NIGER DELTA UNIVERSITY
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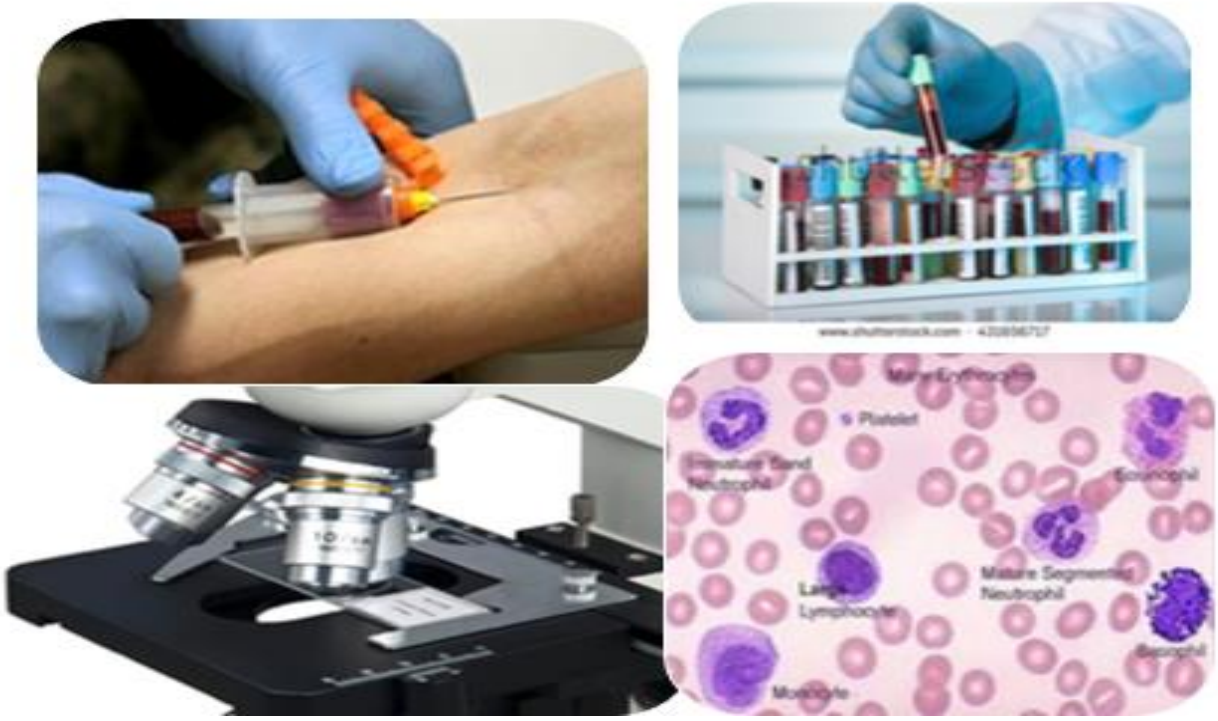
30th INAUGURAL LECTURE



THE ORACLE IN THE BLOOD

By

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13TH DECEMBER, 2017.

THE INAUGURAL LECTURER

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DEDICATION

I dedicate this lecture to:

God:
The giver of life and the fountain of all knowledge

My wife:
Mrs. Theresa A. Jeremiah
Who has sojourned with me for 22 years as my wife, friend, confidant and mother of all my children

My children:
Bliss Nsan-Awaji
Favour Awaji-Inyemesu
MirabelMetong-Awaji
David Awaji-Inomida.

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Deans of Faculties
Distinguished Professors and Scholars
Heads of Departments
Distinguished Guests and Friends
Great Students of NDU
Ladies and Gentlemen.

1.0 PREAMBLE

For the benefit of my guests who must have travelled far and near to grace this event, I choose to begin this lecture by answering one pertinent question often asked by many people and that is……

1.1 WHAT IS AN INAUGURAL LECTURE?

An inaugural lecture is an academic ceremony (a ceremonial event with an academic content) which provides an opportunity for a new professor to share his/her achievement in research, innovation, engagement and teaching activities before an audience of the University community and the general public.

