis B and C infections and co-infections among blood donors in a rural community of Ghana.	2773 Blood Donors in a Rural Setting In Ghana	Retrospective study	HBV prevelence13.8 (CI:114-16.4) HCV prevalence was 9.4% The single infections of HBV and HCV reduced however, co-infection of these transfusion transmitted infections (TTI) increased.	Measures such as more sensitive techniques and education must be employed in these areas.
Ofori-Asenso et al. (2016)	To estimate HBV infection prevalence in Ghana over two decades (1995–2015).	30 studies across all the 10 regions of Ghana.	Systematic Review and Meta- analysis	Overall HBV prevalence was 12.3% with rates of 10.8%, 12.7% and 13.1% in voluntary donors, replacement donors and pregnant women.	HBV is a public health problem in Ghana and urgent strategies are needed to eradicate the infection.
Osei et al. (2017)	To estimate the sero-prevalence of HBsAg among blood donors in Ho Municipal Hospital, Ghana	576 Prospective Blood Donors	Retrospective study	Prevalence rate of 7.5 % was estimated. With prevalence highest in 30-39 age category and females	HBV prevalence among donors in Ho municipality is relatively low compared with previous reports from other parts of Ghana. Educational programmes on the risks and benefits of immunization are needed to reduce the transmission rate of the infection.
Walana et al. (2014)	To establish HBsAg sero-prevalence among blood donors in the Kintampo municipality of Ghana.	3402 Prospective Blood Donors	3 year hospital based Retrospective study	Prevalence of 9.6% was obtained. .	Kintampo municipality has a relatively high prevalence of hepatitis B among blood donors with the youth being at greater risk than all other population sub groups.

2.2.4 Prevalence among Health Care Workers (HCWs)

Health care workers (HCWs) or the workforce form an important building block of the health system and their collective function is to provide curative, preventive and promotive activities towards improving and maintaining the health and wellbeing of all individuals (WHO, 2006). At the global level however, Prüss-Üstün et al (2005) estimated 66,000 HBV infections among HCWs in the year 2005. A related systematic review of 18 studies published in the last three decades also reported HBV prevalence ranging from 0.1% to 8.1% among all categories of HCWs (Coppola et al., 2016).

Prevalence of HBV among HCWs have been observed to mirror that of the general population closely hence the differences in the various regions of the world. Reports from developed regions specifically, United States, Brazil and Spain suggest lower HBV prevalence of 0.1%, 0.77% and 0.8% respectively (Calleja-Panero et al., 2013; Ciorlia & Zanetta, 2005; Thomas et al., 1993). Reports available from two northern African countries namely Libya and Egypt both indicate lower prevalence of 1.8% and 1.4% respectively (Elmaghloub, Elbahrawy, Didamony, & Elwassief, 2017; Elzouki, Elgamay, Zorgani, & Elahmer, 2014). In contrast, in Southern, Eastern and Western parts of Africa, high prevalence ranging from 6.7% to 11.0% were reported from Tanzania, Cameroon and Nigeria respectively (Adekanle et al., 2015; Mueller et al., 2015; Tatsilong et al., 2016). These studies described had good methodological designs yet the studies failed to describe into details how HBV infection prevalence varies across the various levels of care within the health care delivery system especially in Ghana.

Ghana has a health system with various categories or cadre of health staff providing health services to the general population. These health workers are equally exposed to HBV by virtue of the continuous contact with patients. However the prevalence of current HBV infection among Ghanaian HCWs is not yet known therefore creating paucity in country

specific information. Table 2.2 shows a summary of HBV prevalence studies among HCWs in four countries.

Table 2.2: Prevalence of HBV infection among HCWs: Summary of prevalence surveys conducted in five countries

Author(s) (Country)	**Objective of the study**	**Population**	**Research design and approach**	**Outcome/main Finding**	**Conclusion and Recommendation**
Biswas, et al. (2015) (Bangladesh)	To estimate the prevalence of HBV infection and vaccination compliance among HCWs	113 HCWs working in a tertiary care hospital	Cross-sectional study with quantitative approach.	The overall Sero-prevalence of HBsAg, anti-HBs and anti-HBc was 8%, 30.1% and 48.7% respectively.	A significant number of HCWs are unvaccinated even at a tertiary care level suggesting the urgent need for early implementation of vaccination policies.
Ciorlia et al. (2005) (Brazil)	To compare the prevalence rates of HBV among two groups of HCWs and a control group	2888 HCWs with direct contact, administrative staff and blood donors.	Hospital based case control study	Sero prevalence of HBV infection was 0.8% in HCWs compared to 0.2% in blood donors.	The prevalence of HBV among HCW was higher than that of blood donors
Elzouki et al. (2014) (Libya)	To determine the frequency of hepatitis B and C among HCWs	601 HCWs recruited from five major hospitals in Eastern Libya	Cross-sectional study with quantitative principles	The overall frequency of HBsAg positivity was 1.8%. Anti-HBc, HBeAg and Anti-HBe antibodies were found in 8.5%, 0.7% and 8.0% of samples, respectively.	HBV vaccines should be more readily available for Libyan HCWs by reinforcing current vaccination programs.
Ogundele et al.(2017) (Nigeria)	To determine the prevalence and assess knowledge of HBV and HCV infection among HCWs in a specialized hospital	209 HCWs at a State specialist Hospital	Descriptive cross-sectional study with quantitative approach	The prevalence of HBsAg was 6.7% anti-HCV positivity was 8.1% and co-infection of both HBV and HCV was 1.0%	High prevalence of HBV and HCV among HCWs and a higher burden of HCV than was commonly reported. There is a need for IPC programme and sustained health education for HCWs

2.3 Serological markers of hepatitis B virus infection

A number of HBV viral markers have been identified. These are antigens produced by the viral particle and their respective antibodies which interact in defining the course and outcome of HBV infections. The detection of these markers provide basis for diagnosis, predicting the natural course as well as assessing the clinical stage of the infection (Song & Kim, 2016).

HBV Deoxyribonucleic Acid (DNA) is one of the markers which possesses the blueprint of the virus and therefore very useful in both diagnosis and monitoring progress of complications as well as response to antiviral therapy (Kukka, 2015).

HBsAg is a protein marker produced from the outer surface coat of the viral particle. This protein is produced in excess in infected liver cells and secreted directly into the bloodstream. It is the first marker to appear and a hallmark for the diagnosis of HBV infection. The HBV core antigen denoted as HBcAg is the marker derived from the protein envelope enclosing the viral DNA. It is intracellular in nature and therefore undetectable in the blood or serum of infected people but rather found only in infected hepatocytes following a biopsy of liver tissues. It is said to be the most accurate index for detecting viral replication (Krajden et al., 2005). HBeAg is the viral peptide found on the envelope of the viral particle that circulates as soluble proteins in serum. It appears within 3rd to 6th week of infection. Its persistence indicates viral replication and infectiousness (WHO, 2002) but currently HBV DNA assays have proved much more useful in assessing viral replication and level of infectiousness (Song & Kim, 2016).

Another marker which is considered as a surrogate for cccDNA was isolated and called HBV related core Antigen (HBrcAg).This marker has been advocated to be a novel marker which is useful for disease monitoring and predicting outcomes of HBV infections

(Seto et al., 2018). Apart from the viral markers described above Hepatitis B X antigen (HBxAg) has also been isolated from hepatocytes. This marker appears to promote the progression to chronic infections suggesting that HBxAg has a role in the development of carcinomas associated with HBV. Reports are available to support the fact that the frequency of HBxAg is higher in those with HCC hence the assertion that the risk of HCC is higher in those positive for HBxAg (Arzumanyan, Reis, & Feitelson, 2013; Lehman & Wilson, 2009; Liu et al., 2008; Wang et al., 2016). HBxAg may also play a role in viral replication and therefore the therapeutic implications especially for drug development is being vigorously perused (Slagle & Bouchard, 2018).

Specific antibodies exist for all the antigen markers described above. Anti -HBs is the specific antibody to HBsAg. When produced by the host, it is able to produce counteracting effect and provide protection against HBV. Specific antibody to the core antigen (Anti-HBc) is produced by the host. Both immunoglobulin M and G classes (IgM and IgG) exist with IgM class signifying an infection in the window period. Anti-HBc is not noted for neutralizing HBV but rather identifies all individuals who have been previously infected by the virus (Song & Kim, 2016). Anti-HBc IgM class apart from its use in diagnosing infections within the window period, in rare cases may be the only HBV marker detected during the early convalescence or 'Window period' when the HBsAg and anti-HBs tests are negative and therefore its presence alone could provide basis for further evaluation for diagnosis (Jeremiah et al., 2011; Krajden et al., 2005).

The specific antibody to HBeAg called Anti-HBe indicates low infectiousness and convalescence especially in the absence of HBsAg.

The interpretation of combinations of HBV serological markers is said to be complex. However, careful interpretation of these combinations is useful in arriving at a correct

diagnosis (Boeras et al., 2015). A summary of characteristics of the viral serological markers and their role in diagnosis of HBV infection is presented in Table 2.3 below.

Table 2.3: Serological markers of HBV infection

Marker	Definition and Diagnostic use
HBsAg Hepatitis B surface Antigen (A protein found on surface of viral particle)	General marker and hallmark of HBV infection. It is the first serological marker to appear following exposure. Persistence of this marker beyond six (6) month suggests chronic HBV infection.
Anti-HBs Antibody to Hepatitis B surface Antigen	It's a neutralizing antibody produced by the immune system of the host against HBV. Its presence suggests an individual has; 1. Developed natural immunity following an infection. 2. Developed immunity as a result of vaccination.
HBeAg Hepatitis B Envelope Antigen (a protein found on envelope)	This is present in both acute and chronic infections. It is a marker that denotes active replication of HBV, and its presence suggests high level of infectivity.
Anti-HBe Antibody to Hepatitis B envelop antibody	Its presence suggests less active HBV replication and a decrease in HBV infection and disease remission. It suggests spontaneous resolution of an acute infection.
Anti-HBc Antibody to Hepatitis B core antigen	This appears at the onset of symptom and signs in acute infection and persists for life. Its presence indicates previous or ongoing infection in undefined time frame.
Igm- Anti HBc IgM antibody to hepatitis B core antigen	It indicates recent infection in an acute phase of less than 6 months.
HBV DNA	The presence of a genetic blue print of HBV through molecular assays and PCRs can give a confirmation of HBV infection and predict viral replication activity.

Source: CDC 2010; Song, 2016

2.3.1 Distribution of serological markers among HCW

The presence or absence of HBV serological markers in a population of HCWs is largely dependent on the burden of the infection in that population and the effectiveness of HCW vaccination against HBV. A significant frequency of HBV naivety and subsequent susceptibility to HBV have been identified among a group of HCWs with these individuals showing neither serological evidence of lifetime exposure, infection nor immunity to HBV. Naivety frequency of 31.3%, 62% and 81% have been observed among HCWs in Tanzania, Sierra Leone and Cameroon respectively (Mueller et al., 2015; Qin et al., 2018; Tatsilong et al., 2016).

Possession of at least one serological marker of HBV is quite a common observation among HCWs. For example, a study in Asia reported that 23% of respondents had at least one marker of HBV and this was predominated by anti-HBs (Hamidi, Bahadori, Mansouri, & Nategh, 1990). Most studies done among HCWs who are targeted with preventive interventions identified anti-HBs as the most predominant marker. Specifically, studies done in Asia and Africa which are highly endemic continents reported a higher prevalence of anti-HBs followed by anti-HBc and finally HBsAg among HCWs (Mbock et al., 2019; Wijayadi et al., 2018). Few studies on the contrary, reported Anti-HBc to be the most predominant HBV marker isolated in a cohort of HCWs (Akalu et al., 2016; Bello, 2000;Biswas et al.,2015; Elmukashfi, Ibrahim, & Elkhidir, 2012). In such studies, HBV vaccination coverage was very low or was strongly recommended by the authors.

Evidence from epidemiological surveys suggest that in most populations, the prevalence of anti-HBc is usually higher than HBsAg reiterating the possibility of HBsAg sero clearance resulting in a difference between lifetime exposure and actual infection with HBV (Bello, 2000; Hamidi et al., 1990; Mbock et al., 2019; Wijayadi et al., 2018). In Ghana, the distribution of HBV serological markers among HCWs remains largely unknown creating paucity in country-specific information.

2.4 Diagnosis of hepatitis B virus infection

Blood is the specimen of choice for identification and subsequent diagnosis of HBV infection (Krajden, McNabb and Petric., 2005). Most laboratory investigations to determine the antigens and antibodies to HBV are done using serum and plasma which could be stored, and remain stable at room temperature for days, at 4.0 ^{0}C for months and temperatures of -20^{0} C to -70^{0} C for many years. The viral markers of HBV are useful in

the diagnosis and differentiation between the two forms of the infection (Acute and Chronic). Serological tests are available to detect all the HBV markers. Nucleic acid based and Polymerase Chain Reaction (PCR) tests are also available to directly detect HBV DNA in human samples. Such tests have excellent sensitivity and specificity (Datta, Chatterjee and Veer, 2014 ;Tang et al., 2018). The detection of HBsAg and the other markers is also done using Rapid Diagnostic Tests (RDT), or Enzyme Immuno- Assays (EIAs). A meta-analysis on studies assessing the effectiveness of techniques in detecting HBV infection suggests that both RDTs and EIAs had outstanding assets for the uncovering of HBsAg and the other markers (Amini et al., 2017). A related study in Ghana that sought to evaluate the prevalence of HBV infections by comparing RDTs with PCR outcomes found prevalence of 7.9% and 7.5% for RDS and PCR respectively. The authors of the study concluded that RDTs were comparable to PCR and that RDTs could offer representative picture of prevalence rates of HBV infection in countries reported to be endemic to HBV (Anabire et al., 2019).

Appearance and disappearance of HBV serological markers forms the basis of diagnosing and describing the course of HBV infection. HBsAg being the first marker to appear is the hallmark for HBV infection. In acute infections however, HBsAg is cleared within 4-6 months of onset of the infection. The clearance of HBsAg is accompanied by the appearance of Anti-HBs which is the neutralizing antibody that suggests recovery from infection. HBV HBcAb IgM which is the marker appearing after HBsAg (in few cases IgM class of Anti-HBc may precede the appearance of HBsAg and this may occur only during the window period) denotes an acute form of HBV infection.

The linear graphs presented in Figure 2.1 below describe the course of HBV infection.

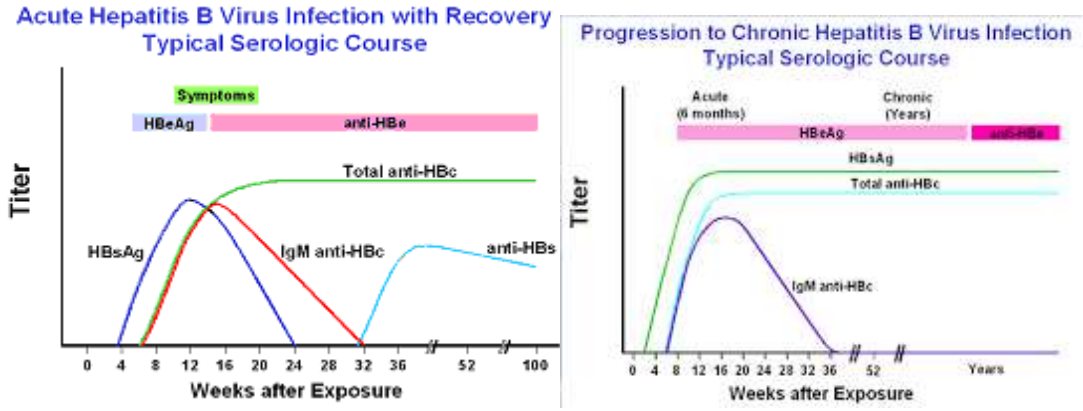

Figure 2.1: Use of Serological Markers in diagnosing the course of HBV infection

Source: CDC 2013

Chronic HBV infection is diagnosed when HBsAg persists in the blood for over six (6) months with corresponding loss of IgM class of anti-HBc and appearance of IgG class of anti-HBc which persist for a lifetime (Kao, 2008; O'shea, 2010).

2.5 Factors associated with lifetime exposure and infection (anti-HBc &HBsAg) among HCWs

HCWs all around the world stand an additional risk of acquiring blood borne pathogens like HBV, Hepatitis C and HIV compared to the general population. However, HBV infection is the most common and yet efficiently transmitted through occupational exposure, and it is highly transmissible compared to the others (Elikwu et al., 2016; Mohebati, Davis, & Fry., 2010).

The risk associated with HBV infection is due to the unique nature of their occupation which involves undertaking exposure prone procedures during health care delivery. The risk is directly correlated with the prevalence of the disease in the general population, the nature and frequency of the exposure to HBV and the risk of transmission of infection following the exposure (Gorar, Butt, & Aziz., 2014). Lokesh, Srinidhi, & Reddy (2014) observed that among unvaccinated HCWs, the risk of acquisition of HBV from Needle

Stick Injuries (NSIs) ranged from 6.0 to 30% and this risk level is reported to have close links with the HBeAg status of the source individual. Prüss-Ustün et al. (2005) indicated that exposures resulting from occupational injuries in the health care setting account for 37 % of all HBV infections among HCWs globally. This observation confirms the fact that the greatest risk of transmission of HBV among HCWs is associated directly with percutaneous exposures followed by muco-cutaneous exposures. Exposures through non intact skin carries the least risk of transmission (CDC, 2013).

At the global level, NSIs account for the most common source of occupational exposures to blood borne infections including HBV (Prüss-Üstün et al., 2005). This finding is important given that, close to 65,600 NSIs occur among HCWs per year. It has also been established that 40-65% HBV infections in HCWs in developing countries are due to NSIs compared to a rate of less than 10% in developed countries (Prüss-Üstün et al., 2005).

Elikwu et al. (2016) in their study of risk factors for occupational HBV transmission identified NSIs resulting from two handed recapping, unsafe collection and disposal of sharp waste as being the two most common causes of occupational exposure among HCWs. Few studies found less than ten years of formal education, increasing age and increasing years of employment as being protective for HBV acquisition (Gorar et al., 2014; Ogundele et al., 2017;Wijayadi et al,. 2018).

Previous training in blood borne infections has been reported to be protective for the acquisition of blood borne infections including HBV. Anwar et al. (2017) found HCWs with previous training in infection prevention having 1.3 times less the odds of blood borne infection.

Lack of HBV vaccination among HCWs had long ago been identified as a major independent risk factor for HBV acquisition. This observation was reaffirmed by a recent

study that found entirely no HBV infection among a group of vaccinated HCWs compared to their unvaccinated counterparts (Akalu et al., 2016).

The risk of infection with HBV following occupational exposure has also been seen to be dependent on the work category as well as work department or unit of work of the HCW. Most studies reported higher risk of infection among surgeons and nurses compared to the other categories (Bekele, Gebremariam, Kaso, & Ahmed, 2015). Few other studies on the contrary, observed higher occupational risks in other categories other than nurses and surgeons. For example, Elikwu et al. (2016) observed a higher occupational risk among cleaning or sanitary staff followed by nurses and doctors. Accidental NSSIs and constant exposure to body fluids during routine housekeeping activities have been cited as factors increasing the vulnerability of this work category to HBV. Increasing age as well as increase in number of years of employment has equally been reported to be risk factors for HBV infection among HCWs (Beltrami, 2000; Kashyap et al., 2018). All the above studies did not report the effect of health facility level or facility type on the risk of HBV acquisition among HCWs, hence, the need for further studies to assess the impact of facility level on HBV infection in this population.

2.6 HBV vaccine and its immunogenicity

Vaccination against HBV is currently the most cost effective approach to prevent HCWs from HBV infection in addition to reducing the level of exposure and taking protective measures during diagnostic and therapeutic procedures (Azami et al., 2017). A recombinant vaccine has been synthetically prepared and it has been available commercially since 1986 to replace the traditional plasma derived HBV vaccine (CDC, 2015; WHO, 2017). The vaccine was produced by inserting a plasmid containing the gene for HBsAg into common baker's yeast (*Saccharomyces cerevisiae*). The yeast cells then

produced HBsAg which is harvested and purified. The recombinant Hepatitis B vaccine is marketed as Engerix-B and Recombivax HB and some others (CDC, 2015; WHO, 2017)

Extensive clinical trials conducted in this area observed that, protective efficacy of hepatitis B vaccination is established by the appearance or development of anti-HBs titers above 10ml/IU/mL following primary series of HBV vaccination. Individuals attaining that antibody titer levels are said to be 100% protected from both the clinical and chronic form of HBV infection (Ashwini & Satish, 2016).

Walayat and his colleagues (2015) found in their study that the recommended series of three intramuscular injections with HBV vaccine was able to induce long lasting immunity in 90%-95 % of healthy adults younger than 40 years. The study also suggested that beyond age 40, the cumulative age-specific decline in immunogenicity drops below 90%, and by age 60, only 75% of individuals receiving the recommended 3 doses develop protective levels of anti-HBs.

A related meta-analysis and systematic review conducted in 2017 also estimated HBV vaccine efficacy among HCWs to range from 90 to 97%. The authors concluded that response to the vaccine was good, long term immunity was a possibility and hence there was no need for booster doses nor revaccination among the study population (Azami et al., 2017).

The rate of Anti-HBs positivity has been identified to be dose dependent. Yoshioka, Deguchi and the others (2017) confirmed the above by stating that 93.0%, 54.5% and 4.2% of participants demonstrated anti-HBs positivity following three (3), two (2) and one (1) dose(s) of vaccination respectively. The National Center for Immunization Research and Surveilance (NCIRS) (2015) also reported that anti-HBs positivity

increases gradually from 35% after the first dose to 90% or more after 3rd dose. These two studies confirm the importance of the three dose schedule recommended for the attainment of seroprotection.

A lot of work has gone into finding out how long immunity against HBV can last following immunization. For instance, Coppola and his peers (2015) in a study that focused on long term immunogenicity of HBV vaccine identified the absence of HBsAg in a cohort of medical students who were vaccinated 17 years before the study. The study concluded that Hepatitis B vaccine has a powerful efficacy and could induce long term protection among vaccinees. Yoshioka and his peers (2017) also after a prolonged clinical study observed that durability of immunity depends on primary response titers and time lapsing after vaccination.

Anti-HBs levels have been known to wane away gradually with time to levels below 10mlU/mL. However, vaccinated responders still possess anti- HBs or cellular immunity that can surmount any potential vaccine challenge. Therefore, the disappearance of anti-HBs does not necessarily mean there is loss of protection since an amnestic response that is rapid and robust could be produced to protect the individual from any HBV exposure (Gara et al., 2015a). A related study found a group of HCWs who were vaccinated years earlier whose anti-HBs titers were lower than the detectable limit to have developed acceptable levels of anti-HBs following the administration of booster doses (Chan et al., 2014).

2.7 Response to HBV vaccine, seroprotection and associated factors

According to Kagina (2014) Seroprotection is the antibody titers level (equal or above) at which an individual is considered as being protected from a particular disease. Seroprotection denotes an antibody level which is capable of preventing the occurrence

of an infection in an individual who has been immunized passively or has developed a natural immunity in response to a previous infection. Specific to HBV however, the protection efficacy of Hepatitis B vaccination is mediated by the development of anti-HB coupled with induction of immune memory (NCIRS, 2015).

Research around the development of immunity following HBV vaccination strongly suggest that anti-HBs levels above 10mlU/mL are indicative of seroprotection against HBV infection (Mast et al., 2005). Therefore a laboratory test aimed at measuring antibody concentration (titer) 1-2 month following the successful completion of 3-dose vaccination schedule is the most reliable procedure of diagnosing clinical protection against HBV. This is because there are variations in the level of antibody development following the 3-dose regimen of HBV vaccination. Three different possibilities have been recognized and reported. Vaccinated individuals could be said to fall in any of the three categories depending on the antibody level measurements obtained specifically 1-2 months post vaccination (NCIRS, 2015). The three categories are namely: (1) those with anti-HBs levels below 10mlU/mL, (2) between10mlU/mL to 100mlU/mL and finally (3) anti-HBs levels above 100mlU/mL. The three categories have been summarized in Table 2.4.

Table 2.4: Antibody titer levels following HBV vaccination

Antibody titer level	Category	Explanation
< 10mlU/mL)	Absence of anti-bodies	Susceptibility to HBV infection
≥10-100mlU/mL)	Adequate Antibody level	Immunity & protection
>100mlU/mL)	High level of immunity	Good immunity & strong protection

Source: Adapted from NCIRS (2015)

According to Speers (2015), HBV vaccine non-responders are people who fail to develop protective antibodies (>10mlU/mL) despite a primary course of hepatitis B vaccination.

A stronger classification of non-responders was proposed by Hepatitis B Foundation (2017) which defined a "true vaccine non-responder" as an individual who does not develop protective surface antibodies after completing two full series of Hepatitis B vaccination and for such a person, an acute or chronic HBV infection has been ruled out completely.

Evidence across multiple studies show that following the standard 3 dose schedule of HBV Vaccination in immunocompetent populations, close to 90-95% of vaccinees who are <40 years at the time of vaccination develop neutralizing antibodies against HBV to the levels of ≥10mlU/mL. This means that close to 5-10% of vaccinees who are immunocompetent fail to respond to the primary HBV vaccine series by failing to elicit detectable specific antibodies and therefore remain susceptible to HBV(NCIRS, 2015; Walayat et al., 2015). However, other studies found non-response rates to be higher than 5-10%. For example, Jouneghani, Khoshdel, Effat and Khalafian (2017), in their study which evaluated HBV vaccine response in 644 individuals, found a higher non-response rate of 38.5%.

Specific to HCW populations, non-response rate of 5.4-6% has been reported. The predominant predictors of non-response to the HBV vaccine identified in this population were age over 40 years, diabetes mellitus, and prolonged use of steroids (Ashwini & Sathish., 2016; Nashibi et al., 2015). In addition, smoking, obesity, HIV and other immunocompromising conditions have been mentioned to be closely linked to non-response (Jouneghani et al., 2017; NCIRS, 2015;)

Heritable genetic characteristics such as HLA tissue types as well as CD150 which are both genetic characteristics that are heritable have been identified as genetic factors mediating the response to HBV vaccine. Lu and his colleagues (2016) in their study found

CD 150 (a useful biomarker) as a factor that may play a role in response to HBV vaccine as its levels were detected to be higher in non-responders than those who developed antibodies and responded positively to the vaccine. In Ghana, the antibody response to HBV vaccination has been studied only in children less than five years and an overall seroprotection rate of 100% was documented (Dassah et al., 2015). Seroprotection against HBV among HCW populations who were vaccinated as adults is not yet known hence creating paucity in country specific-information.

2.8 Ideal hepatitis B virus vaccination program recommended for HCWs

The CDC, WHO and other international organizations have recommended that all HCWs who are exposed to blood and body fluids should undertake pre vaccination testing for HBV infection, receive three (3) doses of HBV vaccine at months 0, 1 and 6 schedule early in their carrier before becoming exposed to the hospital environment (CDC, 2013a; GHS, 2010; WHO, 2004). The recommendation also proposed that the vaccine should be administered intramuscularly into the deltoid muscle. Additionally, HCWs are mandated to undertake a post vaccination serological testing to evaluate or assess the development of antibodies to the HBV antigen 1-2 months post vaccination (CDC, 2013a; GHS, 2010; WHO, 2004). Individuals who comply with the three-dose series of the vaccine are said to be fully or completely vaccinated whereas those taking less than the recommended three doses of the vaccine are said to be partially or incompletely vaccinated. Individuals failing to respond to the first or primary vaccination series need to be revaccinated in secondary vaccination series. They are only declared as true vaccine non-responders after failing to respond to the secondary series and when HBV infection has completely been ruled out (Hepatitis B Foundation., 2017). In addition, all vaccinated individuals are expected to build antibody levels to >10mlU/mL to be seroprotected from HBV.

2.9 Hepatitis B virus vaccination uptake and its determinants among HCWs

Despite the availability of a safe and effective vaccine coupled with the awareness of the potential risk of HCWs acquiring HBV infection, some HCWs never get vaccinated Therefore HBV vaccination coverage globally is still below the expected level as adherence has remained poor in various healthcare facilities, especially in developing countries (Auta et al., 2018). For example, vaccination coverage has been reported to be as low as 4.5 % in Rwanda, 5.4% in Ethiopia and 14.2% in Nigeria (Kateera et al., 2014; Omotowo et al., 2018; Abeje & Azage, 2015)

On the contrary, high vaccination coverages have been reported in much developed countries such as Italy as a study reported complete HBV vaccination coverage to be 70.1% among HCWs (Fortunato et al., 2015). This observations confirms Auta et al's (2018) findings that vaccination coverage against HBV infection among HCWs vary across countries and also across the various regions of the world. In their Systematic review and meta-Analysis of 35 studies from 15 African countries (excluding Ghana), they found complete HBV vaccination coverage to be 24.7% with regional coverage being highest in North Africa with a coverage of 62.1% and Central Africa being the lowest recording a coverage as low as 13.4% (Auta et al., 2018).

Vaccination coverage may be determined by a complex of demographic, structural, social and behavioral factors. Evidence across few studies suggest an association between age and duration of employment and willingness to vaccinate (Fortunato et al., 2015; Zheng , Gu1, Zhang, Wang,Huang, Lin & Gao, 2015). Confirming this observation, Omotowo et al. (2018) reported that age and duration of employment both have positive influence on the uptake of HBV vaccination and that the odds for vaccine uptake increases with increasing age and duration of employment among HCWs.

Gender is widely considered in most concepts to be a determinant for adherence to healthy practices. It was not surprising for vaccination uptake of four (4) times higher was reported among females HCWs compared to their male counterparts in one study (Abebaw, Aderaw, & Gebremichael, 2017). In contrast, Auta et al. (2018) found no difference in vaccination uptake between males and females.

The department or work unit of the HCW is also known to be a determinant for HBV vaccination uptake. HCWs working in invasive departments are likely to accept HBV vaccination than others. Aaron, Nagu, Rwegasha and Komba (2017) in their study identified that, a significant association between the unit of wok or department and vaccination status. Those working in less invasive areas were less likely to vaccinate than those working in highly invasive units.

Reports available indicate that vaccination uptake is not the same for all the categories of HCWs and that their uptake varies across the various categories or professions. Papagiannis et al. (2016) established that, even though paramedical health workers are equally at risk of acquiring HBV, they receive HBV vaccination less often than medics (doctors and nurses). The reason given for the low uptake among the paramedics was that they perceive less risk of HBV infection compared to their medic counterparts. However, among the medic populations, variations have been noted as well. Auta et al. (2018) observed a 2-3 times higher rates of vaccination among doctors compared to nurses.

Few studies provided evidence to prove that training in blood born infections and their prevention could increase preventive behavior. Regarding HBV vaccination, this observation was confirmed by Akibu, Nurgi, Tadese, and Dibekulum (2018) in their study of determinants of vaccination uptake which found workshop and training attendance on blood borne infections as being important positive determinants for HBV vaccination.

According to Gough (1990), perceived risk is the individual or group's judgment or evaluation of the degree and possibility of likely negative outcomes which may result from an action. Risk perception is an important prerequisite for behavioral change. According to theories on health behavior and practice, risk perception interventions are targeted at achieving behavioral change. There is evidence to support the above hypothesis that health interventions that are tailored at increasing risk perception generally produce an increase in positive health behavior (Ferrer & Klein, 2015).

Perceived risk has been found to influence the uptake of preventive practices as far as the prevention and control of blood borne infections in the hospital environment are concerned. For example, Morowatishaifabad, Sakhvidi, Gholianavval, Boroujeni and Alavijeh (2015) identified risk perception to be one of the most important determinants of HBV preventive behaviour among HCWs. They therefore emphasized that concepts tailored at improving risk perception be integrated into training programs aimed at increasing HCWs practices regarding hepatitis B prevention.

Specifically, risk perception is a widely known factor that influences vaccination practice. For instance, a multi-center study that sought to assess attitudes towards vaccination against health care associated infections found a strong association between high risk perception and willingness to vaccinate (Taddei et al., 2014).

External factors beyond the immediate control of the individual HCW have been mentioned to have effect on the decision of a HCW to uptake HBV vaccination. Liu et al. (2018) in a recent study reported that, strong hospital environmental policies such as an HBV vaccination policy with free vaccine for HCWs are the two most important and major determinants of vaccination uptake among HCWs. Supporting this argument, Zimmerman et al. (2012) also suggested that employer-led and sponsored on-site

vaccination campaigns are the most cost effective strategies of enforcing HCW vaccination compliance.

Differences exist among health facility types or levels in terms of HBV vaccination coverage. Specifically, Abebaw et al. (2017) in their multi-center study that explored external factors associated with HBV vaccination found that HCWs working in government facilities were two (2) times more likely to vaccinate than their counterparts who work in privately owned facilities. They therefore concluded that the type of facility representing the immediate environment of the HCWs has influence on the HCWs' decision to vaccinate against HBV. However, there is paucity of information regarding how vaccination uptake varies in the various levels of the health care system presenting a gap in literature. This study could fill this gap by identifying how HBV vaccination coverage varies from the lowest (CHPs) to the highest level (Regional Hospital). Table 2.5 illustrated the design and outcomes of few studies that sought to assess HBV vaccination coverage among HCWs.

Table 2. 5 HBV vaccination coverage among HCWs: summary of uptake surveys conducted in five countries

Author(s) (Country)	Objectives	Population	Research Design	Outcome/Main finding	Conclusion and Recommendation
Aaron et al.(2017) Tanzania	To assess the proportion of HCWs vaccinated for HBV	348 HCWs	A descriptive cross-sectional study	Partial or complete vaccination coverage was 56.9% among HCWs	The current vaccination coverage among practicing HCWs at Muhimbli National Hospital is low despite a high level of awareness and acceptance.
Auta et al. (2018) Africa continent	To estimate full HBV vaccination coverage among HCWs in Africa	35 studies across 15 countries in Africa	Systematic Review and Meta-analysis	Complete overall HBV vaccination coverage was 24.7(CI: 17.3-32). Regional coverage in North Africa was 62.1(CI:42.5-81.7) Lowest coverage of 13.4% (CI:4.5-22.3) was recorded in Central Africa	Many HCWs in Africa are at risk of HBV infection as only a quarter were fully vaccinated against HBV virus. The study highlights the need for all African governments to establish and implement HBV vaccination policies for HCWs.
Mungandi **et al. (2017**) Zambia	To determine the prevalence and determinants of HBV vaccination among HCWs in selected health facilities in Lusaka.	331 HCWs	Cross sectional facility based study	Only 64 (19.3 %) were fully or partially vaccinated. Age, sharp injuries per year and training in IPC were the variables that were statistically significant in predicting a HCW's vaccination status.	Health institutions should bear the cost for vaccinating staff and efforts should be made for appropriate health education regarding HBV infection and prevention. Establishment of policies on compulsory HBV vaccination for HCWs in Zambia recommended.
Aydemir et al. (2016) Turkey	To determine the rate of HBV vaccination uptake among Medical Laboratory Workers in Turkey	1359 Medical Laboratory Workers in 26 centers	Descriptive Epidemiological research study	HBV vaccine was coverage was 82.3% 54.4% of the vaccinated participants had their anti HBs levels above 10ml/IU/ML	Anti-HB positivity screening is important to detect those truly protected from HBV.
Pathak et al. (2013) India	To evaluate HBV vaccination coverage and associated factors.	600 HCWs	A cross-sectional study hospital based study	The overall prevalence of HBV vaccination acceptance was 60%. Only 40% of the HCWs receiving 3 doses.	Coverage of complete immunization was low among HCWs. Level of knowledge regarding the disease was also not satisfactory.

2.10 Adherence to hepatitis B virus vaccination recommendations

2.10.1 Adherence to three-dose regimen and 0, 1, 6 vaccination schedule

Complete vaccination refers to adherence to the 3 dose HBV vaccination whilst correct vaccination schedule refers to compliance with the interval between vaccine doses in accordance with manufacturer's instructions (Hepatitis B Foundation, 2019). Most HBV vaccine manufactures have recommended 0, 1, 6 schedule for adult immunocompetent men and women and this forms the basis for recommendations in most international and country-specific HBV prevention guidelines for HCWs vaccinating as adults (CDC,2005; GHS, 2010,Mast et al., 2005).

Even though some studies among adolescents have offered evidence in support of the two-dose regimen, this findings may not hold true for other populations. Studies suggest that the three-dose regimen is best for those over age 40 (individuals vaccinating as adults). Adherence to the three-dose regimen is particularly important for people at high risk of contracting HBV such as HCWs (Junewicz, Brateanu, & Nielsen, 2014).

Negative consequences of non-adherence to 3 doses and correct interval have been documented. For example, CDC (2005) observed that longer intervals between the last 2 doses result in higher final antibody levels but might increase the risk for acquisition of HBV infection among persons who have a delayed response to vaccination.

Many studies have reported poor adherence to HBV vaccination recommendations. In the United Kingdom for example, poor adherence to timeliness and complete vaccination series were observed among adults. In that study, only 22% of individuals were adherent to the complete 3 doses at the correct schedule (Johnson, Lu, & Zhang, 2019). Similarly, in Central Brazil and the United States, only 28% and 30% of individuals (other than

HCWs) adhered to complete three doses regimen and schedule (Motta-Castro et al., 2009; Trantham, Kurosky, Zhang, & Johnson, 2018).

Both internal and external factors have been identified as being associated with adherence to HBV vaccination recommendations. Trantham et al. (2018) found that older age was associated with complete adherence to correct timing or schedule as well as receipt of three dose vaccine regimen. This is because the elderly perceive risk much more compared to the younger population. External provider and environmental factors have also been identified to be affecting adherence to 3-doses at the right schedule. An intervention study observed an increase in vaccine initiation rate as well as completion at the correct schedule among adult participants who received electronic record reminders on initiation and completion of HBV vaccination (Hechter et al., 2019).

Other external factors including availability of publicly funded vaccination programmes and availability of free testing services have been shown to promote adherence (Abiola et al., 2016).

2.10.2 Adherence to post vaccination serological testing

Norizuki1 et al. (2019) strongly suggest that vaccination coverage is a conventional indicator of the effectiveness of vaccination programs, yet another objective indicator is needed to measure the quality of the vaccination program. Post-vaccination serologic testing becomes a useful strategy. Post vaccination antibody testing against HBV is recommended for HCWs and all individuals at high risk of HBV infection. Testing for antibody levels one to two months post vaccination has been strongly suggested (Wexler, 2016). Unfortunately, the issue of post vaccination serological testing for HBV has been a controversial one for almost two decades. For instance, health economists including

Alimonos, Nafziger, Murray, & Bertinos (1998) believe that the HBV vaccine is highly effective and that all but just a few would not produce antibodies hence testing of all HCWs post vaccination is not cost effective. John (2000) argued strongly that adequate PEP management requires knowledge of immune status to determine whether HBIG should be administered hence, knowledge of immune status is important in at 'risk' populations. Additionally, vaccine-induced antibodies decline with time, and up to 60% of those who initially respond to vaccination lose antibodies within 12 years (John, 2000). Without a post vaccination serological testing perhaps early enough, it is difficult to distinguish between individuals who responded and seroconverted after vaccination or those having antibody levels waned away with time. These people may, therefore, receive HBIG unnecessarily if they should suffer any form of exposures. This reason proposed by John (2000) perhaps also gave credence to the strong national and international recommendations for all HCWs to undergo post-vaccination serological testing for anti-HBs.

