HUMAN PARVOVIRUS B19 INFECTIONS AMONG BLOOD DONORS IN SOME SELECTED BLOOD CENTERS IN GHANA.

BY

AWUNI KINTAMPO LYDIA (10636611)

DEPARTMENT OF MEDICAL LABORATORY SCIENCE. SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCE COLLEGE OF HEALTH SCIENCES

UNIVERSITY OF GHANA

This dissertation is submitted to the University of Ghana, Legon, in partial fulfillment of the requirement for the award of MSC in MEDICAL LABORATORY SCIENCES Degree.

MAY, 2020

DEDICATION

I dedicate this work to the Almighty God who has made me what I am today, it was not by might but by His grace.

I also dedicate this work to my entire family whom I consider as gifts from the Almighty God.

ACKNOWLEDGEMENT

In the present world of competition there is a race of existence in which those having the will to come forward succeed.

I would like to thank the supreme power the almighty God who is obviously the one that has always guided me to work and the one that always guided me on the right path of life, without his grace the research could not become a reality.

Next to Him is my entire family whom I am greatly indebted to for their enormous support to this stage.

I am feeling oblige in taking the opportunity to sincerely thank Mr. Dzandza Isaac Mandy my husband for his help.

I have no available words to express my thanks, but my heart is still full of the favours received from every person.

TABLE OF CONTENTS

CONTENTS **PAGE**

DECLARATION ii

DEDICATION iii

ACKNOWLEDGEMENT iv

TABLE v

LIST OF TABLES viii

ABSTRACT xi

CHAPTER 13

INTRODUCTION 13

1.1 Background 13
1.2 Statement of the Research Problem 17
1.3 Justification of the Study 20
1.4 Hypothesis 20
1.5 Aim of the Study 20
1.6 Objectives of the Study 21
1.7 Research Questions 21

CHAPTER TWO 22

LITERATURE 22

2.1 Blood donation 22
2.2 Parvovirus B19 22
2.2.1 Epidemiology of Parvovirus B19 Infection 23
2.2.2 Pathogenesis of Parvovirus B19 Infection 23
2.2.3 Transmission of Parvovirus B19 Infection 25
2.3 Disease associations 25
2.3.1 Diagnosis of Parvovirus B19 Infection 25
2.4 Clinical features and prevalence of B19 27
2.4.1 Chronic infections of B19 27
2.5.1 Immunity through antibody mediated response 30
2.5.2 Cellular immunity 32
2.6 Detection of HPV B19 IgM 35
2.7 Detection of HPV B19 IgG 36

2.8 Blood product safety 37
2.9 Treatment and vaccination of Parvovirus B19 38
CHAPTER 39

METHODOLOGY 39

3.1 STUDY METHOD 39
3.2 Study Population 40
3.3 Sampling and sample size 40
3.4 Sampling method 41
3.5 Inclusion criteria 41
3.6 Exclusion criteria 41
3.7 Questionnaire Administration 42
3.8 Specimen collection and testing 42
3.9 ASSAY PROCEDURE FOR IgG 42
3.9.1 Interpretation of Results 43
3.10 ASSAY PROCEDURE FOR IgM 44
3.10.1 Interpretation of results 44
3.11 INFORMED CONSENT 44
3.12 Data collection process and tools 45
3.13 Data analysis 45
CHAPTER 46

RESULTS 46

4.1.1 Demographic Characteristics of Participants 46
4.2 Prevalence of Parvovirus B19 IgG and IgM among age groups and education 48
4.4 Prevalence of Parvovirus B19 IgG and IgM according to Medical and Lifestyle Characteristics 51
4.5 Correlation analysis 53
4.6 Summary of Results 55
CHAPTER 56

DISCUSSION 56

5.1 Discussion 56
5.1.1 Demographic characteristics 56
5.1.2 Prevalence of parvovirus HPV B19 IgG and IgM among age groups and education 57
5.1.3 Presence of Parvovirus B19 IgG and IgM 58
5.2 Conclusions 60
5.3 Recommendations 61
REFERENCES 62

APPENDIX 75

QUESTIONNAIRE 75

LIST OF TABLES

Table 1 Demographic characteristics of participants

Table 2 Medical and lifestyle activities

Table 3 Reactivity and Prevalence of IgG and IgM

Table 4 IgG and IgM according to blood transfusion

Table 5 IgG and IgM results according to medical and lifestyle characteristics

Table 6 Correlation analysis of IgG and IgM and risk factors

HPV B19	Human Parvovirus B19
WHO	World health organization
TTI	Transfusion Transmitted infection
SS	Single Stranded
HIV	Human immune defficiency virus
HBV	Hepatitis B virus
HCV	Hepatitis C virus
PCR	Polymerase Chain reaction
IgG	Immunoglobulin G
DNA	Deoxyribonucleic Acid
VP1	viral protein 1
VP2	Viral protein 2
NS1	Nonstructural protein
HLA	Human Leukocyte Antigen
IFN.g	Interferon Gamma
IL-2	Interleukin-2
FDA	Food and Drugs Authority
ROC	Receiver Operating Characteristic
EIA	Enzyme Immunoassay
HSV	Herpes Simplex Virus

OD	Absorbence Density
CV	Coefficient Of Variation
ELISA assay	Enzyme Linked Immunosorbent
IVIG	Intravenous Immunoglobulin

ABSTRACT

Background: Blood transfusion is a lifesaving therapy in hospital practice for patients. It is an invaluable human resource for a wide range of medical and surgical conditions. Human Parvovirus B19 is the only member of the *Parvoviridae* family known to be pathogenic to humans. Infections of parvovirus B19 occur all year round. It is also manifest in all age groups. A number of the patients show subclinical manifestations.

Aim: The aim of this research was to determine the sero-prevalence of Human Parvovirus B19 infections among blood donors at selected blood centers in Ghana.

Method: The research was a cross- sectional study carried out among blood donors who donated blood at the selected blood banks from March 2019 to March 2020. Blood samples were collected from the participants and screened for both IgG and IgM antibodies to Human Parvovirus B19 using ELISA Kits to establish the sero prevalence of Human Parvovirus B19 among the blood donors. Risk factors associated with the spread of the infections were also determined.

Results: Majority of the participants for the study were males (93.7%). About70.7% of them were between the ages of 30 to 39 years. Ten (10) of participants tested positive for the IgM antibodies (Reactive), indicating that 5.9% of the total participants had the Human parvovirus B19. 108 (64.7%) of the participants were reactive for the IgG antibodies, representing those that have been exposed to the Human parvovirus B19. The study participants have not had any blood transfusion. About 47.3% had however donated blood before. The study also showed that none of the participants had multiple sex partners, used drugs, smoked or shared needles but about 22.8% had however received hepatitis B vaccination.

Conclusion: The study shows that more than 50% of the participants were reactive to the IgG antigen and 5.9% were reactive for the IgM antibodies. The study therefore recommends that parvovirus screening must be included in the procedure for blood donation.

CHAPTER ONE

INTRODUCTION

1.1 Background

Blood transfusion is a lifesaving therapy in hospital practices for patients. It is an invaluable human resource for a wide range of medical and surgical conditions (Musa *et al.*, 2013). Blood is a biologically active substance and for effective blood transfusion services, the blood and its products provided should be as safe as possible and adequate to meet the patient requirements. Infections of the blood are common. This can be transmitted when the blood of an infected person is transfused to a healthy person. This can also be transmitted when blood is transfused by an asymptomatic individual (Rode *et al.*, 1990). First step for safe blood donation depends on building a panel of regular, voluntary, non-remunerated blood donors. According to the World Health Organization (WHO), all blood donations should be screened for infections prior to use. In fact, the goal of WHO is to obtain all blood supplies from voluntary, non-remunerated donors by 2020 (WHO, 2011).

Without blood, the management of many medical conditions such as trauma, cardiac surgeries, organ transplantation, malaria and obstetric haemorrhage, would have been difficult or nearly impossible. However, this life-saving procedure is often associated with significant clinical risks, which can be broadly classified as infectious or non-infectious complications. The main challenges inscribed throughout the history of blood transfusion were centred on adequacy and safety of the blood supply. Attempts to resolve these challenges led to the evolution of blood transfusion into a multidisciplinary field, beyond issues related to blood procurement and storage (Musa et al., 2013). Blood transfusion now involves several aspects, including but not limited to, adequate and safe blood supply, appropriate use of blood & blood products, development of novel cellular therapies,

manipulation and prevention of immune responses and economic evaluation. The blood supply is now much safer largely due to conversion from paid to voluntary non-remunerated blood donors, improvements in donor screening, improvement of assays that detect transfusion-transmissible infections in donor blood, regular quality control on blood units, leucoreduction techniques, blood management, hospital transfusion committees and haemovigilance. Although strategies to improve supply and minimise transfusion risk have been fully implemented with successful results in most developed countries, they are considered to be too expensive to implement in most resource-limited settings. As such, most resource limited settings are still confronted with challenges in terms of limited access to blood transfusion or the provision of safe blood. Most of the countries in the African Region collect about 4 units per 1000 population, less than half of the World Health Organisation recommendation of 10 per 1000, compared with an average of over 30 per 1000 population in developed countries (WHO, 2011).

In resource-limited countries, blood transfusion is mainly used for complications of pregnancy, anaemia, infectious diseases, cancer, and gastrointestinal diseases (Adekale et al., 2010). The majority of blood and blood component use in sub-Saharan Africa (SSA) is for emergencies, hence unavailability may result in loss of lives. Although there is striking evidence of limited access to blood transfusions, there is very little information on actual utilization patterns prompting suspicions of irrational use. Blood component utilisation data is widely available for a variety of countries globally while it's limited to a few studies in Africa (Alao et al., 2010). These studies demonstrate substantial variations in transfusion practices, arising from differences in population age structures, prevalence of conditions requiring transfusion, and levels of health care provision. Most developed countries are characterised with ageing populations, chronic non-infectious diseases and advanced surgical

technologies, all of which may result in different patterns of blood component use when compared with developing countries. In contrast, the population in developing countries is predominantly young and blood utilisation patterns are likely to be very different. Information on blood utilisation will assist in conducting cost-effectiveness analyses.

Economic evaluations are increasingly being used to support decisions related to resource allocation in the health care field (Pitman et al., 2015). Three fundamental economic principles highlight the need for economic evaluations; scarcity of resources, need for making choices and consideration of opportunity costs. Because there are limited resources, decision makers have to make choices on the interventions to be implemented; and at the same time they have to take into consideration the value of forgone benefits because resources are not available for their best alternative use. The main purpose of economic evaluations is to provide decision makers with quantitative measures of the efficiency of health care interventions necessary to guide resource allocation. Two most common types of economic evaluations are cost-effectiveness analysis (CEA) and cost-utility analysis (CUA). CEA describes a set of methods where results are expressed in natural units, as a ratio of cost to health benefits e.g. infections prevented or life year saved. CUA is a subset of CEA which accounts for both morbidity and mortality when measuring health benefits by making use of preference weights assigned to relevant health states. Results of CUA are frequently expressed as costs per quality adjusted life year (QALY) or disability adjusted life year (DALY) saved/gained. Decision making on policies and adoption of technologies in transfusion medicine are complicated by the implications on public health, legal and liability issues, as well as political, regulatory and public expectations regarding blood safety (Schneider, 2013). These issues, plus the general desire to achieve ‘zero’ risk have limited the application of economic evaluations in transfusion decision making. Economic

evaluations are considered an important aspect of risk based decision modelling, particularly when comparing competing interventions.

A transfusion transmitted infection (TTI) is any infection identified in a recipient that is suspected to have been transmitted by blood or blood products at any time or any infection (with potential for blood-borne transmission) identified in a blood donor who was infectious at the time they donated blood (Mladic *et al*., 2006). Any infections with the potential of being carried from person to person because of blood transfusion are among the TTIs (Alana, *et al*, 2014). Transfusion transmitted infections that have been detected include cytomegalovirus, Epstein Barr virus and Human Parvovirus B19 virus which is a newly recognized agent of blood transfusion transmitted diseases (Kishore *et al.,* 2011). Preventing transmission of these infectious diseases through blood transfusion presents one of the greatest challenges of transfusion medicine (Chandra Sharma *et al,* 2014). Subsequently, TTIs are still major concerns in blood transfusion in Ghana and the world all over making the practice of safe blood transfusion increasingly difficult.

The Human Parvovirus B19 (HPVB19) was discovered by an Australian virologist in 1970. This was a newly emerging DNA virus. The virologist discovered it while testing donor sera for hepatitis B. through her work, she discovered B19 virus in the sera. This was on the row numbered 19. She thus named it B19. B19 was thus later placed in the genus *Erythrovirus* of the family *Parvoviridae*. Human parvovirus B19 is the only member of the *Parvoviridae* family known to be pathogenic to human. It is a non-enveloped small single stranded (ss) DNA virus that infects and destroys human erythroid progenitor cells. These erythroid progenitor cells in the bone marrow and spleen, when infected, undergo lysis. This therefore results in reduction in erythrocyte count as well as in lymphocyte, granulocyte and platelet counts (Alao *et al.,* 2010).