A Professor occupies a chair in the University, so this ceremony is synonymous to the chieftaincy installation/coronation that announces the official recognition of a titled chief in an academic environment. The inaugural lecture is not just a formality but a serious academic event with the following benefits:

a) The new professor can celebrate an important personal milestone with family, friends and colleagues (old and new).
b) It is an opportunity for the University to recognize and showcase the academic achievements of its staff.
c) Colleagues, both within the faculty and more broadly, can hear about research that is going on around the University.
d) It represents an essential component of the University's public event programme, helping to create awareness of the latest development in science, engineering, arts and humanities, medicine, law and social sciences.
e) It affords the Professor who is like a performing masquerade to thank all those who helped to dress him up.

The definition of who a new Professor is, I cannot exactly tell but as a Professor of three years standing, I feel this lecture is rather coming late. This lecture was originally scheduled to be delivered on the 13th April, 2016 but several revisions on the inaugural time table by the management shifted the date to the 13th of December 2017, more than a year after. One thing that is constant in all these changes in the number of 13 which has come a day after my birthday 12th December, This inaugural lecture therefore serves dual purposes of an academic ceremony and a birthday celebration

It is on this note that I sincerely thank the Vice Chancellor for giving me this 'one in a life time' opportunity to deliver this lecture titled: **THE ORACLE IN THE BLOOD.** This lecture is also very unique and significant because it marks the celebration of a foundation chair in Haematology and Blood Transfusion Science in this University and the first in this specialty in the Department of Medical Laboratory Science.

1.2 WHAT IS AN ORACLE?

The word oracle comes from the Latin verb *ōrāre* "**to speak**" and properly refers to the priest or priestess uttering the prediction. In extended use, *oracle* may also refer to the site of the oracle, and to the oracular utterances themselves, called *khrēsmoi* (χρησμοί) in Greek.

Oracles were thought to be portals through which the gods spoke directly to people. In this sense they were different from seers (*manteis*, μάντεις) who interpreted signs sent by the gods through bird signs, animal entrails, and other various methods. Back in ancient times, an *oracle* was someone who offered advice or a prophecy thought to have come directly from a divine source.

In modern usage, any good source of information can be called an *oracle.* The most important characteristic of an oracle is the ability to speak. What the oracle speaks is informative, insightful, predictive and authoritative. The first mention of Blood in the Bible was by God himself

> ***'And he said, what hast thou done? the VOICE of thy brother's blood CRIETH unto me from the ground.'*** **Genesis 4:10**

For the first time God said, the VOICE of the blood of Abel was **speaking** and speaking loudly to the point of crying. The more I pondered over this, the more I get to understand that there is something inside the blood that **speaks**. Then I asked myself, what language does the blood speak? If blood can speak from its confined and hidden position then blood must be an **oracle** and the language it speaks would be spiritual and scientific, thus we are bound to have both spiritual and scientific haematology

1.3 SPIRITUAL HAEMATOLOGY

Blood is the spiritual link between God and man. It is a liquid of life and possesses both spiritual and biological properties. The spiritual aspect of blood which I call SPIRITUAL HAEMTOLOGY makes it mysterious and explains the reason why blood is often used in sacrifices.

The Hebrew word translated '**Blood**' is Dam (pronounced as Dawm). Dam is used to denote the 'blood' of animals, birds and men(never of fish) (Strong, 2001). In Genesis chapter nine verses four, 'Blood' is synonymous with life. "*But flesh with the life thereof, shall ye not eat*". The high value of life as a gift of God led to the prohibition against eating blood and" It shall be a perpetual statute for your generations throughout all your dwellings (Leviticus 3:17).

Dam can also mean '**blood shed by violence'** "*So ye shall not pollute the land wherein ye are: for blood defilleth the land; and the land cannot be cleansed of the blood that is shed therein"* (Numbers 35:33)

Dam can also mean **Death**."*So will I send upon you famine and evil beasts and they shall bereave thee; and pestilence and Blood shall pass through thee; and I will bring the sword upon thee*" (Ezekiel 5:17)

Dam also connotes an act in which **human life is taken or blood is shed**. "*If there arise a matter too hard for thee in judgement; between blood and blood (one kind of homicide or another"* (Deuteronomy 17:8. To 'shed blood' is to commit murder. "*Whoso sheddeth man's blood; by man shall his blood be shed" (Genesis 9:6)*