Adherence to post HBV vaccination serological testing among HCWs have been reported to be poor. Murphy (2000) mentioned that uptake of vaccination among 'at risk' groups may be high but assessment of serological status is often poor with consequent continuing risk of HBV acquisition. This observation holds true for resent researchers who found low adherence to post-vaccination serological testing. For instance, among HCWs in Africa, Aaron et al. (2017) and Abiola et al. (2016) both reported very low post vaccination serological testing rates of 29.0% and 33.6% among HCWs in Tanzania and Nigeria respectively. A related study done in South America also reported poor adherence to post vaccination testing recommendations by reporting rates of 34.8% (de-Souza & Teixeira, 2014). Contrary to what is widely known, two studies conducted at two different settings

specifically Brazil and Pakistan reported post vaccination serological testing of 78.8-96.5% among HCWs (Hussain et al., 2005; Rossato & Ferreira, 2012) . These two studies were interventional studies where efforts were made to prevent loss to follow-ups hence majority of the participants were made to return to undertake post vaccination serological testing.

2.10.3 Overall Adherence to hepatitis B virus vaccination protocol

(Three doses, 0, 1, 6 schedule and post vaccination serological testing)

Most studies reviewed so far used mostly three-dose vaccination (complete vaccination) as an indicator to describe adherence to HBV vaccination (Aaron et al., 2017; Muvunyi et al., 2018; Yuan et al., 2019). Others used combination of three doses with post vaccination serological testing as an indicator for measuring adherence to HBV vaccination (Hussain et al., 2005; Rossato & Ferreira, 2012). No literature to the best of my knowledge used three indicators (3 doses, correct schedule of 0, 1, 6 and post vaccination serological testing) to measure overall adherence to HBV vaccination specifically among HCWs. This study perhaps, may be the first to have combined the three indicators to measure an overall adherence to HBV vaccination recommendations.

2.11 Post Exposure Prophylaxis (PEP) for hepatitis B virus infection

Post exposure prophylaxis (PEP) refers to the rapid medical response provided to prevent the transmission of blood-borne pathogens following a potential exposure to HIV, HBV, HCV and others. It is recommended that PEP should be initiated as soon as practicable, within hours but not no later than 72 hours after the potential exposure (Lokesh et al., 2014). Mponela, Oleribe, Abade, & Kwesigabo (2015) described occupational exposure among HCWs as any percutaneous injury (needle stick injury or cut from a sharp object)

or contact with mucous membrane or non-intact skin (skin that is chapped, abraded, or affected with dermatitis) with blood, tissue, or other body fluids that are potentially infectious while performing routine patient care activities.

2.11.1 Ideal post exposure prophylaxis procedure recommended for HCWs

Avoiding occupational exposures to blood and body fluids is the primary step in preventing the transmission of HBV in the health care environment. However, in the absence of an effective primary prevention practices, secondary prevention by use of PEP agents become very useful (Beekmann & Henderson, 2015). Two main products or agents are available and have been recommended for use as PEP against HBV infection.

Hepatitis B vaccine which provides long-term protection against HBV infection is recommended for pre post-exposure prophylaxis.

Hepatitis B immunoglobulin (HBIG) provides a temporary form of protection which lasts for three to six months and is only indicated in certain post-exposure situations (CDC, 2013a; Chang & Chen, 2015). Beekmann & Henderson (2015) and CDC (2016) both strongly recommend that an appropriate, timely and effective prophylaxis is needed to mitigate HBV infection and subsequent development of complications. They concluded that the mainstay of PEP is HBV vaccine, however, Hepatitis B immunoglobulin (HBIG) is recommended in addition to vaccination when additional protection is required. Hepatitis B immunoglobulin is recommended for PEP for HBV in situations of both percutaneous and mucosal exposures. It is recommended that HBIG be administered as soon as possible, preferably within 12 - 24 hours following percutaneous or mucosal exposure. PEP for HBV is highly unlikely to be effective if its use is initiated 7 days after the exposure (Country of Los Angeles Public Health Immunization Program (2015). According to CDC (2006) recommendations, the decision to use HBIG and HBV vaccine

as PEP also depends largely on the HBsAg status of the source patient as well as anti-HBs status of the exposed HCW. Table 2.6 below presents a summary of PEP steps for HBsAg positive or negative source and vaccinated and unvaccinated HCWs respectively.

2.11.2 Components of effective post exposure prophylaxis management for HBV

Successful implementation of PEP management programme for HBV depends on the interplay between health facility responsibilities and responsibilities of the exposed HCW (Boden, Petrofsky, Hopcia, Wagner, & Hashimoto, 2016). Courtenay-Quirk et al. (2016) proposed that the health facility has a role of instituting an exposure reporting pathway or system with trained individuals who would respond to HCWs with exposures in a timely manner. The availability of facility level policies and guidelines regarding the implementation of PEP coupled with appropriate stock of recommended testing supplies of PEP logistics have all been identified as major components of an effective PEP programme in a health facility. Positive knowledge and good attitudes of HCWs towards exposure reporting and use of PEP is another important component of an effective PEP programme.

Borden et al. (2016) observed that a clear pathway is needed for effective PEP management of exposed HCWs. First and foremost, the exposed HCW has the responsibility to report the injury or exposure, then the report is forwarded for documentation and surveillance. The next step is the comprehensive assessment of both the exposed HCW and the source patient (if known). PEP prescription and subsequent PEP initiation follows in a timely manner depending on the outcome of both exposed HCW and source assessment or evaluation. Appointments are then given for follow up after PEP use (WHO, 2014). According to Boden et al. (2016) any break experienced in this sequence of events may lead to suboptimal adherence to a successful PEP

programme. Figure 2.2 illustrates the sequence of both HCW and health facility actions and responsibilities towards a successful PEP implementation among HCWs. Table 2.6 indicates the summary of recommended steps in PEP management of exposed HCWs.

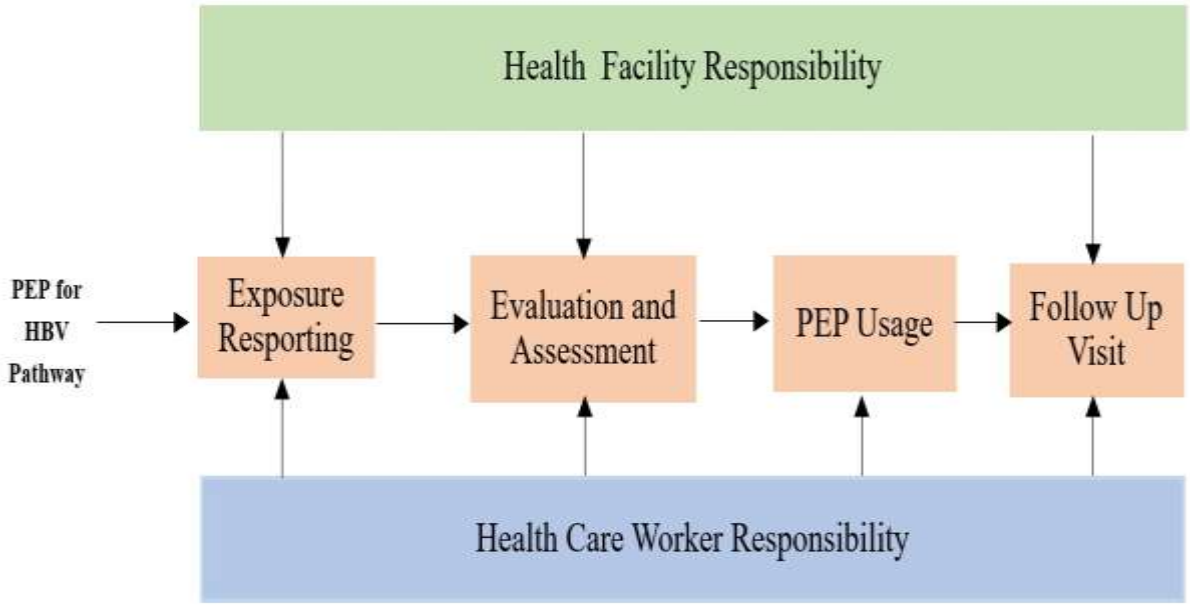

Figure 2.2: PEP management pathway for exposed HCWs

Source: Adapted from WHO, 2014

Table 2. 6: Summary of recommended steps in PEP management of HCWs exposed to HBV

Vaccination & Anti body Status	**Treatment if Source is: HBsAg +VE**	**HBsAg-VE**	**Treatment Source patient unknown or unavailable for testing**
Unvaccinated	HBIG*1 & vaccine series	Initiate vaccination series	Initiate vaccination series
Vaccinated & Responder	No treatment required	No treatment required	No treatment required
Vaccinated Non responder	1 dose of HBIG & Initiate vaccination series 2 doses of HBIG only for true non responders	No treatment Required	Treat as if source were HBsAg +VE
Antibody response is unknown	Test for antibodies. If adequate, No treatment required. If inadequate, HBIG*1 and a vaccine booster is required	No Treatment Required	If Anti-HBs is adequate, No treatment required. If inadequate, HBIG*1 and a vaccine booster is required Recheck titer I 1-2 months

Adapted from Beekmann & Henderson, 2015; CDC, 2001 *Hepatitis B immunoglobulin

2.11.3 Hepatitis B virus post exposure prophylaxis knowledge and associated factors

Few studies have strongly linked poor knowledge to poor health practices among the general population and even HCWs since knowledge and attitudes are known to have direct correlation with practice (Karbalaeifar et al., 2016; Stanton, Scott, & Happell, 2016). Therefore having sufficient knowledge and positive attitudes regarding PEP for HBV is paramount to effective PEP practice.

Poor knowledge and negative attitudes towards utilization of PEP for HBV have been identified as one of the factors that affect PEP use for HBV (Shaghaghian, Pardis, & Mansoori, 2014). Unfortunately, lack of knowledge of PEP for HBV have been reported across few studies done in Africa and elsewhere. For example, undesirable knowledge and practice towards PEP for HBV were reported among practicing dentists and their interns in tertiary care hospitals in Iran (Shaghaghian, Pardis, & Mansoori, 2014). In another Australian study that explored utilization of PEP by graduate medical doctors, the authors concluded that significant gaps in both knowledge of PEP and skills around PEP management existed among the studied population as they found discrepant knowledge towards PEP with only 57.5% of participants who identified correctly the availability of PEP and steps towards its correct utilization (Koehler, Vujovic, Dendle, & McMenamin, 2014). The findings were similar to what was reported by Konlan, Aarah-Bapuah, Kombat, & Wuffele (2016). Their study identified poor knowledge of PEP for HBV amidst a high level of risk perception for HBV among Nurses in Ghana. Insufficient integration of PEP for HBV into routine IPC trainings have been mentioned as the reason for the reported poor knowledge.

Facility factors such as unavailability of protocols and poor implementation of PEP policies have association with the poor knowledge among HCWs (Shaghaghian et al.,

2014). A recent study found 25% of HCWs exposed to blood and body fluids failed to utilize PEP because they were less knowledgeable about the existence of PEP policies within the hospital where they work (Okoh & Saheeb, 2016).

2.11.4 Adherence to post exposure prophylaxis management among HCWs

2.11.4.1 Adherence to self-reporting of exposure incidents

Prompt reporting of all occupational blood and body fluid exposures among HCWs is critical for appropriate post exposure management (Konlan, Aarah-Bapuah, Kombat, & Wuffele, 2016). Thus, timely initiation of PEP against HBV reduces the chances of seroconversion after events of exposure to HBV, however, timely PEP use is based on timely incident reporting, which is the only way that an exposed individual can benefit from PEP regimen and counseling. In the absence of PEP reporting however, an exposed HCW could miss the opportunity of being evaluated towards PEP use (Yi, Yuan, Li, Mo, & Zeng, 2018). Unfortunately, it has been observed that blood and body fluid exposures are historically under reported despite institutional policies mandating self-reporting. According to occupational health authorities, high under reporting of exposure by HCWs is a major barrier to PEP utilization (Juan, Mc, Lucas, Mc, & Words, 2016). Pervaiz, Gilbert and Ali (2018) in their systematic review including nine different studies from Asia and identified a very high under reporting rate of 76% among HCWs. In Botswana for example, Kassa et al. (2016) found just one third of HCWs who had occupational exposures in the last six months reported their exposures to the facility authorities.

A related study among 175 Turkish HCWs who were exposed to blood and body fluids, found that only 54 (30.8%) reported they had sustained occupational injuries (Engin et al., 2015. However, a slightly higher level of exposure incident reporting has been found among HCWs in Ghana. Babanawo, Ibrahim, Bahar, Adomah-Afari, & Maya, (2019)

identified 50% of Ghanaian HCWs who suffered occupational exposures subsequently reported the exposure incidents.

Many factors have been known to influence HCWs decision to report exposure incidents. Generally, the HBV status of the source patient has been identified as a factor that influences HCWs decision to report an exposure. For example, Mbaisi et al. (2013) observed that reporting exposures and subsequent utilization of PEP among HCWs was strongly associated with the source patient being seropositive for HBV. In that study, lower risk perception of infection and being too busy to report were the factors mentioned as barriers to exposure reporting (Engin et al., 2015). Kasatpibal et al. (2016), observed that HCWs being of an older age and also having an exposure in the form of mucocutanous exposure and the perception of the exposure being minor or not serious were the main factors negatively associated with exposure incident reporting among HCWs. In addition, longer years of practice and the HCW category have also been known to be independently associated with exposure reporting (Ngwa, Ngoh & Cumber,2018). According to Zingg et al. (2015) good hospital organizational culture and work climate are external factors influencing exposure reporting. Kassa et al. (2016) mentioned that unclear reporting pathways and unavailability of systems could pose as major barriers to exposure reporting.

2.11.4.2 Adherence to Timeliness of PEP initiation

PEP initiation is recommended as soon as possible, ideally within 2 hours with the first dose of PEP being offered to the exposed HCW while other evaluation procedures are still underway. This is because research has shown that timely PEP initiation after exposure to high risk body fluids can significantly reduce the rate of occupational transmission (WHO, 2014). Therefore, timeliness of initiation of HBV vaccine and HBIG is essential for HCW safety and protection. Availability of HBIG and HBV vaccine coupled with

abundant supplies of testing materials in a work climate that prioritises HCW safety have been observed as facilitating factors for rapid and timely PEP initiation and use. For instance, a study in Nigeria identified lack of logistics for PEP in a primary health care facility as a structural negative determinant to timely initiation and utilization of PEP after an occupational exposure (Uzochukwu, Sibeudu, Ughasoro, Okwuosa, & Onwujekwe, 2015).

2.11.4.3 Adherence to PEP use

Even though CDC and WHO both strongly recommend the use of HBIG and HBV vaccine for the management of exposures associated with blood and body fluids contaminated with HBV, poor or inappropriate and incomplete use of the HBV vaccine and HBIG for PEP have been reported in many settings (Kumar,Nambiar, Mohapatra, Khanna, Praveen & Bhawana, 2015). According to Sheth, Leuva and Mannari (2016), it is sometimes impossible for HCWs to benefit from this strategy due to complete unavailability of HBIG and HBV vaccine or its high cost in especially resource limited countries.

Many studies in the area of PEP utilization among HCWs found suboptimal adherence to PEP use even in the presence of high risk exposures. For instance, adherence to PEP usage among HCWs in 2 different health care settings in Ghana and Cameroon were 33.8% and 30.8% respectively (Babanawo et al.,2018; 2016; Ngwa et al., 2018).

Other studies to the contrary reported moderate levels of PEP use among diverse populations. Specifically for occupational exposures, Adebimpe, (2018) reported an intermediate level of PEP use among Nigerian HCWs with 65.8% of those requiring PEP actually utilizing it. Another systematic review and meta-Analysis measuring adherence to PEP use for both occupational and non-occupational exposures found 62.60% of participants in all the included studies adhering to PEP use (Ford et al., 2014) .

Individual HCW factors have been shown as impeding PEP use (Owolabi et al., 2011). In Nigeria, HCWs were reported to have poor practices towards PEP. In that study, fear of stigmatization and the perception that PEP was unnecessary were the individual factors that prevented majority of the participants from benefiting from PEP (Owolabi et al., 2011).

Health facility factors can influence PEP use by HCWs. Mill, Nderitu and Richter, (2014) observed that lack of hospital infection prevention policies or guidelines regarding HBV prevention and or failure of implementation of such policies prevented HCWs from utilizing PEP.

Research has shown that provider deficiencies in evaluating HCWs for PEP as well as deficiencies in counseling of affected HCWs have negative effects on PEP use. In a public health setting, Vetten & Haffejee (2005) reported that insufficient training of occupational health and safety officers in the area of evaluation, counseling and PEP administration resulted in a decrease in PEP use among those eligible to use PEP.

2.11.4.4 Adherence to post PEP follow-up evaluations

According to Miceli et al.(2005) adherence to follow-ups for assessment and monitoring for seroconversion following the use of PEP is an important element of every post exposure management for HCWs. Complete adherence to follow-up visits after PEP use is when the affected HCW complies with 100% of the follow-up visits on the scheduled or agreed dates of appointments. After accidental occupational exposure to blood and body fluids, and the use of PEP for HBV, it is particularly important for HCWs to undergo follow-up evaluations for the detection and early treatment of acute infection, especially in cases where seroconversion to HBV positivity is inevitable. According to Behrman, Shofer, and Green-McKenzie (2001), in cases of exposure to blood-borne pathogens, the

efficacy of post exposure treatment has been shown to correlate positively with the completion of follow-ups. Unfortunately, overall sub-optimal rates of follow-ups after PEP use have been observed among HCWs. Even in the presence of high risk exposures, HCWs failed to undergo follow-ups to be evaluated (Behrman et al., 2001; Escudero, Furtado, & Medeiros, 2015).

Contrary to the above findings, other studies elsewhere reported intermediate to good level of adherence to post PEP follow-up visits. For example Tetteh et al. (2015) found a good level of adherence among HCWs working in a teaching Hospital in Ghana.

There is evidence to show that adherence to first follow-up is higher compared to subsequent appointments. A study evaluating adherence to follow-ups among HCWs in Brazil found adherence to follow-ups to have reduced from 43.5% to 36.6% in 6 and 12 months respectively (Escudero et al., 2015). Specifically in Ghana, it was reported from a large teaching hospital that adherence to follow-up after PEP use reduced linearly with time from 87.2% to 75.1% and finally 62.6% in 6 weeks, 3 and 6 months respectively (Tetteh et al., 2015).

2.12 Hepatitis B virus prevention and control environment for HCWs (Health facility factors)

Following the recognition of HBV as a blood-borne infection which could be transmitted via occupational exposures, health institutions the world over have been mandated to organize and implement infection prevention strategies and recommendations to ensure that all HCWs are adequately protected (Zingg et al., 2015). Occupational exposure and occupationally acquired infection prevention requires strong hospital or facility management oversight in all settings. According to Shahab et al. (2013) prevention of HBV in the health care setting is largely accomplished through: (1) establishment of

organizational control programs and procedures, (2) training and insistence on safer workplace practices, (3) the use of personal protective equipment, (4) availability and use of vaccines and logistics that are aimed at ensuring the occupational health and safety of employees.

The Hospital Infection Control Committee (HICC) is a mandatory body or committee that is instituted within health facilities (Far, Marino, & Medeiros, 2001). The committee is an independent authority within the hospital that solely adopts control measures to prevent transmission of health care associated infection within the hospital (Far, Marino, & Medeiros, 2001). The committee provides a forum for inputs and co-operation and information sharing from all sectors within the health care setting. According to the WHO (2004b), every hospital infection control committee is mandated to have a wide representation from relevant departments and be an integral component of the HCW and patient safety.

It has been documented that health facilities and hospitals having a well-organized hospital infection control committee have demonstrated significant improvement in both patient and HCW safety. Such facilities have also been known to have seen improvement in overall quality of services, lowering cost of health care and most importantly reducing mortality and morbidity associated with HAIs in both patients and HCWs (Far et al., 2001). Specifically, Kandi (2018) in a related review stated that the implementation of the hospital infection control programme managed by a functional committee helped to control HAIs, and also reduce overall morbidity and mortality.

The provision of free immunization for HCWs and where necessary, the provision of a timely post exposure prophylaxis against HBV are a strong recommendations to health institutions by WHO in the global health sector strategy on viral hepatitis (WHO, 2016). Other health organizations have also strongly advocated for pre-exposure and post

exposure vaccinations to be offered at no cost to employee HCWs who are at risk of occupational exposures (CDC, 1997).

Effective utilization of PEP following blood and body fluid exposure is largely dependent on timely reporting of exposure incidents. Prompt reporting of occupational exposures is essential for management of exposures as well as identifying workplace hazards that mitigate the occurrence of exposures. Evidence is available to show that failure of health institutions to establish clear reporting channels or pathways with easy accessibility to a practitioner or consultant who can evaluate, counsel and manage exposed HCWs are detrimental to HCW safety. In Tanzania for instance, Laisser and Ng'Home, (2017) found that HCWs were unable to report their exposure incidents because the reporting pathways in their facilities were unclear and the HCWs lacked knowledge on the required process to follow after the occurrence of occupational exposures.

Accurate documentation of exposures is very fundamental to effective evaluation of HCWs for PEP following an exposure. Hospital authorities have been mandated by WHO and country specific recommendations to document exposures in terms of time, date, type of duty being performed among others. The documentation is to clearly describe the nature of the exposure (severity, amount and type of body fluid involved, type of device causing the exposure) as well as sociodemographic characteristics of the exposed HCW (Beltrami, Williams, Shapiro, & Chamberland, 2000). Lahuerta et al. (2016) conducted a study in the area of occupational exposure reporting and documentation and reported gross discrepancies between the number of self-reported exposures and what was available in exposure database of the health facility. This is an indication of a poor documentation regarding HCW exposure to blood borne infections at the health facility level.

Policies and guidelines produced by international organizations such as CDC, WHO and other country-specific guidelines are available to HCWs on prevention of blood borne infections. The guidelines principally are centered on occupational health and safety as well as infection prevention in the health care setting. According to Irving (2014), the presence of these protocols and guidelines in the immediate work environment of HCWs have been identified to facilitate adherence, promote compliance and most importantly reduce variations in practice. These positive attributes were highlighted in a recent review which strongly recommended the use of evidenced-based guidelines and policies in the health care setting for the prevention of HAIs and advocated for HCWs to be educated and periodically monitored to ensure effective adherence to these protocols and guidelines (Storr et al., 2017). Irrespective of the numerous benefits offered by the use of policies and guidelines to HCWs, availability and implementation or enforcement at the health facility levels, adherence and use has been reported to be inadequate or sub optimal in many health settings especially in developing countries (Rowe, De Savigny, Lanata, & Victora, 2005).

Facility-led education and training for HCWs on infection prevention has been shown to reduce the incidence of exposure to blood-borne pathogens (Zafar et al., 2009). Infection prevention education and training for HCWs using strategies that are participatory and involving both bedside and simulation exercises have been recommended to be effective in promoting HCW safety. For instance, a review of randomized control trials identified in-service education and training for HCWs to have contributed to a significant reduction in inappropriate practices by HCWs (Opiyo & English, 2010). Specifically to HBV prevention among HCWs, studies done in Africa and other developed countries documented the protective nature of well targeted HCW trainings and recommended its periodic implementation as a strategy to improve adherence to policies regarding infection prevention (El-leithy, 2013; Zafar et al., 2009).

2.13 Occupational health and safety policy for Ghanaian HCWs in relation to prevention of occupational transmission of hepatitis B virus infection

The Occupational Health and Safety Policy Guideline (OHSPG) for the health sector was developed and disseminated in year 2010. It is the first of its kind and its preparation and subsequent dissemination was in response to the fact that the greatest occupational health and safety risk faced by healthcare workers are as a result of exposure to blood and body fluids. The Ministry of Health also considered it prudent to provide a safe and healthy working environment as far as reasonably practicable for its employees in accordance with the 1992 constitution and the labour law 2003, Act 651 (GHS, 2010). The policy even though was not developed solely for HBV prevention among HCWs, just like other international guidelines, it recognized HBV infection as a blood-borne infection with occupational dimensions and therefore recommended specific preventive practices to be implemented at the Individual HCW as well as health care facility levels. The following strategies have been outlined for HBV prevention:

Pre exposure prophylaxis: HCWs exposed to blood and body fluids are to receive 3 doses of HBV vaccine (Engerix B 20 micrograms or Recombivax-HB 20 micrograms) at a schedule of 0,1,6 months, and serological testing should be done for Hepatitis 'B surface antigen and Hepatitis B antibody prior to initiating vaccine administration. If the antibody titer level is low or negative, Hepatitis B vaccination should proceed.

Post exposure prophylaxis: Health personnel sustaining muco-cutenous and percutaneous exposures to blood or body fluids contaminated with HBV are expected to undergo serological testing for HBsAg and Anti-HBs. HBV vaccine and HBV immunoglobulin are to be used based on post exposure serological results. The policy recommends that in situations where antibody titer is low or negative in already vaccinated individuals, a booster dose of Hepatitis B vaccination should be administered. The policy further stated

that for unvaccinated persons (unlikely to have had previous exposure to HBV) who have suffered exposures, HBIG should be administered for immediate action followed by the complete HBV vaccination series. Thereafter, serological testing should be repeated at one (1) and six (6) months interval (GHS, 2010).

The policy gave clear directives to health facilities and employers to establish systems and implement programs within the health facility to promote sound occupational health and safety of employees. Some of these programs include the institution of the occupational health and safety as well as infection prevention and control committees and coordinators who are expected to drive infection prevention as well as occupational health and safety efforts within the health facility. Others are the organization of new employee screening, vaccination programmes, in-service education and training. A summary of the preventive recommendations is shown in Fig.2.2 below.

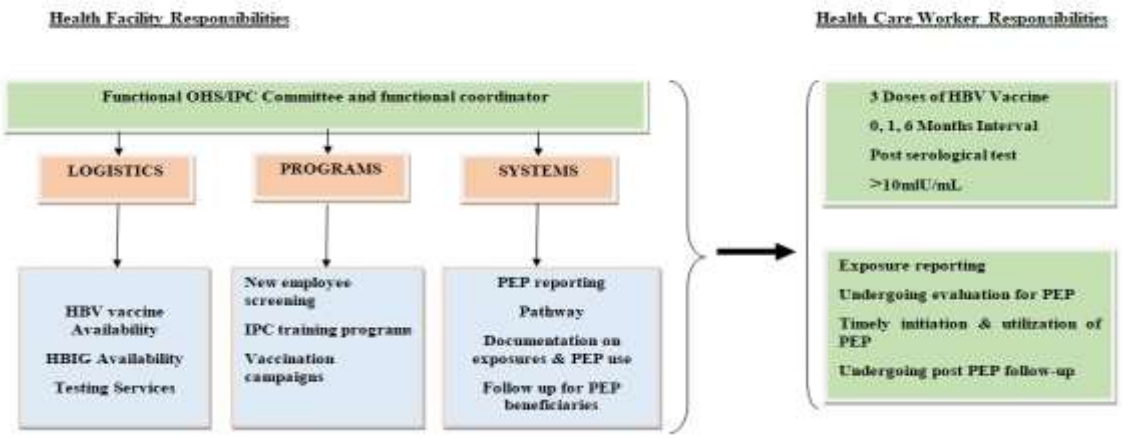

Figure 2.3: HBV preventive strategies outlined in the Occupational Health and Safety Policy guideline for the Health Sector

Source: Adapted from GHS, 2010**.**

2.14 Ghana's Health care delivery system and levels of health care

In Ghana, most health care is provided by the government and is largely administered by the Ministry of Health and the Ghana Health Services. The healthcare system has five

levels of providers: health posts or CHPs compounds, health centres and clinics and polyclinics, district hospitals, regional hospitals and teaching hospitals (GHS, 2008).

Teaching hospitals are at the peak of the health care delivery system in Ghana. They provide complex curative tertiary care. They manage referrals from district hospitals as well as the regional hospitals. These facilities are well equipped and have very high skilled individuals who provide high level medical care (GHS, 2008).

Regional hospitals represent a secondary level of care in the health care delivery system. Such facilities provide specialized care, involving skills and competence not available at district hospitals, which makes them the next level of referral from district hospitals. The workforce who work in such facilities include medical professionals, such as general surgeons, general medical physicians, pediatricians, general and specialized nurses, and midwives (GHS, 2008).

District hospitals are the health institutions mandated to provide clinical care at the district level. District hospitals serve an average population of 100,000 to 200,000 people in a clearly defined geographical area and is the first referral hospital and forms an integral part of the district health system (GHS, 2008).

The polyclinic is the urban version of the rural health centre. Polyclinics are usually larger, offer a more comprehensive array of services, and most often governed by physicians, and can offer surgical services. They are mainly in metropolitan areas (GHS, 2008).

The health centre is the first point of contact between the formal health delivery system and the client especially in areas where the CHPs system is unavailable. It is headed by a medical assistant and is staffed with heads in the areas of midwifery, laboratory services, public health, environment, and nutrition. Basic curative and preventive services for adults and children, as well as reproductive health services are available at this level of

care. Service coverage provided at this level is augmented with outreach services, and referral of severe and complicated conditions to the other higher levels (GHS, 2008).

2.15 Background to the climate and environment of higher and lower level facilities

The ministry of health and the Ghana health service refer to regional and district hospitals as higher level facilities (Ministry of Health, 2015). The reason being their ability to provide referral services and other complicated therapeutic and diagnostic services related to patient care. Higher level facilities have been identified as having improved infrastructure and staffed with highly educated and skilled workforce compared to the lower levels of care (WHO, 2012). Higher level facilities have also been reported to have good governance and leadership systems to streamline activities and maintain standards

2.16 Effect of facility level factor on adherence to recommended protocols

Varying reports are available on how health facility level influence adherence of HCWs to standard protocols. Some authors have argued strongly that, health care workers in well-equipped facilities in many instances do not adhere to recommended standards. For example, Leslie, Sun & Kruk (2017) observed that HCWs working in high level facilities with improved infrastructure adhered poorly to standard protocols regarding the provision of quality care to clients. In their study, there was poor correlation between infrastructure and adherence to standard protocols. Contrary to the above finding, Boostra et al. (2002) found a positive relationship between higher facility level and adherence to treatment guideline.

Again, an African study conducted in Tanzania reported that lower level facilities demonstrated deficiencies in their readiness to provide chronic respiratory disease management. Lack of infrastructure and weak governance being the two main

contributing factors. Reports are unavailable on the effect of health facility on level of adherence to HBV vaccination protocol. This has been identified as a gap in literature. Especially in the African context, most of the studies conducted were not multi-facility studies and for that matter the influence of health facility level could not be assessed. Perhaps one of the strengths that this present study has over others is its multi-facility design that made it possible for the facility level component to be assessed.

2.17 Gaps identified in literature

The extensive review of literature has demonstrated that a lot of work has been done to assess the burden of HBV infection and its prevention among HCW populations. Despite this level of research, country-specific information is largely unavailable in the Ghanaian context. Country specific information on HBV serological marker distribution among HCWs in Ghana is lacking.

Even though HCWs transmitting HBV infection to vulnerable patients and others within the health care setting is a possibility, most of the studies reviewed were skewed to describing the distribution of HBsAg, anti-HBc and anti-HBs with limited or no attention to HBeAg and its distribution among the various categories of HCWs.

None of the studies reviewed so far reported the impact of facility level on HBV exposure and infection due to the fact that most of the studies were not multi-facility based neither was the work climate or environment in which HCWs operate was assessed. Attempts to link health facility environmental factors to HBV infection and its prevention is lacking.

Although three indicators are listed under the recommendation for HBV vaccination, measurement of adherence to vaccination recommendations was limited to results obtained by using the receipt of 3 doses and also to some extent 3 doses and post vaccination serological testing. Surprisingly, 0, 1, 6 vaccination schedule was not

considered as an important indicator for measuring adherence to HBV vaccination among HCWs. Most of the studies reviewed so far regarding adherence to PEP management protocol focused largely on exposure reporting and PEP use. A components in the PEP management pathway including evaluation for PEP eligibility has most often not been given important consideration.

Information regarding seroprotection rates following HBV vaccination among Ghanaian HCWs who vaccinated as adults has not been documented in literature.

2.15 Chapter summary

There are variations in HBV infection prevalence among various populations in the various geographical regions of the world. Based on the prevalence of the chronic form of HBV infection, three zones of endemicity have been described with Ghana and other countries within the sub-Saharan African region belonging to the high endemicity zones where prevalence of the chronic form of the infection is over 8.0%. HBV prevalence among HCWs is also not uniform as prevalence has been observed to mirror that of the general population where the HCW works. Among Ghanaian HCWs, reports are unavailable on the level of lifetime exposure and subsequent infection with HBV.

Hepatitis B prevention among HCWs globally is not optimal in terms of both pre-exposure and post exposure prophylaxis. However, HCWs in developing countries appear to stand greater advantage of being protected from the infection. Most studies done in other African countries and developed countries measured adherence to HBV vaccination protocols using either three doses or a combination of three doses and post serological testing resulting in poor level of adherence especially among HCWs in Africa. Seroprotection against HBV among HCWs vaccinated as adults follow the natural immunogenic pattern of HBV vaccine as described in individuals vaccinating as children

however age at vaccination, body mass index and other individual characteristics of the HCW could affect level of seroprotection hence among HCWs vaccinating as adults, seroprotection may not be universal.

Post exposure prophylaxis knowledge and adherence to recommended protocols outlined regarding PEP for HBV are generally poor with both individual HCW and facility factors contributing largely to the poor level of adherence.

CHAPTER THREE

METHODS

3.1 Study design

The study was a hospital based cross-sectional one conducted in the Greater Accra Region of Ghana during the months of January to April 2018. Stratified random sampling technique was used to select health care workers for the study. A pretested structured questionnaire developed specifically for this study was used to collect data from Health Care Workers (HCWs) in their respective health facilities. Data on socio-demographic factors, vaccination adherence and post exposure prophylaxis knowledge and adherence were collected from the respondents. Approximately 5mls of venous blood was collected from all consenting HCWs and screened for the presence of five serological markers of HBV. Enzyme Linked Immunosorbant Assey (ELISA) procedures were subsequently undertaken to quantitatively estimate Anti- HBs levels and qualitatively detect IgM HBcAb.

3.2 Study region

The study took place in the Greater Accra Region. According to Snow and colleagues (2014), the Greater Accra Region has the largest distribution of HCWs and Health facilities and this provided the basis for its purposive selection as a study region. The region lies on the south eastern part of Ghana along the Gulf of Guinea. It occupies a total land surface area of 3,245 square kilometers, being 1.4% of the total land surface area of Ghana. In terms of land size, Greater Accra Region is the smallest region in Ghana. The capital town of Ghana is located in this Region.

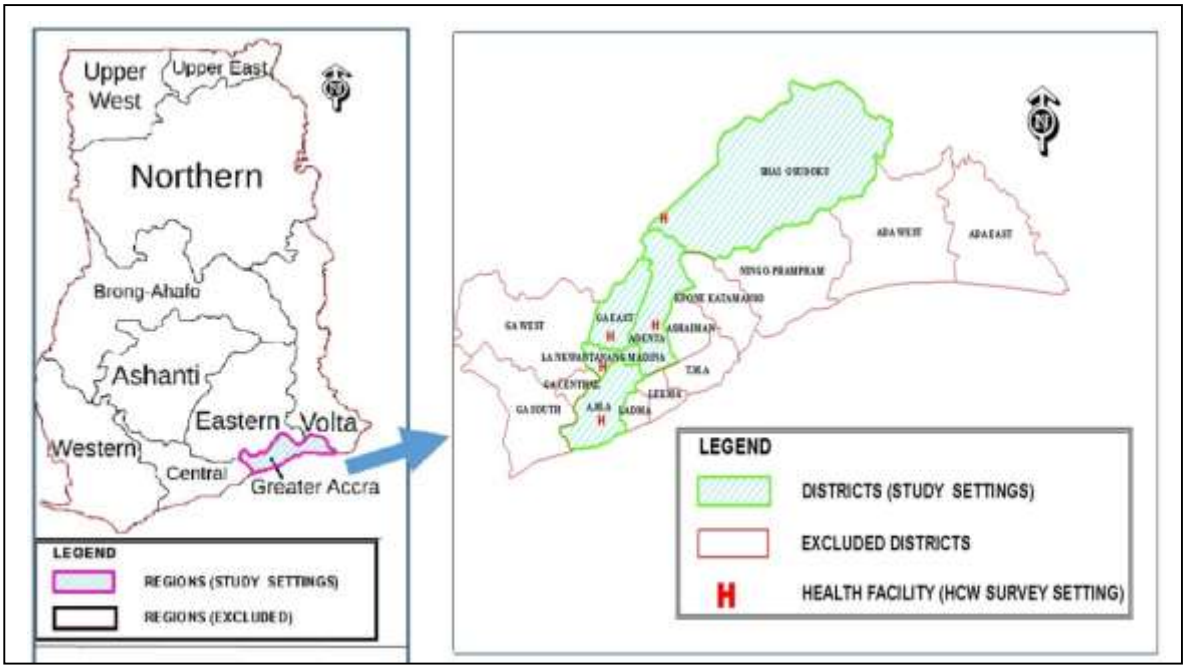

Figure 3.1: Map Showing Selected districts and health facilities for the study.

Source: Ghana Statistical Service 2018 & Geomappers Eng. Limited (2019)

According to the Ghana Statistical Service (2010), the Greater Accra Region is the second most populous region following the Ashanti Region. The population of the Greater Accra region grew from 2,905,726 in the year 2000 to 4,010,054 in the year 2010 with population density of 3,245 km^2.

The Greater Accra Region is boarded to the north by the Eastern Region, east by Volta region, and west by Central region and the south by the Gulf of Guinea (GSS 2010). The political administration of the Greater Accra Region is a decentralized system operated by the local government system. At the time of the study, 16 demarcated zones (Metropolitan/ municipal/districts) existed within the region. The region has two (2) metropolitan areas, 14 Districts and municipalities as well as subdivision of the metropolitan areas to 5 sub metros, making a total of 21 political demarcated zones. This political demarcation is operational in the areas of health care provision as well as local governance (Ministry of Local Government and Rural Development, 2014).

3.3 Study sites

The study was implemented in five health facilities within the Greater Accra Region. The facilities are: Greater Accra Regional Hospital, Shai Osudoku District Hospital, Madina Polyclinic-Rawlings Circle, Abokobi Health Center and Fafraha Community Based Planning Services (CHPs) or primary care center.

3.3.1 Study site one: Ridge Regional Hospital

The refurbished Ridge Regional Hospital also known as the Greater Accra Regional Hospital was commissioned in the year 2017. The first Phase of the hospital expansion project is a 420-bed capacity institution which is equipped with state of the art facilities. The refurbished Hospital if completed will completely replace the traditional Health institution called Ridge Hospital which was built in 1928 by the British. The old facility evolved from a Women's Hospital in 1974 to a District Hospital in 1994. The facility covers a total land area of 15.65 acres. Greater Accra Regional Hospital is a referral center with an estimated population coverage of 4,283,233. The hospital is accredited by the Medical and Dental Council of Ghana for the training of House officers and Post Graduate Residents in the major areas of medicine. The facility also houses a training school for Anesthetists. The medical director who is assisted by the health service administrator as well as head of the Nursing Services are responsible for leadership and governance in the institution. The Greater Accra Regional Health Directorate of the Ghana Health Service has an oversight responsibility over the hospital. The facility has an average daily Out Patient Department (OPD) attendance of over 440 patients with over 1200 workforce of which 156(13%) participated in the study. The major units or departments of this hospital include internal medicine, surgery, dentistry, obstetrics and gynecology, dentistry and eye departments and finally preventive or public health department. As at December 2017

the doctor patient ratio was 1:937 and 1:159 for out-patients and in-patients respectively (Greater Accra Regional Hospital, 2017).