The principal targets for the human parvovirus B19 are the immature cells in the erythroid lineage. A viral replication can cause the cells to die. This interrupts the production of red blood cells. B19 is seen as an important pathogen that can cause morbidity and mortality. This is seen in patients across the globe (Jegede *et al.*, 2014). The virus is found in the blood and respiratory secretions of infected persons. It can be transmitted through respiratory secretions, transplacentally and more importantly by transfusion of blood or blood products (Bukar *et al.*, 2013).

Infections caused by Human parvovirus B19 occurs all year round. It also occurs for all ages. Many of these people show subclinical manifestations. There have been 20 to 50% estimated attack rates in susceptible contacts (Brooks *et al.*, *2007*). It has been shown that close to a third or a sixth of blood donors have the B19 antibodies. They may however be asymptomatic (Kaur and Basu, 2005). Acute infection is associated with a viremic phase. This is followed shortly by an IgM antibody production. This occurs between 10 to 14days post infection. After this there is the production of IgG4 against the viral capsid. There is a decline in viraemia with the production of IgM. After a few months IgM declines. The IgG however persists longer to convey immunity against a reinfection (Iheanaho *et al.*, 2014).

1.2 Statement of the Research Problem

In addition to studying the demographics of blood transfusion recipients and utilization patterns, it is equally important to establish the outcomes following transfusion. These may include risks (infectious and non-infectious), length of hospital stay and mortality following a blood transfusion. Continuous surveillance of the whole transfusion chain, which includes

assessing information on unexpected or undesirable effects resulting from the use of blood transfusions and preventing their occurrence and recurrence, is a necessary activity for any country. The major transfusion-transmissible infections (TTIs) of clinical importance in Africa are mainly the human immunodeficiency virus I and II (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV). Although variable, the residual risk of HIV, HVB and HCV transmission by blood transfusion has been substantially described for countries in SSA29-34. Variability may be due to the adoption of different screening technologies by different countries, application of different methodologies in the estimation process and therefore emphasizes the need for additional data on TTI incidence and prevalence and residual transfusion risk in Africa. Information on the number of TTIs verified to have been transmitted via transfusion is lacking due to the difficulties that exist in tracking of patients and blood components (LaMonte *et al.,* 2003). As a result, there are very few functional transfusion-transmissible infection 'lookback' programmes in Sub Sahara Africa. In addition to these infectious risks, the significance of non-infectious risks in transfusion medicine is on the rise and these risks are often associated with significant morbidity and mortality. This information is very important for performing meaningful risk assessment and assessing the effectiveness of blood transfusions. There is a general paucity of information on non-infectious risks associated with blood transfusions in SSA, despite its significance. Further to the challenges in terms of limited access to blood transfusion or the provision of safe blood, blood transfusion services in SSA are required and expected to comply with stringent regulatory demands, implement quality management systems, and comply with internationally recognized standards of ethics and practice. Technologies and advancements required to ensure such compliance may require a great deal of investments subsequently resulting in higher costs of producing blood. In resource-limited settings, such increases may

threaten adequate supply of blood hence access as well as the safety of the supply (Kishore *et al.,* 2011).

The common infections (pathogenic markers) screened for before blood is termed safe for transfusion are Human immunodeficiency virus (HIV), Hepatitis B virus (HBV), Hepatitis C virus (HCV) and syphilis (WHO, 2014). But these are not the only infectious agents that can be transmitted through blood transfusion. In recent times Parvovirus B19 has been mentioned as a virus that can easily be transmitted through blood transfusion. Human parvovirus B19 is the causative agent of the fifth disease in children. This disease is also known as erythema infectiosum. This is associated with a wide range of clinical disease (Kishore *et al.,* 2011). Some of these diseases include acute or chronic arthritis in adults. The rest are transient anemia in healthy adults and aplastic crises in infected persons. These infected persons may have an underlying disorder in the blood. It may also be as a result of a prolonged anaemia in immunocompromised persons. Such persons include persons with HIV and organ transplant patients. These persons do not have the ability of producing antibodies that can neutralize or cleat the virus. This leads to a situation where patients who a chronic for B19 have or do not have anaemia (LaMonte *et al.,* 2003). The virus can also be transmitted from mother to foetus during pregnancy. This can lead to spontaneous abortions or intrauterine foetal death (IUFD). This normally occur during the second trimester of pregnancy (Tolfvenstam *et al., 2001*).

Transmission of the parvovirus occurs through a number of routes. These include respiratory droplets on patients, transfusion of B19 infected blood and its products. This can also be through the placenta during maternal B19 infection (Kishore and Kapoor, 2000). Since parvovirus B19 is emerging as a common viral infection with a serious threat of getting

transmitted via blood transfusion, this cross-sectional study is being conducted to observe and analyze the seroprevalence of Human parvovirus B19 among voluntary blood donors. An estimate of the seroprevalence of Human parvovirus B19 among voluntary blood donors may be of help to decide whether screening for parvovirus B19 prior to blood donation would eliminate transmission of the infection to high risk groups

1.3 Justification of the Study

Parvovirus B19 has been said to be transmitted through transfusion of improperly screened blood (Kishore and Kapoor, 2000; Adekanle *et al.*, 2010). Current blood banking practice does not require routine screening for human Parvovirus B19 prior to blood donation. It is important to determine the prevalence of Parvovirus B19 antibodies among blood donors since blood transfusion has been identified as one of the major means of transmitting this infection. The study therefore is aimed at screening blood samples for the presence of Parvovirus B19 among blood donors in some selected blood banks in Ghana. The study hopes to aid in controlling the spread of the infection

1.4 Hypothesis

H_0: Blood samples from donors are infected with Human Parvovirus B19

H_1: Blood samples from donors are not infected with Human Parvovirus B19

1.5 Aim of the Study

The aim of this research is to determine the sero-prevalence of human parvovirus B19 infections among blood donors in some selected blood centers in Ghana.

1.6 Objectives of the Study

The objectives of this study are to:

1. To determine the demographic characteristics of the donors.
2. To detect antibodies against Human parvovirus B19 in blood units.
3. Determine the sero-prevalence of human parvovirus B19 infection among blood donors

1.7 Research Questions

1. What are the demographic characteristics of blood donors?
2. What is the sero-prevalence of human parvovirus B19 infections among blood donors?
3. What antibodies are against parvovirus B19 in blood samples?

CHAPTER TWO

LITERATURE REVIEW

2.1 Blood donation

Blood transfusion is very vital in healthcare delivery. It offers a form of supportive care for both surgical and medical patients (Alana *et al*., 2014). To equip the blood bank with pints of blood, blood is sourced from commercial blood donors, voluntary blood donation and from family replacement blood donation (Bloch *et al.*, 2012). Commercial blood donors are people hired to donate blood for a fee. They are either called by officials of the blood bank to donate or are contracted by individuals in need of the blood. They are paid for the blood donation (Bloch *et al*., 2012). Voluntary donors are people who donate blood to the various hospitals and blood banks for the use of the health facility at no cost to the health facility.

In sub-Saharan Africa, apart from individuals walking into the health facilities once a while to donate blood voluntarily, most voluntary blood donation comes from organized groups such as churches, keep-fit clubs, associations, organized institutions and educational institutions (Bloch *et al*., 2012). The commonest form of blood donation in sub-Saharan Africa is from family or replacement donors. Family or replacement donors are people who have a form of relationship with an individual requiring blood transfusion and are available to donate blood for that purpose. This is where a friend, family member, a spouse, a parent or a sibling gives blood for a relation in time of need

2.2 Parvovirus B19

Parvovirus was discovered by an Australian virologist. This was discovered when the scientist was working on the hepatitis B virus. It was placed in the genus *Erythrovirus* of the

family *Parvoviridae*. Human Parvovirus B19 is the causative agent of fifth disease in children. This is associated with a number of clinical diseases (Kishore and Kapoor, 2000). Some of these diseases include acute or chronic arthritis in adults. The rest are transient anemia in healthy adults and aplastic crises in infected persons. These infected persons may have an underlying disorder in the blood. It may also be as a result of a prolonged anaemia in immunocompromised persons. Such persons include persons with HIV and organ transplant patients. The virus can also be transmitted from mother to foetus during pregnancy. This can lead to spontaneous abortions. The abortions occur in the second trimester of pregnancy (Tolfvenstam *et al., 2001*).

2.2.1 Epidemiology of Parvovirus B19 Infection

The infection of parvovirus is common. It occurs worldwide. Seroprevalence of human B19 virus is age related. This is acquired during childhood. This continues at lower rates throughout adulthood. It has been shown that between 70% to 85% of adults have shown serologic evidence in past infections *(*Kelly *et al.,* 2000). In USA, seropositivity rate is 5-10% among young children (aged 2-5 years), increasing to 50% by age 15 years and 60% by 30 years of age. A small percentage of adults acquire infection every year, resulting in an incidence of approximately 90% in adults older than 60 years (Servey*et al.,* 2007)

2.2.2 Pathogenesis of Parvovirus B19 Infection

The virus is known to replicate in the human erythroid cells of the bone marrow. They are also found in blood of people who carry the erythrocyte group P antigen (Lefrere *et al., 2006*). Viremia in early infections are associated with higher titers. These range between 1,011 to 1,013 genome equivalents/ml (Frickhofen and Young, 1989). This point makes the patient asymptomatic. Thus blood donors with parvovirus B19 cannot be recognized. This

higher titre viremia can last for only 5 to 10days. This continues until there is an expression of specific antibodies.

The DNA of the virus can be detected even at lower levels with a PCR. This however declines over the years after infection (Cassinotti and Sigel, 2000). This viral infection only displays a broad spectrum of clinical manifestations. These include erythema infectiosum in children. It can also be aplastic crisis in patients with haemolyticanaemia and failure of chronic bone marrow in immune compromised hosts. Spontaneous abortion can also be part (Tolfvenstam *et al., 2001*).

The virus enters its target cells after an initial replication in the respiratory tract. The target cells may be the bone marrow or erythroid precursor cells. Receptors and the blood group P antigen can also serve as target cells (van Elsacker-Niele and Kroes, 1999). An arrest of Erythropoiesis occurs when viral replication has been ensured. This usually lasts for approximately one week. The patient at this stage of erythropoietic stress can experience an aplastic crisis

Some viremia cases can be as a result of virus specific antibodies. These occur in the serum of patients. Their presence triggers potentially immune-mediated symptoms. Such symptoms include rash. The infection is however cleared within several weeks for immunologically normal persons. This is caused by a hormonal response with detectable specific IgG. They confer lifelong immunity to re-infection. There is a persistent infection in dysfunctional or patients with absent hormonal immunity. This results in a chronic suppression of the erythropoiesis. There is also acute anaemia (van Elsacker-Niele and Kroes, 1999).

2.2.3 Transmission of Parvovirus B19 Infection

This is commonly through personal contact. This can be as a result of aerosol or respiratory secretions. There is also an iatrogenic transmission through contaminated blood products. These may include concentrates of clotting factors (Elnifro *et al.,* 2009). The virus is also transmitted through blood transfusion (Jagede *et al.,* 2014). There is a possibility of a trans placental transmission of B19 occurring in the course of pregnancy. These transmissions are major causes of the non – immune foetal hydrops. Spontaneous abortions can be caused by this in the second trimester (Emiasegen *et al.,* 2011).

2.3 Disease associations

Infections of most parvovirus B19 can be mild or asymptomatic (Harger *et al.,1985).* Asymptomatic patients may however be encountered with reticulocytopenia. These may have slight drops in the concentrations of their hemoglobin (Woolf *et al.,* 1989; Heegaard and Brown, 2002). These signs can also be seen in symptomatic patients (Anderson *et al.,* 1985). The symptoms may be nonspecific in some cases. The signs are almost similar to that of common cold. A large spectrum of diseases is associated with the human parvovirus B19.

2.3.1 Diagnosis of Parvovirus B19 Infection

The parvovirus infection of a patient can be diagnosed in three major ways. This is normally based on the condition of the individual. These include detection of pronormoblasts, detection of B19 virus and detection of antibodies. For people with suppressed immune systems, the detection for the presence of human parvovirus is carried out. The presence of antibodies is detected for persons with competent immune systems.

In recent times a number of diagnostic tools are available. Modern diagnostic tools have been included. The measurement of the parvovirus B19 IgG and IgM antibodies are examples of such modern tools. The blood samples or tissue samples are measured. In some cases, samples in the bone marrow are measured. These are quantified using the polymerase chain reaction (PCR) (Reed *et al.*, 1999). Mature erythroid precursors are not shown by bone marrow aspirates. These are revealed morphologically. They however show giant pronomoblast. These occur during periods of acute infection (Broliden *et al.*, 2006).

2.3.2 Treatment of Parvovirus B19 Infection

There are no specific antiviral therapies available in treating parvovirus B19. In determining an approach to therapy of infection some host factors must be considered. These include immune status, underlying conditions and the manifestations of the infection. In most of the cases involving immunocompetent persons, no treatment is needed. This is because symptoms in such cases are transient. In some cases, non-steroidal anti-inflammatory agents are needed. This is especially in the cases involving anthropathy. Blood transfusion is needed for patients with transient aplastic crisis. This is only used as a supportive therapy.