Have you ever heard the phrase? '**His blood be upon his head'**? This signifies that the guilt and punishment for a violent act shall be upon the perpetrator. *"For everyone that cursed his father or his mother; his blood (guiltiness) shall be upon him" (Leviticus 20:9; Joshua 2:19).*So here, blood means responsibility for one's death

The animal sacrifice that was practiced in the old testament days to take the place of a sinner's blood in atoning or covering for sin pre-figured and typologically represented the blood of Christ, who made the great and only effective substitutionary atonement and whose offering was the only offering that gained life for those whom He represented. The shedding of His blood sealed the covenant of life between God and Man. "*For this is the blood of the new testament which is shed for many for the remission of sins" (Matthew 26:28)*

"And almost all things are by the Law purged with blood and WITHOUT SHEDDING OF BLOOD IS NO REMISSION" (Hebrews 9:22). You don't have to shed any man's blood for any reason. Christ has offered it once for all.

Of all the voices in the world, the blood is the only voice that cannot be silenced. When it speaks or cries, it never ceases until it receives answers. The longer it

waits for the answer, the louder it cries. It is interesting to note that the BLOOD of Abel was speaking from the ground where man originated from.

> '*And the LORD God formed man of the dust of the ground, and breathed into his nostrils the breath of life; and man became a living soul*'. Genesis 2: 7

1.4 SCIENTIFIC HAEMATOLOGY

When God created man, he created blood which contained haemoglobin but there was no life until God introduced oxygen through the divine act of inbreathing. The haemoglobin combined with oxygen, became oxidized and immediately turned its colour from blue to red. In the oxidized form, blood could transport oxygen and nutrients to every part of the body and man become a living soul. So you are alive because blood is flowing in your body. When it stops flowing, Life ceases

Nothing was known about this blood until about **350 years ago** when it was discovered that blood circulates around the human body, but it was not possible to study it because blood is constantly enclosed within blood vessels out of the reach of the naked eyes. Naked eye inspection of blood at phlebotomy was practiced far back to ancient times.

Invention of the compound microscope at Holland around 1590 by Hans and Zacharias Jannsen made possible the examination and content of the blood (Hajdu, 2003). The human blood appears to be a red liquid to the naked eye but under the microscope, a whole lot of stories could be told about you.

From this point, we understood that **BLOOD** can speak another language and this language is SCIENTIFIC**.** It takes a man with the scientific ear to understand the language of blood. This is where science came in and this where my role as a Medical Laboratory Scientist is domesticated. All the years I spent in the University culminating in my career as a Pathology Scientist and Professor was to enable me train my eyes to see and ears to hear from the oracle 'blood' so I can interpret what it says to those who care to consult. Some other useful time lines are as follows:

200 years ago**:** First human blood transfusion (from one person to another person) was performed so you can imagine how medicine was practiced before this time.

100 years ago**:** Different blood types were discovered. This gave way for safe transfusion practice because it was known what molecules you inherited from your ancestors that match with that of the recipient of the blood.

30 years ago**:** Tests were developed to detect viruses that can transmit diseases to another person through blood transfusion.

1.5 WHAT DOES THE ORACLE SAY?

"Keep thy heart with all diligence for out of it are the ISSUES OF LIFE". Proverb 4:23

Figure 1: Blood cells being pumped out by the human heart

The heart as we know is the engine that moves the blood through the body. It does a huge job of pumping one gallon of blood every minute. This is about 1,500 gallonsevery day. From the moment the heart starts working, it beats tirelessly, 100,000 times, a day, 365 days a year without break. What comes out of this heart is the BLOOD and out of this blood comes **ISSUES OF LIFE**. So the blood speaks **ISSUES** that bother on your life

As a Professor occupying this **"BLOODY CHAIR",** I owe everyone seated here the responsibility of sharing these issues with you which evolved through several years of research in this bloody discipline. I will leave the task of 'keeping the heart' to the cardiologist.

The Cambridge English Dictionary as well as Merriam – Webster dictionary define ISSUE as a subject, problem or something that people are thinking and talking about, in other words, an important subject or topic for discussion. Issue is one word short of tissue.