3.3.2 Study site two: Shai Osudoku District Hospital-Dodowa

Shai Osudoku District Hospital was established as a Health Post in 1970 by the people of Shai and handed over to the Government of Ghana (Ministry of Health) with the aim of meeting the health needs of the people within the Shai and Osudoku communities. The hospital is situated at Dodowa, the capital of the district. The facility evolved from a health post to a health center in 1984 and was finally upgraded to a District Hospital in 2009. The hospital being the only bigger government facility in the Shai Osudoku district, serves as a referral center for both public and private facilities nearby. The facility however since 2016 has been operating from a state of the art facility which has a capacity of one hundred and twenty five (125) beds with six (6) wards and two (2) operating theaters. Medical, Surgical, Obstetrics and Gynecology, Child Health, Accidents and Emergency as well as Public health departments are all in full operation in this facility. The facility is well resourced in terms of equipment, and has a total health workforce population of 308 of which 26% participated in the study. The O.P.D per capita as at 2017 was 2.63 (Shai-Osudoku District Hospital, 2017).

3.3.3 Study site three: Madina Polyclinic (Rawlings Circle)

The Madina Polyclinic was first established as a Health Center in the year 2005 to extend quality health care services to the people of Madina and its environs. However, in the year 2008, the facility was adjudged the status of a Polyclinic and therefore deemed as a Budget Management Center with a bed capacity of 18 beds. The polyclinic is one of the five public or government facilities within the Madina Municipality. It covers a total of 1400

square meters and located at Madina New road, Rawlings Circle. The polyclinic provides health services via departments including Emergency and Recovery, General Out Patient Department (O.P.D.), Antenatal and delivery as well as special clinics which manage eye and ear, nose, and throat conditions. The La-Nwantanang Madina Municipal Health Directorate supervises the activities and operations of this institution. Governance and leadership are provided by the medical Doctor who is assisted by the Health Services Administrator and the Deputy Director of Nursing Services. The total workforce of the facility as at December 2017 was 204 (both casuals and permanent workers).This number also comprises of all cadre irrespective of their likelihood to be exposed to blood and body fluids. However, 28% of the workforce participated in the study. The O.P.D. per capita as at 2017 was 0.67 with a doctor patient ratio of 1: 4394 (Madina Polyclinic, 2017).

3.3.4 Study site four: Abokobi Health Center

Abokobi Health Center was the first Government or public health facility to be established within the Ga East Municipality. It is a 20-bed capacity institution that provides services ranging from Antenatal and delivery, general O.P.D. and consultation, emergency care and recovery as well as public health or preventive services. The facility was built in the late 1970s, and has remained functional with a very slow pace of development in infrastructure and equipment. The facility provides health care services to over 14,020 community members. Even though the health center is a Budget Management Center on its own, the Ga East Municipal Health Directorate has an oversight responsibility over its operations. The facility is managed by a Physician assistant who is assisted by a Health Service Administrator and a Principal Nursing Officer. The total health workforce population is 103 (including population of interest and all other categories). However, the

proportion of the workforce that participated in the study was 35%. The daily average OPD attendance is 40 (Abokobi Health Center, 2017).

3.3.5 Study site five: Frafraha CHPs (Primary Care Center)

This facility is a basic level health care facility that evolved from a reproductive and child health outreach point to a primary level care unit in 2014. The facility currently provides antenatal care, general OPD and consultation, treatment of minor ailments as well as post-natal and family planning services. Most of the cases seen in this facility are minor ailments whilst serious and life-threatening conditions are referred to higher levels for management. A physician assistant currently manages the facility and technical support for the facility's operation is provided by the Adentan Municipal Health Directorate. On average, the facility sees 10-20 cases per day with a workforce population of thirty-two (32) (Fafraha CHPSs, 2017).

3.4 Study population

The study was restricted to HCWs belonging to six cadres or categories of staff including: doctors, nurses and midwives, laboratory staff, orderlies, anesthetists and physician assistants (PAs). The above listed cadre of HCWs are directly involved in patient care and may be at increased risk of HBV exposure due to exposure to blood and body fluids during their day to day interactions with patients in the hospital environment (Auta et al., 2017) and this is what informed their inclusion in the study. These HCWs were selected from five facilities representing five levels of care within the Greater Accra Region.

3.5 Study variables

As shown in the conceptual framework of this study, (Fig. 1.3), the primary outcome variables of interest is adherence to HBV prevention practices (vaccination and PEP for

HBV). The secondary outcome variable which is the antecedent of this research is HBV status which was measured as either presence or absence of serological markers in a HCW.

The exposure variables which are referred to as independent variables are consequent in nature and were observed for their effect on the outcome variables. The independent variables include sex, age, educational status, cadre, duration of employment and two other generated variables (risk perception and facility factor). Tables 3.1 (A-C) provide a summary and operational definition of some of the dependent and independent variables as well as their scales of measurement as utilized in the study.

Table 3.1(A) List of variables and their scales of measurement

Variable	Operational Definition	Variable Type	Scale Of Measurement
	Background variables		
Age	Age in years of participating health care worker	Independent	*Categorical Variable*
Sex	Biological sex of the participating health care worker	Independent	*Binary* Male Female
Body mass index (BMI)	Mass in kilograms per height in meter square	Independent	*Binary Variable* <25kg/m^2 ≥ 25kg/m^2
Level of education	Highest educational level that the HCW has attained	Independent	*Categorical*
Chronic disease	The presence of a diagnosed chronic disease condition e.g. diabetes, hypertension	Independent	*Binary* Chronic disease present Chronic disease absent
Cadre of staff	Type of profession, cadre or designation of the Health Care Worker	Independent	*Categorical* : Nurse/Midwife Doctor Anesthetist Orderlies Laboratory staff Physician Assistant (PA) *Categorical*
Behavioral risk factor	A combination of risk factors other than occupational factors that predisposes HCWs to HBV infection (transfusion, surgery, dental procedures tattoo, Family history etc)	Independent	No risk –(0) Low risk(1-3) High risk(≥4*)*

Table 3.1(B) List of variables and their scales of measurement

Variable	Operational Definition	Variable Type	Scale Of Measurement
Occupational and facility variables			
Facility type	The level of care or facility where HCW works	independent	*Categorical* Regional Hospital District Hospital Polyclinic Health center CHPs
Duration of employment	Number of years that the health worker has been employed and worked as a care provider	Independent	*Binary* <10 years ≥10 years
Facility factor	Working climate of HCWs assessed and identified to promote adherence to prevention of HBV infection (Logistics, programs, systems and structures in the health facility)	Independent	*Binary* Good facility factor (Score of ≥50%) Poor Facility Factor (Score of <50%)
Work unit	The immediate work environment of HCWs where occupational exposures to HBV are likely to occur	Independent	*Binary* Critical: High risk of blood and body fluid exposure Non-critical: lower risk of blood and body fluid exposure
Training	A health care worker receiving at least one in-service training in the prevention of blood borne infections in the past 5 years	Independent	*Binary* Trained Not Trained
Risk perception (Appendix 8 for further explanation**)**	Perception of vulnerability to HBV infection (assessed using a 5point likert scale)	Independent	*Binary* High Risk Perception (Score of ≥50%) Low Risk Perception (Score of <50%)

Table 3.1(C) List of variables and their scales of measurement

Variable	Operational Definition	Type	Scale of measurement
Occupational risk factors	Life time exposure to blood borne pathogens through: (a) Percutaneous (b) Mucocutanous exposures	Independent	*Binary* Exposure Not exposed
	Outcome variables		
Component specific adherence	Adherence to each vaccination component a. 3 doses b. 0,1,6 Schedule c. Post vaccination testing	Dependent	*Binary* Adhered Did not adhere
Overall Adherence	Adhering to all the three components of HBV vaccination (3doses + 0,1,6+ post testing)	,,	*Binary* Optimal or complete Adherence (100%) Sub-optimal or partial Adherence (<100%)
Adherence to specific components of Post Exposure prophylaxis (PEP) protocol	Exposed HCW: 1.Reporting exposure 2.Undergoing evaluation 3.Initiating and using PEP 4. Undergoing post Pep Evaluation.	,,	*Binary* Adhered Did not adhere
Levels of adherence	Proportion of HCWs adhering to specific HBV prevention recommendation	,,	*Categorical* Poor (≤50%) Intermediate 51-74% Good ≥75%

3.6 Sample Size Estimation

The sample size for this survey was estimated using the formula for estimating proportions proposed by Cochran (1977).

$$N_o = \frac{Z^2 pq}{d^2} \ldots\ldots\ldots\ldots (1)$$

Where:

N_0= minimum sample required, **Z** = standard normal distribution which was set at 1.96

p = the proportion of the population with positive HBsAg tests denoting current HBV infection and d=margin of error. In Ghana, HBV prevalence among HCWs is not yet known. Considering that a national prevalence of 12.3% had been estimated from a systematic review and meta-analysis by Agyeman & Ofori-Asenso (2016) and also given the fact that HBV prevalence among HCWs could be 2-4 times higher compared to the general population (Ott, Stevens, Groeger, & Wiersma, 2012), a prevalence of 50% was used in estimating the sample size.

With the margin of error set at 5%, a minimum of 384.4 samples was obtained.

Given that stratified random sampling technique was used in the selection of five (5) health facilities and HCWs by stratifying both variables into levels and cadre of staff, a design effect of 1.5 was applied to the estimated sample size. According to Kaiser, Woodru, Bilukha, Spiegel, & Salama (2006) a design effect of 1.5 would produce a more efficient sample size in surveys involving sampling procedures such as stratified random sampling.

The application of design effect is as shown in Equation (2)

$$N_0 \times 1.5 = K \ldots\ldots\ldots (2)$$

Where K is the sample size obtained after applying design effect

The application of design effect yielded a sample of 576.

Given that the population from which the HCWs were sampled is finite with a number of the six cadres of staff totaling 928 (Greater Accra Regional Health Directorate, 2017), a finite population correction factor formula proposed by Neyman (1934: 1938) was applied as demonstrated in Equation (3) below.

$$\frac{KN}{K+(N-1)} = S \ldots\ldots\ldots\ldots \textit{(3)}$$

Where K = calculated Sample Size after applying design effect (576)

N = population of the five categories of HCWs in the five (5) facilities/study sites (928)

S=sample size after population correction

The population correction factor produced a sample of 356.

This study was targeted at HCWs. Advertisements on explanations regarding the benefits of the study were undertaken at all the 5 facilities prior to data collection. This was done to gain HCW interest in the study. Therefore a lower non-response rate of 2% was anticipated and adjusted for. According to Fryrear (2015) non-response rate could be around 2% provided the population is very well targeted and that there is a high anticipation of respondents to derive benefits. The adjusting for 2% non-response is as shown in Equation (4) below

0.02 x 356=F……. ***(4)***

Where F= final sample size estimated for the study

The adjustment for 2% non-response brought the final minimum sample size to **363**.

3.6.1 Sampling technique

A stratified random sampling strategy was adopted in selecting participants for the study. Stratification and proportional allocation procedures were undertaken with HCW category or cadre being the unit of stratification. The sampling was implemented as follows:

(1) Four of the five study districts were selected at random from a list of 16 districts/municipalities and metropolis within the Greater Accra Region using the lottery method where the names of the districts were written on pieces of paper, placed in a bowl and thoroughly mixed prior to picking. According to Alvi (2016), simple random sampling is a method of probability sampling where each element has a non-zero chance of being selected to participate in a study. Accra Metropolitan Area which harbors the only regional hospital within the Greater Accra Region was selected purposively.

(2) All the health facilities within the five selected districts have already been stratified into five levels. (CHPS, Health Centre, Polyclinic, District Hospital and Regional Hospital). One facility each was selected from the already existing strata using the lottery method. (The selection from the strata was necessary because the researcher was interested in understanding the role of health facility level on HBV infection and its preventive behavior). The selection was such that all the five levels of care were represented.

(3) Proportional allocation of sample procedure was subsequently carried out to allocate HCWs to each of the five selected health facilities using facility specific staff strength to allocate samples to each facility.

Thereafter, the facility specific sample size obtained after proportional allocation was used at each facility where, proportional allocation of sample procedure was again utilized to allocate HCW to the six cadres or categories using the cadre or category

specific Human Resource Data for each facility. The proportional allocation procedure originally proposed by Bowley (1926), as applied at the facility and cadre levels ensured that the health facility and HCW category with the largest number of units contributed more participants to the study.

The Table 3.2 below gives a summary of the number of HCWs proportionally allocated to the five facilities and the six categories of HCW professions.

Table 3.2 Proportional allocation of HCWs to facility type and cadre of staff

Facility Type	No. Of HCWs Proportionally Allocated	Doctors	Nurses & Midwives	Anesthetists	Laboratory Staff	Orderlies	Physician Assistants
Regional Hospital	158	61	54	17	15	11	0
District Hospital	81	10	36	1	15	10	9
Polyclinic	57	2	24	0	13	10	8
Health Centre	36	0	24	0	1	8	3
CHPs Zone	31	0	28	0	0	0	3
TOTAL	**363**	**73**	**166**	**18**	**44**	**39**	**23**

(4) Finally, selection of HCWs from each cadre or HCW category was done using systematic random sampling procedures where the cadre specific list was used as a sampling frame for each category or cadre in all the five study sites.

Sample fraction or sampling interval was calculated for each cadre category in all the five facilities. For example a sample interval for doctors at regional hospital was calculated and called ‘K’.

A starting point was determined at random between the very first unit in the sample frame and the sample fraction ‘K’.

The K Th element or unit became the random starting point. Thereafter every Kth individual counting from the random starting point in that cadre specific list was selected. This procedure was repeated for all the categories in all the five study sites.

3.7 Inclusion criteria

The study was restricted to HCWs working in the five selected health facilities in the Greater Accra Region belonging to the categories of doctors, physician assistants (PAs), laboratory staff, orderlies, nurses & midwives, and anesthetists. These individuals were 18 years and above, worked as permanent staff in their respective facilities for not less than 6 months, and were willing to follow the study protocol.

These HCWs were recruited from five health facilities whose management permitted the use of the facilities as study sites. Additionally these five facilities were those whose management agreed to delegate a representative core management member to participate in a key informant interview which sought to assess HBV prevention environment of the health force.

3.8 Exclusion criteria

HCWs who were on long term steroid therapy or documented immune suppression and those who were still undergoing HBV vaccination series were also excluded from the study.

3.9 Data collection

3.9.1 Preliminary arrangements and site preparation

Permission letters and all other relevant documents including research protocol and ethical clearance letters were presented to the facility heads of the five facilities selected for the study. Support and collaboration was sought and arrangements were made to have

access to a room in the facility that was eventually used as the research office for data collection. Cadre of staff specific human resource data was obtained for each of the five facilities to help in proportional allocation and actual HCW sampling procedures.

The study was advertised by putting notices concerning the research on notice boards, and also circulation of memos within the various clinical units of the facilities. Also, information was made available to HCWs on facility social media platforms and cadre specific Whatsapp platforms that were already in existence, and utilized routinely for disseminating information in the facilities. The purpose of the advertisement was to gain HCW interest in the study and also make known the random sampling procedure to avoid disappointments on the day of data collection.

The messages were designed to give a brief background to HBV infection. The messages also included the voluntary nature of the exercise, the phlebotomy procedure which may produce slight pain and the fact that steps would be taken to control bleeding and infection following the procedure. The benefits of knowing one's HBV infection status as well as immunity status were all highlighted. The dates for the screening were also communicated to the HCWs. One important information that was given was the random selection procedure that would be adopted. The HCWs were made to understand that only those selected by random sampling procedures could be allowed to participate in the study. The HCWs were also encouraged to report to the screening sites with their vaccination cards or any document to validate previous HBV vaccination.

3.9.1 Participant recruitment

On the dates scheduled for the screening, all the eligible participants reported at the screening site (designated office within the health facility) in their respective facilities. Explanation on the procedures of the study which involve answering a set of questions, undergoing weight and height measurements as well as a blood draw procedure was given.

The risks of suffering slight pain during phlebotomy and the possibility of slight bleeding were mentioned. The benefits of knowing one's HBV infection status and immunity status were also explained. The rights and responsibilities of the participants in terms of voluntary participation and discontinuation from the study were also clarified. Explanation was also provided for confidentiality and privacy issues concerning disclosure of laboratory results and care of blood samples was also given. Those who were selected to participate in the study, and passed all the inclusion criteria and expressed interest and for that matter gave their consent voluntarily to be part of the study were those recruited into the study.

3.9.2 Actual data collection procedure and techniques

3.9.2.1 Questionnaire session

Majority of the eligible and consenting HCWs self-administered the pre-tested questionnaire whereas trained research assistants interviewed just a few participants who, on their own requested to be interviewed. In such cases, the interview was of the face to face type in the designated research office in that facility where auditory privacy was ensured and each interview session lasting for about 30-60 minutes. All the participants who presented their HBV vaccination records had the cards reviewed and information regarding the number of doses taken, schedule of vaccination and time of initiation of vaccination series were extracted and documented and their cards were subsequently given to them. A bio-measurement procedure followed immediately after completion of the questionnaire session.

3.9.2.2 Weight and height measurements

Weight measurements were taken using Seca 877 mobile weighing scale with participant's shoes and hair accessories and decorations that could add on participants' weight were removed and both feet at the center of the scale. Weight measurements were done in kilograms to the nearest 0.10 kilograms.

Height measurements were then taken to the nearest 0.100 centimeter using a standardized 217 Seca stadiometer with participant's (1) arms resting on the sides, (2) shoulders and head leveled, (3) heal, back and calves touching the pole of the stadiometer and the (4) lever lowered to the level of the participant's head. The measurements were taken with the eyes of the measurer at the same level with the headpiece or lever. Participants completed the research procedures by undertaking a phlebotomy procedure.

3.9.2.3 Phlebotomy procedure

All participants were asked to undertake a voluntary blood draw procedure where 5mls of venous blood was collected from each consenting participant for laboratory analysis (Refer appendix 8 for phlebotomy procedure). The blood samples for each participating HCW was collected into two separate gel separator tubes (CHENGDU Rich Science Industry). Both samples were boldly labeled with the participant's identity/serial numbers as well as the facility code. Two samples for each participant was taken to make allocation of the determination of the five serological markers which was a point of care test, and also to make samples available for the ELISA procedures which was done outside the study site.

Figure 3.2: HCWs taking height measurement and phlebotomy procedures respectively

3.10 Laboratory procedures

3.10.1 Blood specimen processing for ELISA procedure

Blood samples intended for ELISA procedure were transported in cold boxes under temperature of 2-8 ^{0}C to one of the study sites that served as a central point for processing and storage within two hours of sample collection. Centrifuging of the samples was done at room temperature for 10-15 minutes at 2200-2500 revolutions per minute using CJ-05C JACTERMAC. The sera was separated from the cells immediately to avoid hemolysis by pipetting, and discharging into tubes that were boldly labelled with participant's identity numbers and subsequently stored at -20^{o}C at the central processing and storage site(one of the study sites) awaiting ELISA procedures. The frozen sera were finally transported under cold chain conditions to the Immunology Department of Noguchi Memorial Institute for Medical Research-Legon, where the samples were tested quantitatively and qualitatively for anti-HBs and anti-HBc IgM using ELISA technique in accordance with the manufacturer's instructions (General Biologicals Corporation, 2008).

Figure 3.3: Centrifuging and Storage of samples at -20^{0c}

3.10.2 Testing algorithm

All the samples of the participating HCWs were screened qualitatively for the five viral markers of HBV. Thereafter, sera in which neutralizing antibodies to HBsAg were detected were further tested using ELISA procedure to quantify the antibodies. Finally, those samples demonstrating the absence of all the markers as well as those from which HBsAg were detected were qualitatively tested for the presence of anti-HBc of IgM class. Figure 3.4 shows the testing algorithm applied during the study.

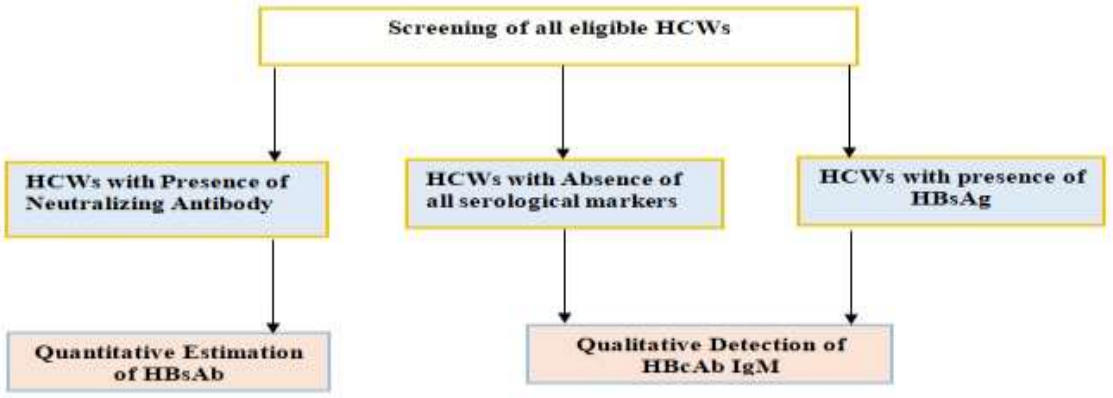

Figure 3.4: Testing Algorithm

3.11 Data collection tools

3.11.1 Data collection tool for HCWs

A structured questionnaire was developed by the principal investigator with guidance from WHO and CDC documents as well as the Occupational Health and Safety Policy Guideline for the health sector. The questions ranged from multiple choice, dichotomous questions and a 5 point ordinal likerts scale. The main components of the structured questionnaire include the following:

1. Sociodemographic characteristics (15 items: including age, sex, training attendance, cadre).

2. Risk factors for HBV infection (9 items dichotomous questions including blood transfusion history, lifetime surgery and dental procedure history and others.)

3. Risk perception for HBV (7 items with 5 points likerts scale with reliability score of Cronbach's alpha of > 0.7.) The scale ranged from 'strongly agree' to 'strongly disagree' and focused on feeling of vulnerability and susceptibility to HBV).

4. Vaccination adherence (14 items with dichotomous and multiple choice questions including HBV vaccination status, number of doses, schedule of vaccination, post vaccination testing).

5. PEP knowledge (5 items with dichotomous questions on what constitute PEP for HBV, good timing for PEP etc.)

6. PEP adherence (12 items comprising dichotomous and multiple choice questions including the resent exposure in immediate past 12 months, exposure reporting, evaluation for PEP, PEP use and timeliness of PEP use).

3.11.2 Data collection tool for assessing HBV prevention environment for HCWs

A structured tool was designed in accordance with the requirements outlined in the Occupational Health and Safety Policy Guideline of the GHS. This quantitative data gathering tool had fourteen (14) items (multiple choice and dichotomous questions) and was basically used to assess the HBV prevention environment or climate of the HCWs who participated in the study. The major themes of the tool included the following:

1 Organization of training sessions on Infection Prevention and control for staff
2 Availability of policy documents and guidelines for implementation of preventive practices within the health facility
3 Availability of infection/occupational health and safety committee and coordinators as well as evidence of implementation of safety and IPC programs
4 Availability of logistics such as immunoglobulin and hepatitis B vaccine in the facility
5 Compulsory screening of new employees and vaccination program for health workers.

3.12 Data collection materials and devices

3.12.1 Hepatitis B Virus Profile Kit (Advanced quality ^{Tm} one step multi-HBV test device cassette (In Tec Products, Inc.)

The study utilized a Rapid Diagnostic Test (RDT) device to detect HBsAg and the other serological markers. Amini et al. (2017) in their systematic review described the usefulness of RDTs in detecting HBV markers. In comparison to laboratory assays as reference standards, RDTs for HBV have good sensitivity and excellent specificity in detecting HBV markers. One study conducted in Ghana also observed that both RDTs

and ELISA techniques are comparable in estimating HBV prevalence and therefore recommended that in resource-poor settings, RDTs could be used successfully in estimating HBV prevalence (Anabire et al., 2019). The test device used in this study is commercially available and has been registered and approved by the Foods and Drugs Authority for use in Ghana as a medical device for detecting HBsAg and other markers. It is a rapid, qualitative, immunoassay. The product has since the year 2001 been listed among series of RDTs evaluated by WHO, and is widely used in testing and diagnosing Hepatitis B Virus infection and markers. It has a sensitivity of 99.0.% (CI 94.5-100) and a specificity of 95.5% (CI 91.3-98.0) (WHO, 2001). The results are readable in 15 minutes. The device consist of 5 chromatographic strips where each strip detects one HBV marker namely; HBsAg, HBsAb, HBcAb, HBeAg, and HBeAb.

3.12.2 Anti HBsAb ELISA test device: Antisurase B-96 Ii (TMB)

This is a 96-plate solid-phase Enzyme Linked Immuno Sorbent Assay (ELISA) based on the sandwich principles. It is effective in the quantitative detection of the presence of antibodies to HBsAg in serum or plasma. The solid phase of the micro titer plate is made of polystyrene wells that are coated with HBsAg of Ad and Ay sub-types. The liquid phase however comprises peroxidase conjugated HBsAg (Ad sub-type). Following a reaction, a color develops in proportion to the amount of Anti-HBsAb bound to the HBsAs. An optical density of the developed color is read with a photometer at 450nm with a selected wavelength of 620-690nm. This ELISA KIT has sensitivity and specificity of 100% and 99.5% respectively(General Biologicals Corporation, 2008). Quantitative measurement of anti-HBs is used to quantify antibody levels and also evaluate the response to hepatitis B vaccination in ‘at risk’ populations especially HCWs. The consistency and similarity in different guidelines regarding the cut-off point for detecting antibody levels make the

measurement of anti-HBs levels by different assays accurate and consistent therefore yielding comparable results (Huzly, Schenk, Jilg, & Neumann-Haefelin, 2008).

3.12.3 Anti-HBc-Igm ELISA test device: Anticorase Mb-96(TMB)

The essence of this ELISA kit was to help identify anti-HBc IgM class which denotes a very recent infection. Even though HBsAg is the hallmark for detecting HBV infection, Krajden et al. (2005) observed that in rare instances, anti-HBc-immunoglobulin (IgM) may be the only HBV marker detected during the early convalescence or 'window period' when both HBsAg and anti-HBs tests are negative. This test may be useful in detecting infections within the window period. The test makes use of anti-human IgM on micro-titer wells as a solid phase and HBcAg and peroxidase-conjugated Anti-HBc in liquid phase in an 'IgM capture' principle to detect Anti-HBc IgM levels in serum or plasma. The ELISA kit has sensitivity and Specificity values of 96.1% and 100% respectively (General Biologicals Corporation, 2008).

3.13. Laboratory analysis

3.13.1. Qualitative detection of serological markers

This test required the use of whole blood or plasma to detect the serological markers. The samples designated for this test were used within 30 minutes of sample collection. Each test cassette was singly used and labeled accurately with participant's identity number and a code that matched with participants' questionnaire identity number. A 60µl or two drops of blood sample was dropped on each of the five wells of the test devise simultaneously. The test sample was allowed to flow through the absorbent device by chromatography in

all the five stripes and the results were read in 15 minutes according to the manufacturer's instructions.

3.13. 2 Qualitative detection of Anti-HBc Igm using ELISA principles.

All reagents and specimens were brought to room temperature (+20 - +30 ^{o}C) before the commencement of the assay. A plate layout was planned. The water bath was adjusted to +37±1^{o}C. The wells were indexed accurately as A1, B1, C1, and D1 etc. For each 96 micro well plate, one well was left as a blank. Each fifty microliters of the test sample was diluted using five hundred microlitres of specimen diluent in a test tube and mixed thoroughly by shaking. One hundred microlitres of negative controls were dispensed into three wells each. Hundred microlitres of positive controls were equally added to 2 wells each. Hundred microlitres of specimen diluent was added to each well for the test specimens. Then, fifty microlitres of each of the diluted specimen was dispensed into wells containing the specimen diluent. The reaction plate was sealed with an adhesive tape and incubated at +37±1^{o}C for one hour. The plate was then washed using washing solution D (20x) diluted in distilled water to make 1:20 dilution. Six cycles of plate washing were done with at least 0.5ml washing buffer per well per cycle.

The plate was blot dried by inverting the plate firmly onto an absorbent paper. Thereafter, 50µl of HBcAg reagent and 50µl of anti-HBc peroxidase solution was added to each reaction well except the blank well. The reaction plate was sealed with an adhesive tape and incubated at +37±1^{o}C for one hour. The plate was then washed. Equal volumes of TMB Substrate solution A and B were mixed and 100µl of the solution was added to the wells. The plate was again incubated at room temperature for 30 minutes. A solution of 100µl of sulfuric acid ($2NH_2SO_4$) was added to each well including the blank to stop the reaction. The absorbance of test specimen and controls were detected within 15 minutes

with a precision photometer at 450nm with a selected reference wavelength within 620-690nm using the blank well to blank the photometer. The cut-off values were calculated for each plate in accordance with manufacturer's instructions. Samples with ODs below the cut-off values were considered as being non-reactive. (Appendix: Calculation of cut off values).

3.13.3 Quantitative estimation of Antibody Levels using ELISA Principles

All reagents and specimens were brought to room temperature (+20 -+30 ^{o}C) before the commencement of the assay. The wells were indexed accurately as A1, B1, C1, and D1 etc. For each of the 96 micro well plates used, one well was left as blank. Fifty microlitres of both zero and positive controls as well as standards (10mlU/ml, 25mlU/ml, 50mlU/mL, 100mlU/mL, 400mlU/mL, and 1000mlU/ml) were pipetted into appropriate wells in duplicates (A1-A2 to H1-H2). Fifty microlitres of test sample was dispensed into the sample wells. Then, 50µl of HBsAg Peroxidase solution was added to each reaction well. A protective seal was used to tightly seal the plate. The reaction plate was incubated at +37±1^{o}C for one hour. The plate was washed (with concentrated solution D (20x) in distilled water achieving 1:20 dilution. Plate washing procedure with overflow aspiration was performed in six cycles with at least 0.5ml washing buffer per well per cycle. A mixture of equal volumes of TMB substrate solution A and B was prepared and 100µl was pipetted into the wells including the blank.

The plate was covered with a black cover and incubated at room temperature for 30 minutes. Finally, 100µl of H_2SO_4 was added to each reaction well including the blank well to terminate the reaction. The absorbance of test specimen and controls were detected within 30 minutes with a precision photometer at 450/620-690nm using the blank well to blank the photometer.

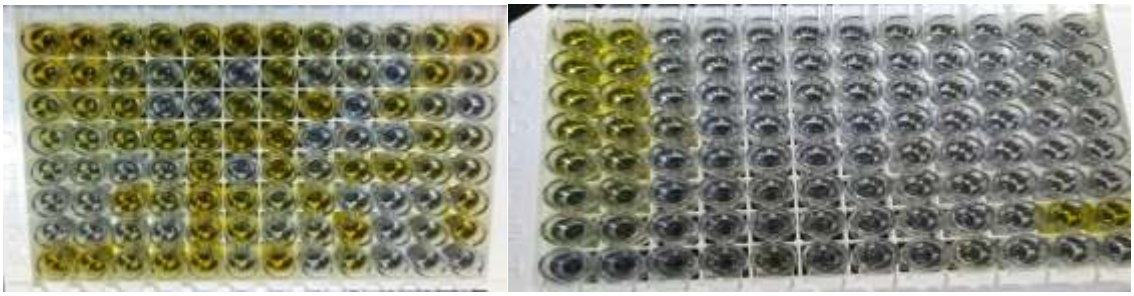

Figure 3.5: ELISA Plates for the detection of HBsAb & HBcAb IgM

(Source: Immunology Department laboratory NMIMR-Legon).

3.13.3.1 Calculation of antibody concentrations

The mean absorbance values for the standards, controls and the samples were calculated. A standard curve was then generated by plotting the concentrations of the standards (1000, 400, 100, 50, 25, 10) (x-axis) against its corresponding average OD values (y-axis). The mean absorbance values of the samples were used to extrapolate mean concentration of anti-HBs from the standard curve. The outcomes were categorized into three groups following the calculation of the antibody concentrations. Those with antibodies levels of; (1) Below 10mlU/mL were classified as not seroprotected, (2) ≥ 10- 100mlU/ml were classified as seroprotected with good immunity, (3) ≥ 100mlU/mL were classified as seroprotected with very High level of immunity (Refer to Appendix for validity of test runs and calculation of concentrations).

3.13.4 Serological assay precautions

All laboratory equipment were accurately calibrated and maintained in complete accordance with the manufacturer's expectations. The reagents and kits were stored at the required temperature at the Noguchi Memorial Institute of medical research. Diluents

buffers, calibrators, controls and all reagent kits were thoroughly examined prior to their utilization.

All the samples were stored at -20^{0}C. The ELISA kits with its reagents were also stored at a temperature range of +2 - +8^{0}C and the temperature of the fridges were monitored and recorded twice daily on the respective temperature charts.

Prior to performing serological assays, all the calibrators, controls, diluents buffer and kits were checked to ensure that they were in good condition and also not expired. All reagents were brought to room temperature +20 to +30^{0}C prior to commencement of the assays. Indexing of the plate and creation of plate layout was preplanned for correct identification of the samples to prevent mix ups.

All positive and negative controls were tested alongside the test samples to help ascertain the validity of the assay. Incubation in all cases was done at 37^{0}C, and duration of incubation was in accordance to kit manufacturer's instruction in all cases. Number of wash cycles was strictly adhered to with only the concentration of wash solutions provided by the manufacturer. A spectrophotometer at 450nm wavelength with selected reference wavelength within 620-690nm was used to determine the absorbance of controls and specimens in 15 minutes following the end of the reaction.

Values obtained for the blanks, negative and positive controls were used in performing quality checks to ascertain the validity of the assays. Cut-off values were calculated using manufactures directives. The optic densities (ODs) of concentrations of the standards provided by the KITs manufacturer were used to plot standard curves from which concentrations of samples were extrapolated.

3.14 Data management

3.14.1 Data entry and processing

The raw data provided by the participants in the questionnaire were examined by the field supervisors for completeness and consistency in the information provided. Thereafter, the information in the questionnaire was then coded using a pre-determined coding template, and entered into a personal computer using SPSS version 20.0.

Data entry was done by two individuals independently and comparison was done as a way of ensuring quality checks. All entries were verified using the source documents. A descriptive statistics in the form of frequency distributions was run on all variables to identify missing data or mistakes in the data entry process and the necessary corrections were effected using the source documents as a guide.

3.14.2 Derived variables

Body mass index was computed by dividing weight by the square of the height measurements (Kg/m^2). Body mass index was then categorized as <25 Kg/m^2 and ≥ 25 Kg/m^2 as normal and overweight respectively in accordance to WHO classification (WHO, 2018). Age at vaccination of the participants were categorized into <40 and ≥ 40 years for seroprotection analysis. This categorization was guided by literature regarding the effect of age at vaccination on seroprotection following HBV vaccination (Chathuranga, Noordeen, & Abeykoon, 2013).

Health facility types were categorized as lower levels (CHPs, Health center and Polyclinics) and higher levels (District and Regional Hospitals) in accordance with classification by Ghana's Ministry of Health (Ministry of Health, 2015).

The anti-HBs concentrations were also log-transformed following a significant outcome of normality tests. Log transformation of the anti-HBs concentration became necessary due to the fact that comparisons between groups was essential to understand variations in seroprotection by other sociodemographic variables.

Continuous variables measuring adherence and PEP knowledge were classified into three categories (≤50%, 51-74% and ≥75-100%) (Said, Ab-Hamid, Tarmizi, & Azizan, 2018; Thanavanh, Kasuya, & Sakamoto, 2013) and was used to describe levels of PEP knowledge.

Risk perception for HBV is an independent variable generated by assessing HCW's perceptions on vulnerability to HBV. Health facility factor is an independent variable generated by assessing HCW's work environment for factors that could promote adherence to HBV prevention recommendations. Both variables were originally obtained as continuous variables but were eventually re-categorized and used as binary variables as described by Fageeh (2014). (Refer to appendix for details on risk perception for HBV) (Refer to supplementary analysis under results session for details).

Risk of HBV exposure that is not related to the occupation of the HCW was referred to as behavioural risk factors. These factors included blood transfusion, and intimate contact with a known HBV carrier, dental procedure, lifetime surgery and tattoo or scarification. HCWs without any of these risk factors were classified as having no risk, those with 1-3 factors as intermediate risk and those with 4 or more risk factors as being at high risk of exposure and infection with HBV. Gara et al. (2015) used similar risk categorization in assessing level of exposure to HBV among HCWs.

3.14.3 Data analysis

Data analysis was done using Statistical Package for Social Sciences (SPSS) version 20.0 software for windows. Frequencies and proportions were used to describe categorical variables whereas continuous variables were summarized using means, medians and standard deviations. Chi-square test or Fisher's Exact where necessary was performed to test for associations between outcome and explanatory variables. Binary logistic regression model was also used to obtain crude estimates of odds ratios (OR) and Confidence Intervals (CIs). A multivariate analysis was subsequently undertaken to obtain Adjusted Odds Ratio (aOR) and its confidence intervals. Level of significance was set at 5% in all the statistical procedures performed. Tables, charts and graphs where appropriate, were used to illustrate the outcomes of the statistical analysis.

Objective one and two: *Determination of HBV vaccination uptake:* Vaccination uptake was obtained by computing proportions of HCWs taking at least one dose of HBV vaccination. Confidence intervals around the proportions were calculated. Chi- square test of significance followed by multivariate analysis procedures were undertaken to identify factors associated with HBV vaccination uptake.

Determination of adherence to 3 doses, 0, 1, 6 schedule and post vaccination serological testing. HCWs adhering to these three recommendations were counted and reported as proportions with their respective 95% CIs. Factors associated with adherence to each component of the protocol were assessed using binary logistic regression models.

Determination of overall adherence to HBV Vaccination Protocol: HBV vaccination adherence scores were obtained by scoring a positive response as '1' and an incorrect response as '0' for the three indicators (3 doses of HBV vaccination, correct schedule of 0,1,6 and post vaccination serological testing). The scores under overall adherence was

summed up to obtain a composite score which was referred to as overall adherence. The total obtainable or expected score of overall adherence being '3' (100%). A score of 100% was considered as complete adherence.

Analysis of Variance (ANOVA) procedure was undertaken to compare the mean overall vaccination adherence scores among the six categories of HCWs and also to examine whether overall vaccination adherence is the same across the categories of HCWs.

The data were subjected to normality and homogeneity of variance tests. A conclusion of non-normality of data and non-homogeneity of variance were made in instances where Shapiro wilk test of normality and Levene's homogeneity of variances tests were significant with p-values of<0.05. Welch's ANOVA or classical ANOVA procedures were undertaken based on the outcome of the normality and homogeneity tests. The vaccination adherence scores were re-categorized into binary variables as described by Fageeh (2014). Complete vaccination adherence was pegged at 100% indicating complete adherence to HBV vaccination recommendations and incomplete vaccination adherence was any score below 100%. A binary logistic regression procedure was subsequently undertaken to determine factors associated with optimal adherence.