This is used until the neutralizing antibodies can clear the virus and there is restoration of the hematopoiesis (Waldman and Kopp, 2007). For pure red cell aplasia, there are several options available for treatment. This is also the case for persistent infection in immunocompromised patients. Especially those with B19 specific antibodies in minimal concentrations or absent. The use of a commercial Ig (IVIG) is efficacious in such cases. No controlled studies have been carried out yet (Moudgil *et al.*, 1997; Egbuna *et al.*, *2006*).

There have been a lot of reported regimens with favourable outcomes. These are based on pooled data. A 400mg/kg per dose of the IVIG is used for 5 to 10 consecutive days. This dose is useful in most clinical cases. The clinical responses are evidenced by reticulocytosis, increased levels of hemoglobin and decline in serum viral DNA. There may also be a complete eradication of the viremia in some patients. This is normally seen in transplant patients with highly immunosuppresors. There can thus be a relapse of anaemia for several months. This can even occur after the completion of treatment. With a repeated administration of the IVIG, some patients may experience multiple relapses (Eid *et al.*, 2006). In order to allow the patient's immune response to mature, immunosuppressive medication must be reduced. IVIG use must also be stopped. It can only be used in severe cases (Geetha *et al., 2000*).

2.4 Clinical features and prevalence of B19

Parvovirus B19 is linked with a number of clinical disorders. This has been its case after its discovery as an etiologic agent. It is also seen in one of two ways. Its either an occasional body wide rash or a facial rash. Complication sin pregnancy is also linked to parvovirus B19. Others are acute arthroplasty and diseased patients with compressed immunity. The transien aplastic crisis is also a part.

2.4.1 Chronic infections of B19

Infections of B19 occur everywhere in the world. It is also known to occur all season. There is an increase in seroprevalence with an increase in age. This is also seen in an increase in adulthood. Cohen and Buckley (1988) in their study concluded that the adult population accounted for at least 70% of patients with parvovirus B19 IgG seropositive. Seronegative children are a significant reservoir for the B19 infection. B19 outbreaks can thus persist in

schools for months. In day care centers, children are the major sources of B19 transmission. This is because there exist a lot of seronegative children. These are in closer contact in the environment with other healthy children (Grilli *et al.,* 1989). During endemic periods, the annual seroconversion rate for women at child bearing age is 1.5%. It is estimated to be 13% for these same women during epidemics (Valeur-Jensen *et al., 1999*).

Arthralgia's and arthritis are the major conditions linked to the infections. In adults these are common. Children can also have these conditions (Reid *et al.,1985*). This is similar to the rubella outbreak. Joint symptomologies have been reported to occur in about 50% of the cases involving adults. Normally these conditions persist for a month (Cassinotti, 1995). There also exist a symmetric association between B19 and arthritis. This condition affect wrist, hands and smaller joints of the hand (Reid *et al.,* 1985).

Females have this condition more when compared to males. In women 60% show symptomatic disease. Arthopathy signs are also seen in the women (White *et al., 1985;* Woolf *et al., 1989*). It has been shown that within three weeks the symptoms diminish. There are no permanent damages to the joint in this case (Woolf et *al.*, 1991). It has also been shown that persistent or recurrent arthroplasty is experienced by close to 20% of the women. Patients with associated rash account for 75% of the patients. 20% have slapped cheeks facial exanthema. It is hypothesized that arthritis associated with B19 has links to patients with haplotypes of human leucocyte antigen (HLA). For those who exhibit increased susceptibility, they are classified as HLA DR4 or B27 (Jawad, 1993).

B19 symptoms which are associated with arthritis has not been clinically proven. In the development of B19 specific antibodies, arthritis has been seen to occur. There is a suggestion that the formation of an immune complex could account for this. The P antigen in

this case is expressed on synovium. These synovial cell membranes are also parvovirus B19 non-permissive (Mikki and Chantler, 1992; Cooling *et al.,* 1995). In some cases, the B19 gets access to the positive receptor cells. These are normally the non-active dividing cells. There is an excess production of cytotoxic as a result (Ennis *et al.*, 2001). The expression of pro-inflammatory cytokine is induced by the presence of an NSI protein.

Cell damage and inflammations can be caused by this action. Patients who have B19 associated with arthritis, inflammatory and autoimmune disorders normally have this condition (Mitchell, 2002). Precise antibodies which act against the nonstructural proteins have not been seen. In a study by von Poblotzki *et al., (*1995a*),* specific NS1 antibodies were identified in patients with Human parvovirus B19. These were not seen in the convalescent serum. This suggest a differential host response in the cohorts. It has been suggested in works of Von Landenberg *et al., (*2003*)* that B19 is associated with the induction of an autoimmune reaction. Anti-phospholipid antibodies can also be a part. This is because they are persistent in Human parvovirus B19 infected individuals. Chronic infection of parvovirus B19 is significant in pregnancy. Viral infections may be facilitated by the status of the maternal immune system (BuItmann *et al.*, 2005).

The chronic infection is because B19 DNA persist in the bone marrow. It is also seen in the blood of the periphery. Patients with associated chronic arthroplasty may also have their synovial tissues with the B19 infections (Toivanen, 1995). The B19 DNA also persist in synovium tissues. This was seen in 28% of children who had chronic arthritis. In another case 48% of the seropositive immune competent volunteers had the B19 DNA. This information suggests an indirect association between chronic arthroplasty and B19 DNA. No B19 was found in the samples of individuals tested. The test result for the parvovirus B19 IgG antibodies was positive (Soderlund *et al.,* 1997). Lehmann *et al.,*

(2003), has found linkage for rheumatic childhood disease and parvovirus B19. This study elucidates significant differences in the serum. From the parvovirus B19 DNA the synovial fluid was derived. Results for between group control was 7%. That of the patients was 35%. The study concluded that the rate of persistent b19 infection was significantly higher than in age-matched controls.

In another study there has been a 64% B19 DNA found in the biopsies of the control group. In the chronic urticarial patients, they found 50%. This is a confirmation that patients must exercise caution in drawing conclusions regarding the Human parvovirus B19 and its involvement in skin disorders. In B 19 clinical disorders, these are seen (Vuorinen *et al., 2002*).

2.5 Building immunity to B19 infection

2.5.1 Immunity through antibody mediated response

Exposing immune competent patients to the Human parvovirus B19 exposes them to viraemia. This is especially at high titre Human parvovirus B19 concentrations. The viraemia normally occurs within a week. This lasts for about 5 days. In the first two days the viruses peak is achieved. There is a late detection of the parvovirus B19 antibodies. These were found in the viraemic stage. This is usually between the 10 to 12 day and persist for up to 5months post infection (Anderson *et al.,* 1985; Schwarz *et al.,* 1988; 1988)

This can be longer in some patients (Musiani *et al.*, 1995). After 15 days of post infection, the B19 specific antibodies appear. For several months they remain elevated. They can persist for several months. During this period the antibodies against VP1 and VP2

proteins may disappear. This occurs when there is B19 infection. The linear epitopes of the VP1 and VP2 proteins may also have some antibodies persisting against them.

In such cases the Human Parvovirus antibodies are detected for only shorter periods (Soderlund *et al.,* 1995: Kerr *et al.,* 1999). After this there is an onset for the manifestation of the Human Parvovirus B19 clinically (Erdman *et al.,* 1991). There is little attraction for knowledge on the diagnostic markers for infection. The viral clearance corresponds to the development of HPV specific antibodies. Immune competent individuals are protected from infections. These occur in a vast majority of the cases (Anderson *et al.,* 1985). The protective and neutralizing properties of the B19 antibodies are yet to be established.

One episode of HPV B19 transient crisis has been detected in children (Serjeant *et al.*, 2001). This is a confirmation for the absence of a re-infection. The VP1 protein for Human parvovirus B19 and the VP1u are immune dominant antigens. They are essential when incorporated in serological assays (Rayment *et al.*, 1990). The absence of antibodies to the VP2 proteins was found as evidence for this. This was seen when screen by the Western Blot. It was shown to be erroneous. There is maintenance of VP2 when the B19 IgG are acted against the VP1u. This is especially when there is a loss of VP1u. this was conclusively established (Corcoran *et al.*, 2002).

There is an emerging role for cellular immunity against infections by B19. In this case specific antiviral antibodies represent the mechanisms for immune protection. Circumstantial evidence has been given for this path. For infected patients, a high dose immunoglobin therapy is required (Schwarz *et al.,* 1990). There may also be persistent infections. These are associated with chronic anaemia. This is when an immune response has failed in producing a

neutralizing antibody. It is also seen when they have very low levels (Coulombel *et al.*, 1989)

2.5.2 Cellular immunity

When compared to humoral response, there has not been comprehensive work done on the cellular immunity. Works on cellular immunity has not been done comprehensively when compared to the humoral response. This is because antibodies were thought to be vital in combating HPV B19 infections. No success was achieved in the initial attempts at proliferative responses to B19 by T cells (Kurtzman *et al.*, 1989). It was agreed that immunity to HPV B19 was conferred by the neutralizing antibodies. CD4+ cell responses were detected in 1996. These are the ex vivo HPV B19. These were targeted at *E. coli.* VP1, VP2 and NS1 antigens were expressed in this study (Poblotzki *et al.*, 1996). There was an ex vivo analysis of 16 individuals to T cells. 62.5% (10) were found to be seropositive. The remaining 37.5 (6) were seronegative blood donors. There was no acute infection in all samples.

The seronegative cohort was stimulated with VP2. This lead to 90% displaying specific T cell response. VP1 responses accounted for 80%. For T- cell proliferation for NS1, no significant differences were observed. This was for both the seronegative and positive patients. The study also included HLA class, I and II monoclonal antibodies. This is an indication that the effector T cell populations and CD4+ cells are the same. This was confirmed by a depletion of peripheral blood mononuclear cell. It was also confirmed by the cells depletion.

Ex-vivo T-cell reactivity in PBMC have been studied by a number of researchers. Such studies were carried out on infected individuals. The study utilized the parvovirus B19 candidate's vaccine. The setting was a remote environment. The study used B19 recombinant proteins (Franssila *et al.,* 2001; Corcoran *et al.,* 2000). Strong T-cell stimulation response was displayed by the infected patients. They responded to the B19 capsids. An average of 36 simulation indices was recorded (Franssila *et al.*, 2001). A comparable rate of T cell stimulation was shown by blood donors with past infections. The seronegative individuals in the study had an SI of 3.3. The study population also responded to the CD4+. No difference was found in T cell response to NS1. This was for both the seronegative and seropositive patients (Poblotzki *et al.,* 1996). Infected persons have responded to this antigen. Patients with chronic arthroplasty following B19 have also developed response (Mitchell *et al.,* 2001). For healthy individuals with a past history of infection, there was a response to NS1 by the T cells. Two individuals were exempted from this scenario. The two had NS1 IgG seropositivity.

An investigation was carried out for cellular immune response to a 15mer epitope. This was an NS1 specific for cytotoxic CD8+ T cell. A histocompatibility complex was used for this study. The study utilized a tetrameric binding complex (Tolfvenstam *et al.,* 2001b). The study obtained responses from 21 individuals. Persons used had HIV – 1. They included both adults and children. In all 16 were HLA matched. The remaining 6 were mismatched. CD8+ T cells were displaced for 63% of the respondents. For individuals in the same cohort, there was a 72% match. This caused interferon- gamma (IFN-g) production. The study found that there were similarities in CD8+ T – cells in healthy patients and individuals with HIV.

The study revealed the role of cellular cytotoxic T cells. Their role was found to be important. This was the T-cells which combated B19 infection (Tolfvenstam *et al.*, 2001b). Responses of T cells can be used as novel methods for confirming past B19 infections. This can be the case when various combinations of analytical approaches are used (Norbeck *et al.*, 2005). The combination induces a T cell response. These can be maintained for up to

2 years. This is when after an immune competent female has been infected with B19. A number of CD8+ T cells were identified by the authors. These were located in the B19 NS1 protein.

For the VP2 peptides, 2 out of 5 respondents were responsive. There was no response for the VP1u peptides. The CD4+ are directed towards the structural B19 proteins. For the NS1 proteins, the CD8+ cytotoxic have been directed against them (Norbeck et al., 2005). The B19 has been postulated as a model organism for viral host interactions.

The importance of an evaluating T-cell response has been demonstrated in works of Chen *et al., (2001)*. This was done to understand the nature of the B19 infection. Chen *et al.*, (2001) identified an HIV patient. This patient had persistent human parvovirus B19. Initially, there was a remission for the B19 infection in the patients. Despite the lack of as specific antibody response, this scenario was evident. The role of a cellular immunity in combating the Human parvovirus B19 was thus indicated. In two of the Human parvovirus B19, NS1 lymphocytes were detected. These were seronegative individuals. The individuals had exposure to parvovirus B19. A subclinical HPV B19 infection was thus indicated as possible. A loss of an antibody against the protein capsids was also seen as a possibility (Mitchell *et al.*, 2001). Tolfeenstam (2001b) identified two healthy immune competent individuals. The author also identified an HIV-1 infected patient. Again a

seronegative patient was identified. All these patients had CD8+ T cells. The cells were responsive against the human parvovirus B19.