Since blood is a tissue, anything missing in the tissue will definitely become an issue and these issues bother on life. Blood is so important to life that God used the lifespan of the red cell to measure our lifespan on earth. It is written in Genesis chapter 6 verse 3

'*And the LORD said, My spirit shall not always strive with man, for that he also is flesh: YET HIS DAYS SHALL BE AN HUNDRED AND TWENTY YEARS*.'

The implication of this statement is that our lifespan on earth is directly proportional to the lifespan of the red cells within our vessels.

The lifespan of red blood cell is **120 days** and the number of our years on earth from the above scripture is **120 years**, so 1 day in the life of a red cell is proportional to 1 year of our life on earth. Whatever compromises the health of your blood will indirectly reduce your lifespan on earth.

1.6 BLOOD DIAGNOSIS AS AN ORACLE IN MEDICINE

The BLOOD as the oracle of Medicine is authoritative, exhaustive, insightful, and predictive. Every department of your life and diseases report to the blood and this explains why BLOOD is the most requested of all body parameters. The message blood passes is often received through accurate blood diagnosis

The Merriam –Webster dictionary defines Diagnosis as an investigation or analysis of the cause or nature of a condition, situation or problem. It also means the act of identifying a disease, illness or problem by examining someone or something .The word diagnosis came from a Greek word *diagignoskein* meaning to distinguish or to know.

Blood diagnosis involves investigations carried out on blood samples to evaluate how well organs are working, diagnose diseases such as cancer, HIVAIDS, diabetes and anemia. To achieve this, a small amount of blood is taken from the veins, processed by qualified Medical Laboratory Scientists and analyzed using the special lens of a microscope.

A complete blood count or full blood count is the most frequently requested blood test in any health facility and is often used to evaluate the overall health and detect a wide range of disorders including anemia, infection and leukemia. It measures several components and features of the blood including; a) the red blood cells which carry oxygen. b) White blood cells which fight infection. c) haemoglobin, the oxygen carrying protein in red blood cells. d) haematocrit, the proportion of red blood cells to the fluid component or plasma in your blood. e) Platelets, which help with blood clotting. Abnormal increases or decreases in cell counts may indicate that there is an underlying condition that calls for further evaluation

1.7THE BLOOD SMEAR AS A DIAGNOSTIC TOOL

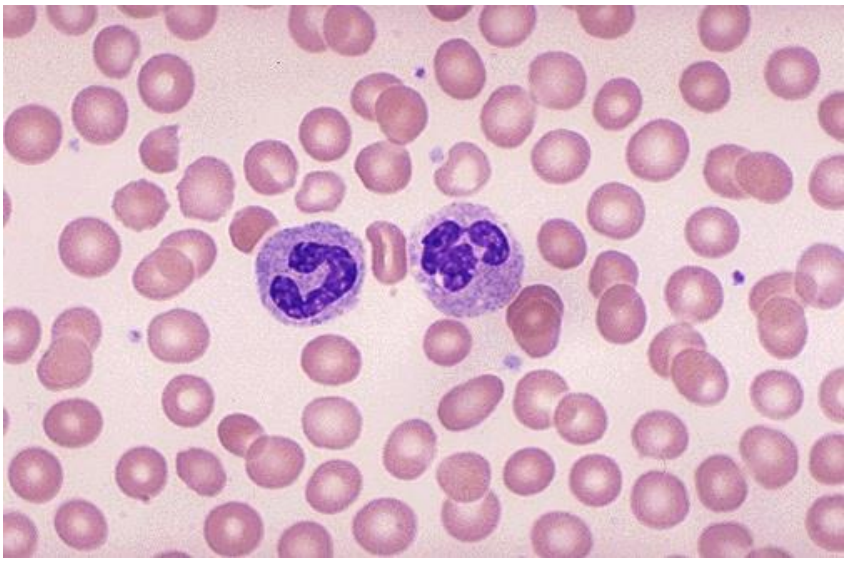

Figure 2: Stained blood picture as seen under the microscope

The figure shown above is a blood picture made from a drop of blood from which the smear was made. With this picture a whole lot of stories could be told about you when interpreted by an experienced and qualified Scientist. It remains a crucial diagnostic aid in the management of blood diseases despite all attempts to relegate it to the background as a result of development of sophisticated blood cell analyzers A proportion of request for full blood count that generates a blood smear continues to decline due to local policies and sometimes by functional and regulatory as well as medical considerations.