*Post exposure prophylaxis knowledge***:** PEP for HBV knowledge scores were obtained by scoring a positive response as '1' and an incorrect response as '0'. The total score was summed up to form an index score. Scores ≤'50%' were considered as low, '51-74%' as intermediate and ≥75and more as 'good' (Said, Ab-Hamid, Tarmizi, & Azizan, 2018; Thanavanh, Kasuya, & Sakamoto, 2013). Percentage mean score and percent standard deviation scores were obtained. ANOVA procedure was undertaken to compare PEP knowledge scores among the six categories of HCWs and also test the hypothesis that PEP knowledge was equal across the categories of HCWs. Post Hoc tests namely Games

Howell was performed to identify the source of differences or variations in the mean PEP knowledge scores among the various categories of HCWs.

Binary logistic regression procedure was used to identify factors associated with good knowledge on post exposure prophylaxis.

Determination of Adherence to PEP protocol: The number of participating HCWs who suffered exposures within the past 12 months, reported their exposures (most recent) and used PEP were counted and reported using frequency statistics. Adherence to PEP protocol was measured by calculating the proportions of HCWs (1) reporting exposures out of all who sustained exposures, (2) proportion of reporting HCWs undergoing evaluation for PEP and (3) the proportion of eligible HCWs utilizing PEP (4) the proportion of PEP beneficiaries returning for follow up tests.

Objective three*: HBV Sero-survey data:* Data on serological markers of HBV was summarized using descriptive statistics procedures for all the serological markers namely: HBsAg, HBsAb, HBcAb HBeAg, HBeAb. Confidence intervals (CI) set at 95% were obtained for the proportions or prevalence of the serological markers.

Factors associated with anti-HBc and HBsA: Bivariate and multivariate analysis were performed to determine associations between HBsAg, HBcAb and other independent variables.

Objective four: *Seroprotection against HBV vaccination*,

Proportions of vaccinated HCWs with neutralizing antibody above and below 10mlU/mL were calculated and reported as seroprotected or not. Raw antibody concentrations were converted to Geometric Mean Titers (GMT) to allow for comparison between groups. The GMT has been known to be one of the most meaningful parameters used to accurately express antibody response following vaccination (Beyer, Palache, Lüchters, Nauta, &

Osterhaus, 2004). Bivariate analysis was undertaken to identify factors associated with seroprotection.

3.14.4 Parameter and scales for measuring adherence

A three-level interval scoring scheme ranging from low, (≤50%) intermediate (51-74%) and high (≥75-100%) was used to categorize PEP knowledge and adherence scores. This three-interval scoring system was adapted from previous studies (Said, Ab-Hamid, Tarmizi, & Azizan, 2018; Thanavanh, Kasuya, & Sakamoto, 2013). The score categorization approach has been widely used by researchers across many disciplines in assessing perception, knowledge and adherence among various study populations (Said et al., 2018; Shokoohi et al., 2016; Tanzania HIV Stigma Study Team, 2007; Thanavanh et al., 2013).

These cut-off values were utilized to be able to objectively categorize adherence to three different levels based on population scores for each indicator investigated. Secondly, evidence across the literature available on HCW adherence to preventive recommendations suggest variations in the levels of compliance with standard protocols for that mater a scale that could objectively describe the proportion of HCWs who adhered to the indicators was needed hence the use of these 3 point interval scale. Table 3.4 shows a summary of scales used in measuring adherence with the respective colour codes.

Table 3.3 Parameter for measuring adherence

Variable	POOR	FAIR	GOOD
Overall adherence **Adherence to all the 3 HBV Vaccination components:** 1. Three doses of vaccine 2. At 0,1,6 months schedule 3. Post vaccination serological testing	Absence of Vaccination against HBV	Score of <100% or intermediate Partial adherence to HBV vaccination practice	Score of 100% Complete adherence to the 3 HBV vaccination components
Adherence to individual vaccination components Three doses of vaccine At 0,1,6 months schedule Post vaccination testing	Adherence score of ≤50%	Adherence score of 51%-74%	Adherence Score of ≥75-100 %
Adherence to individual PEP components: **1.** Exposure reporting **2.** Evaluation for PEP **3.** Timeliness of PEP use **4.** Post PEP follow ups	Adherence score of ≤50% Poor adherence to PEP recommendations	Adherence score of 51%-74% Partial adherence to PEP recommendations	Adherence Score of ≥75-100 % Good adherence to PEP recommendations
PEP Knowledge	Score of ≤ 50% Poor PEP knowledge	Scores between 51% -74% Fair or intermediate PEP knowledge	Score of ≥75-100 % Good PEP knowledge

3.15 Quality control measures

3.15.1 Training of research staff.

The research staff were trained in two separate sessions as follows:

A day's training was organized for research assistants. The training entailed interviewing procedures, complying with sampling procedures, as well as following the consenting processes outlined in the research protocol. The training also ensured that the research instruments were administered in a manner that conveyed the intended message to the research participants and most importantly, that the rights and safety of the participants were not violated.

A day's training was organized for the laboratory staff s well. The training focused on updating the knowledge and skills of the personnel on aseptic techniques in performing phlebotomies, as well as using the identity codes that matched with the research questionnaire in identifying each individual participant. The training also covered sample preparation procedures as well as monitoring of temperature range to ensure that samples were maintained at -20^{0}C and the integrity of the samples was not compromised in any way that could affect the outcome of the laboratory analysis.

3.15.2 Review and pretesting of data collection instruments

Academic supervisors who are all authorities in the field of occupational health and safety as well as epidemiology reviewed the data collection tools and made important suggestions regarding the improvement in reliability and validity of the tools. Officials of the occupational health and safety department of the Ghana Health Service also reviewed the research tool.

The tools were subsequently piloted at Ningo Prampram District in the Greater Accra Region. The pretesting procedure helped to reword the questions that were not too clear, re-arrange the questions in a more logical sequence as well as remove questions that were repeated or did not appear to be very relevant to the study.

3.16 Ethical considerations

3. 16.1 Ethical approval

The protocol of this research was reviewed, and approval for the conduct of the study was granted by the Institutional Review Board of Noguchi Memorial Institute for Medical Research *(005/17-18*) and the Ghana Health Service Ethical Review Committee *(GHS-ERC: 006/08/17).*

3.16.2 Study area approval

Permission was obtained from the Greater Accra Regional Health Directorate of the Ghana Health Service *(GHS/GARHD/006/17*) as well as the District Health Directorates that oversee the operations of all the five (5) facilities where the HCWs were recruited from. Permission and approval letters were presented to the facility heads of the five study sites and they all permitted the conduct of the study in their respective facilities.

3.16.3 Approval from collaborating Authorities

Health Facilities Regulatory Agency of the Ministry of Health (HEFRA) is the regulating body of health facilities. Permission or approval was also obtained to allow entry to the facilities *(H/REG/0617/118)*

Finally, the Occupational and Environmental Health Programme of the GHS which is the body that developed the occupational health and safety policy guideline for the health sector was equally informed about the study and the department collaborated with the research team in terms of technical support only.

3.16.4 Consent from participants and ethical issues

The participants were informed that the purpose of the study was to estimate HBV prevalence and the extent to which they have undertaken prevention measures against the infection. It was explained to them that participation in the research entailed answering a set of questions in the questionnaire, undertaking weight and height measurements and also giving 5mls of their blood for laboratory tests. The participants were made aware of the voluntary nature of the research and hence their rights to discontinue or withdraw at any point without suffering any consequences. Absence of incentives of all forms was

also declared. Following thorough explanation on the nature, purpose and procedures involved as described above, the informed consent forms were administered to all the eligible participants who had passed all the inclusion criteria. A valid consent meant that the participant had a better understanding of the nature, procedures and purpose of the study and had appended his or her signature as a way of demonstrating willingness to be included in the study.

The right to privacy concerning participant's personal information was respected. Disclosure of the laboratory results (HBsAg status) was done solely by the principal investigator to the affected HCW only and it was confidential. Participants who were positive for the surface antigen were counselled and supported to make their own decisions concerning medical care and treatment. Referral to see a specialist following a positive HBsAg test result was also voluntary, however, the importance of seeking early treatment was emphasized. The blood samples were discarded according to standard hospital waste management procedures once laboratory analysis was completed. The blood samples were not subjected to any other analysis other than specified in the research protocol.

All participants' documents bore special serial numbers and codes to ensure anonymity.

All source documents (questionnaire, laboratory results) were kept in a cabinet that was only accessible to the principal researcher. Participation in the study was voluntary. Individuals who were contacted and yet declined the researcher's request were not persuaded in any way.

3.17 Summary of chapter three

A cross-sectional hospital based analytical study was planned and executed with 363 HCWs drawn from five facilities and six different cadre within the Greater Accra Region of Ghana. The main procedures of the study included answering a set of questions in a questionnaire, undergoing weight and height measurements as well as providing 5mls of venous blood for laboratory analysis. The five study sites were assessed to identify the HBV preventive environment of the HCWs, and facility representatives served as key informants in that regard. A pretested questionnaire was used to collect data from HCWs and another supplementary tool was used in assessing the health facilities. All participants gave written consent prior to recruitment into the study. The laboratory analysis done with the aim of identifying the serological markers of HBV and quantification of anti-HBs levels was achieved through point of care tests and ELISA procedure at Noguchi Memorial Institute of Medical Research. SPSS version 20.0 was used in analyzing data. An objective three-interval scoring scale was adapted and used to measure adherence. The Institutional Review Board of Noguchi Memorial institute of Medical Research and Ethical review Committee of the GHS both gave ethical approval for this study to be undertaken. All the participants were selected using stratified random sampling procedure and they duly gave written consent prior to their recruitment and participation.

CHAPTER FOUR

RESULTS

4.0 Introduction

The minimum sample allocated for the study was 363 Health Care Workers (HCWs) all of whom agreed and gave consent to participate in both the questionnaire procedure as well as the blood draw. Data for eighteen (18) HCWs were excluded from analysis due to incomplete data and inconsistencies in the responses given by the participants. Five HCWs had their data not analyzed due to the fact that they were found to be non-seroprotected. Even though they admitted receiving at least one dose of HBV vaccine, they were the few who had no documentation on previous HBV vaccination. These individuals were excluded because the principal investigator could not validate their vaccination claims. Therefore the results presented in this chapter are based on 340 completed questionnaires and corresponding blood samples representing 93.7 % response rate. According to Evans (1991), 100% response rate is not always possible in real practice and that rates of >80% are considered to be. The Figure 4.1 accounts for the difference in estimated sample and actual number of units of analysis in this study.

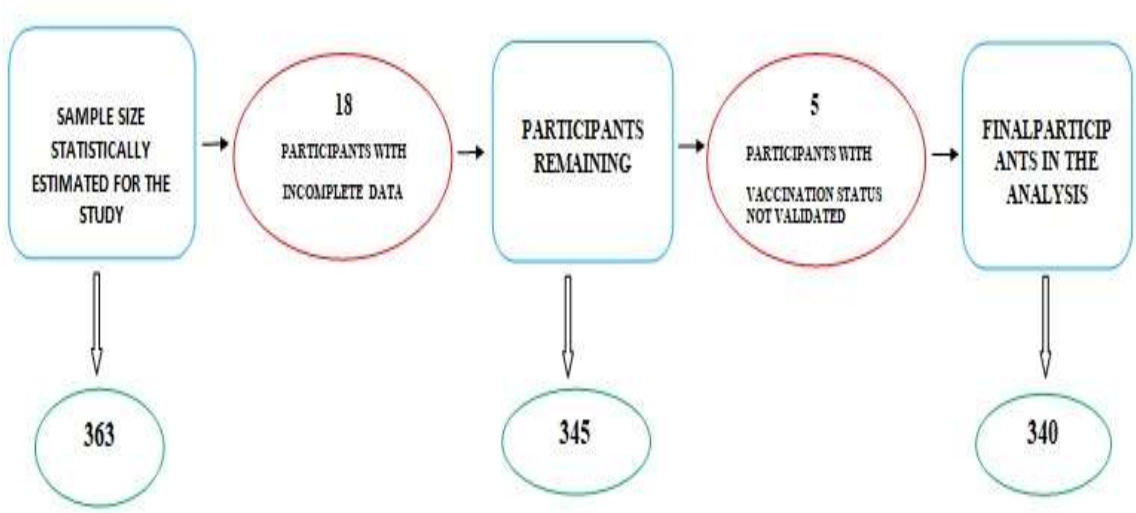

Figure 4. 1: The difference in estimated sample and actual number of units of analysis in this study.

4.1 Background characteristics of study participants

Most of the HCWs who participated in the study were females (74.1%, 252/340). The participants were aged between 22 and 58 years with the mean age of 34.5 years and a standard deviation of SD ± 7.7. A total of 127 participants (37.4%) were aged 22-30 years, with 45% (153) aged between 31-40 years. Majority of the participants 70.6%, (240/340) had attained tertiary level education. Nurses and midwives formed 47.6% (162/340) of the participants with doctors forming 20.3% (69/340) and anesthetists being the least professional group 4.4%, (15/340). Majority representing 76% (260/340) of the Health Care Workers had less than 10 years working experience. One-tenth of the respondents 10.9% (37/340) admitted having at least one form of chronic condition however of which hypertension was predominant (6.5%) among the HCWs who had chronic conditions. Less than 1% (3) of the participants ever smoked. A total of 155/340 (45.6%) worked as providers in critical units (e.g. Labor ward, theatre) where blood and body fluid exposures are much more likely, whilst 54.4% (185) provided care at less critical units or departments.

Receipt of training in prevention of blood borne infections was widespread with almost 80.6 %, (274/340) of the respondents admitting ever attending such training workshops.

Health facility environment of the HCW was observed to be good or conducive for majority of the participants 69.7% (273/340) (Table 4.1).

The participants weighed between 39 and136 kg with an average weight of 72.55kg (SD±13.83). Their heights ranged from 145 to 185.20cm with a mean height of 162.8 cm (SD±7.83). Forty three percent (43%) of the participants recorded Body Mass Index (BMI) below 25kg/m^2 where as 57% had BMI above 25 kg/m^2. The average Body Mass BMI however was 34.12. Antibody to HBsAg ranged from ≤1.0 to 119.9 IU/mL (Table 4.2).

Table 4.1: Background characteristics of respondents (N=340)

	VARIABLE	FREQUENCY	PERCENT (%)
Sociodemographic factors	**Age group**		
	21-30	127	37.4
	31-40	153	45.0
	41-50	43	12.6
	51-60	17	5.0
	Sex		
	Male	88	25.9
	Female	252	74.1
	Cadre of staff		
	Doctor	69	20.3
	Nurse/midwife	162	47.6
	Anesthetist	15	4.4
	Laboratory Staff	40	11.8
	Orderly	35	10.3
	Physician Assistant (P.A.)	19	5.6
	Educational level		
	No formal education	6	1.8
	Primary	17	5.0
	Secondary	36	10.6
	Tertiary	240	70.6
	Post tertiary	41	12.1
	Chronic condition		
	Condition present	37	10.9
	Condition absent	303	89.1
	Educational level		
	No formal	6	1.8
	Primary	17	5.0
	Secondary	36	10.6
	Tertiary	240	70.6
	Post tertiary	41	12.1
Occupational factors	**Duration of employment**		
	<10 Years	260	76.5
	≥10 Years	80	23.5
	Work unit		
	Critical	155	45.6
	Non-Critical	185	54.4
	Facility Type* **		
	CHPS	19	5.6
	Health Centre	28	8.2
	Polyclinic	56	16.5
	District Hospital	80	23.5
	Regional Hospital	157	46.2
	Facility Factor* **		
	Good	237	69.7
	Poor	103	30.3
	Training		
	Trained in BB IPC*	274	80.6
	Not Trained	66	19.4
Personal Risk factors	**Risk perception**		
	High	295	86.8
	Low	45	13.2

*BBIPC blood borne infection prevention and control *** Facility factor refers to a composite score obtained following assessment of HBV preventive environment of the HCWs by use of a pretested structured checklist. Score. of 50% and above considered as good facility factor.

Table 4.2: Summary of bio-measurements of respondents

	Variables			
Statistic	**Weight(Kg)**	**Height(cm)**	**BMI(Kg/m^2)**	**Antibody (mIU/mL)**
Mean	72.55	162.8	34.12	119.90
Std. Deviation	13.83	7.83	5.31	233.69
Maximum	135.5	185.20	50.38	1964
Minimum	39.9	145.00	16.25	1.00

4.2 Hepatitis B virus vaccination uptake

Out of the 340 HCWs with complete data, 207(60.9%) had taken at least one dose of HBV vaccination giving an overall Hepatitis B vaccination coverage of 60.9% (CI=55.5%-66.1%).

The results presented in Table 4.3 shows that HBV vaccination uptake was highest (62.8 %) 27/43 in those within the 41-50 years age group. Among HCWs who received formal education, vaccination uptake increased with level of education as those with post tertiary education recorded the highest coverage of 73.2% (30/41). Vaccination uptake was also observed to be highest 63.5 % (174/274) in those who had received training in blood-borne infection prevention compared to the untrained group. Vaccination uptake increased with increasing working experience with those with over 10 years work experience recording the highest coverage of 63.8% (51/80). HCWs working in critical units where blood and body fluid exposures were much more likely were those who vaccinated more 69% (107/155) compared to those at less critical units. Vaccination uptake was observed to be higher among HCWs who had good risk perception for HBV infection; 62.4% (184/295) compared to 51.1% (23/45) in those with low perception of risk. Health facility factor was observed to play a role in HCW vaccination uptake as those with good facility

support in terms of HBV infection prevention vaccinated more; 63.7% (151/237) than their colleagues in facilities with poor facility support.

More laboratory staff were vaccinated than any other category; 77.5% (31/40) with the Orderlies having the least vaccination coverage of 37.1% (30/41) against HBV virus.

Regional hospital that represents the highest level of care had the highest vaccination coverage of 67.5% (106/157) and Health center level facility had the least coverage of 39.3% (11/38) (Table 4.3).

Table 4.3 Vaccination uptake by sociodemographic and occupational variables (N=340), (n=207)

Variables	N	n	Vaccination uptake Percent (95% CI)	Chi-square	P-value
Age				0.7	0.881
21-30	127	76	59.8(50.8-68.4)		
31-40	153	95	62.1(53.9-69.8)		
41-50	43	27	62.8(46.7-77)		
51-60	17	9	52.9(27.8-77)		
Sex				0.1	0.718
Female	252	152	60.3(54-66.4)		
Male	88	55	62.5(51.5-72.6)		
Cadre of staff				14.9	0.011
Doctor	69	44	63.8(51.3-75)		
Nurse/Midwife	162	95	58.6(50.6-66.3)		
Anesthetists	15	11	73.3(44.9-92.2)		
Laboratory	40	31	77.5(61.5-89.2)		
Orderly	35	13	37.1(21.5-55.1)		
PA	19	13	68.4(43.4-87.4)		
Education				19.3	0.001
No formal	6	4	66.7(22.3-95.7)		
Primary	17	4	23.5(6.8-49.9)		
Secondary	36	15	41.7(25.5-59.2)		
Tertiary	240	154	64.2(57.7-70.2)		
Post tertiary	41	30	73.2(57.1-85.8)		
Risk Perception				2.1	0.149
Low	45	23	51.1(35.8-66.3)		
High	295	184	62.4(56.6-67.9)		
Duration of employment				0.4	0.548
<10	260	156	60(53.8-66)		
≥10	80	51	63.8(52.2-74.2)		
Training				4.1	0.044
No	66	33	50(37.4-62.6)		
Training	274	174	63.5(57.5-69.2)		
Facility Type				9.7	0.046
CHPS	19	10	52.6(28.9-75.6)		
Health center	28	11	39.3(21.5-59.4)		
Polyclinic	56	35	62.5(48.5-75.1)		
District	80	45	56.3(44.7-67.3)		
Regional	157	106	67.5(59.6-74.8)		
Facility factor				2.6	0.105
Poor	103	56	54.4(44.3-64.2)		
Good	237	151	63.7(57.2-69.8)		
Work Unit				7.9	0.005
Non-critical	185	100	54.1(46.6-61.4)		
Critical	155	107	69(61.1-76.2)		

4.2.1 Factors associated with HBV vaccination uptake

The results presented in Table 4.3 revealed that cadre or professional category, unit of work, educational status, facility type and blood-borne infection prevention training attendance were associated with HBV vaccination uptake as all these factors recorded p-value of <0.05. Other factors such as sex, age and duration of service did not show any statistical significant association with vaccination uptake at the bivariate level.

As presented in Table 4.4, after adjusting for other possible factors that could influence vaccination uptake, training, unit or department and the least odds of vaccination observed among orderlies all lost their statistical significance at the multivariate stage.

Table 4.4 Factors associated with HBV vaccination uptake

			Unadjusted Estimates		Adjusted Estimates	
Variables	**N**	**n**	**uOR (95% CI)**	**P-value**	**aOR (95% CI)**	**P-value**
Age						
21-30	127	76	1.0		1.0	
31-40	153	95	1.1(0.7-1.8)	0.701	1.2(0.7-2.1)	0.483
41-50	43	27	1.1(0.6-2.3)	0.732	1.1(0.5-2.7)	0.796
51-60	17	9	0.8(0.3-2.1)	0.588	1.5(0.4-5.3)	0.550
Sex						
Female	252	152	1.0		1.0	
Male	88	55	1.1(0.7-1.8)	0.718	0.9(0.5-1.5)	0.622
Cadre of staff						
Doctor	69	44	1.0		1.0	
Nurse/Midwife	162	95	0.8(0.5-1.4)	0.467	0.9(0.5-1.6)	0.663
Anesthetist	15	11	1.6(0.4-5.4)	0.482	1.8(0.4-7.4)	0.43
Laboratory	40	31	2(0.8-4.8)	0.139	2.2(0.8-6.3)	0.133
Orderly	35	13	0.3(0.1-0.8)	0.011	0.6(0.2-1.6)	0.312
PA	19	13	1.2(0.4-3.6)	0.707	1.3(0.4-4.1)	0.659
Education						
No formal	6	4	1.0		1.0	
Primary	17	4	0.2(0.6-8.5)	0.071	0.2(0-1.8)	0.148
Secondary	36	15	0.4(1.8-18.4)**	0.268	0.4(0.1-2.9)	0.371
Tertiary	240	154	0.9(2.4-33.1)**	0.900	0.8(0.1-5.4)	0.849
Post	41	30	1.4(0.9-49.7)	0.740	1.1(0.1-7.7)	0.961
Risk Perception						
Low	45	23	1.0		1.0	
High	295	184	1.6(0.8-3)	0.152	1.2(0.6-2.4)	0.640
Duration of employment						
<10	260	156	1.0		1.0	
≥10	80	51	1.2(0.7-2)	0.548	1.1(0.6-2.2)	0.766
Training						
No	66	33	1.0		1.0	
Training	274	174	1.7(1-3)	0.045	1.8(1-3.2)	0.064
Facility Type						
CHPS	19	10	1.0		1.0	
Health center	28	11	0.6(0.2-1.9)	0.368	0.6(0.2-2.0)	0.382
Polyclinic	56	35	1.5(0.5-4.3)	0.449	1.4(0.5-4.3)	0.535
District	80	45	1.2(0.4-3.2)	0.775	1.3(0.4-3.8)	0.648
Regional	157	106	1.9(0.7-4.9)	0.201	1.6(0.6-4.5)	0.340
Facility factor						
Poor	103	56	1.0			
Good	237	151	1.5(0.9-2.4)	0.106	*	*
Work Unit						
Non-critical	185	100	1.0		1.0	
Critical	155	107	1.9(1.2-3)	0.005	1.1(0.6-1.9)	0.806

*Omitted in the model due to collinearity with facility level ** significant at the bivariate level. uOR does not include 1

4.3 Adherence to hepatitis B vaccination recommendations

4.3.1 Adherence to three doses of HBV vaccination (complete vaccination)

Results presented in Table 4.5 show that, out of the 340 HCWs, 159 were adherent to the three-dose regimen (receipt of 3 doses of HBV vaccine), giving three (3) doses vaccination adherence of 46.8%. However, the three-dose vaccination coverage among the 207 vaccinated HCWs was 76.8 % (159/207).

Table 4.5 Number of doses of HBV vaccine received by HCWs.

Number of vaccine doses	Number	Percent (%)
Three or more	159	46.8
Two doses only	30	8.8
One dose only	18	5.3
None	133	39.1
Total	**340**	**100.00**

The crude results presented in Table 4.6 show that majority of HCWs working in critical units adhered to the three-dose regimen 78.5% (84/107) compared to 75% (75/100) of those working in less critical departments. Seventy eight percent (144/184) of HCWs with high risk perception for HBV adhered to the 3 dose-regimen. Majority of HCWs, indicating 78.7% (137/174) who received training in blood borne infection prevention adhered to the three dose-regimen. HCWs working in health facilities where there is high level of organization of HBV preventive programs adhered better to the 3-dose regimen; 78.8% (119/151) compared to those having poor facility support in terms of HBV prevention. However, these relationships were not significant at the bivariate level as all the p-values were >0.05. Educational attainment was the only factor associated with having received three doses of the HBV vaccine at the bivariate level.

Table 4.6 Adherence to three-dose HBV vaccination (N=207)

Variables	N (207)	Three Doses of HBV Vaccine n (159)	Percent (95% CI)	Chi-square	P-value
Age				7.79	0.051
21-30	76	64	84.2(74-91.6)		
31-40	95	67	70.5(60.3-79.4)		
41-50	27	23	85.2(66.3-95.8)		
51-60	9	5	55.6(21.2-86.3)		
Sex				0.08	0.779
Female	152	116	76.3(68.7-82.8)		
Male	55	43	78.2(65-88.2)		
Cadre of Staff					0.085
Doctor	44	36	81.8(67.3-91.8)		
Nurse/Midwife	95	68	71.6(61.4-80.4)		
Anesthetist	11	7	63.6(30.8-89.1)		
Laboratory	31	29	93.5(78.6-99.2)		
Orderly	13	9	69.2(38.6-90.9)		
P.A.	13	10	76.9(46.2-95)		
Education				**	0.009
No formal	4	3	75.00(19.4-99.4)		
Primary	4	0	_		
Secondary	15	13	86.7(59.5-98.3)		
Tertiary	154	122	79.2(72-85.3)		
Post tertiary	30	21	70.0 (50.6-85.3)		
Risk Perception				1.95	0.162
Low	23	15	65.2(42.7-83.6)		
High	184	144	78.3(71.6-84)		
Duration of employment				1.47	0.225
<10	156	123	78.8(71.6-85)		
≥10	51	36	70.6(56.2-82.5)		
Training				2.27	0.132
No training	33	22	66.7(48.2-82)		
Received Training	174	137	78.7(71.9-84.6)		
Facility Type					0.185
CHPs	10	8	80(44.4-97.5)	**	
Health center	11	10	90.9(58.7-99.8)		
Polyclinic	35	22	62.9(44.9-78.5)		
District	45	38	84.4(70.5-93.5)		
Regional	106	81	76.4(67.2-84.1)		
Facility Factor				1.25	0.264
Poor	56	40	71.4(57.8-82.7)		
Good	151	119	78.8(71.4-85)		
Work Unit				0.36	0.550
Non critical	100	75	75.0(65.3-83.1)		
Critical	107	84	78.5(69.5-85.9)		

**Estimates from Fishers Exact Test.

4.3.2 Factors Associated with adherence to three dose HBV vaccination

The multivariate logistic regression analysis results presented in Table 4.7 revealed that HCWs who perceived high risk for HBV infection and also received training in prevention

of blood-borne infections had higher odds of adhering to the three dose regimen (aOR= 4.0; 95% CI= 1.3-12.5) and (aOR= 2.8; 95% CI= 1.0-7.5) respectively.

Table 4.7 Factors Associated with Adherence to three dose HBV vaccination.

			Unadjusted Estimates		Adjusted Estimates	
Variables	**N**	**n**	**UOR (95% CI)**	**P-value**	**AOR (95% CI)**	**P-value**
Age						
21-30	76	64	1.0		1.0	
31-40	95	67	0.4(0.2-1.0)	0.038	0.6(0.2-1.3)	0.18
41-50	27	23	1.1(0.3-3.7)	0.904	2.8(0.5-15.3)	0.225
51-60	9	5	0.2(0.1-1.0)	0.050	0.7(0.1-6.3)	0.76
Sex						
Female	152	116	1.0		1.0	
Male	55	43	1.1(0.5-2.3)	0.779	0.9(0.3-2.2)	0.755
Cadre of staff						
Doctor	44	36	1.0		1.0	
Nurse/Midwife	95	68	0.6(0.2-1.4)	0.199	0.5(0.2-1.4)	0.169
Anesthetist	11	7	0.4(0.1-1.7)	0.201	0.3(0-1.6)	0.146
Laboratory	31	29	3.2(0.6-16.4)	0.158	3.4(0.5-23.6)	0.219
Orderly	13	9	0.5(0.1-2.0)	0.334	0.6(0.1-4.6)	0.586
P.As.	13	10	0.7(0.2-3.3)	0.695	0.5(0.1-3.2)	0.502
Education						
No formal	4	3	1.0		1.0	
Primary	4	0	1 *		1 *	
Secondary	15	13	2.2(0.1-32.5)	0.576	13.8(0.6-327.5)	0.105
Tertiary	154	122	1.3(0.1-12.6)	0.838	4.5(0.4-58)	0.246
Post	30	21	0.8(0.1-8.5)	0.837	2.1(0.2-30.5)	0.574
Risk perception						
Low	23	15	1.0		1.0	
High	184	144	1.9(0.8-4.9)	0.168	4(1.3-12.5)	0.016
Duration of employment						
>10	156	123	1.0		1.0	
≥10	51	36	0.6(0.3-1.3)	0.227	0.5(0.2-1.4)	0.189
Training						
Not trained	33	22	1.0		1.0	
Received Training	174	137	1.9(0.8-4.2)	0.136	2.8(1.1 -7.5)	0.043
Facility Type						
CHPs	10	8	1.0		1.0	
Health center	11	10	2.5(0.2-32.8)	0.485	1.6(0.1-24.6)	0.755
Polyclinic	35	22	0.4(0.1-2.3)	0.32	0.3(0-1.9)	0.182
District	45	38	1.4(0.2-7.8)	0.732	1(0.1-7.3)	0.991
Regional	106	81	0.8(0.2-4.1)	0.798	0.8(0.1-5.2)	0.846
Facility factor						
Poor	56	40	1.0			
Good	151	119	1.5(0.7-3)	0.265	***	***
Work unit						
Non-critical	100	75	1.0		1.0	
Critical	107	84	1.2(0.6-2.3)	0.551	0.7(0.3-1.8)	0.496

*** Omitted due to collinearity with facility level *No count observed in that category

4.3.3 Adherence to 0, 1, 6 vaccination schedule

Out of the 207 HCWs who vaccinated, 62.3% (129/207) of them took the vaccine at the recommended schedule and timing giving an overall intermediate level of adherence to HBV vaccination schedule. Adherence was highest among HCWs who were 31-40 years old; 69.5% (66/95). It was obvious that female HCWs adhered more than their male counterparts; 63.2% (96/152). Adherence was highest among anesthetists; 72.7% (8/11) whilst orderlies recorded the least with only 53.8% (7/13) of them adhering to the 0, 1, 6 schedule. Adherence in HCWs without any formal education was universal whilst those with primary education were the least adhering category of 40% (2/5). Majority of HCWs at health center level; 81.2% (9/11) admitted following the recommended schedule compared to those from other facility levels. None of these relationships was statistically significant as p-values were all > 0.05 (Table 4.8).

4.3.4 Factors Associated with adherence to 0, 1, 6 vaccination schedule

At both the bivariate and multivariate logistic regression analysis levels, and as illustrated in Table 4.9, no statistical significant difference was observed between the various independent variables and adherence to 0, 1, 6 vaccination schedule.

Table 4.8 Adherence to 0, 1, 6 vaccination schedule

		Vaccination Schedule of 0,1,6			
Variables	**N(207)**	**n(129)**	**Percent (95% CI)**	**Chi-square**	**P-value**
Age				6.3	0.098
21-30	77	46	59.7(47.9-70.8)		
31-40	95	66	69.5(59.2-78.5)		
41-50	26	14	53.8(33.4-73.4)		
51-60	9	3	33.3(7.5-70.1)		
Sex				0.2	0.679
Female	152	96	63.2(55-70.8)		
Male	55	33	60(45.9-73)		
Cadre of staff				0.9	0.963
Doctor	44	27	61.4(45.5-75.6)		
Nurse/Midwife	95	59	62.1(51.6-71.9)		
Anesthetist	11	8	72.7(39-94)		
Laboratory	31	20	64.5(45.4-80.8)		
Orderly	13	7	53.8(25.1-80.8)		
P.A	13	8	61.5(31.6-86.1)		
Education				***	0.487
No formal	4	4	100(39.8-77.3)		
Primary	5	2	40(5.3-85.3)		
Secondary	14	8	57.1(28.9-82.3)		
Tertiary	154	97	63(54.8-70.6)		
Post	30	18	60(40.6-77.3)		
Risk perception				0.2	0.640
Low	24	16	66.7(44.7-84.4)		
High	183	113	61.7(54.3-68.8)		
Duration of employment				0.5	0.469
<10	157	100	63.7(55.7-71.2)		
≥10	50	29	58(43.2-71.8)		
Training				0.3	0.574
No training	33	22	66.7(48.2-82)		
Received Training	174	107	61.5(53.8-68.8)		
Facility Type					0.270
CHPs	10	7	70(34.8-93.3)	***	
Health center	11	9	81.8(48.2-97.7)		
Polyclinic	35	18	51.4(34-68.6)		
District	45	25	55.6(40-70.4)		
Regional	106	70	66(56.2-75)		
Facility factor				0.1	0.772
Poor	56	34	60.7(46.8-73.5)		
Good	151	95	62.9(54.7-70.6)		
Work Unit				0.01	0.845
Non-critical	100	63	63(52.8-72.4)		
Critical	107	66	61.7(51.8-70.9)		

** Estimates from fishers exact test.

Table 4.9 Factors Associated with adherence to 0, 1, 6 schedule

			Unadjusted Estimates		Adjusted Estimates	
Variables	**N**	**n**	**UOR (95% CI)**	**P-value**	**AOR (95% CI)**	**P-value**
Age						
21-30	77	46	1.00		1.00	
31-40	95	66	1.5(0.8-2.9)	0.184	1.4(0.7-2.7)	0.357
41-50	26	14	0.8(0.3-1.9)	0.599	0.5(0.2-1.6)	0.245
51-60	9	3	0.3(0.1-1.4)	0.144	0.3(0.1-1.9)	0.214
Sex						
Female	152	96	1.00		1.00	
Male	55	33	0.9(0.5-1.6)	0.679	0.7(0.3-1.4)	0.284
Cadre of staff						
Doctor	44	27	1.00		1.00	
Nurse/Midwife	95	59	1(0.5-2.2)	0.933	0.9(0.4-2.1)	0.839
Anesthetist	11	8	1.7(0.4-7.2)	0.486	1.5(0.3-7.4)	0.642
Laboratory	31	20	1.1(0.4-3.0)	0.781	1.1(0.3-3.4)	0.899
Orderly	13	7	0.7(0.2-2.6)	0.628	0.7(0.2-3.2)	0.647
PA.	13	8	1(0.3-3.6)	0.991	1.2(0.3-4.6)	0.828
Education						
No formal	4	4	1*		1*	
Primary	5	2	1.00		1.00	
Secondary	14	8	2(0.3-16)	0.513	2.1(0.2-21.6)	0.541
Tertiary	154	97	2.6(0.4-15.7)	0.313	1.4(0.2-13.9)	0.732
Post	30	18	2.3(0.3-15.5)	0.411	1.2(0.1-12.7)	0.855
Risk Perception						
Low	24	16	1.00		1.00	
High	183	113	0.8(0.3-2.0)	0.641	1(0.4-2.6)	0.952
Duration of employment						
<10	157	100	1.00		1.00	
≥10	50	29	0.8(0.4-1.5)	0.47	1.3(0.6-3.2)	0.512
Training						
No training	33	22	1.00		1.00	
Received Training	174	107	0.8(0.4-1.8)	0.575	0.8(0.3-2.0)	0.662
Facility Type						
CHPs	10	7	1.00		1.00	
Health center	11	9	1.9(0.2-14.9)	0.529	2.1(0.3-17.6)	0.493
Polyclinic	35	18	0.5(0.1-2)	0.304	0.4(0.1-2.2)	0.325
District	45	25	0.5(0.1-2.3)	0.407	0.4(0.1-2.2)	0.318
Regional	106	70	0.8(0.2-3.4)	0.8	0.8(0.2-3.8)	0.827
Facility Factor						
Poor	56	34	1.00		***	***
Good	151	95	1.1(0.6-2.1)	0.772		
Work unit						
Non critical	100	63	1.00		1.00	
Critical	107	66	0.9(0.5-1.7)	0.845	0.8(0.4-1.7)	0.571

*** ORs and 95% CIs. Omitted due to collinearity with facility type. 1* indicating empty cell for that category.

4.3.5 Adherence to post vaccination serological testing

Out of the 207 vaccinated HCWs, 21.3% (44/207) did post vaccination serological testing to confirm their immunity to HBV. The 21.3% represents an overall low level of adherence to post vaccination serological testing recommendation among the HCWs. In

all the age categories, less than half of the HCWs undertook post vaccination sererological testing. More of the female HCWs undertook the test 23.7% (36/152)) compared to the males. Orderlies were the category that adhered more to the recommendation with 30.8 % (4/13) of them taking the post vaccination test. At the bivariate level, there was a significant association observed between facility level and facility factor and adherence to post vaccination recommendations. For example, 50% (5/10) of vaccinated HCWs from CHPs level undertook the post vaccination testing.

Participants from facilities where conditions are not favorable for HBV prevention among HCWs recorded higher testing rates of 33.9% (19/56) compared to those with good facility environment, this relationship is significant at p-<0.05 (Table 4.10).