With VP1 and VP2 stimulation, there are higher levels of IL2. Production of IFN-g and IL-2 are observed in B19 seronegative pregnant women. It was lower than in previously observed non pregnant women (Corcoran *et al.,* 2003). The effect of maternal immunity during pregnancy to HPVB19 has been studied (Franssila *et al., 2005*). Their study revealed weaker T cells and cytokine secretions. These were detected in infected pregnant women. No IL-10 was found in the B 19 women when compared to the controls. IFN-g response was displayed by some patients who had no symptoms. This was relative to the VP2 capsid only when they were compared to the other pregnant women. This was seen in the loss of asymptomatic case in B19. The authors claim that pregnancy may contribute to pathogenicity of the HPVB19.

Increased levels of inflammatory cytokine are caused by the expression of NS1. These occur in cell lines. The cells include hematopoietic and human umbilical vein endothelial cells (Moffat *et al.,* 1996). Evidence exist to suggest that production of IL2 determines the outcome of gestation. This is for women with maternal foetal interface who seroconvert during pregnancy. There is also a trend towards CD3+ T cells and IL2 secretions. These can be found in pregnancies on the foetal side. The outcomes in these cases are poor. Favourable prognosis are associated with IL2. These are normally on the maternal side. They can be found within the intervillous space (Jordan *et al.,* 2001).

2.6 Detection of HPV B19 IgM

Detection is confirmed by the presence of a B19 IgM reactivity. The IgG reactivity can also detect the past infections (Anderson *et al.,* 1985). The IgM antibodies can appear from 7 to 10 days. These occur post infection. These are directed against conformational and linear epitopes of the VP1 and VP2 (Manaresi *et al.,* 2001). Presently, a B19 IgM test kit have been made available. The United States Food and Drugs administration has approved this test kit. It is also used as a marker for infections in pregnancies. The enzyme immunoassay techniques are used in this test. The B19 VP2 capsid is used in detection. The sensitivity of the immunoassay is pecked at 89.1%. A specificity of 99.4% was achieved (Doyle *et al.,* 2000). This has been used in diagnosis (Jordan, 2000; Mitchell *et al.,* 2001; Vuorinen *et al.,* 2002). There has been an alteration in the cutoff for the immunoassay.

2.7 Detection of HPV B19 IgG

When HPV B19 IgG antibodies are exposed to Human parvovirus B19, there are changes. This happens when it coincides with the diminishing IgM antibody response. The IgG reactivity against the VP1 and VP2 persist. These are against the conformational epitopes. It occurs post infection. There is however a decline in the post infection for both capsid proteins. This happens against the VP2 abruptly. For the VP1, it occurs slowly (Kaikkonen *et al.,*

1999; Kerr *et al.,* 1999; Manaresi *et al.,* 1999). There are significant consequences for diagnosis. The reactivity of the antibodies is directed against the heptapeptides.

An inter assay data has been conducted. It used blinded analysis of unreactive panel. The study found a reproducibility associated with B19 immunoassay. A comparative study was conducted for the baculovirus based immunoassay and the E coli based VP1 immunoassay. There is a confirmation of a B19 infection. This is done by standardizing an IgG. This can

be done when there is an availability of international standards. Different test systems can be used in detection. The second international standard code is 01/602; 77 IU/ampoule (Ferguson *et al.*, 1997; Searle *et al.*, 1997).

No significant differences were seen between the NS1 IgG in control patients. These were found in a number of studies. This was also compared to past infections and those that had chronic cases (Searle *et al.*, 1998; Venturoli *et al.*, 1998; Jones *et al.*, 1999). The B cell epitopes have been mapped by Tolfvenstame *et al., (*2000*).* This was done on NS1. Three antigenic regions have been identified in these studies. All three exhibited reactivity towards the antibodies from healthy patients. These were patients with past B19 infection cases. They also included B10 infected patients. It has been shown that the NS1 IgG reactivity is prevalent in serum. This is especially seen in infections in pregnant women. They accounted for 61% of the study population (Hemauer *et al.*, 2000).

2.8 Blood product safety

There is no strategy in managing infections caused by B19 infections during pregnancy. Intravascular transfusions are used in some cases in treatment. In one such study 539 specialists were used. 6% of the cases had deaths. For those who did not the transfusion the death rate was 30% (Rodis et al., 1998).

This treatment is not effective. Another study utilized 100 study participants. These participants were healthy volunteers. A 1-unit plasma was given to individuals who were found to be sero negative for B19. This was either a solvent or treated detergent (Davenport *et al.*, 2000). In this study some of the participants had seroconverted over the previous three

months. These participants after screening had incidence of parvovirus B19. They accounted for 18% of the participant. High levels of B19 were found in three of the batches that had high amounts B19. The batches used coincided plasma administered to the volunteers. Currently some of the plasma are eliminated during manufacture. These are those with high B19 levels. The minimum amount of virus that cannot cause a disease is yet to be detected. A retrospective study in plasma pool has been studied by Daly *et al.,* (2002). Their study utilized the data of Davenport *et al.,* (2000). The transfused blood was contaminated with plasma. This can only be done at low levels of the parvovirus B19. Two incidences of B19 transmission have been identified by Blumel *et al., (*2002*).* They were seen by separate transmission of lots of clotting factors

2.9 Treatment and vaccination of Parvovirus B19

High titre IVIG administration has been proven to be successful in treating patients with chronic infections. This treatment is however expensive (Lui *et al.*, 2001). IVIG treatment does not work in all cases.

Pregnancy must be allowed to proceed if B19 infection during pregnancy. It should however be carefully monitored. Presently no reliable way has been given for the prognosis of individual fetuses. Pregnancy termination must not be recommended (Barrett *et al.*, 1994).

CHAPTER THREE

METHODOLOGY

3.1 STUDY METHOD

The research is a cross sectional study conducted among blood donors at the Bolgatanga regional hospital (Blood bank) and the national blood bank, korle- bu from March 2019 to March 2020.

3.1.1 Research setting

The Upper East Region formerly called the Upper Region (Upper East and Upper West Regions) was separated from the Northern Region in 1960. The Upper East Region has its regional capital at Bolgatanga, popularly called Bolga. The Region shares boundaries with Burkina Faso at the north, Upper West Region at the west, with the Republic of Togo at the east and to the south with the Northern Region. The Region has a total land area of about 8,842 square kilometres with flat land and few hills. According to the 2010 population and housing census report from the Ghana Statistical Services (GSS), the Upper East Region has a total population of 1,046,545 people (GSS, 2012). The Region is divided administratively into fifteen (15) Municipalities and Districts Assemblies namely the Bolga Municipal, Bolga East District, Bawku Municipal, Bawku West District, Pusiga District, Binduri District, Kassena-Nankana West District, Kassena-Nankana East District, Bongo District, Talensi District, Nabdam District, Garu District, Tenpane District, Builsa North District, and Builsa South District. The religious groupings in the region are Christian, Traditionalist, and Islam. The languages spoken by the people in the Region are Gurune, Builsa, Kassem, Nankane, Kussal, Nabdan, and Talene.

The Regional Hospital was the setting for the study and is located in Bolga Municipal precisely Zaare community. The hospital is situated about 200 meters close to the Ghana Broadcasting Co-operation. The Hospital was established on 13th January 1953 to take care of a small number of patients. The Regional Hospital currently has a total bed capacity of 381 after some rehabilitation works completed in 2016. The hospital remains the largest hospital in the Region and receives referrals from the District Hospitals, Health Centres, and Private Hospitals. The hospital currently has a staff strength of 612 with a nurse to patient ratio of 1:18 (Annual Performance Review Report, 2017)

3.2 Study Population

The study population refers to all the people who meet the specific condition for the study (Alvi, 2016). It is also the population that the researcher will be inferring the findings of the study. The study involved healthy males and females who visited the blood bank to donate blood voluntarily or for a relative (family replacement) and have passed both the medical and laboratory examination prior to donation.

3.3 Sampling and sample size

The sample size was drawn from the accessible population for the study that is patients and volunteers at the Blood bank. The accessible population was determined by calculating the average of a six-month period of patients' who donate blood. Data from the Upper East Regional hospital quality assurance committee indicated that an average number of patients. From this data, the sample size was determined by using Yamane (1967) sample calculating formula as follows:

The sample size was calculated using the formula;

$n = \frac{Z^2pq}{}$ (Mugenda and Mugenda, 2003)

d^2

Where n = the desired sample size

Z = the confidence interval (1.96)

d = the standard deviation

p = the proportion in the target population estimated to have the same characteristics being measured. (0.122)

q = 1 – p (0.89)

Hence n = $\frac{(1.96)^2(0.122)(0.89)}{(0.05)}$ =167participants.

3.4 Sampling method

All donors who met the inclusion criteria and consented were used for the study. The study protocol required that every blood donor who consented were taken through pre-donation counselling and then interviewed using a well- structured questionnaire. Blood donors were recruited each day at the selected blood banks until the required sample size was obtained.

3.5 Inclusion criteria

All persons who visited the blood bank to donate blood and pass both the medical and laboratory examinations and consented to be part of the study were included.

3.6 Exclusion criteria

All persons who visited the blood bank to donate and did not pass their medical and laboratory examination were excluded and also individuals who did not consent to be part of the study were excluded

3.7 Questionnaire Administration

This study used a structured questionnaire. It was administered to the blood donors. These were only those who concerted to the study. Information obtained included socio-demographic characteristics, clinical data and risk factors. These were taken in reference to human parvovirus B19 infection.

3.8 Specimen collection and testing

After the recruitment, 5ml of blood samples were taken from the participants, spun and plasma separated for use in the testing. If sample could not be analyzed straight away, they were frozen to be worked on later. The participant's sera were tested for Human Parvovirus B19 with IgG and IgM using the enzyme-linked immunosorbent assay (ELISA) test. This was based upon the use of micro titer strip wells precoated with parvovirus B19 antigens (conformational epitopes of VP-2 and linear epitopes of specific part of VP-1). These were used in binding antibodies to the specimen. The manufacturers' instructions were followed in all steps. The ELISA microwell plate reader was used in taking readings. This was done at a wavelength of 450nm.

3.9 ASSAY PROCEDURE FOR IgG

Precautionary steps were taken during the procedure to ensure precision and accuracy. All reagents and chemicals were brought to room temperature. This was done before a test run was conducted. Aseptic conditions were observed in conducting the test.

The solution was diluted. This was done in the following manner: 10µL of sample + 1ml of sample diluent. It was mixed well before pipetting. The required number of micro titer strips

or wells were selected and inserted them into the holder. It was then dispensed. The wells were covered with foil and incubated for 60 minutes at 37^0C. The contents were briskly shaken. The wells were rinsed 5times with diluted wash solution (300ul per well). Striking of the wells sharply was done on absorbent paper to remove residual droplets. 100µL

Enzyme Conjugate were dispensed into each well and incubated for 30minutes at room temperature (20^0C to 25^0C). The contents of the well were shaken. 100µL of substrate solution was added into all wells. They were incubated for exactly 15minutes at room temperature (20^0C to 25^0C) in the dark. The enzymatic reaction was stopped by adding 100µL of stop solution to each well. The optical density was read at 450/620nm with a micro titer plate reader within 30minutes after adding the stop solution.

3.9.1 Interpretation of Results

POSITIVE sample (mean) absorbance values more than 20% above CO (Mean OD sample >1.2×CO)

GREY ZONE Samples (mean) absorbance values from 20%

20% below CO repeat text 2-4 weeks later with new fresh sample draw (0.85×CO≤ mean OD samples ≤ 1.2×CO) Results and the second test again in the Grey Zone =>

NEGATIVE samples (mean) absorbance values more than 15% below CO (Mean OD sample <0.85×CO)

(CO=CUT OFF, OD=ABSORBANCE)

3.10 ASSAY PROCEDURE FOR IgM

All reagents were brought to the room temperature (20-25^{0}C) before starting the test. The reagents were mixed gently prior to use without inducing foaming. A clean, disposable tip was used for dispensing each control and sample.100µl controls were dispensed together with diluted samples into their respective wells. They were incubated for 1 hour at 37^{0}C. After incubation, each well was washed three times with 300µl of washing solution.100µl parvovirus B19 anti-IgG Conjugate were dispensed into all wells except for the blank well. It was incubated in room temperature for 30 minutes. Each well was washed three times after incubation. This was done with 300µl of washing solution. About 100µl of TMB substrate solution was dispensed into the wells. This was incubated for 15 minutes under room temperature. This was done in the dark. A 100µl stop solution was dispensed into the wells. Measurement of optical density was carried out. This was done at a 450nm wavelength.

3.10.1 Interpretation of results

Samples were considered POSITIVE if the absorbance value was>10% of cutoff value. Samples were considered NEGATIVE if the absorbance value was <10% of cut-off value. Samples with an absorbance value of 10% above or below the cut-off value were considered to be in GREY ZONE. It was recommended to repeat the test again 2-4 weeks later with a fresh sample. If the second test was again in grey zone, the sample was considered NEGATIVE

3.11 INFORMED CONSENT

All the study details were explained to the donors in vernacular language and consent was obtained. Ethical clearance was obtained from the ethical and protocol review committee of the School of Biomedical and Allied Health

Science as well as the institutional ethical committee of The National blood bank and Bolgatanga regional hospital.

3.12 Data collection process and tools

Blood donors were interviewed by trained data collectors using the questionnaire to collect information on some socio-demographic factors as well as some behavioral factors. The laboratory screening outcomes of the various infections tested was recorded for each blood donor that was interviewed.