For maximum information to be derived from a blood smear, the examination should be performed by a well trained and experienced Medical Laboratory Scientist/haematologist as it is applicable in Europe and partly in the United States. A blood smear can reveal vital information on anaemia, haemolytic anaermia, thrombocytopenia, leukaemia, lymphoma bone marrow failure etc.
Sometimes the blood smear provides the primary or the only evidence of a specific diagnosis, such as myelodysplastic syndrome, leukemia, lymphoma, or hemolytic anemia.

A simple blood test can be used as a crystal ball to detect early signs of diseases such as cancer, most especially the breast and prostate cancers. Recently, a simple blood test called Brain natriuretic peptide (BNP) was discovered which has the ability to predict cardiovascular risk. It is a hormone in the ventricles of the heart which is the main pumping muscle of the heart. It is now well established marker for the diagnosis of heart failure and a predictor of death in people who

MM have stable coronary disease with no symptoms and are told that they are doing just fine. Levels over 500ng/ml of BNP can predict risk of heart attack 5-8 fold within the next four years. Research has shown that people with a level of over 400ng/ml are eight times more likely to die in the next 1-5 years than those with levels of 100ng/ml(Mega *et al*, 2004; Omland *et al,* 2005).

According to the Lancet report, the occurrence of one or more circulating tumour cells (CTC) in the blood stream can predict early re-occurrence of cancer cells and if left untreated can decrease the possibility of survival. Early detection can help advance the stages of treatment more aggressively with the hope of a more positive outcome for the patients.

A simple blood test may allow young women to predict their menopause with enough accuracy to plan a family. This is done by measuring the anti-Mullerian hormone (AMH) in the blood. AMH blood concentration of 4.1ng/ml or less can predict early menopause. This hormone is produced by cells in the woman's ovaries to control the development of follicles, the fluid filled ovary sacs in which eggs mature (hhtp:www.dailymail.co.ukhealtharticle-12900blood test-menopause)

1.8 IN THIS LECTURE

We shall be looking at a wide range of issues that relate to blood and my contributions in these areas which include blood diseases, infectious diseases, coagulation disorders, immunohaematology, blood transfusion, blood banking practices; molecular biology etc. as much as time will permit us.

My fifteen years research journey in this field that culminated in my elevation to this Professorial Chair is summarized in this lecture but since I am first a Medical Laboratory Scientist before I became a Professor, I will like to define the profession I belong to, which is Medical Laboratory Science and my area of specialty, haematology

2.0 MEDICAL LABORATORY SCIENCE

According to the Medical Laboratory Science Council of Nigeria (MLSCN) Act No. 11 of 2003, the Medical Laboratory Science Profession means the practice involving the analysis of human or animal tissues, body fluids, excretions, production of biologicals, design and fabrication of equipments for the purpose of Medical Laboratory Diagnosis, treatment and research. The practice involves medical microbiology, clinical chemistry, chemical pathology, haematology, blood transfusion science, serology, histopathology, histochemistry, immunology, cytogenetics, exfoliative cytology, parasitology, forensic science, molecular

biology, laboratory management or any other related subject as may be approved by the council.

From the above definition, it is clear that the scope of the practice of Medical Laboratory Science profession is so broad that we have not yet explored the full dimensions of it in Nigeria. It is multidisciplinary even though it is presently lumped together as a Department in the University.

The Medical Laboratory Scientist or Biomedical Scientist as in UK or Medical Scientist as in Australia is a person who has acquired a basic pre-requisite qualification such as the B.MLS and is registered and licensed by the Medical Laboratory Science Council of Nigeria to practice the profession wherever his or her services are needed in any of the disciplines listed above. Our first name is Medical, the middle name is Laboratory and the surname is scientist. To address him/her properly, the three names must be complete to reflect what he/she is called to do and not just addressing him/her as Lab Scientist.