Table 4.10 Adherence to post vaccination serological testing

Variables	N	Post vaccination Serological Testing n	Percent (95% CI)	Chi-square	P-value
Age				0.9	0.828
21-30	76	16	21.1(12.5-31.9)		
31-40	95	19	20(12.5-29.5)		
41-50	27	6	22.2(8.6-42.3)		
51-60	9	3	33.3(7.5-70.1)		
Sex				2.0	0.156
Female	152	36	23.7(17.2-31.3)		
Male	55	8	14.5(6.5-26.7)		
Cadre of staff					0.920
Doctor	44	10	22.7(11.5-37.8)	***	
Nurse/Midwife	95	20	21.1(13.4-30.6)		
Anesthetist	11	2	18.2(2.3-51.8)		
laboratory	31	5	16.1(5.5-33.7)		
Orderly	13	4	30.8(9.1-61.4)		
PA	13	3	23.1(5-53.8)		
Education				***	0.507
No formal	4	1	25(0.6-80.6)		
Primary	4	1	25(0.6-80.6)		
Secondary	15	4	26.7(7.8-55.1)		
Tertiary	154	29	18.8(13-25.9)		
Post tertiary	30	9	30(14.7-49.4)		
Risk Perception				2.8	0.093
Low	23	8	34.8(16.4-57.3)		
High	184	36	19.6(14.1-26)		
Duration of employment				0.0	0.95
<10	156	33	21.2(15-28.4)		
≥10	51	11	21.6(11.3-35.3)		
Training				0.9	0.357
No training	33	9	27.3(13.3-45.5)		
Received Training	174	35	20.1(14.4-26.8)		
Facility Type					0.002
CHPs	10	5	50(18.7-81.3)	***	
Health center	11	1	9.1(0.2-41.3)		
Polyclinic	35	13	37.1(21.5-55.1)		
District	45	12	26.7(14.6-41.9)		
Regional	106	13	12.3(6.7-20.1)		
Facility Factor				7.4	0.007
Poor	56	19	33.9(21.8-47.8)		
Good	151	25	16.6(11-23.5)		
Work Unit				1.6	0.203
Non-critical	100	25	25(16.9-34.7)		
Critical	107	19	17.8(11-26.3)		

*** Estimates from Fishers Exact Test

4.3.6 Factors associated with post vaccination serological testing

The results presented in Table 4.11 show that, HCWs with high risk perception and those working at regional hospital level both had lower odds of undertaking post vaccination testing (aOR= 0.2; 95% CI= 0.1-0.7) and (aOR= 0.1; 95% CI= 0.1-0.6) respectively.

Table 4.11 Factors associated with adherence to post vaccination serological testing

			Unadjusted Estimates		Adjusted Estimates	
Variables	**N**	**n**	**UOR (95% CI)**	**P-value**	**AOR (95% CI)**	**P-value**
Age						
21-30	76	16	1.00		1.00	
31-40	95	19	0.9(0.4-2)	0.865	0.9(0.4-2.1)	0.822
41-50	27	6	1.1(0.4-3.1)	0.899	1.2(0.3-4.7)	0.839
51-60	9	3	1.9(0.4-8.3)	0.409	2.2(0.3-14.3)	0.422
Sex						
Female	152	36	1.00		1.00	
Male	55	8	0.5(0.2-1.3)	0.160	0.7(0.3-1.8)	0.449
Cadre of staff						
Doctor	44	10	1.00		1.00	
Nurse/Midwife	95	20	0.9(0.4-2.1)	0.823	0.8(0.3-2.3)	0.727
Anesthetist	11	2	0.8(0.1-4.1)	0.745	1.9(0.3-14.1)	0.532
Laboratory	31	5	0.7(0.2-2.1)	0.484	0.8(0.2-3.8)	0.82
Orderly	13	4	1.5(0.4-6)	0.556	1.7(0.3-9.1)	0.514
PA.	13	3	1(0.2-4.4)	0.979	0.7(0.1-4.4)	0.734
Education						
No Formal	4	1	1.00		1.00	
Primary	4	1	1(0.01-24.5)	1	0.5(0.1-18.6)	0.704
Secondary	15	4	1.1(0.1-13.8)	0.946	0.2(0.1-2.8)	0.207
Tertiary	154	29	0.7(0.1-6.9)	0.757	0.3(0.1-3.9)	0.372
Post	30	9	1.3(0.1-14.1)	0.837	0.9(0.1-12.1)	0.936
Risk Perception						
Low	23	8	1.00		1.00	
High	184	36	0.5(0.2-1.2)	0.099	0.2(0.1-0.7)	0.014
Duration of employment						
<10	156	33	1.00		1.00	
≥10	51	11	1.0(0.5-2.2)	0.950	0.6(0.2-1.9)	0.418
Training						
No Training	33	9				
Received Training	174	35	0.7(0.3-1.6)	0.359	0.8(0.3-2.1)	0.609
Facility Type						
CHPs	10	5	1.00		1.00	
Health center	11	1	0.1(0.1-1.1)	0.06	0.1(0-1.2)	0.064
Polyclinic	35	13	0.6(0.1-2.4)	0.467	0.8(0.2-4.2)	0.828
District	45	12	0.4(0.1-1.5)	0.158	0.5(0.1-2.3)	0.343
Regional	106	13	0.1(0.1-0.5)	0.005	0.1(0.1-0.6)	0.008
Facility Factor						
Poor	56	19	1.00			
Good	151	25	0.4(0.2-0.8)	0.008	***	***
Work unit						
Non-critical	100	25	1.00		1.00	
Critical	107	19	0.6(0.3-1.3)	0.205	1.2(0.5-2.9)	0.747

*** ORs and 95% CIs. Omitted due to collinearity with facility type.

4.3.7 Overall adherence to HBV vaccination recommendations among HCWs

Overall adherence to HBV vaccination (3-doses, 0, 1, 6 schedule and post vaccination testing) was assessed among the population. As illustrated in Figure 4.2, out of 340 HCWs whose data were analyzed, 6.2 % (21/340) completely followed all the steps regarding HBV vaccination (3 doses, correct schedule, post serological testing) by obtaining scores

of 100%. Among only the vaccinated HCWs 10.1%, (21/207) adhered to all the three indicators. The majority of 54.7% (186/340) had scores below 100% indicating partial or incomplete adherence to all the three recommendations. However, a total of 133(39.1%) did not vaccinate at all.

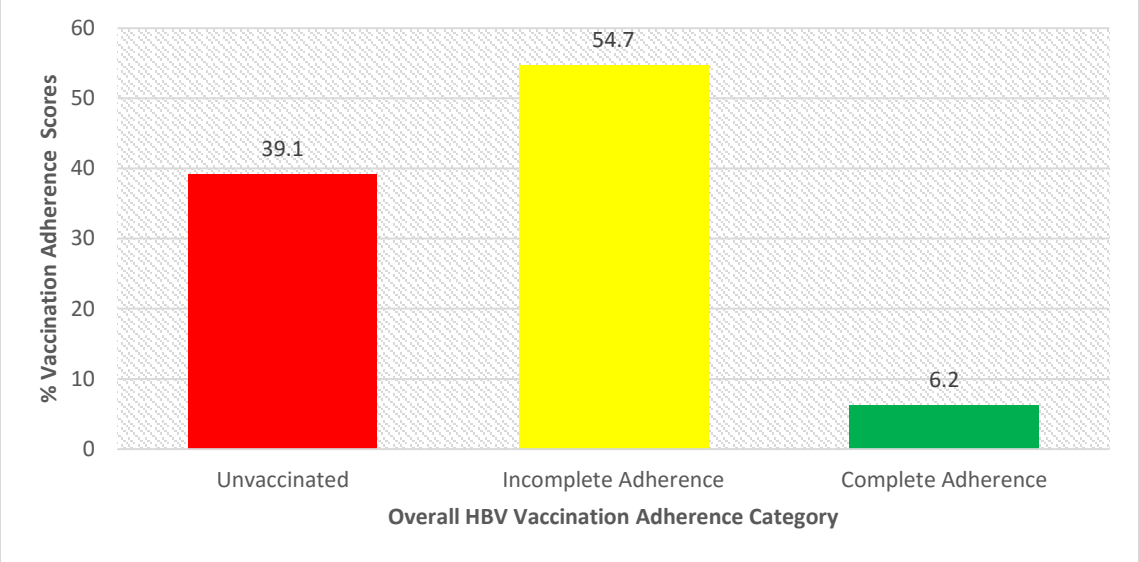

Figure 4.2: Overall HBV vaccination adherence categories.

From Table 4.12 it can be seen that the overall mean vaccination adherence score was 53.46 (95%CI=49.86-57.05) indicating overall intermediate adherence to all the three recommendations regarding HBV vaccination (3-doses, 0, 1, 6 vaccination schedule& post vaccination serological testing) at the population level. Orderlies were the least adhering group with scores of 51.28% followed by nurses and midwives as well as anesthetists. Laboratory staff had the highest mean scores of 58.06. An analysis of variance (ANOVA) procedure did not show any statistically significant difference between the various categories of HCWs (F=0.357, P=0.877) indicating that the intermediate level of adherence to recommended HBV vaccination adherence was similar across all the six categories of HCWs examined and therefore the assertion that overall HBV vaccination practice is the same across the six categories of HCWs is upheld whilst

rejecting the hypothesis that there are variations in level of overall adherence among the six categories of HCWs.

Table 4. 12 Comparison of overall vaccination adherence scores among the various categories

Cadre of Staff	N	Mean	Std. Deviation	Std. Error	95% CI for Mean Lower Bound	95% CI for Mean Upper Bound
Doctor	44	55.303	26.844	4.047	47.142	63.464
Nurse/Midwife	95	51.579	26.970	2.767	46.085	57.073
Anesthetist	11	51.515	31.140	9.389	30.595	72.435
Laboratory Staff	31	58.065	22.718	4.080	49.731	66.398
Orderly	13	51.282	22.008	6.104	37.983	64.581
Physician Assistant (PA)	13	53.846	28.991	8.041	36.327	71.365
Total	**207**	**53.462**	**26.226**	**1.823**	**49.868**	**57.056**
	Sum of Squares	df	Mean Square	F	Sig.	
Between Groups	1248.060	5	249.612	0.357	0.877	
Within Groups	140437.394	201	698.694			
Total	**141685.454**	**206**				

* Levene's test =0.344; p=0.886 Classical One way ANOVA performed.

4.3.8 Factors associated with overall Adherence to HBV vaccination recommendations (3 doses, 0, 1, 6 schedule & post vaccination testing)

Both occupational and personal factors that are likely to influence overall adherence to vaccination recommendations were assessed using binary logistic regression procedures. The results presented in Table 4.13 revealed that those HCWs who had high risk perception for HBV had the least odds of completely adhering to all the three indicators recommended for HBV vaccination (aOR=0.15; 95%CI=0.04-0.58).

Table 4.13 Factors associated with Overall Adherence to HBV vaccination Recommendations

			Unadjusted Estimates		Adjusted Estimates	
Variables	**N**	**n**	**uOR (95% CI)**	**P-value**	**aOR (95% CI)**	**P-value**
Facility Type						
CHPS	10	2	1.00		1.00	
Health Center	11	1	0.4(0.03 - 5.25)	0.485	0.34(0.02 - 6.12)	0.465
Polyclinic	35	4	0.52(0.08 - 3.34)	0.487	0.59(0.06 - 5.36)	0.637
District Hospital	45	6	0.62(0.1 - 3.62)	0.591	0.46(0.06 - 3.9)	0.480
Regional Hospital	106	8	0.33(0.06 - 1.8)	0.199	0.35(0.05 - 2.47)	0.289
Educational level						
No Formal	4	1	1.00		1.00	
Primary	4	0	1*		1*	
Secondary	15	2	0.46(0.03 - 6.93)	0.576	0.11(0.01 - 2.87)	0.187
Tertiary	154	15	0.32(0.03 - 3.31)	0.342	0.13(0.01 - 1.84)	0.132
Post Tertiary	30	3	0.33(0.03 - 4.3)	0.4	0.16(0.01 - 2.96)	0.218
Cadre of staff						
Doctor	44	6	1.00		1.00	
Nurse/Midwife	95	8	0.58(0.19 - 1.79)	0.346	0.37(0.1 - 1.47)	0.159
Anesthetist	11	1	0.63(0.07 - 5.88)	0.688	1.77(0.12 - 25.81)	0.675
Laboratory	31	3	0.68(0.16 - 2.95)	0.605	1.10(0.13 - 9.09)	0.928
Orderly	13	1	0.53(0.06 - 4.83)	0.572	0.41(0.04 - 4.55)	0.465
PA	13	2	1.15(0.2 - 6.53)	0.873	1.24(0.14 - 10.72)	0.847
Age category						
21-30	76	9	1.00		1.00	
31-40	95	10	0.88(0.34 - 2.28)	0.786	0.87(0.29 - 2.6)	0.800
41-50	27	1	0.29(0.03 - 2.37)	0.246	0.12(0.01 - 1.51)	0.101
51-60	9	1	0.93(0.1 - 8.33)	0.949	1.2(0.08 - 17.19)	0.895
Risk perception						
Low	23	6	1.00		1.00	
High	184	15	0.25(0.09 - 0.73)	0.011	0.15(0.04 - 0.58)	0.006
Facility Influence						
Poor	56	7	1.00			
Good	151	14	0.72(0.27 - 1.88)	0.496	****	
Duration of employment						
<10	156	16	1.00		1.00	
≥10	51	5	0.95(0.33 - 2.74)	0.926	1.47(0.34 - 6.4)	0.606
Work unit						
Noncritical	100	13	1.00		1.00	
Critical	107	8	0.54(0.21 - 1.37)	0.194	0.4(0.11 - 1.51)	0.176
Receipt of training						
Not Trained	33	4	1.00		1.00	
Received training	174	17	0.79(0.25 - 2.5)	0.682	1.25(0.32 - 4.82)	0.750
Sex						
Female	152	17	1.00		1.00	
Male	55	4	0.62(0.21 - 1.94)	0.414	0.65(0.17 - 2.5)	0.535

**** ORs and 95% CIs. Omitted due to multicollinearity with facility type. * No count or observations in this category

4.4 Adherence to HBV Post Exposure Prophylaxis (PEP) protocol

4.4.1Assessment of knowledge on PEP for HBV

This study recognized the fact that PEP for HBV knowledge is prerequisite for good adherence to PEP protocol hence this variable was assessed among the participants. A total of 174 (51.2%) of the participating HCWs admitted that they knew about PEP. The remaining 166 (48.8%) did not know about PEP for HBV. Majority of the HCWs 140 (80.5%) stated that PEP for HBV is solely by the use of HBV vaccination. Surprisingly, 64% of the participating HCWs also believe that antiretroviral drugs were effective when used as PEP against HBV. A total of 133 (76.4%) gave correct response to the importance of immunoglobulin within the first 48hours of exposure. Summing up the responses generated to form a composite score or index, and categorizing the knowledge scores into three performance categories, it emerged that 58 (17.1%) of the HCWs had scores below 50, representing poor knowledge on PEP for HBV. Those who had fair or intermediate knowledge on PEP for HBV were 69 (20.3%). Approximately, 47 (13.8%) obtained scores above 75% indicating good knowledge for PEP.

4.4.2 PEP knowledge by cadre of staff

Table 4.14 below shows that overall mean percentage score on PEP knowledge was 47.85% (CI=44.35-51.35). Indicating poor knowledge on PEP for HBV among the population. Physician Assistants obtained the highest mean score of 66.67% followed by Doctors who had mean score of 54.54%. Orderlies however, recorded the lowest mean score of 42.64%. Analysis of the variance procedure revealed a statistical significant difference in knowledge scores obtained by the various categories of HCWs (F=3.110; P=0.010).

A post hoc analysis (Tukeys' method) revealed a difference in PEP knowledge between Nurses/Midwives and Physician Assistants with a mean difference of -23.98 (p=0.036; 95%CI=-46.99 -97.54) (Appendix 8 for Post Hoc Analysis Table).

Table 4. 14 Comparison of PEP knowledge score by cadre of staff

Cadre of staff	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Doctor	44	54.55	22.41	3.38	47.74	61.36
Nurse/midwife	82	42.68	22.73	2.52	37.69	47.68
Anesthetist	8	53.13	20.86	7.38	35.68	70.57
Laboratory staff	17	42.68	22.99	5.58	30.83	54.47
Orderly	14	48.22	22.93	6.13	34.98	61.45
PA	9	66.67	25.00	8.33	47.45	85.89
Total	**174**	**47.85**	**23.42**	**1.78**	**44.35**	**51.35**

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8033.03	5	1606.60	3.11	0.010
Within Groups	86783.78	168	516.57		
Total	**94816.81**	**173**			

4.4.3 Factors associated with good PEP knowledge among health care workers

Both individual factors as well as occupational factors including educational level, blood-borne infection prevention training attendance and unit of work were assessed for their effect on PEP knowledge. It was evident from the results in Table 4.15 that only cadre of staff was the factor that had a significant association with PEP knowledge at both bivariate and multivariate levels. Cadre of staff was associated with having good knowledge about PEP for HBV. Nurses and midwives demonstrated lower odds of having good knowledge on PEP compared to doctors (aOR=0.4; 95%CI=0.1-0.9).

Table 4.15 Factors associated with good PEP knowledge.

	Knowledge Level				Unadjusted Estimates		Adjusted Estimates	
Variables	**Poor**	**Good**	**chi**	**p-value**	**uOR(95% CI)**	**P-value**	**aOR (95% CI)**	**P-value**
Sex								
Male	95(75.4)	31(24.6)	1.34	0.246	1.00		1.00	
Female	32(66.7)	16(33.3)			1.5(0.7 – 3.2)	0.248	1.2(0.5 – 3.0)	0.656
Age in years								
21-30	45(79)	12(21.1)	3.63	0.304	1.00		1.00	
31-40	57(73.1)	21(26.9)			1.4(0.6.0– 3.1)	0.434	1.3(0.5 – 3.5)	0.558
41-50	16(59.3)	11(40.7)			2.60(1.0 – 7.0)	0.063	2.9(0.8 – 10.4)	0.099
51-60	9(75)	3(25)			1.3(0.3 – 5.3)	0.764	1.9(0.3 – 11.5)	0.460
Cadre of staff								
Doctor	27(61.4)	17(38.6)	21.18	0.001	1.00		1.00	
Nurse/Midwife	69(84.2)	13(15.9)			0.3(0.1 – 0.7)	0.005	0.4(0.1 – 0.9)	0.028
Anaesthetist	5(62.5)	3(37.5)			1(0.2 – 4.5)	0.952	0.7(0.1 – 4)	0.726
Laboratory Staff	14(82.4)	3(17.7)			0.3(0.1 – 1.4)	0.128	0.3(0.1 – 1.5)	0.148
Orderly	10(71.4)	4(28.6)			0.6(0.2 – 2.4)	0.497	0.8(0.2 – 3.2)	0.705
P.A.	2(22.2)	7(77.8)			5.6(1.0– 30.0)	0.046	5.0(0.8 – 32)	0.088
Post Graduate								
Above.	112(75.7)	36(24.3)	3.63	0.057	1.00		1.00	
Below	15(57.7)	11(42.3)			0.4(0.2 – 1)	0.061	0.7(0.3 – 1.9)	0.467
Training								
Trained	107(71.8)	42(28.2)	0.73	0.394	1.00		1.00	
Not trained	20(80)	5(20)			0.6(0.2 – 1.8)	0.397	1.1(0.3 – 3.3)	0.951
Duration of employment								
≥10 years	37(69.8)	16(30.2)	0.39	0.532	1.00		1.00	
<10 years	90(74.4)	31(25.6)			0.8(0.4 – 1.6)	0.533	1.1(0.4 – 2.9)	0.846
Work unit								
Critical	56(68.3)	26(31.7)	1.73	0.188	1.00		1.00	
Non-Critical	71(77.2)	21(22.8)			0.6(0.3 – 1.2)	0.189	0.7(0.3 – 1.6)	0.376
Facility factor								
Good	79(69.3)	35(30.7)	2.28	0.131	1.00		1.00	
Poor	48(80)	12(20)			0.6(0.3 – 1.2)	0.133	0.6(0.3 – 1.5)	0.32
Risk Perception								
High	113(72.4)	43(27.6)	0.23	0.629	1.00		1.00	
Low	14(77.8)	4(22.2)			0.8(0.2 – 2.4)	0.63	0.8(0.2 – 2.9)	0.726

4.5 Adherence to the various components of post exposure prophylaxis

4.5.1 Adherence to exposure reporting among HCWs

The results presented in Table 4.16 reveal that exposure to blood and body fluids via percutaneous and per mucous routes were recorded in 11.2% (38/340) of the HCWs within the past twelve months before the study. The study recognized the fact that multiple exposures could have occurred within the period under review and that HCWs may have responded differently to each exposure incident and for that matter the study only measured or assessed adherence to exposure reporting based on the most recent exposure that the HCW experienced. Needle stick injuries formed the majority of 28 (73.7%) of all the recent exposures. Exposure reporting which was identified as an important element for PEP utilization was assessed in the population of exposed HCWs. Out of the 38 HCWs who sustained exposures, 76.3% (29/38) self-reported the exposure incident giving, the overall exposure reporting prevalence of 76.3% indicating a good level of adherence to reporting recommendations.

Table 4.16 Exposure to blood and body fluids and exposure incident reporting

Variable	Frequency	Percent (%)
Exposure in last 12 months		
Yes	38	11.2
No	302	88.8
Type of Exposure		
Percutaneous	28	73.7
Per mucous	10	26.3
Reported most recent exposure/12months	29	76.3
Yes	9	23.7
No		

Variations in exposure reporting was observed across the various categories of HCWs as well as the various levels of health care. The Table 4.17 shows that exposure reporting was highest and universal (100%) among anesthetists, laboratory staff and PAs. Doctors were the category that reported considerably lower number of exposures i.e. (66.7%)

compared to the other categories of HCWs. Reporting was also observed to be much higher in trained HCWs; 77.4% (24/31) than their untrained counterparts. Males reported more exposures; 77.8% (7/9) than females. HCWs who had good risk perception reported less exposures; 75.0% (24/32) compared to those with poor perception of risk for HBV. Exposure reporting was universal for those who did not know about PEP for HBV. All these relationships were not statistically significant at the bivariate level except for facility type. Exposure reporting was observed to increase with increasing level of health care as Regional Hospital recorded the highest reporting rate of 100%. This relationship was statistically significant (p-value of < 0.05) in a bivariate analysis. The analysis was limited to bivariate level due to the limited or small number of observations in the various groups.

Table 4. 17 Adherence to exposure reporting by sociodemographic and occupational variables

Variable	Exposure (12month)	Reported an Exposure Yes(n=29)	No (n=9)	Reporting Rate	χ^2 or Fisher's Exact	P-Value
Cadre of staff						
Doctor	9	6(66.7)	3(33.3)	66.7		
Nurse/Midwife	16	12(75.0)	4(25.0)	75.0		
Anaesthetist	1	1(100.0)	0(0.0)	100.0	2.133	0.939
Laboratory Staff	1	1(100.0)	0(0.0)	100.0		
Orderly	8	6(75.0)	2(25.0)	75.0)		
P.A.	3	3(100.0)	0(0.0)	100.0		
Overall	**38**	**29.0**	**9.0**	**76.3**		
Level of Facility						
CHPS	1	0(0)	1(100)	0		
Health Centre	6	1(16.7)	5(83.3)	16.7	17.990	<0.001**
Polyclinic	7	5(71.4)	2(28.6)	71.4		
Dist. Hospital	10	9(90)	1(10)	90		
Reg. Hospital	14	14(100)	0(0)	100		
Training						
Trained	31	24(77.4)	7(22.6)	77.4	0.113	0.736
Not trained	7	5(71.4)	2(28.6)	71.4		
Work unit						
Critical	14	12(85.7)	2(14.3)	85.7	1.083	0.298
Non critical	24	17(70.8)	7(29.2)	70.8		
Age						
21-30	9	7(77.8)	2(22.2)	77.8		
31-40	19	15(79)	4(21)	79.0	1.896	0.654
41-50	6	5(83.3)	1(16.7)	83.3		
51-60	4	2(50)	2(50)	50.0		
Sex						
Male	9	7(77.8)	2(22.2)	77.8	0.140	0.906
Female	29	22(75.9)	7(24.1)	75.9		
Level of Education						
Primary	2	1(50.0)	1(50.0)	50.0		
Secondary	5	3(60.0)	2(40.0)	60.0	2.833	0.641
Tertiary	23	18(78.3)	5(21.7)	78.3		
Post Tertiary	7	6(85.7)	1(14.3)	85.7		
No formal	1	1(100.0)	0(0.0)	100.0		
HBV Vaccination						
Yes	21	18(85.7)	3(14.3)	85.7	2.294	0.130
No	17	11(64.7)	6(35.3)	64.7		
Facility factor						
Good	13	6(46.2)	7(53.9)	46.2	****	0.003
Poor	25	23(92.0)	2(8.0)	92.0		
Risk Perception						
Low	6	5(83.3)	1(16.7)	83.3	****	1.000
High	32	24(75.0)	8(25.0)	75.0		
PEP Knowledge						
Good	18	10(55.6)	8(44.4)	55.6		
Intermediate	12	10(83.3)	2(16.7)	83.3	****	0.990
Poor	8	8(100.0)	0(0.0)	100.0		

**** Estimates from Fishers exact ** Multivariate analysis not done due to limited observations in the various facility categories

4.5.2 Adherence to evaluation or assessment for PEP among HCWs

Out of the 29 HCWs who reported their exposure incidents, all except one were evaluated or assessed for the eligibility to receive PEP, giving an overall evaluation rate of 96%. This score is high according to the adherence scale for this study.

4.5.3 Adherence to PEP use

The results as presented in fig 4.4 indicate that PEP for HBV was used by seven (7) individuals out of 10 HCWs who were evaluated and were eligible to receive PEP, giving PEP use rate of 70.0%, an indication of an intermediate or fair level of adherence to PEP use among the population of HCWs surveyed. Cost for PEP in 5(71.4%) of the Exposed HCWs who benefited from PEP were borne by the facilities where they worked. Three (3) HCWs who were eligible to use PEP could not use PEP due to unavailability or cost involved in getting vaccine and or immunoglobulin.

4.5.4 Adherence to timeliness of PEP use

All the eligible 100% (7/7) HCWs who used PEP initiated PEP averagely within 24-48 hours and none of the HCWs requiring PEP initiated beyond 72 hours. This gave 100% timeliness of PEP initiation among the exposed HCWs who used PEP.

4.5.5 Adherence to post PEP evaluation and follow-up

All the (7/7) HCWs who used PEP returned for first follow-up after 6 months, giving adherence to follow up rate of 100%

The flow diagram in Fig 4.4 below shows PEP for HBV steps and level of adherence to recommendations at each step.

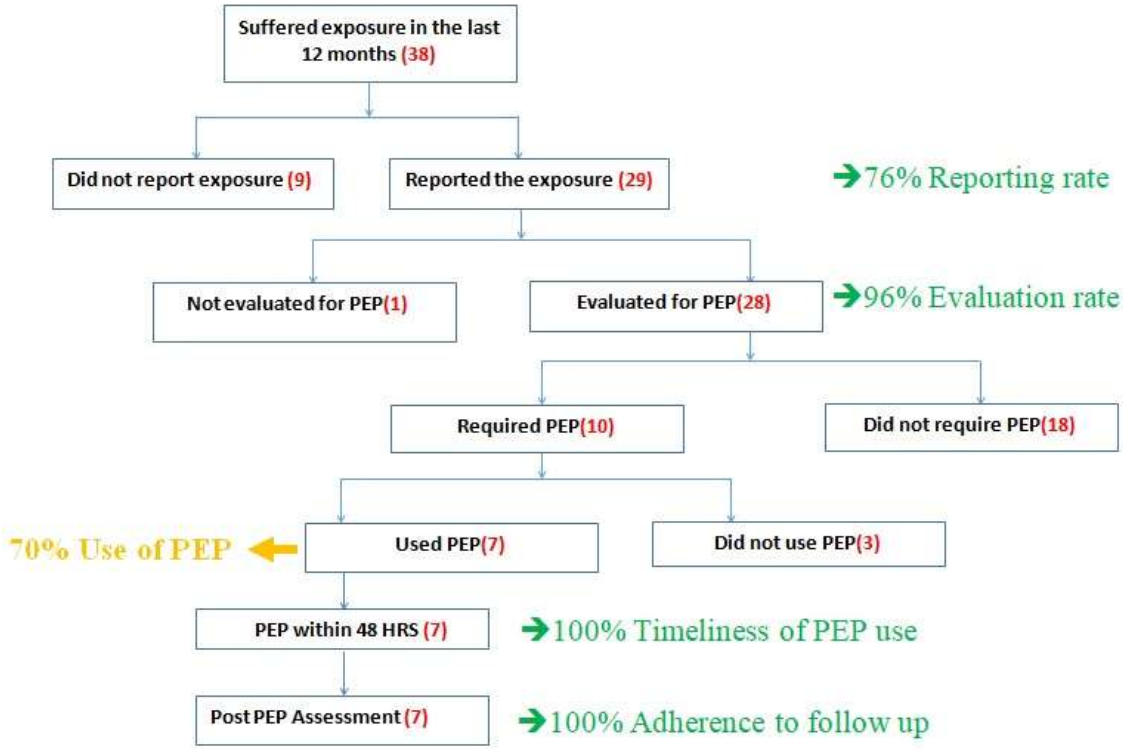

Figure 4.3: Adherence to the various stages of Post Exposure Prophylaxis Practice

4.6 Distribution of HBV serological markers among HCWs

The laboratory results of the HCWs revealed that 5.9% (20/340) were reactive to HBsAg denoting the presence of current HBV infection. Envelope antigen which is a marker of active viral replication was identified in 1.5 %(5/340) of the total population. Most of the infections were in the inactive form as 75 % (15/20) of those infected demonstrated positivity to anti-HBe which is a marker of slow viral replication. A total of 195 (57.4%) HCWs showed the presence of protective antibody (anti-HBs) against HBV infection. Total HBV core antibody (anti-HBc) IgG class which denotes lifetime exposure to HBV was isolated in 27 (7.9%) of the participating HCWs. Only 1 (0.3%) HCW was reactive to anti-HBc IgM class, an indication of a new or recent infection. The overall anti-HBc prevalence was 8.2% (28/240) (Table 4.18).

Table 4.18: Distribution of serological markers of hepatitis B virus among participating HCWs (N=340).

Variable/ Marker	Frequency(N=340)		Overall Prevalence
	Positive	Negative	
HBsAg	20	320	5.9
Anti-HBs	195*	144	57.4
HBeAg	5	335	1.5
Anti-HBe	15	325	4.4
Anti-HBc IgG	27**	313	7.9
Anti-HBc IgM	1	339	0.3

* Both vaccine induced and naturally acquired, ** Current, Healed and Isolated infections.

4.6.1 Distribution of HBV serological markers by cadre HCWs

The overall prevalence of antigen serological markers namely HBsAg, HBeAg were 5.9%, (20) and 1.5% (5) respectively. Twenty five percent of those that were reactive to

HBsAg were also reactive to HBeAg. The two antigens were more prevalent among orderlies than the other categories of HCWs (Fig. 4.5).

Protective antibody to HBV (HBsAb) was the most predominant marker detected in the population with an overall prevalence of 57.4% (195/340). The prevalence was highest among laboratory staff (70.0%) followed by physician assistants (63.2%). The least Anti-HBs prevalence was observed among Orderlies. Anti-HBc (IgM & IgG) which denotes lifetime exposure to HBV recorded an overall prevalence of 28(8.2%) with a highest prevalence among orderlies (Table 4.19).

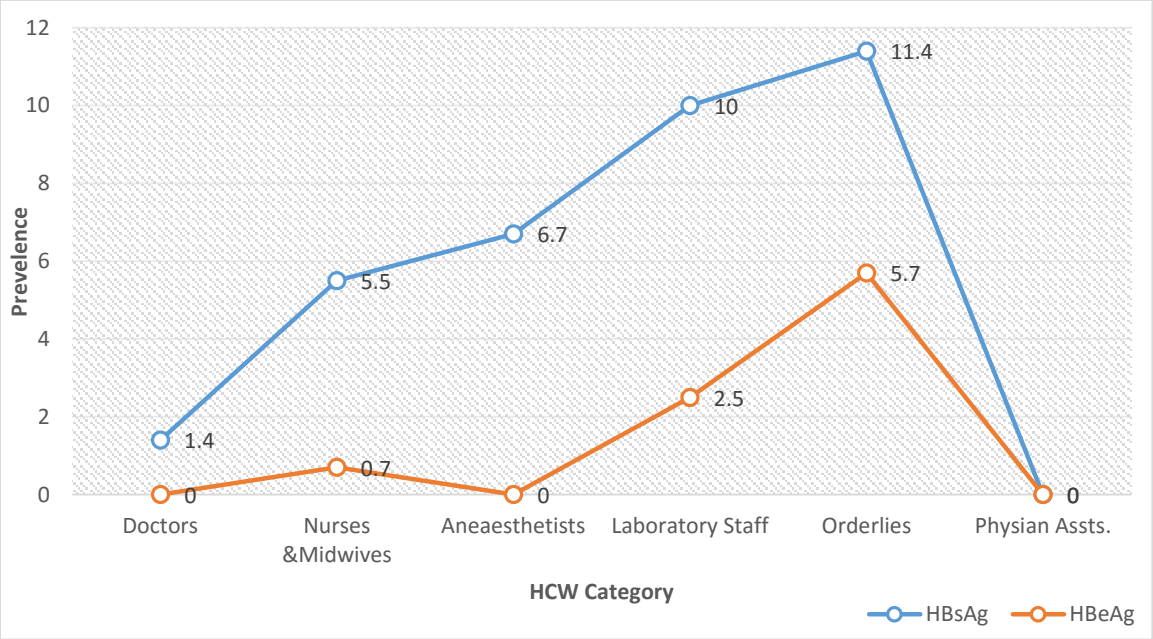

Figure 4.4: Distribution of Serological HBV Antigen Markers by Cadre

Table 4.19: Distribution of serological HBV antibody markers by cadre or job categories (N=340)

Cadre	No Tested	Anti-HBe	Anti- HBs	Anti- HBc
Doctor	69	1(1.4%)	40(58.0%)	3(4.3%)
Nurse & Midwife	162	9(6.1%)	90(55.6%)	13(8.0%)
Anesthetist	15	0(0.0)	11(73.3%)	1(6.7)
Laboratory staff	40	3(10.0)	29(72.5%)	5(12.5%)
Orderly	35	2(11.4)	12(34.3%)	5(14.3%)
Physician Assistant (PA)	19	0(0.0%)	13(68.4%)	1(5.2%)
Overall	**340**	**15(4.4%)**	**195(57.4%)**	**28(8.2%)**

4.6.2. Classification of HCWs based on the presence or absence of serological markers

Table 4.20 shows that majority 189 (55.6%) of the HCWs had isolated Anti-HBs an indication of immunity against HBV as a result of vaccination. Another 6 (1.8%) had a combination of anti-HBs and anti-HBc denoting immunity as a result of past exposure to HBV. No serological marker was identified in 123 (36.1%) of the HCWs indicating their susceptibility to infection with HBV in the presence of an exposure. Two individuals 2 (0.5%) had intermediate results.

Table 4.20: Classification of HCWs based on the presence or absence of Markers (N=340)

Serological Markers			Marker combination Category	Freq. (%)
HBsAg	**Anti-HBs**	**Anti-HBc**		
Negative	Negative	Negative	Susceptible to HBV infection	123(36.1%)
Negative	Positive	Positive	Immune after past infection	6(1.8%)
Negative	Positive	Negative	Immune after Vaccination	189 (55.6%)
Positive	Negative	Positive	Current Infection	20 (5.9%)
Negative	Negative	Positive	**Intermediate result** 1.Isolated Anti-HBc or 2.Resolving Acute infection or 3.Chronic infection with low Level of HBsAg	2(0.6%)
Total	-	-	-	**340(100%)**

4.6.3 Factors associated with lifetime exposure to HBV (Anti-HBc positivity)

In all, 28 participants were positive to anti-HBc (IgM &IgG) indicating a lifetime exposure to HBV. The overall prevalence of anti-HBc is 8.2 % (95%CI= 5%-11%). Lifetime exposure prevalence was higher among HCWs who were <30 years, (7.5%) males (13.6%) and those who belonged to other cadre categories other than being a doctor or nurse (11.0%).

The results presented in Table 4.21 show that, HCWs working at lower levels of care recorded a higher prevalence of HBV infection 13 (12.6%) compared to those at higher level facilities. HCWs working at critical units where blood and body fluid exposure were much more likely also had a higher frequency of HBV exposure 16 (10.3%) compared to 12 (6.5%) in those at less critical departments. The frequency of lifetime exposure to HBV was high in individuals with poor facility conditions regarding HBV infection prevention; 13 (12.6%) and those who had worked for less than 10 years as HCWs in their respective professions; 23(8.8%) compared to the other counterparts who had good facility conditions and worked for over 10 years in their respective professions respectively.

Table 4.21: Prevalence of lifetime exposure to HBV (Anti-HBc positivity)

Variables	N(340)	n(28)	HBV (Anti-HBc positivity) Percent (95% CI)	Chi	P-value
Age in years				0.40	0.530
≤30	127	12	9.4(5-15.9)		
>30	213	16	7.5(4.4-11.9)		
Sex				4.58	0.032
Male	88	12	13.6(7.2-22.6)		
Female	252	16	6.3(3.7-10.1)		
Tertiary Education**				***	0.760
Above.	41	24	9.8(2.7-23.1)		
≤Below	299	4	8(5.2-11.7)		
Cadre of staff				1.60	0.201
Doctors/Nurses	231	16	6.9(4-11)		
Others	109	12	11(5.8-18.4)		
Risk level				2.00	0.377
No	44	6	13.6(5.2-27.4)		
Medium	269	20	7.4(4.6-11.2)		
High	27	2	7.4(9.1-24.3)		
Risk Perception				1.78	0.182
High	295	6	7.5(4.7-11.1)		
Low	45	22	13.3(5.1-26.8)		
Duration of employment				0.54	0.460
<10 years	260	23	8.8(5.7-13)		
≥10 years	80	5	6.3(2.1-14)		
Facility type*				3.76	0.052
Higher Level	237	15	6.3(3.6-10.2)		
Lower Level	103	13	12.6(6.9-20.6)		
Facility Factor				3.76	0.052
Good	237	15	6.3(3.6-10.2)		
Poor	103	13	12.6(6.9-20.6)		
Work unit				1.64	0.200
Critical	155	16	10.3(6-16.2)		
Non-Critical	185	12	6.5(3.4-11.1)		
Training				5.18	0.023
Trained	274	18	6.6(3.9-10.2)		
Not Trained	66	10	15.2(7.5-26.1)		
Life time NSIs¥				0.82	0.365
Exposure	216	20	9.3(5.7-13.9)		
No exposure	124	8	6.5(2.8-12.3)		
Mucocutanous				0.68	0.410
Exposed	264	20	7.6(4.7-11.5)		
Not exposed	76	8	10.5(4.7-19.7)		

*Reclassified as lower level: CHPS, Health center & Policlinic. Higher levels: District and Regional Hospitals, **Reclassified as below and above tertiary, *** Estimates from Fishers Exact Test. NSIs¥= Needle stick injury

A binary logistic regression was undertaken to assess the host and occupational factors associated with exposure to HBV exposure. Adjusting for behavioral factors which could also predispose HCWs to exposure to HBV, previous training in prevention of blood-borne infections, sex and level of health facility were the variables that showed significant association with lifetime exposure to HBV. The results presented in Table 4.22 show that

HCWs who were not trained in prevention of blood-borne infections had 2.6 times higher odds of being exposed to HBV (aOR= 2.6; 95% CI= 1.0-6.4). Also, female HCWs were 4 times less likely to contract HBV infection compared to their male counterparts (aOR=0.4; 95%CI= 0.1-0.9). At the crude level, lower level health facilities had two times higher the odds of contracting HBV (uOR=2.1; 95%CI= 1.0-4.7). However, this statistical significance was lost after adjusting for age, sex, cadre, and behavioral and occupational factors.