3.13 Data analysis

The data obtained from the study was analysed using SPSS 20. This was mainly for the questionnaire and laboratory test results. The results from the data were presented in tables. The prevalence for each viral infection was calculated. They were expressed as percentages. Correlation analysis was conducted to find the relationship between variables. A pearson chi-square analysis was conducted. The relationship between the socio-demographic characteristics and clinical manifestations were determined. P value of 0.05 was considered.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

4.1.1 Demographic Characteristics of Participants

This section presents the demographic characteristics of the participants (table 1).The outcome of the study shows that majority (93.7%) of the participants were male. Also, more than half (70.7%) of the participants were between the ages of 30 and 39 years. It was also seen that majority of the participants were educated as most of them had completed secondary education and nearly half (43.1%) have had tertiary education. It was also noted that majority (65.9%) of the study population were married. Only 3.6% of the participants were widowed.

The risk factors associated with the parvovirus were also studied. The findings showed that none of the participants had had a blood transfusion before. However, about 79 (47.3%) of them have given or donated blood before and out of these, 59.49% donated blood more than 10years ago and about 26.58% had also donated blood between 1 to 5 years. About 7 people representing 8.86% of the participants had donated blood in less than a year. The results also showed that only 2 (1.2%) of the participants had undergone surgery in the past. Only 38 (22.8%) of the participants have received the hepatitis B vaccine meaning majority 129 (77.2%) of them have not received hepatitis B vaccine. The results also show that none of the participants had multiple sex partners and majority (98.8%) used condoms during sexual intercourse. Also, none of the participants abused drugs, share needles or smoked but 49 (29.3%) of them have tasted alcoholic beverages before which showed that the majority of about 70.7% do not drink alcohol (Table 2).

Table 1: Demographic characteristics of participants

	Characteristics	Frequency	Percentage (%)
Sex	Male	156	93.7
	Female	11	6.6
Age	18 – 19 years	23	13.8
	20 – 29years	26	15.6
	30 – 39years	118	70.7
Education	None	13	7.8
	Primary	15	9
	Secondary	65	38.9
	Tertiary	72	43.1
	Quaternary	2	1.2
Marriage	Single	51	30.5
	Married	11	65.9
	Widow	6	3.6
Occupation	Businessman	34	20.4
	Civil servant	11	6.6
	Driver	2	1.2
	Farmer	8	4.8
	Health worker	9	5.4
	Student	43	25.7
	Other	60	35.9
Blood transfusion	Yes	0	0
	No	167	100
Blood Donation	Yes	79	47.3
	No	88	52.7
Donation period	Less than 1 year	16	8.86
	1 – 5 years	44	26.58
	6 – 10 years	8	5.06
	More than 10years	99	59.49

Table 2: Medical and lifestyle activities

	Characteristics	Frequency	Percentage (%)
Surgery	Yes	2	1.2
	No	165	98.8
Hepatitis B vaccine	Yes	38	22.8
	No	129	77.2
Multiple sex partners	Yes	0	0
	No	167	100
Condom use	Yes	165	98.8
	No	2	1.2
Drug use	Yes	0	0
	No	167	100
Sharing needles	Yes	0	0
	No	167	100
Smoking	Yes	0	0
	No	167	100
Alcohol use	Yes	49	29.3
	No	118	70.7

4.2 Prevalence of Parvovirus B19 IgG and IgM among age groups and education

The IgG and IgM of the participants were also determined and the results are displayed in Table 3. The results showed that 10 (6%) of the participants were reactive for IgM whilst the majority (94%) were non-reactive.

With respect to IgG, the study revealed that 108 (64.7%) of the participants were reactive while 59 representing 35.3% were non-reactive.

Table 3: Reactivity and Prevalence of IgG and IgM

IgM		**IgG**			
		Reactive	Nonreactive	*Reactive*	Nonreactive
Sex	Male	*9 (5.39%)*	147 (88.02%)	*104 (62.23%)*	52 (31.14%)
	Female	*1 (0.59%)*	10 (5.98%)	*4 (2.44%)*	7 (4.19%)
Age	18 – 19	*1 (0.59%)*	22 (13.17%)	*12 (7.19%)*	11 (6.59%)
	20 – 29	*1(0.59%)*	25 (14.97%)	*16 (9.58%)*	10 (5.98%)
	30 – 39	*8 (4.80%)*	110 (65.87%)	*80 (47.90%)*	38 (22.75%)
Education	None	*0*	13 (7.78%)	*12 (7.18%)*	1 (0.59%)
	Primary	*2 (1.20%)*	13 (7.78%)	*14 (8.38%)*	1(0.59%)
	Secondary	*3 (1.80%)*	62 (37.12%)	*43 (25.75%)*	22 (13.17%)
	Tertiary	*5 (2.99%)*	67 (40.12%)	*37 (22.16%)*	35 (21%)
	Quaternary	*0*	2 (1.20%)	*2 (1.20%)*	0

From the table above, it can be seen that for IgM, majority of the males (5.39%) were reactive as compared to females (0.59%). It can also be seen that the males were about 5 times reactive compared to females. Again, the age group that was more reactive was the ages between 30 and 39 years. They accounted for 4.49%. For educational background, the study showed that participants with a quaternary education recorded 0% of reactivity. On the other hand, participants with tertiary education were highly reactive when compared to the primary and secondary education levels. For IgG, majority of the male participants were reactive and accounted for 62.23%. Females who were reactive recorded 2.40%. The study also showed that 80 (47.90%) participants who were within the ages of 30 – 39 years were IgG reactive. The least reactive age was recorded by participants who were below 19 years. For education, the majority reactive group was recorded by those with secondary education (25.75%), followed by tertiary (22.16%), primary (8.38%) and those with no education

recorded 7.18%. The least reactive group was recorded by participants with quaternary education (1.2%).

4.3 Prevalence of parvovirus B19 IgG and IgM according to blood donation and history of blood donation

The prevalence of parvovirus B19 related to blood donation and donation history are recorded in Table 4. The outcome of the study also showed that out of the participants who had donated blood 1.8% were reactive and 4.19% of the participants who had not donated blood were also found to be reactive. The study also shows that about 5.99% of the participants who had not donated blood were reactive.

Table 4: IgG and IgM according to blood transfusion

IgM		**IgG**			
		Reactive	Nonreactive	*Reactive*	Nonreactive
Transfused	Yes	*0*	0	*0*	0
	No	*10 (5.99%)*	157 (94.01%)	*108 (64.67%)*	59 (35.33%)
Blood donation	Yes	*3 (1.80%)*	76 (45.51%)	*50 (29.94%)*	29 (17.37%)
	No	*7 (4.19%)*	81 (48.50%)	*58 (34.73%)*	30 (17.96%)
Donation period	Less than 1 year	*0*	7 (4.19%)	*3 (1.80%)*	4 (2.4%)
	1 – 5 years	*0*	21 (12.57%)	*12 (7.19%)*	9 (5.39%)
	6 – 10 years	*0*	4 (2.40%)	*2 (1.20%)*	2 (1.20%)
	Can't remember	*10 (5.99%)*	125 (74.85%)	*91 (54.49%)*	44 (26.35%)

From Table 4, it is seen that 108 (64.67%) of the participants who had not had a blood transfusion were reactive. Only 59 representing 35.33% of the participants in that category were not reactive. For participants who had donated blood, the study showed that 50 representing 29.94% were reactive and 34.73% of the participants who had not donated

blood before were also found to be reactive. 91 participants representing 54.49% of participants who had not donated blood were found to be reactive.

4.4 Prevalence of Parvovirus B19 IgG and IgM according to Medical and Lifestyle Characteristics

The medical and lifestyle practices of the participants were also studied in relation to parvovirus B19 reactivity and the outcome is summarized in Table 5. The medical and lifestyle practices included surgery, hepatitis B vaccination, having multiple sex partners, condom use, use of drugs, sharing needles, smoking and alcohol use (Table 5).

Table 5: IgG and IgM results according to medical and lifestyle characteristics

IgM		IgG			
		Reactive	Nonreactive	Reactive	Nonreactive
Surgery	Yes	0	2 (1.20%)	1 (0.60%)	1 (0.60%)
	No	10 (5.99%)	155 (92.81%)	107 (64.07%)	58 (34.73%)
Hepatitis B vaccine	Yes	1 (0.60%)	37 (22.16%)	20 (11.98%)	18 (10.78%)
	No	9 (5.39%)	120 (71.86%)	88 (52.69%)	41 (24.55%)
Multiple sex partner	Yes	0	0	0	0
	No	10 (5.99%)	157 (94.01%)	108 (64.67%)	59 (35.33%)
Condom use	Yes	10 (5.99%)	155 (92.81%)	106 (63.47%)	59 (35.33%)
	No	0	2 (1.20%)	2 (1.20%)	0
Drug use	Yes	0	0	0	0

	No	10 (5.99%)	157 (94.01%)	108 (64.67%)	59 (35.33%)
Sharing needle	Yes	0	0	0	0
	No	10 (5.99%)	157 (94.01%)	108 (64.67%)	59 (35.33%)
Smoking	Yes	0	0	0	0
	No	10 (5.99%)	157 (94.01%)	108 (64.67%)	59 (35.33%)
Alcohol	Yes	7 (4.19%)	42 (25.15%)	29 (17.37%)	20 (11.98%)
	No	3 (1.80%)	115 (92.81%)	79 (47.31%)	39 (23.35%)

With respect to IgM, the study showed that 10 (5.99%) of the participants who had not have surgery before were reactive. The remaining 92.18% were not reactive. Of the participants who had had hepatitis B vaccination, only 1 (0.60%) was found to be reactive while 22.16% were found not to be reactive. Further, 9 (5.39%) of the participants who had not had a hepatitis B vaccination were found to be reactive. The study also revealed that only 5.99% of the participants with a single sex partner and used condoms were reactive. None of the participants used drugs, shared needles or smoked, but 5.99% of those in that category were found to be reactive. For the participants who consumed alcohol, 7 (4.19%) were found to be reactive while 3 (1.80%) of those who did not consume alcohol were also found to be reactive.

When medical and lifestyle characteristics were related to IgG reactivity, majority (107 (64.07%)) of the participants who had not had surgery before were found to be reactive. Only 1 (0.60%) respondent who had undergone surgery was found to be reactive. The study also revealed that 20 (11.98%) of the participants who had received the hepatitis B vaccine

were found to be reactive while 88 (52.69%) who had not received the vaccine were reactive. It was also seen that 108 (64.67%) of participants who did not have multiple sex partners, used drugs, shared needles or smoked were IgG reactive. For condom use 106 representing 63.47% of the participants were reactive while 2 (1.20) of the participants who did not use condoms were not reactive. Furthermore, 79 (47.31%) of participants who did not consume alcohol were found to be reactive whilst only 29 participants representing 17.37% of those who consumed alcohol were found to be reactive.

4.5 Correlation analysis

Correlation analysis was conducted to determine the extent of the relationship between IgG and IgM reactivity and the various risk factors (Table 6). The results revealed that there was a negative relationship for all the risk indices with respect to IgM. Only alcohol use had a positive correlation with IgM. Also, there was a 22.5% relationship between alcohol use and IgM reactivity which was significant at 95% confidence interval.

The study also found negative relationships between age, blood donation, donation period, hepatitis B vaccination and alcohol use with IgG. There was however a positive relationship with sex. The correlation could explain 15.7% of the relationships. These were also significant at a 99% confident interval.

Table 6: Correlation analysis of IgG and IgM and risk factors

	Sex	**Age**	**Blood donation**	**Donation period**	**Hepatitis B vaccine**	**Alcohol use**	**IgM**	**IgG**
Sex	1							

Age	-1.42	1						
Blood donation	0.058	-1.67**	1					
Donation period	-0.072	-1.43	0.38**	1				
Hepatitis B vaccine	0.029	0.111	0.087	0.128	1			
Alcohol	0.012	-1.30	0.101	0.188*	0.058	1		
IgM	-0.035	-0.035	-0.087	-0.117	-0.077	0.225**	1	
IgG	0.157*	-0.114	-0.027	-0.121	-0.137	-0.074	0.028	1

4.6 Summary of Results

Detection of B19 IgM is an indication of recent infections with B19. The presence of B19 IgG confirms its exposure. The detection is optimal in immunoassays which utilize VP2 capsids. Detection of antibody against B19

NS1 proteins can be used to confirm cases. This can only be done when they are associated with standardized VP2 immunoassay

CHAPTER FIVE

DISCUSSION AND CONCLUSION

5.1 Discussion

Data for human parvovirus B19 infection in Africa is limited. These data are critical in health policy formulation. The current study was to determine the sero-prevalence of Human Parvovirus B19 infections among blood donors at selected blood centers in Ghana.

5.1.1 Demographic characteristics

In the study, majority of the study participants were males and this could be attributed to the fact that as far as blood donation is concerned, males have always been in the majority since women generally have low hemoglobin levels and hence are mostly disqualified as blood donors (Alana *et al*., 2014; Tessema *et al*., 2010). Again, certain biological life cycles also naturally do not permit females to part take in blood donation example pregnancy, breastfeeding and menstruation.