Medical Laboratory Scientists are the only group of professionals authorized by law through Act 11 of 2003 in Nigeria to receive patient specimens, analyze the specimen, interpret and report results. The Medical Laboratory Scientist is taught to recognize anomalies in their test results and know how to correct problems with the instrumentation. They monitor, screen and troubleshoot analyzers featuring the latest technology available in the market. The Medical laboratory Scientist performs equipment validations, calibrations, quality controls, 'STAT' or run-by-run assessment, statistical control of observed data and recording normal operations. To maintain the integrity of the laboratory process, the Medical Laboratory Scientist recognizes factors that could introduce error and rejects contaminated or sub-standard specimens.

Medical Laboratory Scientists role is therefore to provide accurate laboratory results in a timely manner, safeguards, such as experimental controls, calibration of laboratory instruments and periodic surveys to ensure accuracy. Laboratory results aid clinical practitioners in confirming or ruling out diagnosis, monitoring chronic disease change and analyzing the effects of medical therapies. Medical Laboratory Science practice in Nigeria remains underutilized and undervalued and this poses a serious barrier to effective health care in Nigeria and Africa in general.

2.1 HAEMATOLOGY (BLOODOLOGY)

Haematology is derived from two words haema (from Greek word *haima* for blood) and logy (meaning study). In terms of anatomy and histology, blood is

considered a specialized form of connective tissue given its origin in the bones and the presence of potential molecular fibres in the form of fibrinogen.

Haematologyis therefore concerned with the study of blood, the blood forming organs and blood diseases. It includes the study of aetiology, diagnosis, treatment, prognosis and prevention of blood diseases. Haematology is broadly classified into Clinical and Laboratory Haematology.

Clinical aspect of haematology mainly includes the care and treatment of patients with haematological diseases which is the responsibility of clinical pathologists. Laboratory haematology involves the laboratory work that goes into the study of blood, which is the responsibility of the Medical laboratory Scientist, who also manages the haematology laboratory. A Medical Laboratory Scientist who specializes in the haematology discipline is called the Haematology Scientist.
Haematology has subspecialities which include:

a) General haematology
b) Blood transfusion science
c) Haemostasis/coagulation
d) Immunohaematology
e) Blood bank
f) Cytoenetics/population genetics
g) Forensic haematology
h) Academic haematology

The responsibilities of the haematology scientist are quite enormous and includes to:

a) Receive and prepare blood samples for analysis
b) Analyze blood samples using computer aided and manual techniques
c) Review initial data that reveals for example white or red blood cell abnormalities
d) Make decision of further haematological analysis
e) Liase with other medical professionals to discuss patient treatment plans.
f) Cross match blood for use in transfusions.
g) Investigate the biochemistry of blood clotting.
h) Help colleague to interpret test results
i) Select appropriate techniques for different types of haematological analysis.
j) Keep accurate and detailed records.

At more senior levels, they also

a) Teach or train medical and biomedical students and other hospital staff
b) Manage haematology laboratory, laboratory finances and resources.

c) Conduct researches and manage research laboratories in both Universities and teaching hospital.

3.0 THE BLOOD

In the human body, there are many different kinds of tissues such as muscle, nerve, fat, gland, bone connective tissues etc. All these tissues have one thing in common; they are fixed cells, microscopically small and having a specific and limited function. Unlike these fixed tissues, the blood is fluid and mobile. It is not limited to one part of the body but is free to move throughout the entire body and touch every other fixed cell as it supplies it with nourishment and caries off waste product and the ashes of cell activity which we call metabolism.