Table 4.22 Host and occupational factors associated with Anti-HBc

Variables		Anti-HBc	Crude Estimates		Adjusted Estimates	
	N(340)	n(28)	uOR (95% CI)	P-value	aOR (95% CI)	P-value
Age in years				0.530		0.836
≤30	127	12	1.0		1.0	
>30	213	16	0.8(0.4 - 1.7)		0.9(0.4-2.3)	
Sex				0.036		0.026
Male	88	12	1.0		1.0	
Female	252	16	0.4(0.2 - 0.9)		0.4(0.1-0.9)	
Tertiary Education**				0.706		0.185
Above.	41	24	1.0		1.0	
≤Below	299	4	0.8(0.3 - 2.5)		0.4(0.1-1.5)	
Cadre of staff				0.205		0.661
Doctors/Nurses	231	16	1.0		1.0	
Others	109	12	0.6(0.3 - 1.3)		0.8(0.3-2.1)	
Risk level						
No	44	6	1.0		1.0	
Medium	269	20	0.5(0.2-1.3)	0.174	0.5(0.2-1.6)	0.280
High	27	2	0.5(0.1-2.7)	0.427	0.6(0.1-3.8)	0.584
Risk Perception				0.367		0.202
High	295	6	1.0		1.0	
Low	45	22	0.7(0.3 - 1.6)		2.1(0.7-6.3)	
Duration of employment				0.462		0.773
<10 years	260	23	1.0		1.0	
≥10 years	80	5	1.5(0.5 - 4)		1.2(0.4-3.7)	
Facility type*				0.005		0.704
Higher Level	237	15	1.0		1.0	
Lower Level	103	13	2.1(1.1 - 4.7)		2.0(0.1-65)	
Facility Factor				0.057		0.741
Good	237	15	1.0		1.0	
Poor	103	13	2.1(1 - 4.7)		1.8(0.1-58.7)	
Work unit				0.204		0.120
Critical	155	16	1.0		1.0	
Non-Critical	185	12	0.6(0.3 - 1.3)		0.5(0.2-1.2)	
Training				0.027		0.044
Trained	274	18	1.0		1.0	
Not Trained	66	10	2.5(1.1 - 5.8)		2.6(1.1-6.4)	
Life time NSIs¥				0.241		0.191
Exposure	216	20	1.0		1.0	
No exposure	124	8	0.6(0.3 - 1.4)		0.5(0.2-1.4)	
Mucocutanous				0.281		0.634
Exposed	264	20	1.0		1.0	
Not exposed	76	8	2.2(0.5 - 9.8)		1.3(0.5-3.5)	

*Reclassified as lower level: CHPS, Health center & Policlinic. Higher levels: District and Regional Hospitals, **Reclassified as below and above tertiary. NSIs¥= Needle stick injury

4.6.4 Factors associated with current hepatitis B infection (HBsAg)

Twenty out of the 340 respondents tested positive for HBsAg. Giving a prevalence of 5.9 % (95% CI= 3.0%-8.0%) among the study population.

The results presented in Table 4.23 show that HBV infection prevalence was highest among participants < 30 years of age (9.4%). There was a male preponderance to HBV infection in this population as the prevalence was 10.2% compared to 4.4% in females. HCWs below post graduate level of education were much more affected 19 (6.4%). The occurrence of HBV infection was also seen to be more frequent (13.6%) in HCWs who never attended any training or workshop on blood-borne infections and their prevention. HCWs working in lower levels of the health care system (CHPs, health centre, and polyclinic) were likely to be affected (9.7%) compared to their counterparts at the higher levels of care (District Hospital and Regional Hospital). With facility specific prevalence, CHPs had the highest with a prevalence rate of 15.8% followed by Health centre. HBV infection was also seen to be more predominant (6.9%) in individual HCWs who had worked for less than 10 years in their respective professions compared to those with over 10 years working experience. The prevalence was also seen to be higher in those working in critical units (6.5%) compared to those working in units with minimal exposures or non-critical areas. HBV prevalence was lower (4.2%) in health facilities having good facility conditions that promote HBV prevention compared to 9.7% in HCWs with poor facility conditions. HCWs with poor risk perception for HBV, previous blood transfusion and having a member of the family having HBV infection all recorded higher HBV prevalence (Table 4.23).

Table 4.23. Prevalence of HBsAg positivity (Current HBV infection)

Variables	N(340)	n(20)	HBV infection (HBsAg) Percent (95% CI)	Chi	P-value
Age in years				4.66	0.031
≤30	127	12	9.4(5 - 15.9)		
>30	213	8	3.8(1.6 - 7.3)		
Sex				4.04	0.044
Male	88	9	10.2(4.8 - 18.5)		
Female	252	11	4.4(2.2 - 7.7)		
Tertiary Education**				***	0.488
Above.	41	1	2.4(0.1 - 12.9)		
≤Below	299	19	6.4(3.9 - 9.7)		
Cadre of staff				3.14	0.076
Doctors/Nurses	231	10	4.3(2.1 - 7.8)		
Others	109	10	9.2(4.5 - 16.2)		
Risk level				***	0.187
No	44	5	11.3(3.8-24.6)		
Medium	269	13	4.8(2.6-8.1)		
High	27	2	7.4(0.9-24.3)		
Risk Perception				5.20	0.023
High	295	14	4.7(2.6 - 7.8)		
Low	45	6	13.3(5.1 - 26.8)		
Duration of employment				2.16	0.141
<10 years	260	18	6.9(4.2 - 10.7)		
≥10 years	80	2	2.5(0.3 - 8.7)		
Facility type*				3.91	0.048
Higher Level	237	10	4.2(2 - 7.6)		
Lower Level	103	10	9.7(4.8 - 17.1)		
Facility Factor				3.91	0.048
Good	237	10	4.2(2 - 7.6)		
Poor	103	10	9.7(4.8 - 17.1)		
Work unit				0.17	0.683
Critical	155	10	6.5(3.1 - 11.5)		
Non-Critical	185	10	5.4(2.6 - 9.7)		
Training				8.89	0.003
Trained	274	11	4(2 - 7.1)		
Not Trained	66	9	13.6(6.4 - 24.3)		
Life time NSIs¥				1.21	0.272
Exposure	216	15	6.9(3.9 - 11.2)		
No exposure	124	5	4(1.3 - 9.2)		
Mucocutanous				1.95	0.162
Exposed	264	13	4.9(2.6 - 8.3)		
Not exposed	76	7	9.2(3.8 - 18.1)		

*Reclassified as lower level: CHPS, Health center & Policlinic. Higher levels: District and Regional Hospitals, **Reclassified as below and above tertiary, *** Estimates from Fishers Exact Test. NSIs¥= Needle stick injury

After adjusting for the other factors associated with HBV infection using a logistic regression model, the results presented in Table 4.24 show that HCWs who were not trained in the prevention of blood-borne infections had close to three times much higher odds of HBV infection (aOR= 3.2; %CI= 1.1-9.5).

Table 4.24: Factors associated with current HBV infection (HBsAg)

Variables	N(340)	HBsAg n(20)	Crude Estimates uOR (95% CI)	P-value	Adjusted Estimates aOR (95% CI)	P-value
Age in years				0.037		0.121
≤30	127	12	1.00		1.00	
>30	213	8	0.4(0.1 - 0.9)		0.4(0.1-1.3)	
Sex				0.051		0.053
Male	88	9	1.00		1.00	
Female	252	11	0.4(0.2 - 1)		0.3(0.1-1)	
Tertiary Education**				0.337		0.859
Above.	41	1	1.00		1.00	
≤Below	299	19	2.7(0.4 - 20.8)		1.2(0.1-11)	
Cadre of staff				0.083		0.211
Doctors/Nurses	231	10	1.00		1.00	
Others	109	10	0.4(0.2 - 1.1)		0.5(0.1-1.5)	
Risk level						
No	44	5	1.00		1.00	
Medium	269	13	0.4(0.1-1.2)	0.094	0.5(0.1-2)	0.352
High	27	2	0.6(0.1-3.5)	0.59	1.2(0.2-8.5)	0.880
Risk Perception				0.278		0.098
High	295	14	1.00		1.00	
Low	45	6	0.6(0.2 - 1.6)		2.9(0.8-10)	
Duration of employment				0.159		0.557
<10 years	260	18	1.00		1.00	
≥10 years	80	2	2.9(0.7 - 12.8)		1.7(0.3-9.3)	
Facility type*				0.054		0.827
Higher Level	237	10	1.00		1.00	
Lower Level	103	10	2.4(1 - 6.1)		1.6(0-106.2)	
Facility Factor				0.054		0.582
Good	237	10	1.00		1.00	
Poor	103	10	2.4(1 - 6.1)		3.3(0-220.5)	
Work unit				0.683		0.916
Critical	155	10	1.00		1.00	
Non-Critical	185	10	0.8(0.3 - 2)		0.9(0.3-2.9)	
Training				0.005		0.033
Trained	274	11	1.00		1.00	
Not Trained	66	9	3.8(1.5 - 9.5)		3.2(1.1-9.1)	
Life time NSIs¥				0.255		0.086
Exposure	216	15	1.00		1.00	
No exposure	124	5	0.6(0.2 - 1.5)		0.3(0.1-1.2)	
Mucocutanous				0.588		0.605
Exposed	264	13	1.00		1.00	
Not exposed	76	7	1.5(0.3 - 6.7)		1.4(0.4-4.3)	

*Reclassified as lower level: CHPS, Health center & Policlinic. Higher levels: District and Regional Hospitals, **Reclassified as below and above tertiary. NSIs¥= Needle stick injury

4.7 Seroprotection against hepatitis B virus among vaccinated HCWs

Following laboratory procedures to quantify Anti-HBs antibody levels, the antibody concentration of participating HCWs were classified into three groups using the WHO and NCIR antibody titer reference range for anti-HBs. The results illustrated in Table 4.25 shows that a total of 18(8.6%) out of 207 vaccinated HCWs had antibody titers below 10mlU/mL and hence referred to as non-seroprotected after having taken at least one dose of HBV vaccination. Ninety-three (44.92%) were adequately protected with antibody levels between 10-100mlU/mL. Majority of the vaccinated HCWs 96 (46.38%) had antibody levels above 100mlU/mL indicating high levels of antibody and for that matter having high level of seroprotection against HBV. In all, 189 HCWs demonstrated anti-HBs levels above 10mlU/mL giving the overall seroprotection prevalence among the vaccinated HCWs to be 91.3% (95% CI=87%-95%).

Table 4. 25 Seroprotection following HBV vaccination

Antibody Level	Category	Frequency N=(207)	Percent (%)
<10mlU/mL	No Protection	18	8.7
10-100mlU/mL	Adequate seroprotection	93	44.92
>100mlU/mL	High level of protection	96	46.38
Total		**207**	**100.00**

4.7.1 Factors associated with of seroprotection following HBV vaccination

There was a need for the anti-HBs concentrations to be log transformed since the data was not normally distributed. The log transformed concentrations of antibodies of the vaccinated HCWs were compared by several categories of independent variables. It was observed that there was no statistically significant difference between the HCWs who had their immunization series less than 5 years to the study compared to those who vaccinated five years earlier. Antibody titer values were also observed to be slightly higher in

individuals who had adhered to the three-dose vaccination regimen, vaccinated before age 40 years, and those who were females. HCWs who had taken booster doses also demonstrated slightly higher antibody concentrations of 4.9 ±1.2. Even though non-smoking HCWs had slightly higher antibody levels of 4.4 ±1.5 compared to their smoking counterparts, this relationship was not statistically significant at the bivariate level. Similarly, the study did not find any statistically significant associations between variables such as BMI, chronic conditions and seroprotection against HBV (Table 4.26).

Table 4. 26: Factors Associated with seroprotection against HBV following Vaccination

Variable	Anti-HBs ≤10 mIU/mL (Non-responders) N=18	Anti-HBs>10 mIU/mL (Responders) N=189	log concentration mIU/mL	T-test p-value
Duration of Vaccination				0.819
< 5years	6(2.9)	68(32.3)	4.4 ± 1.5	
≥5years	12(5.8)	121(58.5)	4.4 ± 1.5	
Age at vaccination				0.668
<40 years	7(3.4)	69(33.4)	4.5 ± 1.4	
≥40 years	11(5.4)	120(57.9)	4.4 ± 1.5	
Vaccination Type				0.129
Complete vaccination	12(5.8)	147(71.2)	4.5 ± 1.5	
Partial Vaccination	6(2.9)	42(20.3)	4.1 ± 1.6	
Sex				0.499
Male	5(2.5)	50(24.2)	4.3 ± 1.6	
Female	13(6.3)	139(67.2)	4.5 ± 1.5	
Smoking Status				0.583
Smoker	0(0.0)	2(0.96)	3.6 ± 1.5	
Non Smoker	18(8.9)	187(90.4)	4.4 ± 1.5	
Booster				0.059
Taken Booster	1(0.48)	23(1.2)	4.9 ± 1.2	
Not Taken Booster	17(8.3)	166(80.2)	4.4 ± 1.5	
Chronic Condition				0.585
Condition present	2(0.96)	14(6.8)	4.7 ± 2	
Condition Absent	16(17.8)	175(84.6)	4.4 ± 1.5	
BMI(Kg/m^2)				0.372
<25	10(4.8)	76(36.7)	4.3 ± 1.7	
≥25	8(3.9)	113(54.6)	4.5 ± 1.4	

4.8 Supplementary results for independent (secondary) variables generated for the study

4.8.1 HBV infection prevention and control environment of HCWs

Analysis of data obtained from key informants representing the 5 facilities where the study took place are presented in this section. All the five facilities had their representatives participating in the key informant interview, giving a response rate of 100%.

Surprisingly, PEP protocol for HBV was not available nor posted in the immediate environment of HCWs in all the five facilities.

All the five 5 facilities organized periodic in-service training for the health care workers on blood-borne infections and their prevention. Protocol for personal protective equipment use was also universal. Only 3 facilities (regional hospital, district hospital and polyclinic) had infection prevention coordinators and or occupational health and safety coordinators coordinating HBV prevention activities in their respective facilities.

All the facilities except CHPs had HBV vaccine readily available at the facility however, only the Regional Hospital offered it for free to its workers. Immunoglobulin (HBIG) against HBV was available at only the Regional Hospital. The occupational health and safety policy guideline which is to provide guidance for health facilities was available in only one of the facilities specifically the Regional Hospital.

In all, a linear but declining trend of performance was observed among the five health facilities with the regional hospital having the highest score; of 10 (out of obtainable score of 14) indicating a good facility environment regarding HBV prevention among HCWs. This was followed by the District Hospital with a score of 6, indicating an intermediate level. The Polyclinic, Health Center and CHPs facilities had 4, 3, and 2 respectively indicating poor facility environment for HBV prevention and control among HCWs.

The overall performance of the facilities in terms of support with structures, systems and logistics to promote HBV prevention among HCWs was low with an overall average score of 45.44%, indicating an overall poor facility environment for HBV prevention among HCWs in the five facilities.

Facilities with total scores of ≥50% considered as having good HBV prevention environment to promote adherence among HCWs. Those with scores below 50% were considered as having poor HBV preventive environment in accordance with score categorization proposed by Fageeh (2014) Table 4.27.

Table 4.27 Facility environment for prevention of HBV infection among HCWs in the five selected Health Facilities

Facility Factors influencing HCW Adherence	Regional Hospital	District Hospital	Polyclinic	Health Center	CHPs Zone	Overall N (%)
			Scores			
Hepatitis B vaccine Available at the facility	1	1	1	1	0	4(80)
Immunoglobulin for HBV available at the facility	1	0	0	0	0	1(20)
PEP Protocol for HBV written and available at the facility	0	0	0	0	0	0(20)
Documentation on Exposure reporting available at the facility	1	1	0	0	0	2(20)
Screening of Newly employed staff undertaken at the facility	1	0	0	0	0	1(20)
Occupational Health and Safety Policy available at the facility	1	0	0	0	0	1(20)
Training on Blood Borne Infections done periodically for staff	1	1	1	1	1	5(100)
PPE protocols available to guide staff on the use of PPE	1	1	1	1	1	(100)
IPC/OHS coordinator or practitioner appointed to coordinate preventive efforts	1	1	1	0	0	3(60)
Active Occupational Health and safety committee or IPC committee functional in the facility	1	1	0	0	0	2(40)
HBV vaccination and HBIG offered for Free	1	0	0	0	0	1(20)
Total score	**10**	**6**	**4**	**3**	**2**	
% score and level of performance	**90.9%**	**54.5%**	**36.4**	**27.2%**	**18.2%%**	**45.44%**
Overall (HBV preventive environment(Health Facility Factor)	**54.53%**					
HBV preventive environment(Health Facility Factor)	**Good***			**Poor***		**Poor***

- Score categorization approach by Fageeh (2014)

CHAPTER FIVE

DISCUSSION

5.1 Adherence to hepatitis B virus vaccination and associated factors

This aspect discusses findings under HBV vaccination uptake and adherence to the three indicators for HBV vaccination as well as overall adherence to HBV vaccination protocol.

5.1.1 Hepatitis B vaccine uptake

This present study used self-reports and vaccination records on previous vaccination against Hepatitis B Virus (HBV) to estimate HBV vaccination coverage among Health Care Workers (HCWs) recruited from five facilities within the Greater Accra Region. The study found HBV vaccination uptake to be 60.9% implying that 60.9 % of the HCW population surveyed had received at least one dose of HBV vaccine. This coverage indicates an intermediate level of HBV vaccine uptake. The WHO, CDC, GHS as well as other health organizations have all recognized HBV vaccination to be the hallmark of occupational HBV prevention (CDC,1997; GHS, 2010;WHO, 2016). However, poor compliance have been reported among HCWs particularly in developing countries (Ziglam, El-Hattab, Shingheer, Zorgani, & Elahmer, 2013) despite the availability of safe and effective HBV vaccine since 1982. Considering the widespread availability of HBV vaccine and given the strong recommendation by the CDC and WHO that HBV vaccination should be made available to all HCWs at the employer's expense (CDC,1997;WHO, 2016), the 60.9 % coverage is lower than expected. The findings of this present study however, is far lower than the vaccination uptake or coverage of 90% reported from the United Kingdom by Smith, Tilzey and Banatvala (1996). The result of the present study however is comparable to 56.9% that was reported by Aaron et al. (2017) in Tanzania. The variations in HBV vaccination uptake between the HCWs in the United Kingdom and those surveyed in this study could probably

be due to disparities between developed and developing countries as far as disease prevention is concerned. This is because HCW protection is still very inadequate in most developing and transitional countries (Prüss-Üstün et al., 2005; Sagoe, Pearson, & Perry, 2001). For example, Ziglam et al. (2013) reported that compliance to HBV vaccination is particularly high in well developed countries than their under-developed counterparts. The disparity could also probably be attributable to the unaffordability of the vaccines to many HCWs working in the developing countries as suggested by Franco et al. (2012). This is because HBV vaccination coverage has been reported to be considerably higher in settings where policies exist and free vaccination is also available for HCWs such that failure of HCWs to vaccinate is largely due to the employers' failing to ensure that policies regarding HCW safety are implemented (Dannetun, Tegnell, Torner & Giesecke, 2006).

This finding has serious implications for HCW safety since failure to vaccinate is associated with increased risk of occupational HBV acquisition.

5.1.2 Adherence to three-dose vaccination recommendation

For health care workers vaccinating as adults, three doses HBV vaccination has been recommended for adequate protection (Junewicz et al., 2014). This study found 46.8% of the total population taking three or more doses of HBV vaccine. This proportion indicates a poor level of adherence. Other researchers also found that not all HCWs adhere to the 3-dose vaccination regimen. For instance, a recent systematic review and meta-analysis of studies in 15 African countries (Ghana not included) estimated overall adherence to three dose regimen to be 24.7% with 62.1% for North African countries and 13.4% for Central Africa (Auta et al., 2018). Specifically, reports from Ethiopia, Nigeria and India all indicated poor adherence of 25.6%, 48.9 %, and 40% respectively among HCWs (Akibu et al., 2018; Omotowo et al., 2018; Pathak, 2013).

Failure to comply with the three-dose regimen has serious implications for HCW safety since attainment of seroconversion and for that matter seroprotection after HBV vaccination has been linked with compliance with the three dose-schedule especially for individuals with delayed seroconversion (CDC, 2005). For example, a randomised control trial reported that only 59.5% of the participants developed anti-HBs to the required obligatory levels after receiving two doses. However, seroconversion and subsequent development of anti-HBs levels to obligatory levels rose to 99.2% after receipt of the third dose suggesting that three dose of hepatitis B vaccine is necessary to increase the seropositive rate of anti-HBs in adults (Baghianimoghadam, Shadkam, & Hadinedoushan, 2011). Even though other researchers found comparable efficacy of two HBV vaccine doses (Cassidy et al., 2001; Van-Damme et al., 2010), this may not hold true for other populations since the basis of such arguments was the outcome of studies done among children and adolescents. Many others support highly the three-dose regimen because it is considered the best for individuals vaccinating as adults especially HCWs who are at high risk of HBV infection (Junewicz et al., 2014).

The implications of this findings are that HCWs receiving less than the recommended three doses may not be protected (especially those with delayed seroconversion) and for that matter remain susceptible to the infection. HCWs having this understanding and their employers making facility-sponsored arrangement for their employees to receive the three doses required would greatly reduce their susceptibility to HBV infection.

This study found high risk perception for HBV to be significantly associated with the receipt of three doses of HBV vaccine. High risk perception in this context refers to feeling of susceptibility or vulnerability to HBV infection. Vaccination against vaccine preventable infections (diseases) has been considered as a positive health behaviour which is influenced by the level of perceived vulnerability or susceptibility to the health threat

(Morowatishaifabad et al., 2015a). Taddei et al. (2014) in their multi-centre study which assessed the effect of risk perception on vaccination also found a strong association between high risk perception and the willingness of HCWs to vaccinate.

Receipt of in-service training in prevention of blood-borne infections was also significantly associated with the receipt of three doses of HBV vaccine. This finding is very similar to what Akibu et al. (2018) found suggesting that attendance of training in prevention of blood-borne infections increased the odds of completely vaccinating against HBV. An in-service program is a professional training or staff development effort, where professionals are trained. This form of training is a key component of continuing medical education for HCWs and therefore are meant to improve knowledge, practice and performance of HCWs regarding patient care and their own safety and protection (Bailey et al., 2018; El-leithy, 2013). Hence, it is not surprising that receipt of such trainings increased the odds of adherence to the 3-dose HBV vaccination regimen.

In this present study, attendance of training in infection prevention was widespread and it is unclear why not all the HCWs who received such trainings vaccinated against HBV and for that matter complied with the three dose regimen given the fact that receipt of in-service training improves adherence to receipt of 3-doses of HBV vaccine. Apart from receiving training in blood-borne infection prevention, other structural barriers within the HCW environment could be contributing to failure to adhere to the 3-dose regimen. This finding emphasises the need to improve on the quality and quantity of in-service training programs in addition to removing structural and institutional barriers affecting adherence to HBV vaccination protocol.

5.1.3 Adherence to 0, 1, 6 HBV vaccination schedule.

This study found that 62.3 % of vaccinated HCWs adhered to the 0, 1, 6 schedule of HBV vaccination indicating an intermediate level of adherence. This observation agrees with a similar study conducted among populations other than HCWs that found adult participants receiving HBV vaccine outside the vaccination schedule recommended (Trantham, Kurosky, Zhang, & Johnson, 2017). Another related study in the United Kingdom found only 22% of the study population completing their third HBV vaccination dose in six months (Johnson et al., 2019). The sub optimal adherence to 0,1,6 schedule observation has implications on HCW safety and protection from HBV given that timely administration of each vaccine dose in a HBV multi-dose vaccination schedule optimizes the overall vaccine effectiveness (Trantham et al., 2017). This finding strongly suggests that there may be significant barriers associated with adherence to the correct vaccination schedule and these barriers need to be addressed to optimize completion of HBV multi-dose vaccine among HCWs who are at increasing risk of HBV infection.

Immunogenic studies mainly among children and adolescents support the view that response to hepatitis B vaccine is not highly dependent on the timing of vaccine doses and that, modest alterations in the timing of doses would not affect the response to HBV vaccine hence a proposal of other vaccination schedules other than 0,1,6 months (Hadler, de Monzon, Lugo, & Perez, 1989). However, recommendations from WHO, CDC and GHS regarding the ideal schedule for HBV vaccination have not changed despite these controversies.

5.1.4 Adherence to post vaccination serological testing

Post vaccination serological testing was very poor among the population with only 21.3% of vaccinated HCWs adhering to this recommendation. The poor adherence to post

vaccination serological testing identified in this present study is not new. Murphy (2000) almost two decades ago suggested that, uptake of vaccination among 'at risk' groups may be high but assessment of serological status is often poor in the presence of increasing risk of HBV acquisition. Similarly, among Tanzanian and Nigerian HCWs, Aaron et al. (2017) and Abiola et al. (2016) found 29% and 33.6 % of vaccinated HCWs undertaking post vaccination serological testing respectively. Contrary to what this study is reporting, two studies done among Brazilians and Pakistanis reported high post vaccination serological testing of 78.8 and 96.5% among HCWs respectively (Hussain et al., 2005; Rossato & Ferreira, 2012). These two studies were interventional studies that sought to understand immune response to HBV vaccine among a particular sub-populations. Participants in these Brazilian and Pakistani studies were offered HBV vaccine free of charge and strategies were implemented to ensure high follow-ups to allow for post vaccination testing. The high follow-up that was targeted and achieved could probably be the reason for the high testing rate observed in the two studies.

Post vaccination serological testing is important. Knowledge and documentation of immune status in the population of HCWs are important since they may affect subsequent post exposure management in cases of accidental exposures (Junewicz et al., 2014). When the response to the vaccine is unknown, the management of the HCW who is exposed to HBV is more complex, and in this context the anti-HBs testing should be performed immediately. However, in most settings in developing and poor countries, testing services and for that matter the anti-HBs results may not be readily available to inform timely decision to use Post Exposure Prophylaxis (PEP). Implying that PEP use in such individuals may be delayed or completely compromised. On the other hand, HBIG is not readily available and its cost is considered to be high in resource poor settings (Sheth et al., 2016). Therefore, people who are exposed yet are seroprotected may end up receiving Hepatitis B

immunoglobulin (HBIG) unnecessarily due to unknown Anti-HBs status. This may bring economic liability to the HCW or the facility depending on who is bearing the cost of the HBIG (Sheth et al., 2016).

Surprisingly, this study found that working in a regional hospital was associated with lower odds of post vaccination serological testing contrary to reports from Poland that identified rather higher odds of post vaccination serological testing among Polish HCWs working at a higher level facility (Ganczak, 2012). Given that the HCWs from the higher level facility in this present study have good environmental conditions, systems, structures and programs in place to promote adherence to HBV vaccination protocol, it is surprising that adherence would be much less likely among HCWs working in a regional hospital. The plausible reason perhaps for this observation could be lack of awareness regarding the importance of post vaccination serological testing among the respondents. Post vaccination serological testing is equally an important indicator. This is because a HCW who failed to undertake this test may be one of the 5-10% immunocompetent individuals (vaccinees) who may have failed to respond to the vaccine and therefore remain unprotected and susceptible to HBV without even knowing.

5.1.5 Overall adherence to HBV vaccination protocol

Health care worker vaccination against HBV early in his or her career, following the recommended 3 doses regimen and vaccination interval in addition to post vaccination serological testing for immunity have been described as elements for ideal HBV vaccination. This study on the other hand, observed an overall intermediate level of adherence to HBV vaccination adherence among the HCWs with only 6.2% of the entire study population (3.8% of vaccinated HCW population) of the HCWs complying completely with all the recommendations regarding HBV vaccination. Even though overall

vaccine uptake was 60.9% in the study population, not all the HCWs (1) followed the recommended schedule, (2) took the compulsory three doses and also (3) undertook post vaccination serological testing to confirm immunity against HBV.

Previous studies done in the Africa and elsewhere have equally reported poor adherence to HBV vaccination recommendations among HCWs. However, none of these studies used three indicators for the basis of measuring adherence. For instance, Auta et al., 2018; Byrd, Lu, & Murphy, 2013 ;Yuan et al., 2019) all relied on only one indicator (three doses) whilst Abiola et al. (2016) and Aaron et al. (2017) used two indicators (3 doses and post vaccination serological testing) to measure vaccination adherence.

The overall adherence result obtained (by combining the three indicators) in this study is perhaps new, and depicts considerably far lower level of adherence compared to what the other studies using either one or two indicators found. It is obvious that the measurement scale applied in this present study in measuring overall adherence was much more rigid and this could possibly have accounted for the very low level of adherence when all the three indicators were pooled together. This study has established the fact that when combining all the three vaccination indicators to measure adherence, very low level of adherence would be observed among HCWs.

5.2 Adherence to Post Exposure Prophylaxis (PEP) for HBV among HCWs

5.2.1 Knowledge of HCWs on PEP for HBV

Health care workers having good knowledge and positive attitudes towards PEP in the presence of policies, reporting structures and availability of testing supplies and logistics have been mentioned as the core elements of PEP management (Courtenay-Quirk et al., 2016). Poor knowledge and negative attitudes towards utilization of PEP for HBV can therefore, negatively impact on the utilization of PEP in situations of exposure. This present

study found knowledge on PEP for HBV to be generally low among the study participants with significant variations in scores obtained by the various categories of HCWs. The knowledge gap was evident by lack of awareness about the correct constituents of PEP (HBIG and Hepatitis B vaccine) and even referred to the use of antiretroviral drugs as an important modality for PEP management for HBV exposure.

Unlike reports from Nigeria which found no association between professional category and PEP knowledge (Owolabi et al., 2012), this present study found a significant association between good PEP knowledge and professional category such that nurses and midwives demonstrated lower odds of having good knowledge of PEP for HBV compared to other categories. This finding is consistent with what was reported among HCWs from Nigeria where great variations in PEP knowledge was reported among the different HCW categories (Adebimpe, 2018).

The overall poor knowledge observed in this study agrees with other studies done in Asia, Europe and Africa and under different settings which all found and reported inadequate or undesirable knowledge of PEP for HBV (Koehler et al., 2014; Konlan et al., 2016; Rafieian, Radi, Hamian, Torkaman, & Davoodi, 2016; Shaghaghian et al., 2014). Specifically, a study by Konlan et al. (2016) among Nurses in Tamale found high risk perception for HBV and yet knowledge on PEP for HBV was poor.

The absence of PEP protocols for HBV in all the five facilities where HCWs who participated in this study (component of facility factor) appears to have accounted for the poor knowledge observed. In this population, training on blood-borne infection prevention was widespread. It may also mean that these trainings did pay little attention to PEP for HBV hence the widespread undesirable PEP knowledge observed. This analogy concurs with findings from a study by Adebimpe (2018) who reported that poor knowledge and

utilization of PEP for blood borne infections could arise from several gaps within the health sector of which the HCW has limited or no control over. Availability of PEP protocols, posters and constant reminders displayed in the immediate environment of HCWs could serve as ques to action to promote PEP utilization through increasing PEP knowledge as posited by health behavior experts (University of Twente, 2019). This is also in line with recommendations by Bintabara and Mpondo, (2018) that availability of guidelines and protocols are crucial in providing knowledge and skills needed to improve health care processes.

Poor knowledge for PEP for HBV has serious consequences on occupational health and safety of health workers especially in situations where HCWs out of fear of being stigmatized opt for self-treatment in presence of exposure to blood and body fluids (Zaidi, Griffiths, Beshyah, Myers, & Zaidi, 2012). HCWs out of lack of knowledge may resort to local, incorrect and ineffective measures that may render them liable to HBV infection (Zaidi, Griffiths, Beshyah, Myers, & Zaidi, 2012).

5.2.2 Adherence to exposure reporting among HCWs.

Surprisingly, given the overall poor knowledge on PEP for HBV demonstrated by respondents in this present study, exposure incidents were duly reported by 29 HCWs out of the total of 38 individuals who sustained exposures in the past twelve months preceding the study giving an overall exposure reporting rate of 76.3% indicating a good level of adherence. This finding is in contrast with what has been suggested by Juan et al. (2016) that exposures to blood and body fluids has been historically under reported. For example, low reporting rates of 30.8%, 37.0 and 24% have been reported in recent studies among HCWs (Engin et al., 2015; Kassa et al., 2016; Pervaiz et al., 2018).

The study also found a statistically significant difference between exposure reporting and the five facility levels with the regional hospital demonstrating the highest exposure reporting rate. In this study also, the regional hospital was assessed to have a good environmental climate that fosters HCW adherence to HBV prevention activities. It is not surprising at all that exposure reporting was universal among exposed HCWs working at the regional hospital level. This is an indication that the HBV prevention environment of the HCW has influence on his or her ability to report exposures.

This finding is similar to overall exposure incident reporting rate of 73.1% reported in a university hospital in Switzerland where facility climate conditions were assessed to be conducive in promoting exposure reporting (Voide et al., 2012). In that study, Voide and his colleagues suggested that resources and information about reporting procedures as well as continuous education were health facility factors contributing to the high reporting rate.

The implications of this finding is worth reassessing given the fact that the least reporting rate was observed among HCWs working at the CHPS and health center levels where poor facility influence in HBV prevention among HCWs was observed. Inferring from the results, HCWs working in the lower level facilities would continue to be at risk of HBV infection until structures and programs are streamlined and work environment becomes safer and much more conducive for HCWs to report their exposures and ultimately adhere to HBV prevention protocols regarding exposure management.

5.2.3 Adherence to evaluation and assessment for PEP

The study found 28 out of the 29 HCWs who reported their exposures, making themselves available to be assessed for eligibility and the need to use PEP, giving evaluation rate of 96.6%. This indicates a good level of adherence to evaluation for PEP. This is consistent with findings from a teaching hospital in Ghana where a rapid assessment system coupled

with clear facility policy was in place and evaluation of HCWs for PEP was observed to be efficient and beneficial (Tetteh et al., 2015). Even though evaluation of both exposed HCW and source patient is an important step in the PEP management pathway, initiation of PEP is not to be delayed by availability of results of both source patient and exposed HCWs (WHO, 2014). However, this step in the PEP management pathway should not be missed to ensure that exposed HCWs requiring PEP receive PEP in a timely manner, exposed HCWs do not receive PEP unnecessarily, and also the source patient has the opportunity to be offered counseling and enrolled into care appropriately if found to be infected with HBV. It is important that health facilities establish systems that are clear and efficient with the abundance of free testing and counseling services to allow for all exposed individuals to be evaluated for the need to benefit from PEP. Not all exposed HCWs are eligible to use PEP. Therefore, in resource-poor settings like Ghana where the cost of HBV vaccine and HBIG are brooked by the exposed HCW, an efficient evaluation of HCWs exposed to HBV could identify those who actually require PEP and therefore reduce the unnecessary financial cost of HBV vaccine and HBIG to HCWs who are already seroprotected.

5.2.4 Adherence to PEP use among exposed HCWs

This study also found that 70% of those who were eligible to use PEP for HBV actually used PEP indicating an intermediate or moderate level of PEP usage. Only 3(30%) of the HCWs failed to use PEP despite the need to do so. Other studies have equally reported moderate or intermediate level of PEP use among diverse populations. Specifically, for occupational exposures, Adebimpe (2018) reported similar intermediate level of PEP use among Nigerian HCWs with 65.8% of those requiring PEP actually had it. A systematic review and meta-analysis measuring adherence to PEP use for both occupational and non-occupational exposures also found 62.60% of adherence (Ford et al., 2014).

In this present study however, unavailability of the HBV vaccine and HBIG were reported as being the barriers to PEP use among the individuals who failed to use PEP. This finding confirms what was observed at the facility level where the five facilities where the HCWs were recruited from were assessed and it emerged that only the regional hospital had HBIG readily available in the facility. It implies from this study that PEP use cannot be optimum since access to HBIG and HBV vaccine is a challenge for HCWs.

In this study, about one-third of the HCW population is naïve for HBV and susceptible for HBV. Their risk level is high and therefore they may require timely initiation of HBIG and HBV vaccine as the only opportunity to be protected from HBV should there be accidental exposures. Absence of these life-saving logistics in the facility and its unaffordability means HCWs would be left to their fate to suffer the consequences of such exposures.

5.2.5 Adherence to post PEP evaluation

In this present study, all the HCWs who used PEP returned for 6 months' follow-up visits indicating a good level of adherence. This finding is consistent with reports from a large teaching hospital in Ghana where a rapid assessment system was in place and over 80% of exposed HCWs who used PEP reported for their first 6 months' follow-up visits (Tetteh et al., 2015). Behrman et al. (2001) observed that the efficacy of post exposure treatment correlates positively with the completion of follow-ups and hence the importance of such follow-up visits cannot be overemphasized. At such follow-up visits**,** HCWs are assessed for the possibility of seroconversion following exposure and subsequent PEP treatment. Both psychological and physical support are provided for affected HCW to cope with the consequences of the exposure should seroconversion to HBsAg (+) occur followed by provision of interventions where appropriate. Given the numerous benefits associated with post PEP use follow-ups and for HCWs to derive the full benefit of PEP use, systems in the

various facilities need to be strong to allow for follow-up testing and evaluations as well as policies to manage HCWs who may be seroconverted even after PEP use.

5.3 Distribution of HBV serological markers

5.3.1 Hepatitis B surface Antigen (HBsAg) (Current HBV infection)

The present study conducted among six different categories of HCWs drawn from the Greater Accra Region found Hepatitis B surface antigen (HBsAg) prevalence of 5.9%. According to WHO classification of levels of HBV infection and endemicity among populations, 5.9% is indicative of an intermediate level of infection since it falls within the range of 2%-7% (Hou et al., 2005; Te and Jensen, 2010).

A national prevalence data on HBV infection is not available for Ghana however, a recent meta-analysis of studies conducted in Ghana among specific populations other than HCWs estimated a pooled HBV infection prevalence to be 12.3% (Ofori-Asenso & Agyeman, 2016) which maintained Ghana in the high endemic region since HBsAg prevalence in that meta-analysis was > 8% (Hou et al., 2005; Te and Jensen, 2010). Even though others believe that HBV prevalence could be two to four times higher in HCWs compared to the general population (Tatsilong et al., 2016;West, 1984), this study found prevalence that is almost two times lower than what has been estimated for Ghana. This observation is not surprising because generally, there has been a decline in the global prevalence of HBV infection since the introduction of HBV vaccine in 1982. Specifically among HCWs, the emergence and use of strategies such as HCW vaccination, standard precautions and infection prevention and control strategies, which are being perused at both individual HCW and health facility levels could have, to some extent, resulted in the lower prevalence of HBV infection among the HCWs, and this could explain the difference in prevalence between the general Ghanaian population and the HCWs in this study. This is supported by findings by Mahoney, Stewart,

Hanxian, Coleman and Alter (1997) that a decline in new HBV infections have been recorded in situations where HCW vaccination against HBV is in pursuit.

However, findings from this study is very comparable to prevalence of 5.7 % reported by Shao et al. (2018) among HCWs in Northern Tanzania which is also located in the high endemic zone. Rather to the contrary, two other studies done in Libya and Egypt which are both Northern African countries reported a far lower prevalence of HBsAg among HCWs even though these two studies had similar design and involved various categories of HCWs just like this present study (Elmaghloub et al., 2017; Elzouki et al.,2014). HBV infection is said to have a great variation in geographical distribution. In Africa, according to Ott, Stevens, Groeger and Wiersma (2012), West African countries bear the greatest burden of the disease. One possible reason for the difference in prevalence obtained in this present study and that of Libya and Egypt could be due to the fact that Libya and Egypt have lower prevalence of HBsAg at the general population level. This explanation considers the observation by Ott et al. (2012) that the prevalence of HBV infection among HCWs in a particular area is dependent on the prevailing disease burden in the general population that the HCW works.