It was also see that majority of the participants were within the age range of 30-39 years and this was consistent with other studies (Ampofo *et al.*, 2002). The reason behind this could be that the. economic benefits attached to commercial donation appear to attract people in this age category to blood donation. From the participant characteristics, it was found that more than50% of the participants had completed secondary education. This was similar to a study carried out in Malawi where most of the blood donors studied were secondary school's students (Allain *et al*., 2008).

Again, more than 50% of the participants in this study were married which conforms with an earlier study by Nagalo where more than 52% of the people who showed up for blood

donation were married (Nagalo *et al*., 2011). In the current study, the medical and lifestyle practices of participants were also studies. These include blood transfusion history, surgery, vaccination, condom use, drug use, needle sharing, smoking and alcohol use. The results of the study showed that only 22% had received hepatitis B vaccination.

5.1.2 Prevalence of parvovirus HPV B19 IgG and IgM among age groups and education

This study showed that seropositivity increased with age. The increase in seropositivity with increasing age was consistent with the work of Girei in Jos, (Nigeria) Girei *et al*., 2010) and those reported in other countries (Ooi *et al*., 2002; Salimi *et al*., 2008; Kishore *et al*., 2010). They found that as with increasing age the seropositivity increased. For Parvovirus B19, seropositivity implies immunity.

There is an inverse relationship between seroprevalence with age and B19. When seroprevalence increases with age there is a decrease in B19. This is for people who are susceptible to B19 infection. (Gilbert *et al*., 2005). However, the finding contrasts the result of Ujo and colleagues (2012). They report of an increase in seropositivity with age. This may be because the children used in the study had sickle cell. The present study was however carried out among healthy adults of 18 to 39 years. A survey was carried out in USA. It showed a gradual increase of seropositivity with age. This ranged for children under 10years to 49years. The range was 19% and 67% for children and adults respectively. This suggested a continuous exposure to the virus (Salimi *et al.*,2008).

The health status of individuals is influenced by their education. There are similarities in poverty, malnutrition and high mortality rate in the world. These are similar when compared to education. Educational studies compensate the effects of poverty on health. The availability of a health facility does not change this situation (Kishore *et al.*, 2010). Those

with formal education had the highest prevalence. The non-educated had low prevalence. These are consistent to findings of Kishore *et al., (*2010*).* They conducted analysis on blood donors and reported HPVB19 in India. Their results showed higher prevalence among illiterates and low educated group. The lowest was recorded among the highly educated.

5.1.3 Presence of Parvovirus B19 IgG and IgM

An infection rate of 64.63% has been reported in the current study. A prevalence of 5.98% has also been recorded. These results are consistent with other studies carried out by other authors. Keikha *et al.,* (2006) reported 10.3% IgM antibodies. In their study they found a prevalence of 21.8%. This study was carried out in Iran. Kaur and Basu (2005) also reported that 30 to 60% of their study participants had B19 antibodies. This results indicated an immunity.

In Malawi and Tunisia B19 prevalence of 58.4 and 65% have been reported respectively (Schwarz *et al., 1989*). A prevalence of IgG and IgM antibodies have also been presented. All these studies were related to pregnant women in Libya. The 61% in this region show a high rate of immunity. This is against the low rate of active transmission. This was recorded as 5% in the study (Elnifro *et al.,* 2009).

In the current study, a prevalence of 6% was achieved. This could mean lower proportions of immune individuals were used. Kishore *et al. (2006)* however reported seroprevalence of 39.9%. This was found among participants in India. Their results are consistent with the current study. In their study they concluded that large proportions of North Indians are susceptible to the B19 infection. In Iran, Keikha *et al., (2006),* reported a prevalence of 21.8%. This figure is also consistent with the result of the current study.

The current study reporte IgG antibodies at 64.7%. These are alarming among the current study population. This is because high rates of IgG antibodies are an indication of active transmission. This has subsequent implications. This is based on the active transmission as represented by the IgM.

In the current study, IgM antibodies increased with age. There was however a decrease of IgG with age. There was no statistical correlation for these parameters. The results agree with reports in some European and Indian regions (Kishore *et al.,* 2010: Mossong *et al.,* 2008). This is the case because individuals acquire infection at childhood. A significantly higher rate of IgM antibodies was reported by participants who had donated blood in the past five years. These are in agreement with reports that link parvovirus B19 with blood transfusions. There is the need for routine screening of blood for parvovirus B19. This is in view of the severity of the cases. This must be included in policy documents for transfusion. This is needed especially for those donating to immune-compromised individuals, for example in sickle disease, human parvovirus B19 infection causes transient aplastic crisis due to temporary interruption in the red blood cell production.

5.2 Conclusions

The findings in this study confirmed the presence of Human Parvovirus B19 infection among the study population with sero-prevalence comparable to the rates found in various countries in the world. Sero-prevalence of Human Parvovirus B19 among patients was high leaving a large proportion of the population still susceptible to B19 infection.

This study also showed the effect of formal education, occupation and marriage on seropositivity of individuals to Human Parvovirus B19 and again the relevance of risk factors on the seroprevalence of Human Parvovirus B19

The prevalence of 64.7% obtained for the IgG showed that majority of the participants have been exposed to HPV B19 infection and 6% IgM positivity also shows the virus is active among a relatively good number of the study population. This means Human Parvovirus B19 still poses as a public health problem which must be addressed. It is very important, especially for health providers and policy makers, to recognize the health implication of this virus and design effective preventive programs in relation to blood transfusion

.

5.3 Recommendations

In view of low prevalence Human Parvovirus B19, obtained in this study hence high susceptibility among population there is need for awareness on the virus to educate the public on the risk especially when pregnant and also immunocompromised.

There is also need to investigate the presence of Human Parvovirus B19 among blood donors for probable inclusion as routine screening since Parvovirus B19 can be transmitted through blood products.

There is need for further investigation on the main risk factors associated with HBV infection in the study population.

This study was hospital based, therefore there is need for a community based study, to detect the presence of current infection by detecting IgM and if possible molecular epidemiology researches as well as in the population in order to find out the persistence of Human Parvovirus B19 DNA in tissues.

REFERENCES

Aberham C, Pendl C, Gross P, ZerlauthG, Gessner MA (2001). Quantitative, internally controlledreal-time PCR assay for the detection of parvovirus B19 DNA. *J Virol Methods*; 92:183–191.

Adekanle, O., Ndububa, D.A., Ayodeji, O.O., Paul-Odo, B.,andFolorunso, T.A. (2010).Sexual transmission of the hepatitis B virus among blood donors in a tertiary hospital in Nigeria. *Singapore MedicalJournal*, **51**(12): 944.

Alao, O.O., Girei, A.I., Joseph, D.E., Banwat, E.B.,Araoye, M.O., Orkuma, J., Jombo, G.T.A., and Damulak, D.O. (2010). Effect of Socio-demographic Variables on Anti-Parvovirus B19 Antibody Seropositivity among Children with Sickle cell Anaemia in Jos, North Central Nigeria. *The Internet Journal of Epidemiology*, **8**: 2

Alger LS (1997). Toxoplasmosis and parvovirus B19. Infect Dis Clin North Am; 11: 55–75.

Allain, J.-P., Candotti, D., Soldan, K., Sarkodie, F., Phelps, B., Giachetti, C. (2008). The risk of hepatitis B virus infection by transfusion in Kumasi, Ghana. Blood, 101(6), 2419–2425.

Ampofo, W., Nii-Trebi, N., Ansah, J., Abe, K., Naito, H., Aidoo, S.,Ishikawa, K. (2002). Prevalence of Blood-Borne Infectious Diseases in Blood Donors in Ghana. Journal of Clinical Microbiology, 40(9), 3523–3525

Anderson MJ, Higgins PG, Daies LR, Willman JS, Jones SE, Kidd IM, Pattison JR, Tyrell DAJ (1985). Experimental parvovirus infection in humans. J Infect Dis; 153: 257–265.

Barrett J, Ryan G, Morrow R, Farine D, Kelly E, Mahony J (1994). Human parvovirus B19 during pregnancy. *J Soc ObstetGynaecol Can*; 16: 1253–1258.

Bataille R, Barlogie B, Lu ZY, Rossi JF, Lavabre-Bertrand T, Beck T, Wijdeness J, BrochierJ, Klein B.(1995) Biologic effects of anti-interleukin-6 murine monoclonal antibody in advanced multiple myloma. Blood; 86: 685–
691.

Beersma MF, Claas EC, Sopaheluakan T, Kroes AC (2005). Parvovirus B19 viral loads in relation to VP1 and VP2 antibody responses in diagnostic blood samples. J Clin Virol; 34: 71–75.

Bloch, E. M., Vermeulen, M., & Murphy, E. (2012). Blood Transfusion Safety in Africa: A Literature Review of Infectious Disease and Organizational Challenges. *Transfusion Medicine Reviews*, *26*(2), 164–180.

Blumel J, Schmidt I, Effenberger W, Seitz H, Willkommen H, Brackmann HH, Lower J, Eis- Hubinger AM (2002). Parvovirus B19 transmission by heat-treated clotting factor concentrates. Transfusion; 42: 1473–1481.

Bousquet F, Segondy M, Faure JM, Deschamps F, BoulotP. (2000) B19 parvovirus-induced fetal hydrops: good outcome after intrauterine blood transfusion at 18 weeks of gestation. Fetal Diagn Ther; 15: 132–133.

Brooks, G. F., Carroll, K. C., Butel, J. S. and Morse, S. A. (2007). Jawetz, Melnick & Adelberg‟s Medical Microbiology (Parvoviruses), 24th Edition. The McGraw-Hill Companies, Inc. ISBN-13: 978-0-07- 128735-7, ISBN-10:
0-07-128735-3: 768

Broliden, K., Tolfvenstam,T. and Norbeck, O.(2006). Clinical aspects of Parvovirus B19 infection. Journal of Internal Medicine, 260:285-304.

Bukar, A.A, Abjah, U.A.M., Kagu, M.B., Ladu, A.I., Zailani, S.B., Abba, A.M., Malah, M.B., Ambe, J.P. and Denue, B.A. (2013). Seroprevalence of parvovirus B19 and its clinical effect among anaemic SCA patients in Northeastern Nigeria. *American Journal of Scientific and Industrial Research,*
4 (2): 195-200.

Bultmann BD, Klingel K, Nabauer M, Wallwiener D, Kandolf R (2005). High prevalence of viral genomes and inflammation in peripartum cardiomyopathy. Am J Obstet Gynecol; 193: 363–365.

Candotti D, Etiz N, Parsyan A, Allain JP. (2004). Identification and characterization of persistent human erythrovirus infection in blood donor samples. J Virol; 78: 12169–12178.

Cassinotti P, Bas S, Siegl G, Vischer TL (1995). Association between human parvovirus B19 infection and arthritis. Ann Rheum Dis; 54: 498–500.

Cassinotti P.and Siegl G. (2000). Quantitative evidence for persistence of human Parvovirus B19 DNA in an immunocompetent individual. European Journal of Clinical Microbiology of Infectious Disease, 19:886-895.

Chandra Sharma, D., Rai, S., Bharat, S., Iyenger, S., Gupta, S., & Jain, B. (2014a). A 10 Years Comparative Study to Assess Trends in Seroprevalence of Transfusion Transmitted Infections among Blood Donors at Gwalior, India. *Open Journal of Blood Diseases, 04*(02), 24–32.

Chen MY, Hung CC, Fang CT, Hsieh SM (2001). Reconstituted immunity against persistent parvovirus B19 infection in a patient with acquired immunodeficiency syndrome after highly active antiretroviral therapy. Clin Infect Dis; 32: 1361–1365.

Cohen BJ, Buckley MM (1988). The prevalence of antibodies to human parvovirus B19 in England and Wales. J Med Microbiol; 25: 151–153.

Corcoran A, Doyle S, Allain JP, Candotti D, Parsyan A (2005). Evidence of serological crossreactivitybetween genotype 1 and genotype 3 erythrovirus infections. J Virol; 79: 5238-5239.

Corcoran A, Doyle S, Waldron D, Nicholson A, Mahon BP (2000). Impaired gamma interferonresponses against parvovirus B19 by recently infected children. J Virol: 74: 9903–9910.

Corcoran A, Mahon BP, McParland P, Davoren A, Doyle S. (2003). Ex vivo cytokine responses against parvovirus B19 antigens in previously infected pregnant women. J Med Virol; 70: 475-480.

Cooling LL, Koerner TA, Naides SJ (1995). Multiple glycosphingolipids determine the tissue tropism of parvovirus B19. J Infect Dis; 172: 1198–1205.

Coulombel L, Morinet F, Mielot F (1989). Parvovirus infection, leukemia and immunodeficiency. Lancet: 1: 101–102.

Daly P, Corcoran A, Mahon BP, Doyle S. (2002). High-sensitivity PCR detection of parvovirus B19 in plasma. J Clin Microbiol; 40: 1958–1962.

Davenport R, Geohas G, Cohen S, Beach K, Lazo A, Lucchesi K, Pehta J. (2000). Phase IV study of Plas+sSD:Hepatitis A (HAV) and parvovirus B19 (B19) safety results. Blood; 96: 1942.

Doyle S, Kerr S, O'Keeffe G, O'Carroll D, Daly P, Kilty C. (2000). Detection of parvovirus B19 IgM by antibody capture enzyme immunoassay: receiver operating characteristic analysis. J Virol Methods: 90: 143–152.