The prevalence of 5.9% even though lower than that of the general Ghanaian population, is still an issue of great concern if the 2030 target of global elimination of HBV is in pursuit. On the other hand, this intermediate level prevalence could explain the inadequacy in implementing preventive efforts among HCWs in the Greater Accra Region. It is important that a lot more is invested into protecting HCWs from occupational exposures and that preventive interventions are made to reach all susceptible HCWs as soon as practicable. This is possible because evidence from the Americas, Asia and Europe suggests that a marginal reduction in HBV prevalence is achievable when HBV vaccination is vigorously

pursued (Alter et al., 1990; Chien, Jan, Kuo, & Chen, 2006; Wasley, Kruszon- Moran, et al., 2010).

An important finding of this study is the high frequency of current HBV infection among Orderlies compared to the other HCW categories. Similar findings were reported by Elikwu et al. (2016) among sanitary workers in a Nigerian hospital. Orderlies do not directly handle patients but are rather involved in the day to day sanitation activities including cleaning of the hospital environment. Their roles and responsibilities also extend to cleaning spillages of blood and body fluids as well as discarding hospital waste which may harbor infectious pathogens including HBV (Murnaghan, 2018). It has also been reported that, this category of HCWs are the most exposed to infectious pathogens due to their lack of awareness, lack of training, low socioeconomic status and low level of education (Chaudhry & Hayat, 2004). This findings suggest that hospital sanitation, cleaning and waste handling activities may be contributing to HBV acquisition and infection among HCWs. This finding also is suggestive that HCWs belonging to the lower level category are much more vulnerable and HBV infection is much more predominant in this category than other cadre of health staff, and hence, calls for urgent support in the form of education, training and vaccination against HBV among this vulnerable population sub-group.

5.3.2 Hepatitis B Core antibody (anti-HBc) (lifetime exposure to HBV)

An important finding of this study is the overall prevalence of Anti-HBc denoting lifetime exposure to HBV being 8.2%. This proportion includes HCWs who currently are infected and those who have cleared the infection and have perhaps developed immunity to HBV and those with isolated anti-HBc. The prevalence of Anti-HBc as documented in this study was however seen to be far lower compared to 60.1% and 48.1% reported among similar population of HCWs in other African countries where higher prevalence of current HBV infection was also reported (Braka et al., 2006; Ziraba et al., 2010).

In contrast, a study conducted in Spain by Domínguez et al. (2017) obtained anti-HBc prevalence of 4.1% which is two times lower than what this study found. Spain is a developed country which lies within a lower HBV endemic zone compared to Ghana which has been placed in WHO African region with the highest HBV prevalence (Hou et al., 2005; Te and Jensen, 2010). This could explain the difference between anti- HBc prevalence in this present study and the Spanish study. This is because, anti-HBc prevalence has been observed to correlate linearly and positively with HBsAg prevalence in most populations (Zhu et al., 2018). It could be explained that the variation in the results of the two studies reflect the geographical distribution of HBV infection and its endemicity. Again, Ziglam, El-Hattab, Shingheer, Zorgani, & Elahmer (2013) suggested that such developed countries have national policies that are directed at protecting HCWs from exposures compared to developing and resource-poor nations, and this has reflected positively on the prevalence of anti-HBc. The developmental gap between the two countries may possibly have accounted for the differences in the level of lifetime exposure to HBV. This explanation is in line with the findings by Fernandes et al., (2013) which suggest that industrialized countries which are largely low HBV endemic zones rather have policies and systems that are aimed at preventing occupational transmission of HBV.

5.3.3 Hepatitis B envelope antigen (HBeAg)

This study identified HBeAg prevalence of 25% (overall prevalence of 1.5%) among HCWs who demonstrated serological evidence of current HBV infection. HBeAg was also more predominant among Orderlies. Elsewhere, Forbi, Iperepolu, Zungwe and Agwale (2012) also found HBeAg prevalence of 19.2% among HCWs which is almost comparable to what this study is reporting.

However, the 25% prevalence is much more than 13.3% reported by Rufai, Mutocheluh, Kwarteng and Dogbe (2014) among Ghanaian blood donors. It is unclear from this study

what could have contributed to the high prevalence of HBeAg among the infected HCWs. However, it is known from previous studies that the HBV genotype predominant in a particular geographical location has a role to play in determining the frequency of HBeAg, chronicity, occurrence of major complications as well as response to anti-retroviral treatment among that population (Kramvis, 2014). It is worth noting that the E HBV genotype is known to be the most predominant genotype in Ghana (Dongdem et al., 2016).

The progression of HBV to chronicity with its associated pathogenesis is directly correlated with viral replication. HBeAg is known from research evidence to be the serological marker denoting active viral proliferation in liver cells, infectivity and the possibility of transmission. This marker has also been associated with chronic liver disease, cancer and cirrhosis of the liver which are all major complications of the infection (Bonino, Piratvisuth, Brunetto, & Liaw, 2010; Hou1 et al., 2017). The implications of this finding however, are that, Orderlies who are the HCW category with the highest HBeAg frequency are those likely to sustain the chain of HBV infection and therefore are likely to transmit the virus to others within or without the health care facility environment given that, other possible means of HBV transmission exist in addition to percutaneous or permucous modes. The possibility of suffering severe complications can also not be overemphasized hence the need for these individuals to be monitored and managed using recommended antiretroviral agents to circumvent the occurrence of adverse consequences to themselves and others. Even though the OHSP guideline for the health sector provided direction on the treatment regimen for HCWs infected with HBV, a clear policy direction is needed regarding management of HBV infected HCWs and also the roles and responsibilities of health facilities or employers in protecting others (patients, other susceptible HCWs, general public) from being infected by the affected HCWs.

5.3.4 Classification of HCWs based on the presence and absence of HBV serological markers

Absence of all markers: One outstanding finding of this study is the observation that 36.1% of the study participants were naïve for HBV in that, no serological marker was detected in their sera. These individuals being naïve means they had never in their lifetime encountered HBV neither do they have any indication of artificial immunity against the virus. They are said to be susceptible to the infection in the presence of exposures to contaminated blood and body fluids. This finding agrees with prevalence of 30%-42% of no HBV marker observed amidst HCW populations in Asia, North Africa and Southern Africa (Biswas, Karim, and Bhattacharjee,2015; Djeriri et al., 2008; Mueller et al., 2015; Ziraba et al., 2010). This finding is however non-compliant with recommendations by WHO, CDC, GHS and other national and international organizations concerning HCW protection from HBV (CDC, 2015;GHS, 2010;WHO, 2016). According to these organizations, in the presence of abundant logistics to prevent contact with blood and body fluids as well as optimum practice of standard precautions, HCWs must obtain at least one serological marker in the form of anti-HBs through vaccination early in their carrier to gain protection from HBV and its associated morbidity and mortality. This finding gives credence to the fact that not all HCWs in the Greater Accra Region are adherent to the recommendation of vaccination against HBV infection. The situation is worrying given the fact that being naïve for HBV is associated with high risk of susceptibility to the infection especially among HCWs who constantly come into contact with blood and body fluids that may be contaminated with HBV.

Immune After past infection: This study found 1.8 % (6/340) of HCWs having a combination of anti-HBs and anti-HBc, denoting natural immunity following past infection. Natural immunity as a result of past exposure is a possibility among HCW populations. In a

European country, prevalence of 11.3% and 22.5% of a combination of Anti-HBs (+) and Anti-HBc (+) have been documented in two separate population sub-groups (De Paschale et al., 2012). Specifically among HCWs in Tanzania, Mueller et al. (2015) found that 36.5% of HCWs were immune as a result of past infections which is far higher than what this study is reporting. The 1.8% natural immunity in this present study is lower than what the studies from Europe and Tanzania reported and therefore suggestive that seroclearance of HBsAg among the population studied was quite low in that, only 1.8% of the HCWs in this present study were able to successfully overcome the acute form of HBV infection, and subsequently developed protective anti-HBs to the virus. This finding nevertheless, provides basis to concur with the claim that HCW protection from HBV is best achieved by vaccination even in highly endemic countries rather than relying on natural immunity that may not happen in all exposed individuals (Muljono, Wijayadi, & Sjahril, 2018).

5.3.5 Factors associated with lifetime exposure to HBV and current HBV infection

Gender differences in exposure to HBV and subsequent infection was another finding in this study. Being a female was protective for lifetime exposure to HBV such that female HCWs had 4 times less the odds of being ever exposed to HBV compared to their male colleagues. Other researchers from the Americas, Asia and West Africa have also reported lesser odds among women (Elikwue et al., 2016; Luong, Diallo, Gannon, Luta, & Maduka-ezeh, 2017; Machado et al., 2013). Studies have shown that female HCWs adhere to standard precautions and vaccinate against HBV infections more compared to their male counterparts (Akosionu et al., 2016 ;Gebresilassie, Kumei, & Yemene, 2014;Ochu & Beynon, 2017). It is worth noting that higher number of female HCWs in this study were vaccinated against HBV compared to males and this could possibly be accounting for the finding of female gender being protective for lifetime exposure to HBV.

Some other researchers suggested that the high male to female ratio of disease frequency could be due to male dominance in their sample (Çiçek-Şentürk et al., 2019).

In this study however, females were much more represented than males although sampling was done randomly, yet lifetime exposure to HBV and subsequent infection among the study population was much more skewed towards males. Therefore, gender disproportion in lifetime exposure and HBV prevalence observed in this study could not have resulted entirely from differences in the sub population sample sizes of the two sexes.

One study done in Pakistan, attributed preponderance of HBV exposure and infection to risky sexual behavior and certain cultural practices which are much more prevalent in men than women (Aziz Ali, Suhail, & Aziz Ali, 2016). It is worth noting that in this present study, no statistically significant association was observed between lifetime exposure, current HBV infection and behavioral factors. Hormonal influences rather than behavior patterns have been strongly implicated in HBV infections as females have been reported to have the ability to clear HBV infections and produce neutralizing antibodies against the virus compared to men (Wang, Chen, & Yeh, 2015). However, the impact of hormonal factor on lifetime exposure was not the focus of this study and for that matter was not assessed.

The implications of this findings are that the females have lower risk of exposure to HBV infection and therefore targeting males and female HCWs and other population groups at the same level may not yield significant results in terms of prevention of HBV. Interventions therefore, designed in controlling HBV infection among HCWs and the general population in general should consider male population to be at higher risk and for that matter target them much more frequently.

Another important finding from this study was the fact that, the type of health facility in which HCW works is significantly associated with lifetime exposure to HBV infection in that, HCWs working in lower levels of the health care system have two times higher the odds of lifetime exposure to HBV compared to those in higher level facilities (crude estimate). Tremblay et al. (2017) also observed that infection preventive and control practices against blood-borne infections vary with facility type or level. This observation also agrees with evidence from Pakistan suggesting that the health facility environmental conditions may influence the risk of health care associated infections (Khan, Baig, & Mehboob, 2017). Hensher, Price, & Adomakoh (2007) reported in their review that, higher level facilities are much more resourced in terms of budget compared to their lower level counterparts. This could mean that higher level facilities have adequate logistics in place to prevent their health force from exposure to HBV compared to lower level facilities with budgetary inadequacies. A supplementary finding generated in this present study regarding the HBV prevention environment of HCWs suggests that higher level health facilities have good environmental climate that promote the prevention of HBV among HCWs compared to lower level health facilities. The implications of this finding are that the working environment or climate may not be too conducive in protecting HCWs from occupational exposures. This calls for stakeholders and health authorities, and occupational health and safety experts, to reconsider and restructure systems and programs at lower level facilities to ensure that HCWs in these lower facilities work in climate that would not compromise their safety. Equal opportunities need to be given to both lower and higher level facilities in terms of budgetary allocations and logistics to ensure HCWs have equal playing fields regarding occupational health and safety issues.

This study also found HCWs who had not received training in blood-borne infection prevention to be almost three to four times more likely to contract HBV and suffer HBV

infection compared to their trained counterparts. A meta-analysis and systematic review of 21 studies from Africa also found the risk of occupational exposure in the last one year to be significantly higher in untrained HCWs compared to their trained counterparts (Auta et al., 2017). In-service training for HCWs in the prevention of blood-borne infection is seen as one of the most important contributions towards the maintenance of HCW competencies. Evidence from North Africa and Europe suggest that such trainings could effectively increase HCW safety through increasing knowledge and better attitudes towards blood-borne infections and their prevention (Bailey et al., 2018; El-leithy, 2013). HCWs need to understand how blood-borne infections occur, how microorganisms involved in blood-borne infections are transmitted and what role they have to play as individuals to break the chain of transmission. When knowledge or information is lacking or insufficient, HCWs are likely to adopt practices and behavior patterns that increasingly put them at risk of exposure to such infections. This could explain the difference in the odds of contracting HBV among the trained and untrained HCWs in this present study.

This finding suggest that, continuous training for HCWs can reduce their risk of exposure to blood-borne pathogens including HBV. Therefore, repeated onsite in-service trainings with continuous evaluation of the impact of such trainings is needed for all HCW populations. Such training programmes need to be designed using holistic strategies that will stimulate behavioral change and ultimately increase preventive behavior for HBV. It is also important that HCWs belonging to the lower category are not left out in such training sessions. This study found a high proportion of Orderlies being exposed and infected with HBV. If training is seen to be protective, this category needs much more attention.

5.4 Anti-HBs levels, seroprotection against HBV and associated factors

Anti-HBs is the only serological marker denoting immunity to HBV therefore its presence in global obligatory levels of >10mlU/mL is an indication of being seroprotected against

HBV (NCIRS, 2015). The overall frequency of seroprotection among the vaccinated HCWs was 91.3% regardless of the time between vaccination and data collection for this study. This level of seroprotection is comparable to what other researchers found regarding the immunogenicity of HBV vaccine that 90-95% of immunocompetent individuals would develop anti-HBs following HBV vaccination (Gara et al., 2015; NCIRS, 2015; Walayat et al., 2015).

On the contrary, some studies done in the Americas, Asia, Middle East and Europe among HCWs who were vaccinated as adults all reported seroprotection rates ranging from 79.1%-89.1% (Averhoff et al., 1998; Panhotra, Saxena, Al-Hamrani, & Al-Mulhim, 2005;Sahana, Sarala, & Prasad, 2017; Yang et al., 2016; Zeeshan et al., 2007) which is slightly lower than what this study found. In these studies, genetic factors, individual characteristics such as age, sex, BMI and others were highly implicated for being associated with the reduced seroprotection, unlike this present study that found no statistically significant association between age, sex, BMI and many others.

The high level of seroprotection reported in this current study, notwithstanding was accompanied by 8.7% (18) of vaccinated HCWs not possessing serological evidence of immunity against HBV in accordance with WHO and NCIR classification of antibody titer although there was evidence that they had received at least one dose of HBV vaccination.

Sufficient evidence is not available to declare these individuals 18(8.7%) as true non-responders to the vaccine. This is because they had not undertaken post vaccination serological evaluation to confirm immunity to HBV 1-2 months post vaccination and for that matter have no idea as to whether they seroconverted as a result of the vaccination or not. According to the CDC, (2018) and de Souza & Teixeira (2014), anti-HBs testing performed years after vaccination is not adequate for evaluating the response to the vaccine

because anti-HBs concentrations decline over time and for that matter it is impossible at this point to differentiate between those who actually responded to the vaccination series from non-responders. Therefore, the HCWs with anti- HBs below the recommended levels could probably be said to have failed to respond to the primary vaccination series or had anti-HBs levels falling below 10mlU/mL with time. This uncertainty could have been avoided if the HCWs had undergone post serological testing and they had confirmed immunity against HBV after vaccination. Based on this inference, post vaccination serological testing (early enough in one's carrier) becomes very expedient in identifying individuals who actually seroconverted and those who are non-responders to HBV vaccine and therefore post vaccination serological testing among HCWs who are highly susceptible to HBV infection cannot be overemphasized by this study.

The 8.7% of HCWs who did not have anti-HBs levels reaching obligatory levels raise concerns about their safety and protection from HBV. These individuals may not know about the absence of protection and may demonstrate a false hope of protection as they may think that vaccination equals being seroprotected against HBV. The false hope may affect their decision to report exposures, and subsequently benefit from post exposure prophylaxis leading to an increasing risk of HBV infection among these non-seroprotected HCWs.

Even though studies reported that absence of seroprotection in vaccinated individuals is associated with vaccinating at age >40 years (Yang et al., 2016), this study did not identify any association between age at vaccination and seroprotection against HBV. This is consistent with findings from a Sri Lankan study by Chathuranga, Noordeen, and Abeykoon (2013) who also found no association between age at vaccination and seroprotection. The average age of participants in this present study was 34.55 years which is below age 40 years and this may have contributed to the lack of differences by age.

It is not surprising that this present study found no statistically significant difference between HCWs who vaccinated <5years and> 5 years in terms of seroprotection against HBV. Among HCWs elsewhere, Chathuranga et al. (2013) and Zanetti et al. (2005) both reported no association between seroprotection and duration of vaccination and therefore concluded that the use of routine booster doses of HBV vaccine did not seem necessary to maintain long-term protection in immunocompetent individuals including HCWs. The basis for their argument was that they found no indication that duration of vaccination influenced maintenance of seroprotection. The observation from this present study favours the hypothesis that booster doses are not necessary in HCWs who vaccinated as adults and have seroconverted following primary HBV vaccination. It is worth noting that contrary to the findings of this study, Dassah et al. (2015) in their study involving children under five years reported that duration of vaccination could influence seroprotection against HBV, and hence recommended the use of booster doses among Ghanaian children who are 5 years and above.

However, the intermediate level of adherence to recommended HBV vaccination and irregularities observed with the timing of vaccination series and perhaps genetic factors (which were not assessed in this study) could possibly have accounted for this rather 8.7% absence of seroprotection observed among the vaccinated HCWs. This is because certain genetic and individual factors have been widely reported to have accounted for non-response or loss of seroprotection following HBV vaccination (Lu et al., 2016).

Clinical trials conducted in healthy adults suggest that seroprotection and for that matter, anti-HBs levels >10mlU/mL could be influenced by dosage and schedule of HBV vaccination (GlaxoSmithKlineBiologicals, 2013), and that, seroprotection increases progressively from 35% with first dose to 90% following the receipt of the third dose (NCIRS, 2015), hence the basis for the 0,1,6 schedule that has been widely approved. Evidence from elswhere specifically indicated the role of complete vaccination in achieving

seroprotection when it was reported that, anti-HBs levels, and for that matter, the rate of seroprotection were both significantly higher in individuals with complete vaccination schedule compared to their partially vaccinated counterparts (Schillie & Murphy, 2013;Yoshioka et al., 2017).

Other external factors including vaccine type, vaccine storage and route through which the vaccine is administered, are all factors that could have contributed to failure to respond to the vaccine and hence the absence of protection observed in this study. It is worth noting that in this study not all the five facilities had vaccines in stock and not all facilities had facility sponsored vaccination campaigns indicating the possibility of HCWs making their own arrangements to get vaccinated. Therefore the effect of quality and integrity of the vaccines as well as storage mechanisms should not be ignored when evaluating the absence of seroprotection among the vaccinated HCWs.

The finding from this present study again brings to bare the need for strict adherence to vaccination recommendations and protocols if the ultimate goal of attaining seroprotection is to be achieved. HCWs need to be informed and educated on the fact that the level of seroprotection and its sustenance depends largely on complete adherence to HBV vaccination recommendations. Health facility-led vaccination campaigns may be much more coordinated and result in an increased uptake, adherence and effectiveness of HBV vaccination in HCW protection.

5.5 Strengths of the study

This study was done among six categories of HCWs which were selected from five different levels in the health care delivery system. The study also used laboratory methods to assess protection against HBV compared to the use of self-reported vaccination claims as an

indicator for seroprotection. This study in measuring adherence to HBV vaccination, pooled 3 vaccination indicators and measured adherence comprehensively.

5.6 Limitations of the study

Not all HCWs could produce their HBV vaccination records. Hence, self-reported vaccination status was used in few cases. For such participants, HBV vaccination was undocumented or records unavailable at the time of the study. However, the WHO recognizes using documented sources of evidence, such as immunization cards or health-facility records as sources of evidence for vaccination in immunization coverage surveys. This notwithstanding, in the absence of the above, self-reports termed as 'evidence by history' may be used with the disadvantage of not being able to validate the actual time of vaccination and number of doses of the vaccine received (WHO, 2008). The study therefore recognized the use of self-reports in these cases as a limitation. However, the use of laboratory tests (serology) to assess, and for that matter confirm the presence of antibody to HBV as a result of HBV vaccination is a strength to override this limitation. In addition, HCWs who admitted having vaccinated but could not provide vaccination records and yet were non-reactive to anti-HBs, were excluded from the study at the analysis stage.

Secondly, this study was a cross-sectional study that measured the prevalence of hepatitis B virus infection at a particular point in time. The study and its design could not entirely attribute causality of HBV infection to exposures resulting from interacting with patients. Earlier studies done elsewhere had recognized the fact that the actual mode and source of transmission of HBV in individuals cannot be established unless there is evidence of transmission via a known exposure. The study recognized the inability to attribute causality as a limitation. This notwithstanding, a logistic regression model was used to adjust for most potential confounding variables that could influence the risk of HBV infection apart from

occupational exposures. Consequently, support in the form of a longitudinal research using the results of this study as a baseline data would be important in the near future, whereby a cohort of health workers could be followed for evidence and documentation on all forms of exposures including occupational and behavioral, and their role in HBV transmission and infection in a cohort of HCWs.

This study assessed the occurrence of occupational exposure and use of PEP for HBV through self-reports. It is possible that respondents reported what was socially desirable and the study duly recognised this as a limitation. However, not all the five facilities had data on exposure incidents, and using self-reports was the only available method of assessing these variables among the respondents.

5.7 Chapter summary

The sub-optimal vaccination adherence observed has implications for HCW safety and this requires facility and stakeholder-led interventions including increasing risk perception for HBV as well as the frequency of training could improve adherence and HCW safety.

Lack of PEP protocols and guidelines in the health facilities contributed to poor PEP knowledge. Poor PEP knowledge may affect the HCW's decision to use PEP and therefore interventions are required to meet the needs of all the categories of HCWs given the variability in PEP knowledge among the population.

Intermediate PEP usage resulted from absence of PEP logistics in the health facilities. Availability of logistics for PEP could promote PEP usage among HCWs.

Intermediate level of HBV infection among the population could be due to the uptake of prevention intervention programs however increasing the quality and frequency of such interventions as well as training of the health force in prevention of blood borne infections

could prevent future infections given the high vulnerability or susceptibility rate observed in the population of HCWs.

Seroprotection is not achieved by all vaccinated HCWs. Suboptimal vaccination practice and other structural determinants may be contributing to this observation. Post vaccination serological testing becomes a powerful strategy in overcoming uncertainties of non-response to HBV vaccine and waning of antibody levels with time.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The study was designed to determine the seroprevalence of Hepatitis B Virus (HBV) serological markers and level of adherence to preventive recommendations among Health Care Workers (HCWs) in the Greater Accra Region of Ghana. Adherence to preventive strategies outlined in the occupational health and safety policy for the health sector regarding HBV prevention is sub-optimal at the HCW level. HCWs remain unvaccinated or adhere partially to vaccination recommendations. Despite the overall poor Post Exposure Prophylaxis (PEP) knowledge demonstrated by the HCWs, adherence to all the components of PEP were optimal except PEP usage which was at an intermediate level of adherence. In the presence of inadequacies observed in adherence to recommendations regarding HBV infection prevention, the overall prevalence of HBV infection was intermediate according to WHO classification and is characterized with high lifetime exposure to HBV infection. The findings of this study calls for stakeholder and employer interventions to ensure that HCWs in the Greater Accra Region are supported to take up and adhere to preventive recommendations optimally to reduce their susceptibility to HBV infection. HCWs of all categories and working at all the levels of care in the health care delivery system need to be given equal opportunities and provided with work climate and conditions that promote total adherence to HBV prevention protocols.

6.2 Specific concluding statements

Adherence to the components of HBV vaccination protocol is sub-optimal across the group. Availability of vaccines and testing supplies coupled with intervention programmes to increase risk perception for HBV and also train HCWs in infection prevention can both

promote adherence to vaccination recommendations and reduce HCW vulnerability significantly.

The sub-optimal vaccination practice observed among the population could also play an additive role among many factors accounting for the absence of seroprotection observed among the population. Therefore, for HCWs to derive the full protective benefits from HBV vaccination, there is the need to practice vaccination optimally by adhering to the number of doses and the recommended schedule. In instances of exposures to blood and body fluids, vaccinated HCWs need to be re-evaluated adequately for Anti-HBs antibody levels in a complete HBV PEP context since not all vaccinated HCWs are seroprotected.

Health care workers who vaccinated as adults may not show antibody levels depicting seroprotection years after HBV vaccination, therefore, post vaccination serological testing early in one's carrier should be promoted highly since it is the only effective strategy of knowing one's status in terms of protection from HBV infection.

The poor PEP knowledge demonstrated in this study have implications on optimal PEP practice. Information and awareness on PEP for HBV is needed given that a lot more of the HCWs are still susceptible to HBV infection. Continuous dissemination of protocols and guidelines in this regard may improve knowledge. Health care workers in the Greater Accra Region adhere optimally to exposure reporting, and post PEP utilization follow-ups. Unavailability of PEP logistics impeded optimal PEP usage. Health facilities would need to have PEP management pathways streamlined with HBV vaccine and immunoglobulin to ensure that HCWs derive full benefits from PEP.

The frequency of HBV infection among the population is of an intermediate degree with orderlies being the HCW category showing greater vulnerability to the infection. The physical and psychological impact of the infection on these individuals cannot be over

emphasized. The morbidity associated with being infected with a chronic infection such as HBV is worrying. Support for these individuals would help them cope better with the condition.

Some of the infected HCWs also possess HBV marker combinations that make them possible reservoirs for sustaining HBV transmission, hence, this is an important implication for HCW to patient transmission of HBV which is a possibility within the health facility environment with huge ethical and legal consequences.

The HCWs who are naïve to HBV and therefore are susceptible to HBV infection could become infected in situations of exposure to contaminated body fluids, there is a great need to enroll these susceptible individuals in preventive programs that are tailored at ensuring adequate protection through HBV vaccination and exposure prevention. Special attention needs to be paid to HCW sub-groups with the highest HBV infection prevalence such as orderlies.

6.3 Recommendations

6.3.1 Health Care workers who are naïve and without any protection

It is important that all unvaccinated HCWs undertake three-dose regimen of Hepatitis B virus vaccination at the recommended schedule and also undertake a post vaccination serological testing to be sure they are protected from the virus.

6.3.2 Health care workers infected with HBV

Health facility management and employers need to support HBV infected HCWs to remain in care and treatment. Recommendations regarding the management of HCWs infected with HBV have to be in place and efficiently applied to ensure that they do not become reservoirs to sustain health care associated transmission of HBV.

6.3.3 Management of health care facilities

1. Arrangements should be put in place to make vaccines and immunoglobulins against HBV available in health facilities. All categories of unvaccinated HCWs especially those in the lower categories (orderlies) should be supported and encouraged to practice preventive behaviour by offering routine HBV screening, vaccination and post serological testing services free for all health workers. Training and awareness creation are urgently needed to improve on PEP for HBV knowledge among all categories of HCWs.

2. HCWs belonging to the lower cadre (orderlies) need special attention in terms of training and education in blood-borne infection prevention. Such trainings need to focus on increasing their risk perception and uptake of recommended preventive practices. The day to day activities of the orderlies need to be re-evaluated to identify sources of exposures.

3. The occupational health and safety units in all the health facilities in the Greater Accra Region need to be empowered to have clear and streamlined PEP for HBV pathways in all health facilities to facilitate timely exposure reporting and PEP use among exposed HCWs.

6.3.4 Regional, Municipal and District Health Directorates

The Regional and the Municipal Health Directorates of the Ghana Health Service within the Greater Accra Region who have oversight roles and responsibilities over the health facilities need to reconsider occupational health and safety issues, specifically protection from HBV and others. This aspect needs re-integration into routine monitoring and supervision activities of the directorates to ensure that all health facilities comply with the policy guideline, and this is translated positively to HCWs adhering optimally to vaccination and PEP recommendations.

6.3.5 Occupational and Environmental Health and safety Programme of the GHS

Protocols on Post Exposure Prophylaxis for Hepatitis B Virus are unavailable in all the five facilities. This may be the reason for the inadequate Post Exposure Prophylaxis knowledge identified by the study. Efforts are needed to improve on the availability of posters and educational materials in this regard. All categories of staff need to be trained on the protocol to enhance increased awareness and adherence.

6.3.6 Health Facilities Regulatory Authority (HEFRA)

Availability of facility level protocols for HCW vaccination against HBV, availability of vaccines and immunoglobulins as well as plans for exposure reporting could become essential requirements for issuing license and renewing the licenses of health facilities within the Greater Accra Region.

6.3.7 Viral Hepatitis Program of Ghana Health Service

Viral Hepatitis Policy for Ghana recommends free HBV vaccination for HCWs. Effective implementation of this policy could compel employers to ensure that HBV vaccination is offered free of charge to all HCWs, and this would largely reduce their risk of HBV infection.

6.4 Recommendations for future research

1. A longitudinal cohort study is needed to follow a group of HCWs (vaccinated and unvaccinated) throughout their professional career to ascertain the variations in their HBV serology over time.

2. Qualitative research approach is needed to explore the experiences of HCWs who are infected with HBV in terms of their role as HCWs.

3. This study did not assess the barriers of adherence to HBV vaccination recommendations. Another study that sets out on such a research enterprise could identify individual and structural barriers regarding adherence to prevention recommendations.

6.5 Contributions of this study

6.5.1 Contributions to knowledge

The study has made few contributions to the body of knowledge and this are as follows:

1. Using combination of three indicators (3 doses, 0, 1, 6 schedule and post vaccination serological testing) in measuring adherence to HBV vaccination recommendations, provide a more concrete measure of adherence to HBV vaccination recommendations.

6.5.2 Methodological contribution

The use of three indicators (3 doses, 0,1,6 schedule & post vaccination serological testing) instead of one or two in measuring adherence to HBV vaccination has established a more rigorous method of measuring adherence to HBV vaccination.

6.5.3 Contextual contributions

This study perhaps is the first to document seroprotection rates among Ghanaians who were vaccinated as adults. The study also documented the prevalence of HBV infection among Ghanaian HCWs which was originally not known.

6.5.4 Contributions to policy

The study, based on its findings, is proposing that the following issues be assessed and considered in the subsequent review of the occupational health and safety policy guideline for the health sector.

1. This study is a wake-up call for policy makers concerning the possibility of HCW to patient transmission of HBV, and calls for a clear policy direction on the types of exposure prone procedures that HBV infected HCWs can perform, and what viral load limits or threshold is allowable to be able to perform patient care activities.

2. The study saw a high frequency of lifetime exposure and current HBV infection among orderlies who belong to the lower cadre category. These workers do not directly provide care to patients but are largely involved in cleaning and hospital waste management. This finding is a wake-up call to re-evaluate the occupational health and safety climate of hospital orderlies within the health facility. A clear policy direction is needed on hospital waste handling and associated safety issues especially among lower level cadre of staff.

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APPENDICES

Appendix One (A)

Health care worker consent to participate in a research project

Adherence to Hepatitis B infection prevention protocol among Health Care Workers in selected public facilities in the Greater Accra Region'

Introduction: My name is Vivian Efua Senoo. I am a student of the University of Ghana, School of Public Health. This research work is a requirement for an award of a PhD Degree. I am the principal investigator for this research exercise. I can be contacted on the following details: Telephone, 0244772402 and Email: efuvivi@yahoo.co.uk.

Nature and Reason for the research*:* This research project is an academic exercise that seeks to assess the level of adherence to strategies outlined to prevent occupational transmission of Hepatitis B virus infection among Health care workers in the Greater Accra region. The research at the long run will establish to what extent health workers in the Greater Accra Region are protected from Hepatitis B virus infection.

Your role as a participant*:*

1. **Participation in this research requires that you answer a set of questions in the questionnaire provided.**

2. In addition to answering questions in the questionnaire, you will be asked to undertake a routine single blood draw procedure where 5mls of your blood will be taken with a sterile needle. The procedure for the blood draw will follow the usual or routine sample or blood collection procedure. The blood will be tested for your infection status as well as level of protection (immunity) to hepatitis B virus and the results will be available to you in a few minutes time if you are interested in knowing. **The whole procedure (both questionnaire and blood draw) will last for about an hour.**

3. You will not pay any fees for the laboratory tests that will be done. You will also not be paid for participating in the research.

Potential Risk and Discomfort

A blood draw will be undertaken to obtain 5mls of blood from preferably in between your hind and fore arms. You will feel a slight pain when the blood is being taken. However, the use of a sharp sterile needle, (needle that has never been opened and even used before) for the process will prevent any form of contamination and also will minimize, pain and discomfort that will be associated with the procedure. In addition, bleeding (any form of blood loss) from the puncture site will be prevented by gently applying pressure and by the application of an adhesive tape (plaster). If you test positive to the test, you may become worried or emotionally disturbed however you will be referred by the principal investigator to see a specialist who will manage your condition if you so desire.

Benefits: - The study will help you to know if you have acquired Hepatitis B infection (your hepatitis B infection status). It will also help you to know if you have ever encountered the organism that causes Hepatitis B infection and lastly the research will help you to know if you are adequately protected to fight against the infection if you become exposed. This is essential for you to reconsider vaccination for adequate protection. To a larger extent, the findings from this research will help in making recommendations that will prevent Hepatitis B Virus transmission in the Health care settings.

***Confidentiality*: -** A very high level of confidentiality will be assured during the research period and beyond. We will do everything within our power to ensure your identity and personal information is very well protected. The questionnaire and laboratory results will strictly bear numbers or codes only. No names will be written on the questionnaires and laboratory forms. Your laboratory test results will be disclosed or given to you directly only by the Principal investigator in an environment where no one else is present to see or even

listen to the communication between you and the principal investigator. The blood sample will only be kept safe in a refrigerator in the laboratory awaiting analysis

The blood specimens following laboratory analysis and interpretation of results will be discarded within six months according to guidelines for disposal of hospital waste. The blood samples will not be subjected to any other analysis other than specified in the protocol.

Privacy: The interview will be conducted in a quiet room where only you and the Principal investigator will be present with care taken that no one else sees or listens to the interaction between you and the interviewer. Disclosure of the laboratory results will be done by the principal investigator and it will be strictly a private and confidential procedure.

Alternatives to participation: Your participation in this study is purely voluntary**.** Refusal to participate in this research project will not attract any penalties. You have the alternative of checking your Hepatitis B infection Status and protection against the virus by walking into any accredited laboratory and demanding these tests to be for you at any time you so desire.

Cost for Participation in the Research: You will not be charged any fees for participating in this research.

Compensation or payment for participation**:** Everything will be done to ensure your safety when you decide to participate in this research. However no compensations will be given to you for participating in the research.

Voluntary Participation and Withdrawal: You have the right to decline to participate in this research or change your mind about your decision to participate at any stage of the process.

Funding for the Research: This research has not seen any financial support from any organization. The entire project is being financed by the Principal Investigator.

Whom to Contact for clarification: In case you need more clarification or wish to make enquiries to inform your decision to or not to participate in this research, you may kindly contact the following:

Ms. Vivian E. Senoo: Investigator- Student SPH-Legon, efuvivi@yahoo.co.uk (0244772402)

Professor. Francis Anto: Co Investigator -Snr Lecturer SPH-Legon, fanto@ug.edu.gh 024457706)

Hannah Frempong: Administrator ERC-GHS:Hannah. Frimpong@ghsmail.org:0507041223

Appendix One (B)
Adherence to Hepatitis B infection prevention protocol among Health Care Workers in selected public facilities in the Greater Accra Region'

Facility representative's consent to participate in the research project

Introduction: My name is Vivian Efua Senoo. I am a student of the University of Ghana, School of Public Health. This research work is a requirement for an award of a PhD Degree. I am the principal investigator for this research exercise. I can be contacted on the following details: Telephone, 0244772402 and Email: efuvivi@yahoo.co.uk.

Nature and Reason for the research*:* This research project is an academic exercise that seeks to assess the level of adherence to strategies outlined to prevent occupational transmission of Hepatitis B virus infection among Health care workers in the Greater Accra region. The research at the long run will establish to what extent health workers adhere to preventive practices and how well the HCWs in the Greater Accra Region are protected from Hepatitis B virus infection.

Your role as a participant*:*

1. Participation in this research requires that you answer a set of questions on your facility on availability of logistics and policies that influence the practice of preventive measures against Hepatitis B infection among the health care workers within your facility.

2. In addition to answering questions in the questionnaire, you will be asked to allow the research staff to visit one patient care area in the facility and observe the environment in which they (HCWs) render care to patients and how well the environmental arrangements of the patient care area promotes the practice of standard precautions. The whole procedure (both questionnaire and observation procedure) will last for about 30 minutes.

Potential Risk and Discomfort

The research does not anticipate any risk with your participation in the interview.

Benefits: - The study will enlighten you on the ideal or standard recommended practices that a health facility needs to put in place to be able to protect HCWs effectively from Hepatitis B and other blood borne infections. To a larger extent, the findings from this research will help in making recommendations that will prevent Hepatitis B Virus transmission in the Health care settings.

***Confidentiality*:** - A very high level of confidentiality will be assured during the research period and beyond. Your personal information and identity as well as that of your facility will be protected. The questionnaire will not bear your name as a facility head neither the name of the facility or hospital. The outcome or findings of the interview and the observation procedures will be kept confidential and would be used only for the purpose of the research. We will put in all efforts within our power to ensure that we protect the information about this facility.

Privacy: The interview will be conducted in a quiet room preferably in your office where we will humbly request that both auditory and visual privacy is ensured during the process.

Alternatives to participation: Your participation in this study is purely voluntary**.** Refusal to participate in this research project will not attract any penalties. You have the option of getting all policies and documents that address health worker safety issues to guide your facility in ensuring that all HCWs are protected from HBV infection.

Cost for Participation in the Research: You will not be charged any fees for participating in this research.

***Compensation or payment for participation*:** No compensations will be given to you for participating in the research.

Voluntary Participation and Withdrawal: You have the right to decline to participate in this research or change your mind about your decision to participate at any stage of the process.

Funding for the Research: This research has not seen any financial support from any organization. The entire project is being financed by the Principal Investigator.

Whom to Contact for clarification: In case you need more clarification or wish to make enquiries to inform your decision to or not to participate in this research, you may kindly contact the following:

Ms. Vivian E. Senoo: Investigator- Student SPH-Legon, efuvivi@yahoo.co.uk (0244772402)

Professorr Francis Anto: Co Investigator –Snr. Lecturer SPH-Legon, fanto@ug.edu.gh 024457706)

Hannah Frempong: Administrator ERC-GHS:Hannah. Frimpong@ghsmail.org:0507041223

Appendix Two (A)

Health Care Workers Volunteer Agreement

The nature and purpose as well as the potential risks and benefits of the research titled "**Adherence to Hepatitis B infection prevention protocol among Health Care Workers in selected public facilities in the Greater Accra Region**' have been read out and carefully explained to me. I have been given an opportunity to obtain clarifications about the research to my satisfaction. I understand the risks and the benefits associated with participating in this Research. I know that I have the right to withdraw from the research at any time that I so desire. I consent voluntarily or agree without any persuasion to participate as a volunteer.

_____ _____

Date Signature or mark of volunteer

For participants who cannot read and write, a witness or legal guardian serves as a witness.

I was present while the nature, purpose, potential risks and benefits as well as procedures of the research were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

_____ _____

Date Signature of Witness

I certify that the nature and purpose, the potential benefits, possible risks associated with participating in this research have been explained to the above individual.

_____ _____

Date Signature of Person Who Obtained Consent

IN CASE OF FURTHER INFORMATION OR ENQUIRY ABOUT THE RESEARCH, THE PRINCIPAL AND CO-RESEARCHERS AS WELL AS ADMINISTRATOR OF ETHICS COMMITTEE OF THE NMIMR CAN BE CONTACTED ON THE FOLLOWING NUMBERS RESPECTIVELY: VIVIAN E. SENOO: 0244772402, DR. FRANCIS ANTO: 024457706, HANNAH FREMPONG: ADMINISTRATOR ERC-GHS: 0507041223

Appendix Two (B)

Health Facility Heads' Volunteer Agreement Form

The nature and purpose as well as the potential risks and benefits of the research titled **Adherence to Hepatitis B infection prevention protocol among Health Care Workers in selected public facilities in the Greater Accra Region**'has been read out and carefully explained to me. I have been given an opportunity to obtain clarifications about the research to my satisfaction. I understand the risks and the benefits associated with participating in this Research. I know that I have the right to withdraw from the research at any time that I so desire. I consent voluntarily or agree without any persuasion to participate in the research.

_____ _____

Date Signature or mark of volunteer

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____ _____

Date Signature of Person Who Obtained Consent

IN CASE OF FURTHER INFORMATION OR ENQUIRY ABOUT THE RESEARCH, THE PRINCIPAL AND CO-RESEARCHERS AS WELL AS ADMINISTRATOR OF ETHICS COMMITTEE OF THE GHANA HEALTH SERVICE CAN BE CONTACTED ON THE FOLLOWING NUMBERS RESPECTIVELY: VIVIAN E. SENOO: 0244772402, DR. FRANCIS ANTO: 024457706 AND HANNAH FREMPONG: ADMINISTRATOR ERC-GHS: 0507041223

Appendix Three

Adherence to Hepatitis B infection prevention protocol among Health Care Workers in selected public facilities in the Greater Accra Region'

Health Care Worker Questionnaire

Instruction: Do not write your name, Kindly tick one response on each question and where applicable, choose multiple response. Only HCWs who have been sampled are eligible to answer these questions.

Date of interview……..Study Site……Questionnaire code……..

Section One

Socio Demographic Characteristics

No	Question	Responds	Skips	Code	Entry Code
1	Participant ID/serial number				Patid
2	Type of health facility	( ) Regional Hospital ( ) District Hospital ( ) Polyclinic ( ) Health Centers ( ) CHPs Zone		4 3 2 1 0	facitype
3	Designation (category of staff)	( ) Doctor ( ) Nurse/Midwife ( ) Anesthetist ( ) Laboratory Staff ( ) Orderlies ( ) Physician Assistants		5 4 3 2 1 0	cadre
4	Gender	( ) Male ( ) Female		1 0	
5	Age in years	…….		-	age
6	What is your Religious Affiliation	( ) Christian ( ) Muslin ( ) Traditional ( ) Other, Specify……..		0 1 2 3	religion
7	Do you smoke	( ) Yes ( ) No		1 0	smoke
8	Do you have any chronic conditions/ disease	( ) Yes ( ) No If yes Specify……		1 0	conditio ns
9	What is your marital Status	( ) Single ( ) Married ( ) Divorced/ Separated ( ) Widowed		0 1 2 3	marriage
10	What is the highest educational level attained	……		-	Edulevel
11					
12	Which unit are you currently working	……		0 1	work unit

13	How long have you worked in your profession (Duration of service)	…….			duration
14	Weight(kg)	……		-	weight
15	Height(m)	……		-	height

Section Two

Risk Factors for HBsAg and HBcAb Infection

No	Question	Response	Skips	Codes	Entry Code
16	Have you ever had a blood transfusion in your lifetime?	( ) Yes ( ) No		1 0	transfussion
17	Have you ever undergone any type of surgery?	( ) Yes ( ) No		1 0	surgery
18	Do you have a body scarification, tribal mark or tattoo on your body?	( ) Yes ( ) No		1 0	tatoo
19	Do you have a family member with Hepatitis B infection?	( ) Yes ( ) No		1 0	familymember
20	Have you ever visited the dentist for any dental procedure?	( ) Yes ( ) No		1 0	dentistvisit
21	Have you ever suffered per mucous exposure or a needle stick or sharps injury since you started working as a health worker?	( ) Yes ( ) No		1 0	lifetimeoccuinjury
22	Have you taken care of a patient with jaundice since you started working as a health worker?	( ) Yes ( ) No		1 0	takencare
23	Have you had the symptom of jaundice since you started working as a health worker?	( ) Yes ( ) No		1 0	signofjaundice
24	If you should test positive to HBV infection today, what would you sincerely attribute it to?	( ) Occupation ( ) Lifestyle		1 0	Sourceinfection

Section Three

Risk Perception for Hepatitis B Infection

No	Questions	Response	Skips	Codes	Entry Code
25	Do you know about Hepatitis B virus Infection	( ) Yes ( ) No	If no Skip to 32		
26	You are vulnerable to HBV infection due to the fact that your profession exposes you to the virus?	( ) Strongly Agree ( ) Agree ( ) Neutral ( ) Disagree ( ) Strongly disagree		5 4 3 2 1	percievedsusceptibility
27	Cross infection can occur between patients and Health Care Workers in the hospital environment	( ) Strongly agree ( ) Agree ( ) Neutral ( ) Disagree ( ) Strongly Disagree		5 4 3 2 1	crossinfection
28	What is your level of risk given that frequent contacts with blood and body fluids puts you at greater risk of HBV infection	( ) High risk ( ) Somewhat risk ( ) Minimum risk ( ) No risk ( ) Not sure		5 4 3 2 1	assessexposure
29	You having HBV infection is a serious issue due to the dare and serious consequences associated with the infection	( ) Strongly Agree ( ) Agree ( ) Neutral ( ) Disagree ( ) Strongly disagree		5 4 3 2 1	perceivedseriousness
30	HBV infection is preventable. The preventive actions if applied correctly can reduce your risk of occupational exposure and infection	( ) Strongly Agree ( ) Agree ( ) Neutral ( ) Disagree ( ) Strongly disagree		5 4 3 2 1	perceivedbenefits
31	You can get Hepatitis B Virus infection through splashes on mucus membrane and needle stick injuries	( ) Strongly agree ( ) Agree ( ) Neutral ( ) Disagree ( ) Strongly Disagree		5 4 3 2 1	trans mucous

Section Four

Hepatitis B Vaccination Practice

No	Question	Response	Skips	Code	Entry Code
32	Have you vaccinated against Hepatitis B Virus?	( ) Yes ( ) No	If no Skip to 45	1 0	vaccinate
33	At what point in time in your carrier did you vaccinate against Hepatitis B Virus?	( ) In training/ school ( )Pre employment ( ) During employment ( ) Prior to marriage ( ) Prior to traveling ( ) other specify ……		0 1 2 3 4 5	whenvaccinate
34	Did you screen for Hepatitis infection before vaccination?	( ) Yes ( ) No ( ) Not sure		1 0	screenpriorvaccinate
35	How many doses of the Hepatitis B vaccines did you receive?	( ) 1 dose ( ) 2 doses ( ) 3 doses ( ) > 3 doses		1 2 3 4	vaccinatedoses
36	Which vaccination schedule did you follow	( ) 0 , 1,6 ( ) 0, 2, 6 ( ) 0, 6, 10 ( ) 0, 6, 12 ( ) 0,1,2 Other……..		1 2 3 4 5 6	vaccinateschedule
37	Have you done a test to know your response to the vaccine after the completion of vaccination series?	( ) Yes ( ) No		1 0	postvaccinatetest
38	Do you know if you have developed immunity against Hepatitis B virus?	( ) Yes ( ) No		1 2 3	knowimmunity

39	Who arranged for you to get vaccinated?	( ) Yourself ( ) Employer ( ) Training institution ( ) Spouse ( ) Others Specify ……		1 2 3 4 5 6 7	arrangedvaccination
40	Who paid for your vaccination?	( ) Self ( ) Employer ( ) Training school ( ) Spouse ( ) Other specify ……		1 2 3 4 5 6 7	paidvaccination
41	For how long have you been vaccinated?	…….			howlongvaccinate
42	Have you ever taken a booster dose of Hepatitis B vaccine?	( ) Yes ( ) No		1 2	takenbooster
43	What motivated you to vaccinate against Hepatitis B Virus? (Multiple answers allowed)	( ) To get Protection ( ) Vaccine is efficient ( ) See yourself at risk ( ) Vaccine is available and cheap ( ) Role models and friends encouraged you ( ) No special Reason ( ) Don't know		1 2 3 4 5 6 7	motivetovaccinate
44	Does your facility currently have HBV vaccine?	( ) Yes ( ) No ( ) Don't know		1 2 3	
45	Does your facility offer HBV vaccine free of charge to staff?	( ) Yes ( ) No ( ) Don't know		1 2 3	

Section Five

Post Exposure Prophylaxis Knowledge and Adherence to protocol

NO	QUESTION	RESPONSE	SKIPS	CODE	ENTRY CODE
46	Do you know about Post exposure prophylaxis for Hepatitis B infection?	( ) Yes ( ) No	If no skip to 50	1 0	knowpep
47	Post Exposure prophylaxis for Hepatitis B Infection is by use of Vaccination only	( ) True ( ) False		0 1	vaccineonly
48	Post Exposure prophylaxis involves use of an Immunoglobulin against Hepatitis B virus	( ) True ( ) False		1 0	useimmunoglobulin
49	Post Exposure prophylaxis against Hepatitis B is by use of anti-viral drugs	( ) True ( ) False		0 1	antiviralpep
50	Post Exposure prophylaxis against Hepatitis B may involve the use of immunoglobulin and hepatitis B vaccine	( ) True ( ) False		1 0	bothforpep
51	Have you ever suffered percutaneous or needle stick injury or any form of sharp Injury in the workplace in the last 12 months?	( ) Yes ( ) No	If no end interview	1 2	12monthsexp
52	What form of exposure was it? Slashes, cuts, puncture etc	……			Injurytype
53	Did you report the most resent injury or Exposure to your superior or Infection Prevention and Control team?	( ) Yes ( ) No	If no End interview	1 2	reportinjury
54	Did the team assessed you for PEP after you reported the exposure?	( ) Yes ( ) No		1 2	teamrespond
55	Was the source Patient tested for Hepatitis B Virus?	( ) Yes ( ) No ( ) Don't know		1 2 3	sourcetested
56	Was there a need for you to use PEP after evaluation of source patient and yourself?	( ) Yes ( ) No			requiredpep
57	Did you take prophylaxis Immunoglobulin or vaccine after the evaluation or assessment	( ) Yes ( ) No		1 2	anypep
58	If no to q.56Why did you not take any prophylaxis	……			whynopep
59	What was the reason for you taking the Post Exposure Prophylaxis	……			whypep
60	Who bore the cost of PEP	( ) Self ( ) Facility ( )other		1 2 3	whopaid

61	What time after the exposure did you start the Post Exposure Prophylaxis treatment?	( ) Within 24 hrs ( ) within 24-48 hrs ( ) within 48-72 hrs. ( ) After 72 hours		1 2 3 4	timestartpep
62	Did you undertake any form of assessment 6 months following Post exposure prophylaxis use for the most resent exposure	( ) Yes ( ) No		1 0	

Section Six

Vaccination Records

To be filled by research assistant only after examining vaccination cards

Number of Doses received	
Date of first dose	
Date of second dose	
Date of third dose	
Date(s) of other doses	
Vaccination Shedule	

Appendix three B

Adherence to Hepatitis B infection prevention protocol among Health Care Workers in selected public facilities in the Greater Accra Region'

PARTICIPANTS LABORATORY TEST AND RESULTS

Serial number of Respondent……

HBV Marker	Results	
	Test	Result
HBsAg	( )Yes ( )No	( ) Positive ( ) Negative
HBeAg	( )Yes ( )No	( ) Positive ( ) Negative
Anti-HBs	( )Yes ( )No	( ) Positive ( ) Negative
Anti-HBs level	……	( ) Nill ( )<10mlU/mL ( )10-100 mlU/mL ( )>100 mlU/mL
Anti-HBc IgM	( ) Yes ( ) No	( ) Positive ( ) Negative
Anti-HBc IgG	( ) Yes ( ) No	( ) Positive ( ) Negative

Appendix three C

Adherence to Hepatitis B infection prevention protocol among Health Care Workers in selected public facilities in the Greater Accra Region'

Health Care Worker referral form

Contact: 0244772402/ 0244577063 email: efuvivi@yahoo.co.uk

PATICIPANT REFERAL FORM

Name of Participant……

Age…….

Sex……..……

Telephone Number ……..

Reasons for referral…….…….

…….……

……

Referring Officer

Name ……..Title…….

Signature …… Date…..……

Appendix Four

Adherence to Hepatitis B infection prevention protocol among Health Care Workers in selected public facilities in the Greater Accra Region'

Questionnaire for Facility key informants

Instruction: Do not write your name or facility's name on this questionnaire. Kindly tick one response on each question. Only heads if facilities or their representatives are eligible to answer these questions.

Date of interview……..Study Site……Questionnaire code……..

	QUESTION	RESPONSE	CODE
1	Serial Number of facility	……	
2	Title of facility Head	( ) Medical director/ manager ( )Doctor in-charge ( ) DDNS/ Nurse manager ( ) Hospital administrator ( )Physician Assistant ( )Midwife in-charge ( ) Other specify ……	1 2 3 4 5 6 7
3	Level of facility	( ) CHPS level ( ) Health Center level ( ) Polyclinic levels ( ) District Hospital level ( )Regional Hospital	1 2 3 4
4	Do you have any Action plan on Infection prevention and health care worker protection from blood born infections?	( ) Yes ( ) No	1 0
5	Do you have a functional Occupational Health and safety committee or IPC committee in your facility?	( ) Yes ( ) No	1 0
6	Do you have a functional Occupational Health and safety coordinator in your facility	( ) Yes ( ) No	1 0
7	Does your facility organize in-service training on infection prevention for employees?	( ) Yes ( ) No	1 0
8	Are employees screened for hepatitis B virus infection?	( ) Yes ( ) No	1 0
9	Does your facility have a clear and documented pathway for exposure reporting?	( ) Yes ( ) No	1 0
10	Has this facility ever undertaken HCW vaccination campaigns against HBV	( ) Yes ( ) No	1 0
11	Does your facility have Hepatitis B vaccine readily available for use in case of accidental exposure?	( ) Yes ( ) No	1 0

12	Does your facility have Hepatitis B immunoglobulin readily available for use as Post exposure prophylaxis in case of accidental exposure?	( ) Yes ( ) No	1 0
13	Does your facility have protocol on occupational exposures and Post exposure prophylaxis use?	( ) Yes ( ) No	1 0
14	Does your facility offer immunoglobulin and HBV vaccine for free to exposed health care workers needing it?	( ) Yes ( ) No	1 0

Appendix six Approval Documents and Letters Section

NOGUCHI MEMORIAL INSTITUTE FOR MEDICAL RESEARCH
Established 1979
A Constituent of the College of Health Sciences
University of Ghana

INSTITUTIONAL REVIEW BOARD

Phone: +233-302-916438 (Direct)
+233-289-522574
Fax: +233-302-502182/513202
E-mail: nirb@noguchi.ug.edu.gh
Telex No: 2556 UGL GH

Post Office Box LG 581
Legon, Accra
Ghana

My Ref. No: DF.22
Your Ref. No:

6th September, 2017

ETHICAL CLEARANCE

FEDERALWIDE ASSURANCE FWA 00001824 **IRB 00001276**

NMIMR-IRB CPN 005/17-18 **IORG 0000908**

On 6th September, 2017, the Noguchi Memorial Institute for Medical Research (NMIMR) Institutional Review Board (IRB) at a full board meeting conducted continuing review and amended your protocol titled:

TITLE OF PROTOCOL : **Adherence to Hepatitis B prevention strategies among health care workers: Seven years of implementation of the occupational health and safety policy in Ghana**

PRINCIPAL INVESTIGATOR : **Vivian Efua Senoo, Ph.D. Cand.**

Please note that a final review report must be submitted to the Board at the completion of the study. Your research records may be audited at any time during or after the implementation.

Any modification of this research project must be submitted to the IRB for review and approval prior to implementation.

Please report all serious adverse events related to this study to NMIMR-IRB within seven days verbally and fourteen days in writing.

This certificate is valid till 5th September, 2018. You are to submit annual reports for continuing review.

Signature of Chair: .....
Mrs Chris Dadzie
(NMIMR – IRB, Chair)

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Tel: +233-302-681109
Fax + 233-302-685424
Email: ghserc@gmail.com

MyRef. GHS/RDD/ERC/Admin/App /808
Your Ref. No.

Vivian Efua Senoo
University of Ghana
School of Public Health
P. O. Box LG 13
Legon, Accra

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	**GHS-ERC: 006/08/17**
Project Title	Adherence to Hepatitis B Preventive Strategies among Health Care Workers: Seven Years of Implementation of Occupational Health and Safety Policy
Approval Date	18th September, 2017
Expiry Date	17th September, 2018
GHS-ERC Decision	**Approved**

This approval requires the following from the Principal Investigator

- Submission of yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report **after completion** of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED.....
DR. CYNTHIA BANNERMAN
(GHS-ERC CHAIRPERSON)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra

In case of reply the number and the date of this letter should be quoted

My Ref. No.....

Your Ref. No. .....

Occupational & Environmental Health Unit
Ghana Health Service
Private Mail Bag
Ministries
Accra-Ghana

Tel: 0302-660693
Email: edith.clarke@ghsmail.org

Ms. Vivian Efua Senoo
School of Public Health
University of Ghana-legon

Approval of Collaboration

In reply to your request for collaboration to conduct Academic Research among Ghanaian health workers, the Occupational and Environmental Health Unit of the Ghana Health Service wishes to state that we are interested in your research titled **"Adherence to Hepatitis B Prevention Strategies among health care workers: Seven years of Implementation of the Occupational Health and Safety Policy in Ghana."**

We express our willingness to collaborate with you for a successful completion of this project.

We believe the findings of this research will inform us to what extent health workers in the Greater Accra Region adhere to policy regulations in terms of Hepatitis B prevention.

We will not hesitate to provide any technical support and advice you may need to enable you to successfully undertake this research project as scheduled.

We wish you well in this effort.

Thank you.

Dr. Carl Osei
Ag. Program Manager
Occupational and Environmental Health, GHS

In case of reply the number and the date of this letter should be quoted

Republic Of Ghana

HEALTH FACILITIES REGULATORY AGENCY
MINISTRIES POST OFFICE
P.O. BOX MB 534
ACCRA.
0302900995
08th August, 2017

H/REG/0617/118

To Whom It May Concern

RE: ADHERENCE TO THE HEPATITIS B PREVENTION STRATEGIES AMONG HEALTH CARE WORKERS: SEVEN YEARS OF IMPLEMENTATION OF THE OCCUPATIONAL HEALTH AND SAFETY POLICY IN GHANA

In accordance with its mandate from the Health Facilities and Institutions 2011 (Act 829) to regulate and monitor activities in a practice, among other things, the Health Facilities Regulatory Agency (HEFRA) is working in collaboration with Ms. Vivian Efua Senoo, a PhD student in the Department of Epidemiology and Disease Control of the School of Public Health, College of Health Science, University of Ghana to ensure credibility and the quality of healthcare that your facility is providing.

We would therefore appreciate your co-operation in this matter of research to enhance healthcare provision as well as occupational health and safety of healthcare workers in the country.

Thank you.

Yours faithfully,

MATTHEW YAW KYEREMEH

AG. REGISTRAR

In case of reply the number and date of this letter should be quoted.

My Ref. No. ***GHS/GARHD/006/17***

Your Ref. No.

GHANA HEALTH SERVICE
REGIONAL HEALTH DIRECTORATE
GREATER ACCRA
P. O. BOX 184
ACCRA

Tel: +233-0302-234225/226203

E-mail:lavanotoo@yahoo.com
linda.vanotoo@ghsmail.org

4th July 2017

ALL METRO/ MUNICIPAL/DISTRICT DIRECTORS OF HEALTH SERVICES
ALL MEDICAL DIRECTORS
ALL MEDICAL SUPERINTENDENTS

RE: LETTER OF INTRODUCTION – MS VIVIAN EFUA SENOO

This is to introduce to you **Ms. Vivian Efua Senoo** who is a Doctor of Philosophy (PhD) student in the Department of Epidemiology and Disease Control of the School of Public Health, College of Health Sciences, University of Ghana, Legon.

She has approval from the Regional Health Directorate to conduct a research on the topic: ***"Adherence to Hepatitis B Prevention Strategies among Health Care Workers: Seven Years of Implementation of the Occupational Health and Safety Policy in Ghana"*** for her project work in your facility/district as per attached.

Kindly provide the needed assistance to ensure a successful exercise.

Thank you.

DR. LINDA A. VANOTOO
REGIONAL DIRECTOR OF HEALTH SERVICES
GREATER ACCRA

cc: Dr. Bismark Sarfo
Head of Department
Department of Epidemiology and Disease Control
School of Public Health
University of Ghana, Legon

Ms. Vivian Efua Senoo
Department of Epidemiology and Disease Control
School of Public Health, University of Ghana, Legon

In case of reply the number and date of this letter should be quoted

My Ref. No : GHS/GARH/RS/G-132
Your Ref. No....

CORE VALUES:
People-Centered
Professionalism
Team Work
Innovation/Excellence,
Discipline
Integrity
Pacesetters

GREATER ACCRA REGIONAL HOSPITAL, RIDGE
GHANA HEALTH SERVICE
P. O. BOX 473
ACCRA

28TH JULY, 2017

TEL: (0302) – 228382
228315
228348

TEL/FAX 228862

E-MAIL: ridge.rgionalhospital@yahoo.com

THE CHAIRMAN
ETHICS REVIEW COMMITTEE
GHANA HEALTH SERVICE
ACCRA

ACCEPTANCE LETTER
MS. VIVIAN SENOO

The above-named person have been given an approval to conduct her research on the topic "**adherence to Hepatitis B prevention strategies among health care workers: seven years of implementation of the occupational health and safety policy in Ghana**" for her project work at the Greater Accra Regional Hospital, Ridge-Accra.

Please accord her the needed assistance.

Thank you.

DR. EMMANUEL K. SROFENYOH
AG. MEDICAL DIRECTOR

cc: Ms. Vivian Senoo

Your Health Our Concern

FOOD AND DRUGS AUTHORITY FDA GHANA

Food and Drugs Authority

Head Office
P. O. Box CT 2783,
Cantonments, Accra-Ghana
Tel: (+233-302)233200, 235100
Fax: (+233-302)229794, 225502
Email: fda@fdaghana.govgh

FDA/MCH/MDD/DU2/17/1034

8th August 2017

School of Public Health
University of Ghana
Legon
Tel: 0244774202/0277324849
Email: efuvivi@yahoo.co.uk

Dear Madam,

RE: REQUEST FOR A LIST OF FDA APPROVED HEPATITIS B PROFILE AND ELISA TEST KITS

This is to acknowledge receipt of your letter submitted to the Food and Drugs Authority (FDA) on August 2, 2017 requesting for the list of registered Hepatitis B Virus Profile test kits and Hepatitis B Elisa Test kits needed for obtaining Ethical Clearance for your research project.

The content of your letter has been noted.

Find below the list of the approved Hepatitis B Rapid Test kits with valid registration.

1. ACCU-TELL ONE STEP HBSAG (HEPATITIS B STRIPS, TEST PAPER)
2. ACCU-TELL ONE STEP HBSAG (HEPATITIS B CASSETTE)
3. MERILINE MERISCREEN HBsAG TEST KIT
4. SD BIOLINE HBsAg RAPID DIAGNOSTIC KITS

However, you can contact the Authority for further enquiries in the course of the study.

Yours faithfully,

AG. DELESE A. A. DARKO (MRS)
CHIEF EXECUTIVE OFFICER

In case of the reply the number and the date of this letter should be quoted.

My Ref. GHS/MPC-RC/ADM/135
Your Ref. No.....

GHANA HEALTH SERVICE
MADINA POLYCLINIC,RC
P.O.BOX MD 839
MADINA

TEL: 031-2291885
m.polydinicRC@yahoo.com

11/07/2017

THE DEAN
SCHOOL OF PUBLIC HEALTH
UNIVERSITY OF GHANA
LEGON
ACCRA

APPROVAL TO CONDUCT RESEARCH WORK
MS. VIVIAN EFUA SENOO

This comes to inform your outfit that approval has been granted for Ms. Vivian Efua Senoo who is a Doctor of Philosophy (PhD) student in the Department of Epidemiology and Disease Control of the School of Public Health to undertake her research in this facility.

Thank you.

A.YEBOAH FORDJOUR
HEALTH SERVICE ADMINISTRATOR
FOR: PRIN. MEDICAL OFFICER IN-CHARGE

Appendix Seven

Supplementary Materials and Methods Section

Phlebotomy or Venipuncture Procedure

A qualified Biomedical Scientist who is very well experienced in the procedure of venipuncture performed all the phlebotomy procedures for all the participants by doing the following:

Participant had given a written informed consent to participate in the study and he or she had successfully completed the answering of the questionnaire. The participant was made comfortable in a chair. All required materials and equipment for the procedure were assembled before the start of the procedure on a trolley to ensure that the sterility of the procedure is not compromised. The phlebotomist performed hand hygiene or Alcohol rub for 40-60 minutes in accordance with WHO standards. The blood draw procedure was carefully explained to the participant making him or her to understand that the entire procedure would last for 2-5minutes and that pain would be minimal and bleeding after the procedure is unlikely.

The needle and vacutainer hub were then assembled followed by cleaning with alcohol of the puncture site he site was cleaned with alcohol and allowed to air dry. A toniquite was applied 3-4 inches above the identified site for the venipuncture (the Median Cubital Vein was used in most instances). The participant was asked to make a fist and a sharp sterile needle of (21G ½ inch 0.8*40mn gauge) was used.

The needle was then inserted into the vein with the bevel side up at about an angle of 15-30^0 with the skin. 5mls of blood was collected following a successful access to the vein. The needle was removed immediately after the collection of specimen. Direct pressure was applied to stop bleeding at the puncture site. The puncture site was rechecked after 2-5minutes to be sure that the bleeding had stopped completely. The specimen was then

labeled in the presence of the participant with his serial number corresponding to the serial number on the questionnaire.

Validity of Quantitative ELISA Test Runs

The Optic Density (OD) values of the standards concentrations, the zero controls, positive controls as well as the R^2 values of the standard curves of all the plates were compared to the manufacturer's reference range of validity. All the four ELISA procedures for the quantitative estimation of antibody levels were valid following the comparison with values provided by the manufacturers of Antisurase MB 96-TMB 11.

Comparing OD values of standards, controls and R^2 Values with Manufactures Ranges

	Mean Absorbance Values for Standards				
Standards	Validity Ranges	PLAT 1	PLAT 2	PLAT 3	PLAT 4
1000	≥2.0	2.98	2.99	3.4	3.08
400	≥1.0	2.07	2.23	2.36	2.27
100	≥0.25	0.72	0.77	0.86	0.78
50	≥0.10	0.36	0.4	0.47	0.437
25	≥0.05	0.2	0.23	0.263	0.24
10	≥0.025	0.089	0.11	0.129	0.108
Positive Control	≥0.5	1.9	2.2	2.3	2.22
	R^2 VALUES				
	≥0.95	0.9996	0.9997	0.9992	0.9995

Calculation of Antibody concentrations

The mean absorbance values for the standards, controls and the samples were calculated. A standard curve was then generated by plotting the concentrations of the standards (1000, 400, 100, 50, 25, 10) (x-axis) against its corresponding average OD values (y-axis). The mean absorbance values of the samples were used to extrapolate mean concentration of HBsAb from the standard curve. The outcomes were categorized into three groups following

the calculation of the antibody concentrations. Those with antibodies levels of; (1) Below 10mlU/mL (2) ≥ 10- 100mlU/Ml (3) ≥ 100mlU/mL

Validity of Qualitative ELISA Test Runs

The mean OD values of both positive and negative controls were compared to the validity ranges outlined by the manufacturers of Anticorase MB-96 TMB and the two ELISA test runs were considered valid for the detection of Igm HBcAb.

Comparing Mean OD values of controls with Manufactures Ranges (Anti-HBc IgM)

Controls	Validity Range	Mean Absorbance Plate 1	Mean Absorbance Plate 2
Positive Control (Pc)	≥0.4	1.61	1.09
Negative Control (NC)	≤ 0.1	0.0485	0.062
PC-NC	≥0.3	1.642	1.028

Calculation of Cut-off values

The cut-off values were calculated in accordance with the manufactures instructions. Based on the calculation of cut-off values, samples that were below the cut-off values of 0.451 and 0.334 for IgM plate 1 and 2 respectively were considered as negative or non-reactive for HBcAb IgM.

Calculation of Cut- off Values for Detection of IgM HBcAb

Controls	Mean OD Value for Plate I	Mean OD value for plate 2
Positive Control (PC)	1.61	1.09
Negative Control (NC)	0.0485	0.062
Cut-off value NC+ (PC)/4	0.0485+ (1.61)/4 0.451	0.062+(1.09)/4 0.334

Appendix Eight
Supplementary Results section
Post Hoc Analysis Results

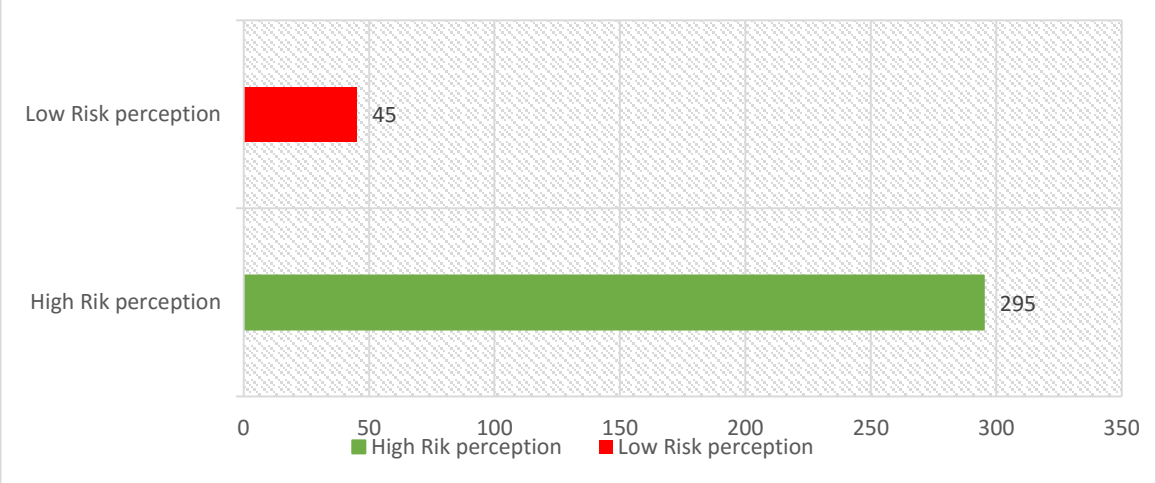
Post Hoc Analysis (Games-Howell) Indicating source of differences in Risk Perception Among the Job Categories/ Cadre.**

(I) cadre	(J) cadre	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Doctor	Nurse/Midwife	3.21837	1.12213	.053	-.0215	6.4583
	Anaesthetist	-.75255	2.62802	1.000	-9.1998	7.6947
	Laboratory staff	1.11728	2.02400	.994	-4.8688	7.1034
	Orderly	**6.72288***	1.96443	**.017**	.8387	12.6071
	PA	.10913	2.19822	1.000	-6.6964	6.9147
Nurse/Midwife	Doctor	-3.21837	1.12213	.053	-6.4583	.0215
	Anaesthetist	-3.97092	2.58102	.647	-12.3404	4.3985
	laboratory staff	-2.10109	1.96258	.891	-7.9284	3.7262
	Orderly	3.50451	1.90109	.452	-2.2238	9.2328
	PA	-3.10924	2.14180	.697	-9.7966	3.5781
Anaesthetist	Doctor	.75255	2.62802	1.000	-7.6947	9.1998
	Nurse/midwife	3.97092	2.58102	.647	-4.3985	12.3404
	Laboratory staff	1.86983	3.08205	.990	-7.5489	11.2886
	Orderly	7.47543	3.04327	.174	-1.8718	16.8227
	PA	.86168	3.19916	1.000	-8.9425	10.6659
Laboratory staff	Doctor	-1.11728	2.02400	.994	-7.1034	4.8688
	nurse/midwife	2.10109	1.96258	.891	-3.7262	7.9284
	Anaesthetist	-1.86983	3.08205	.990	-11.2886	7.5489
	Orderly	5.60561	2.53999	.250	-1.8675	13.0787
	PA	-1.00815	2.72483	.999	-9.1359	7.1196
Orderly	Doctor	**-6.72288***	1.96443	**.017**	-12.6071	-.8387
	Nurse/midwife	-3.50451	1.90109	.452	-9.2328	2.2238
	Anaesthetist	-7.47543	3.04327	.174	-16.8227	1.8718
	laboratory staff	-5.60561	2.53999	.250	-13.0787	1.8675
	PA	-6.61376	2.68088	.160	-14.6536	1.4261
Physician Assistants (P.A,)	Doctor	-.10913	2.19822	1.000	-6.9147	6.6964
	Nurse/midwife	3.10924	2.14180	.697	-3.5781	9.7966
	Anaesthetist	-.86168	3.19916	1.000	-10.6659	8.9425
	Laboratory staff	1.00815	2.72483	.999	-7.1196	9.1359
	Orderly	6.61376	2.68088	.160	-1.4261	14.6536

** The mean difference is significant at the 0.05 level. ** Games Howell Post hoc Test chosen because of a significant levene's test

Risk Perception for Hepatitis B Infection

The overall scores ranged from a minimum of 42.86% to 100% with a SD of 8.96% with overall percentage mean score of 92.3%; an indication of a high level of risk perception for HBV among the HCWs surveyed. In all, majority representing 300(88.2%) obtained good risk perception scores of over 75% however 27(7.9%) did not know of HBV and hence did not answer on their perception of risk for HBV. Those with scores below 50% and those who did not give any response were categorized as low risk and those with mean scores above 50% as high risk for HBV.



Appendix Risk perception score category

Post Hoc Analysis (Tukey) Indicating source of differences in PEP Knowledge Among the Job Categories/ Cadre.**

Post Hoc Test	(I) Cadre	(J) Cadre	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	Doctor	Nurse/Midwife	11.86253	4.24734	.064	-.3821	24.1072
		Anaesthetist	1.42045	8.73565	1.000	-23.7635	26.6044
		Laboratory Staff	11.89840	6.49051	.447	-6.8131	30.6099
		Orderly	6.33117	6.97410	.944	-13.7744	26.4368
		PA	-12.12121	8.31486	.691	-36.0921	11.8497
	Nurse/Midwife	Doctor	-11.86253	4.24734	.064	-24.1072	.3821
		Anaesthetist	-10.44207	8.41849	.816	-34.7117	13.8275
		Laboratory Staff	.03587	6.05691	1.000	-17.4256	17.4973
		Orderly	-5.53136	6.57248	.959	-24.4791	13.4164
		PA	**-23.98374***	7.98100	**0.036**	-46.9921	-.9754
	Anaesthetist	Doctor	-1.42045	8.73565	1.000	-26.6044	23.7635
		Nurse/Midwife	10.44207	8.41849	.816	-13.8275	34.7117
		Laboratory Staff	10.47794	9.74463	.891	-17.6148	38.5707
		Orderly	4.91071	10.07319	.997	-24.1292	33.9507
		PA	-13.54167	11.04391	.824	-45.3801	18.2968
	Laboratory Staff	Doctor	-11.89840	6.49051	.447	-30.6099	6.8131
		Nurse/Midwife	-.03587	6.05691	1.000	-17.4973	17.4256
		Anaesthetist	-10.47794	9.74463	.891	-38.5707	17.6148
		Orderly	-5.56723	8.20270	.984	-29.2148	18.0803
		PA	-24.01961	9.36927	.112	-51.0302	2.9910
	Orderly	Doctor	-6.33117	6.97410	.944	-26.4368	13.7744
		Nurse/Midwife	5.53136	6.57248	.959	-13.4164	24.4791
		Anaesthetist	-4.91071	10.07319	.997	-33.9507	24.1292
		Laboratory Staff	5.56723	8.20270	.984	-18.0803	29.2148
		PA	-18.45238	9.71054	.406	-46.4468	9.5421
	PA	Doctor	12.12121	8.31486	.691	-11.8497	36.0921
		Nurse/Midwife	**23.98374***	7.98100	**0.036**	.9754	46.9921
		Anaesthetist	13.54167	11.04391	.824	-18.2968	45.3801
		Laboratory Staff	24.01961	9.36927	.112	-2.9910	51.0302
		orderly	18.45238	9.71054	.406	-9.5421	46.4468

**Turkey Post hoc Test chosen because of a non-significant levene's test variances F=0.058;p=0.99

Appendix Ten
Current guidelines on the management of Health care workers infected with HBV

	CDC*	**SHEA****	**ACS*****	**Canada**	**UK********	**********Europe**	**********Australia**
Frequency of testing/ monitoring	Every 6 month	Every 6 months	Not specified	Every 12 months	Every 12 months, or every 3 months while on antiviral therapy	Every 12 months if HBeAg negative, every 3 months if HBeAg positive or on antiviral therapy	Every 3 months if on antiviral therapy, every 12 months if cleared HBsAg
Viral load limit	1000 IU/mL or 5000 GE/mL	10^4 GE/mL	Not specified	Not specified	10^3 GE/mL	10^4 GE/mL	Undetectable by PCR assay
HBeAg	Not required to be negative	Not required to be negative	Not required to be negative	Not required to be negative	Must be negative	Not required to be negative	Not addressed in guideline

	CDC*	**SHEA****	**ACS*****	**Canada**	**UK******	******Europe**	*******Australia**
Restriction of practice	EPPs restricted if viral load greater than set threshold	Category III procedures restricted if viral burden greater than or equal to 10^4 GE/mL or HBeAg positive	Determined by expert panel	Determined by expert panel	If HBeAg positive or if viral load greater than 10^3 GE/mL	If viral load greater than 10^4 GE/mL	If HBV DNA level detectable
Definition of EPPs	Yes	Yes	No	Yes	Yes	Yes	Yes
Expert panel recommended	Yes	Yes	Yes, if HBeAg positive or high viral load	Yes, if HBsAg positive	No, recommend monitoring by an occupational health physician	No	Yes
Pre-emptive patient notification	No	No	Not specified	No	No	Optional for HCWs with HBV DNA levels above the cut-off level in order to continue practicing EPPs	No