Eid, A.J., Brown, R.A., Patel, R.andRazonable, R.R. (2006). Parvovirus B19 infection after transplantation: A review of 98 cases.*Clinical Infectious Diseases*, **43**:40-*48.*

Elnifro, E., Nisha, A.K., Almabsoot, M., Daeki, A., Mujber, N., and Muscat, J. (2009). Seroprevalence of parvovirus B19 among pregnant women in Tripoli, Libya. *Journal of Infection in Devveloping Countries*; **3**: 218-220.

Emiasegen, S.E., Nimzing, L., Adoga M.P., Ohagenyi, A.Y., and Lekan, R. (2011). Parvovirus B19 antibodies and correlates of infection in pregnant women attending an antenatal clinic in central Nigeria. *Memórias do Instituto Oswaldo Cruz*, **106**(2): 227-231

Enders M, Weidner A, Zoellner I, Searle K, Enders G. (2004). Fetal morbidity and mortality after acute human parvovirus B19 infection in pregnancy: prospective evaluation of 1018 cases.

Prenat Diagn; 24: 513–518.

Ennis O, Corcoran A, Kavanagh K, Mahon BP, Doyle S. (2001).Baculovirus expression of parvovirus B19 (B19V) NS1: utility in confirming recent infection. J Clin Virol; 22: 55–60.

Erdman DD, Usher MJ, Tsou C, Caul EO, Gary GW, Kajigaya S, Young NS, Anderson LJ. (1991). Human parvovirus B19 specific IgG, IgA, and IgM antibodies and DNA in serum specimens from persons with erythema infectiosum. J Med Virol; 35: 110–115.

European Pharmacopoeia (2004). European Pharmacopoeia monograph of human anti-D immunoglobulin. Document 01:0557. European Pharmacopoeia, Strasbourg, France.

Fairley CK, Smoleniec JS, Caul OE, Miller E. (1995). Observational study of effect of intrauterine transfusions on outcome of fetal hydrops after parvovirus B19 infection. Lancet 346: 1335–1337.

Ferguson M, Walker D, Cohen B. (1997). Report of a collaborative study to establish the international standard for parvovirus B19 serum IgG. Biologicals;
25: 283–288.

Franssila R, Auramo J, Modrow S, Mobs M, Oker-Blom C, Kapyla P, Soderlund-VenermoM, Hedman K. (2005). T helper cell-mediated interferon- gamma expression after human parvovirus B19 infection: persisting VP2- specific and transient VP1u-specific activity. Clin Exp Immunol; 142: 53–61.

Franssila R, Hokynar K, Hedman K. (2001). T helper cell-mediated in vitro responses of recently and remotely infected subjects to a candidate recombinant vaccine for human parvovirus B19. J Infect Dis; 183: 805–809.

Frickhofen,N. and Young, N.S. (1989). Mini-review:persistent parvovirus infections in humans.*Microbial Pathogenesis*, **7**:319-327.

Geetha, D., Zachary, J.B., Baldado, H.M., Kronz, J.D. and Kraus, E.S. (2000). Pure red cell aplasia caused by Parvovirus B19 infection in solid organ transplant recipients: A case report and review of literature.*Clinical Transplantation,* **14**:586-*591*

Gibbs RS, Sweet RL. (1994). Clinical disorders. In: Maternal Fetal Medicine (Creasy RK, Resnik R, editors). 3rd ed. Philadelphia: W.B. Saunders; pp. 671–752.

Gilbert, N.L., Gyorkos, T.W., Beliveau, C., Rahme, E., Muecke, C. and Soto, J.C. (2005). Seroprevalence of Parvovirus B19 infection in daycare educators. Epidemiology of Infection, 133: 299-304.

Girei, A.I., Alao, O.O., Joseph, D.E., Damulak, D.O., Banwat, E.B., Nwadioha, S.I. and Jombo, G.T.A. (2010). Haematological profile of sickle cell anaemia with human Parvovirus B19 in Jos, North central Nigeria. Journal of Clinical Medicine and Research. 2:9.

Grilli EA, Anderson AJ, Hoskins TW. (1989). Concurrent outbreaks of influenza and Parvovirus B19 in a boys boarding school. Epidemiol Infect; 103: 359–369.

Hansmann M, Gembruch U, Bald R. (1989). New therapeutic aspects in non- immune hydropsfetalisbased on four hundred and two prenatally diagnosed cases. Fetal Diagn Ther; 4:29–36.

Heegaard ED, Petersen BL, Heilmann CJ, Hornsleth A. (2002a). Prevalence of parvovirus B19 and parvovirus V9 DNA and antibodies in paired bone marrow and serum samples from healthy individuals. J Clin Microbiol; 40:
933–936.

Heegaard ED, Petersen BL, Heilmann CJ, Hornsleth A, Heegaard ED, Rasksen CJ, Christensen J. (2002b). Detection of parvovirus B19 NS1-specific antibodies by ELISA and western blotting employing recombinant NS1 protein as antigen. J Med Virol; 67: 375–383.

Hemauer A, Gigler A, Searle K, Beckenlehner K, Raab U,Broliden K, Wolf H, Enders G, Modrow S. (2000). Seroprevalence of parvovirus B19 NS1- specific IgG in B19-infected and uninfectedindividuals and in infected pregnant women. J Med Virol; 60: 48–55.

Henriques I, Monteiro F, Meireles E, Cruz A, Tavares G, Ferreira M, Araujo F. (2005). Prevalence of parvovirus B19 and hepatitis A virus in Portuguese blood donors. TransfusApher Sci; 33: 305–309.

Iheanacho, M.C., Akanmu, S.A. and Nwogoh, B. (2014).Seroprevalence of Parvovirus B19 antibody in blood donors and Sickle cell disease patients at Lagos University Teaching Hospital (LUTH): a comparative study. *African Journal of Clinical and Experimental Microbiology*, **15**(1): 14-20

Jawad ASM. (1993). Persistent arthritis after human parvovirus infection. Lancet; 341: 494.

Jegede, A., Aminu, M. and Ella, E.E. (2014). Sero-prevalence of Human Parvovirus B19 among patients attending some hospitals in Kano Metropolis, Nigeria. *African Journal of Clinical and Experimental Microbiology*, **15**: 21-

26.

Jones LP, Erdman DD, Anderson LJ. (1999). Prevalence of antibodies to human parvovirus B19 nonstructural protein in persons with various clinical outcomes following B19 infection. J Infect Dis; 180: 500–504.

Jordan JA. (2000). Comparison of a baculovirus-based VP2 enzyme immunoassay (EIA) to an Escherichia coli-based VP1 EIA for detection of human parvovirus B19 immunoglobulin M and immunoglobulin G in sera of pregnant women. J Clin Microbiol; 38:1472–1475.

Jordan JA, Huff D, DeLoia JA. (2001). Placental cellular immune response in women infected withhuman parvovirus B19 during pregnancy. Clin Diagn Lab Immunol; 8: 288–292.

Kaikkonen L, Lankinen H, Harjunpaa I, Hokynar K,Soderlund-Venermo M, Oker-BlomC, Hedman L, Hedman K. (1999). Acute-phase-specific heptapeptide epitope for diagnosis ofparvovirus B19 infection. J Clin Microbiol; 37: 3952–3956.

Kaur, P. and Basu, S. (2005). Transfusion-transmitted infections: Existing and emerging pathogens. *Journal of Postgraduate Medicine,* **51**:146-151.

Kelly, H.A., Siebert, D., Hammond, R., Leydon, J., Kiely, P.andMaskill, W.(2000). The age-specific prevalence of human parvovirus immunity in Victoria, Australia, compared with other parts of the world. *Epidemiology and Infection,* **124**:449- 457

Kerr S, O'Keeffe G, Kilty C, Doyle S. (1999). Undenatured parvovirus B19 antigens are essential for the accurate detection of parvovirus B19 IgG. J Med Virol; 57: 179–185.

Kurtzman GJ, Cohen BJ, Field AM, Oseas R, Blaese RM, Young NS. (1989). The immune response to B19 parvovirus and an antibody defect in persistent viral infection. J Clin Invest; 84: 1114–1123.

Kishore, J. and Kapoor, A. (2000). Erythrovirus B19 infections in humans.
Indian Journal of Medical Research, **112:149**-164.

Kishore, J.,Srivastava, M. and Choudhury, N. (2010). Standardization of B19 in North Indian voluntary blood donors. *Asian Journal of Transfusion science,*
4: 86-90.

Kishore, J. Srivastava, M. and Choudhury, N. (2011). Serological study on parvovirus B19 infection in multitransfused thalassemia major patients and its transmission through donor units.*Asian Journal of Transfusion Science,* **5**(2):
140-143.

LaMonte, A. C., Paul, M. E.and Read, J. S. (2003). Persistent Parvovirus B19 infection without the development of chronic anaemia in HIV infected and uninfected children: the women and infant transmission study. *Journal of Infectious Diseases*, **189**: 847-851.

Lefrere, J.J., Maniez-Montreuil, M., Morel, P., Defer, C. and Laperche, S. (2006). Safety of blood products and B19 Parvovirus. *Transfusion Clinique et Biologique,* **13**: 235-241

Lehmann HW, Knoll A, Kuster RM, Modrow S. (2003). Frequent infection with a viral pathogen, parvovirus B19, in rheumatic diseases of childhood. Arthritis Rheum; 48: 1631–1638.

Lui SL, Luk WK, Cheung CY, Chan TM, Lai KN, Peiris JS. (2001). Nosocomial outbreak of parvovirus B19 infection in a renal transplant unit. Transplantation; 71: 59–64.

Manaresi E, Zuffi E, Gallinella G, Gentilomi G, Zerbini M, Musiani M. (2001). Differential IgM response to conformational and linear epitopes of parvovirus B19 VP1 and VP2 structuralproteins. J Med Virol; 64: 67–73

Markenson GR, Yancey MK. (1998). Parvovirus B19 infections in pregnancy. SeminPerinatol; 22: 309–317.

Miki NPH, Chantler JK. (1992). Non-permissiveness of synovial membrane cells to human parvovirus in vitro. J Gen Virol; 73: 1559–1562.

Mitchell LA. (2002). Parvovirus B19 nonstructural (NS1) protein as a transactivator of interleukin-6 synthesis: common pathway in inflammatory sequelae of human parvovirus infections? J Med Virol; 67: 267–274.

Mitchell LA, Leong R, Rosenke KA. (2001). Lymphocyte recognition of human parvovirus B19 non-structural (NS1) protein: associations with occurrence of acute and chronic arthroplasty? J Med Microbiol; 50: 627–635.

Moffatt, S., Yaegashi, N., Tada, K., Tanaka, N. and Sugamura, K. (1998). Human parvovirus B19 nonstructural (NS1) protein induces apoptosis in erythroid lineage cells. Journal of Virology, 72:3018–3028.

Mossong, J., Hens, N., Friederichs, V., Davidkin, I., Broman, M. and Litwinska, B. (2008). Parvovirus B19 infection in five European countries: Seroepidemiology, force of infection and maternal risk of infection. Epidemiology of Infection, 136:1059-1068.

Morgan-Capner P, Crowcroft NS. (2002). PHLS Joint Working Party of the Advisory Committees of Virology and Vaccines and Immunisation. Guidelines on the management of, and exposure to, rash illness in pregnancy (including consideration of relevant antibody screening programmes in pregnancy). Commun Dis Public Health; 5: 59–71.

Moudgil, A., Shidban, H., Nast, C.C., Bagga, A., Aswad, S., Graham, S.L., Mendez, R.and Jordan, S.C. (1997). Parvovirus B19 infection-related complications in renal transplant recipients: Treatment with intravenous immunoglobulin. *Transplantation*, **64**:1847- 1850.

Musiani M, Zerbini M, Gentilomi G, Plazzi M, Gallinella G, Venturoli S. (1995). Parvovirus B19 clearance from peripheral blood after acute infection. J Infect Dis; 172: 1360–1363.

Mugenda, O., & Mugenda, A. (2003). Research Methods, quantitative and qualitative approaches. Nairobi, Kenya: ACTS Press.

Musa, Sunday A. U, Banwat et al. (2013). Risk of Transfusion-Transmitted Human Parvovirus B19 Infection in Anyigba and Lokoja, Kogi State – Nigeria. Iosr Journal of Pharmacy. Vol-3(3): 66-70.

Nagalo, M. B., Sanou, M., Bisseye, C., Kaboré, M. I., Nebie, Y. K., Kienou, K.. (2011). Seroprevalence of human immunodeficiency virus, hepatitis B and
C viruses and syphilis among blood donors in Koudougou (Burkina Faso) in
2009. Blood Transfus, 9(4), 419–24.

Nigro G, Bastianon V, Colloridi V, Ventriglia F, Gallo P, D'Amati G, Koch WC, Adler SP. (2000). Human parvovirus B19 infection in infancy associated with acute and chronic lymphocyticmyocarditis and high cytokine levels: report of 3 cases and review. Clin Infect Dis; 31: 65–69.

Norbeck O, Isa A, Pohlmann C, Broliden K, Kasprowicz V, Bowness P, KlenermanP, Tolfvenstam T. (2005). Sustained CD8+ T-cell responses induced after acute parvovirus B19 infection in humans. J Virol; 79: 12117–
12121.

Ooi, S.L., Hooi, P.S., Chua, B.H., Lam, S.K. and Chua, K.B.(2002). Seroprevalence of Human Parvovirus B19 Infection in an Urban Population in Malaysia. Medical Journal of Malaysia, 57 (1):97-103

Pastuszak AL. (1994). Outcome after maternal varicella infection in the first 20 weeks of pregnancy. N Engl J Med; 330: 901–905.

Prowse C, Ludlam CA, Yap PL. (1997). Human parvovirus B19 and blood products. Vox Sang: 72: 1–10

Pryde PG, Nugent CE, Pridjian G, Barr Jr. M, Faix RG. (1992). Spontaneous resolution of nonimmune hydrops fetalis secondary to human parvovirus B19 infection. ObstetGynecol; 79: 859–861.

Rayment FB, Crosdale E, Morris DJ, Pattison JR, Talbot P, Clare JJ. (1990). The production of human parvovirus capsid proteins in Escherichia coli and their potential as diagnostic antigens. J Gen Virol; 71: 2665–2672.

Reed, J.,Brown, K. and Young, N. (1999). Quantitative analysis of neutralizing immune responses to human parvovirus B19 using a novel reverse transcriptase-polymerase chain reaction-basedassay. *Journal of Infectious Diseases,* **179**:619-626

Reid DM, Reid TMS, Brown T, Rennie RAN. (1985). Human parvovirus associated arthritis: a clinical and laboratory description. Lancet; 1: 422–425.

Rodis JF, Borgida AF, Wilson M, Egan JF, Leo MV, Odibo AO, Campbell WA. (1998). Management of parvovirus infection in pregnancy and outcomes of hydrops: a survey of members of the Society of Perinatal Obstetricians. Am J ObstetGynecol; 179:985–988.

Rodis JF, Quinn DL, Gary et al. (1990). Management and outcomes of pregnancies complicated by human B19 parvovirus infection: a prospective study. Am J Obstet Gynecol. 163: 1168-71.

Salimi, V., Gouya, M.M., Esteghamati, A.R., Safaie, A., Heshmat,R., Saadatmand, Z. and Mokhtari-Azad, T. (2008). Seroepidemiology of Human Parvovirus B19 in 5-25 Year Old Age People in Iran. Iranian Journal of Public Health, 37 (4):19-25.

Santagostino E, Mannuci PM, Gringeri A, Azzi A, Morfini M. (1994). Eliminating parvovirus B19 from blood products. Lancet; 343: 798–799. Santagostino E, Mannucci PM, Gringeri A, Azzi A,Morfini M, Musso R, Santoro R, Schiavoni M. (1997). Transmission of parvovirus B19 by coagulation factor concentrates exposed to 100 degrees C heat after lyophilization. Transfusion: 37: 517–522

Schwarz TF, Roggendorf M, Hottentrager B, Deinhardt F, Enders G, Gloning KP, Schramm T, Hansmann M. (1988). Human parvovirus B19 infection in pregnancy. Lancet; 2:566–567.

Schwarz TF, Roggendorf M, Hottentrager B, Modrow S, Deinhardt F, Middeldorp J. (1990). Immunoglobulins in the prophylaxis of parvovirus B19 infection. J Infect Dis; 162:1214.

Searle K, Guilliard C, Enders G. (1997). Parvovirus B19 diagnosis in pregnant women—quantification of IgG antibody levels (IU/ml) with reference to the international parvovirus B19standard serum. Infection; 25: 32–34.

Searle K, Schalasta G, Enders G. (1998). Development of antibodies to the nonstructural protein NS1 of parvovirus B19 during acute symptomatic and subclinical infection in pregnancy:implications for pathogenesis doubtful. J Med Virol; 56: 192–198

Selbing A, Josefsson A, Dahle LO, Lindgren R. (1995). Parvovirus B19 infection during pregnancy treated with high-dose intravenous gammaglobulin. Lancet; 345: 660–661.

Serjeant BE, Hambleton IR, Kerr S, Kilty CG, Serjeant GR. (2001). Haematological response to parvovirus B19 infection in homozygous sickle- cell disease. Lancet; 358: 1779–1780.

Servey, J.T., Reamy, B.V.and Hodge, J. (2007). Clinical presentations of parvovirus B19 infection. *American Family Physician*, **75**(3):373-376.

Sloots T, Devine PL. (1996). Evaluation of four commercial enzyme immunoassays for detection of immunoglobulin M antibodies to human parvovirus B19. Eur J Clin Microbiol Infect Dis; 15: 758–761.

Soderlund M, Brown CS, Spaan WJ, Hedman L, Hedman K. (1995). Epitope type-specific IgG responses to capsid proteins VP1 and VP2 of human parvovirus B19. J Infect Dis; 172: 1431 1436.

Soderlund M, von Essen R, Haapasaari J, Kiistala U, Kiviluoto O, Hedman K. (1997). Persistence of parvovirus B19 DNA in synovial membranes of young patients with and without chronic arthroplasty. Lancet; 349: 1063–1065.

Tessema, B., Yismaw, G., Kassu, A., Amsalu, A., Mulu, A., Emmrich, F., & Sack, U. (2010a). Seroprevalence of HIV, HBV, HCV and syphilis infections among blood donors at Gondar University Teaching Hospital, Northwest Ethiopia: declining trends over a period of five years. BMC Infectious Diseases, 10(1), 111.

Toivanen P. (1995). Persistence of parvovirus B19 in synovial fluid and bone marrow. Ann Rheum Dis; 54: 597–600.

Tolfvenstam T, Lundqvist A, Levi M, Wahren B, Broliden K. (2000). Mapping of B-cell epitopes onhuman parvovirus B19 non-structural and structural proteins. Vaccine; 19: 758–763.

Tolfvenstam T, Oxenius A, Price DA, Shacklett BL, Spiegel HM, Hedman K, Norbeck O, Levi M, Olsen K, Kantzanou M, Nixon DF, Broliden K, Klenerman P. (2001a). Direct ex vivomeasurement of CD8 (+) T-lymphocyte responses to human parvovirus B19. J Virol; 75: 540–543.

Tolfvenstam T, Papadogiannakis N, Norbeck O, Petersson K, Broliden K. (2001b). Frequency of human parvovirus B19 infection in intrauterine fetal death. Lancet; 357: 1494–1497.

Tolfvenstam T, Ruden U, Broliden K. (1996). Evaluation of serological assays for identification of parvovirus B19 immunoglobulin M. Clin Diagn Lab Immunol; 3: 147–150.

Ujo, H., Mamman, A. I., Aliyu, A. and Ogunrinde, G.O. (2012). The seroprevalence of Parvovirus antibodies among children with sickle cell anaemia in Zaria. African Journal of Clinical and Experimental Microbiology,
13, 2:74-78.

Valeur-Jensen AK, Pedersen CB, Westergaard T, Jensen IP, Lebech M, Andersen PK, AabyP, Pedersen BN, Melbye M. (1999). Risk factors for parvovirus B19 infection in pregnancy. JAMA; 281: 1099–1105.

Van Elsacker-Niele, A.M.andKroes, A.C. (1999). Human parvovirus B19:
relevance in internal medicine. *Netherlands Journal of Medicine*, **54**: 221-230

Venturoli S, Gallinella G, Manaresi E, Gentilomi G, Musiani M, Zerbini M. (1998). IgG response to the immunoreactive region of parvovirus B19 nonstructural protein by immunoblot assay with a recombinant antigen. J Infect Dis 178: 1826–1829.

Von Landenberg P, Lehmann HW, Knoll A, Dorsch S, Modrow S. (2001). Antiphospholipid antibodies in pediatric and adult patients with rheumatic disease are associated with parvovirusB19 infection. Arthritis Rheum; 48:
1939–1947.

Von Landenberg P, Lehmann HW, Knoll A, Dorsch S, Modrow S. (2003). Antiphospholipid antibodies in pediatric and adult patients with rheumatic disease are associated with parvovirusB19 infection. Arthritis Rheum; 48:
1939–1947.

von Poblotzki A, Gerdes C, Reischl H, Wolf H, Modrow S. (1996). Lymphoproliferative responseafter infection with human parvovirus B19. J Virol; 70: 7327–7330

von Poblotzki A, Gigler A, Lang B, Wolf H, Modrow S. (1995a). Antibodies to parvovirus B19 NS-1protein in infected individuals. J Gen Virol; 76: 519–
527.

Vuorinen T, Lammintausta K, Kotilainen P, Nikkari S. (2002). Presence of parvovirus B19 DNA in chronic urticaric and healthy human skin. J. Clin Virol; 25: 217–221.

Wagner AD, Goronzy J, Matteson E, Weyland C. (1995). Systemic monocyte and T cell activation in a patient with human parvovirus B19 infection. Mayo Clin Proc; 70: 261–265.

Alana, W., Hokey, P., & Ahiaba, S. (2014). Sero-Prevalence of Hepatitis B Virus Infection among Blood Donors: A Retrospective Study in the Kintampo
Municipal Hospital, Ghana. *Open Journal of Medical Microbiology*, *04*(01),
64–69.

Waldman, M. and Kopp, J.B. (2007). Parvovirus B19 and the Kidney. *Clinical Journal of the American Society of Nephrology*, **2**: Supplement 1 S47-S56.

Wattre P, Dewilde A, Subtil D, Andreoletti L, Thirion V. (1998). A clinical and epidemiological study of human parvovirus B19 infection in fetal hydrops using PCR Southern blot hybridization and chemiluminescence detection. J Med Virol; 54: 140–144.

WHO. (2014). Resolutions Relating to Blood Safety Adopted by WHO Governing Bodies, Vol. III.

White DG, Mortimer PP, Blake DR, Woolf AD, Cohen BJ, Bacon PA. (1985). Human parvovirus arthroplasty. Lancet; I: 419–421.

Woolf AD, Campion GV, Chishick A, Wise S, Cohen BJ, Kloeida PT, Caul O, Dieppe PA. (1989). Clinical manifestations of human parvovirus B19 in adults. Arch Intern Med; 149: 1153–1156.

Woolf AD, Cohen BJ. (1995). Parvovirus B19 and chronic arthritis—causal or casual association? Ann Rheum Dis; 54: 535–536.

Woolf AD, Hall ND, Giulding NJ. (1991). Predictors of the long-term outcome of early synovitis: a 5-year follow-up study. Br J Rheumatol: 30:
251–254.

Wolff K, Broliden K, Marsk A, Tolfvenstam T, Papadogiannakis N, Westgren M. (2005). One stillborn and one severely hydropic twin due to parvovirus B19 infection; successful outcome of the surviving twin. Acta ObstetGynecolScand; 78: 828–830.

WHO. (2011). Blood safety. Key global facts and figures in 2011. fact sheet
279: 1-9.

Yaegashi N, Shiraishi H, Tada K, Yajima A, Sugamura K. (1989). Enzyme- linked immunosorbent assay for IgG and IgM against human parvovirus B19, use of monoclonal antibodies and viral antigen propagated in vitro. J Virol Methods; 26: 171–181.

Yoto Y, Kudoh T, Haseyama K, Suzuki N, Oda T, Katoh T, Takahashi T, Sekiguchi S, Chiba S. (1995). Incidence of human parvovirus B19 DNA detection in blood donors. Br JHaematol; 91: 1017–1018.

APPENDIX I

QUESTIONNAIRE

Prevalence of Parvovirus B19 Infections among Blood Donors at

Korle-Bu Teaching Hospital.

1. Reference No: ……..

2. Sex: Male ( ) Female ( )

3. Age: 18-24( ) 25-31( ) 32-38( ) 39 and above

4. Address……..……

5. Ethnic group: ……

6. Educational level: Tertiary () Secondary ( ) Primary ( )Quranic ( )none ( )

7. Marital status: Single ( ) Married ( ) Widower/Widow ( ) Separated ( ) Divorced ( )

8. Type of family: Monogamous ( ) Polygamous ( )

9. Occupation: Farmer ( ) Civil Servant ( ) Business ( ) Student/Applicant ( ) Health worker ( ) Other ( )

10. Have you ever been transfused before? Yes ( ) No ( ) If yes,

why?.....; When?.....;

How many pints of blood did you received?.....

11. Have you donated blood? Yes ( ) No ( ). If yes, when?

12. Have you ever had surgery before? Yes ( ) No ( ). If yes,

when?.....

Were you transfused? Yes () No ().

If yes, how many pints did you received?

13. Have you been vaccinated for Pap B19? Yes ( ) No ( ) If yes, when?

14. Do you have multiple sexual partners? Yes ( ) No ( )

15. Do you use condom when having with any person other than your spouse? Yes ( ) No ( )

16. Have you had scarification? Yes ( ) No ( ). If yes, when?

17. Do you practice drug injection on yourself? Never ( ) Once ( ) Twice ( ) Thrice ( )

Four times ( ) Fives times >Five times ( )

18. Do you share unsterilized sharp objects such as razor, injection needle, cuticle

removal etc? Yes ( ) No ( )

19. History of smoking None ( ) 1-5yrs ( ) 6-10yrs ( ) 11-15yrs ( ) 16-20yrs

( ) >20yrs( )

20. History of alcohol consumption None( ) 1-5yrs( ) 6-10yrs( ) 11-15yrs( )

16-20yrs( ) >20yrs( )