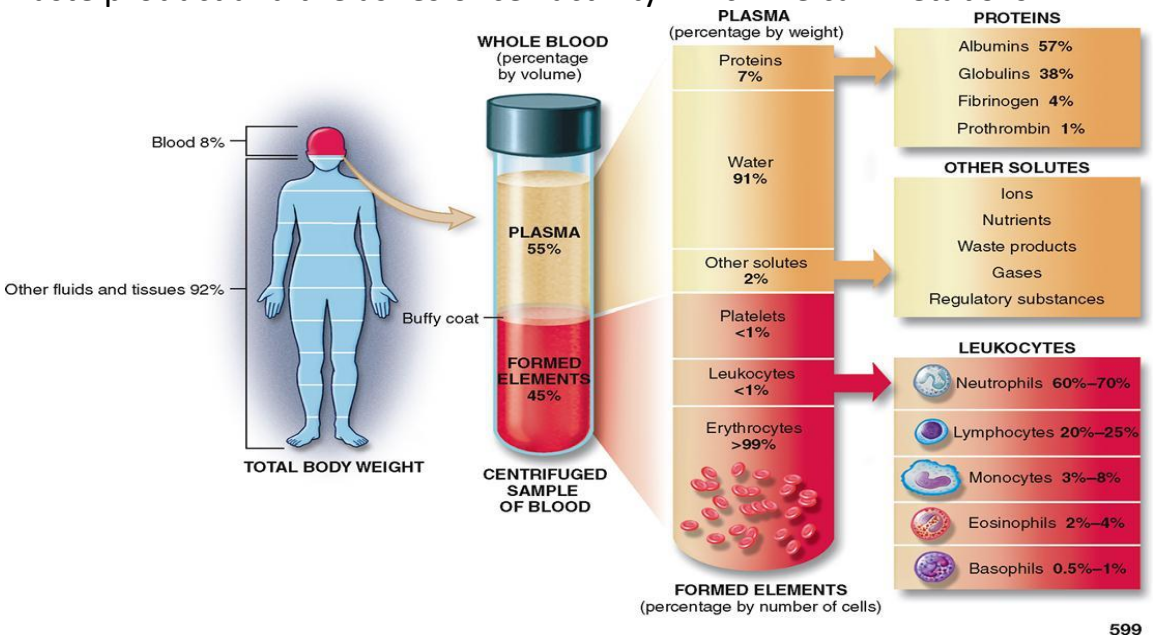

Figure 3: Blood inside the test tube separated into components

Blood is therefore a mixture of cells and a watery liquid called PLASMA. It also contains other things like nutrients (such as sugar), hormones, clotting factors and waste products to be flushed out of the body. There are three kinds of cells in the blood;

a) Red blood cells
b) White blood cells
c) Platelets.

Red blood cells (also called erythrocytes) are the most numerous, making up 40 – 45 percent of one's blood and they give blood its characteristic colour (RED). Red blood cells are shaped like tiny doughnuts with an indentation in the center instead of a hole. They contain a special molecule called **HAEMOGLOBIN** which carries the oxygen. In the lungs where there is a lot of oxygen, the haemoglobin molecule loosely binds with oxygen.

Each molecule of haemoglobin contains four iron atoms and each iron can bind with one molecule of oxygen, allowing each haemoglobin molecule to carry four molecules of oxygen. In the capillaries where there is little oxygen, the haemoglobin readily sheds the oxygen it is carrying and allows it to be absorbed by the body cells.

In the human body, there are about five pints of this fluid called blood and this blood, pumped by the heart circulates through the system every twenty-three seconds so that every cell in the body is constantly supplied and cleansed and at the same time is in constant communication and touch with every other cell in the body.

The **white blood cells** (Leukocytes) are the body's mobile warriors in the battle against infection and invasion. There are three types of white blood cells; granulocytes, hymphocyte and monocytes. The granulocytes consist of neutrophils, eosinophils and basophils.

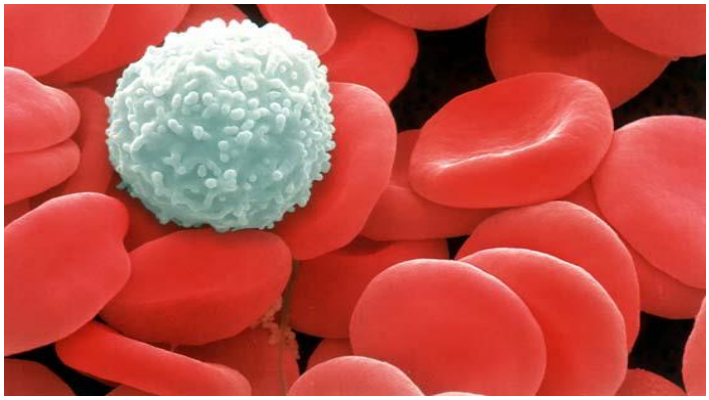

Figure 4: A white blood cell surrounded by red blood cells

Granulocytes actually contain granules that hold digestive enzymes. Neutrophils kill invading organisms by ingesting and then digesting them. Eosinophils kill parasites that are involved in allergic reaction.

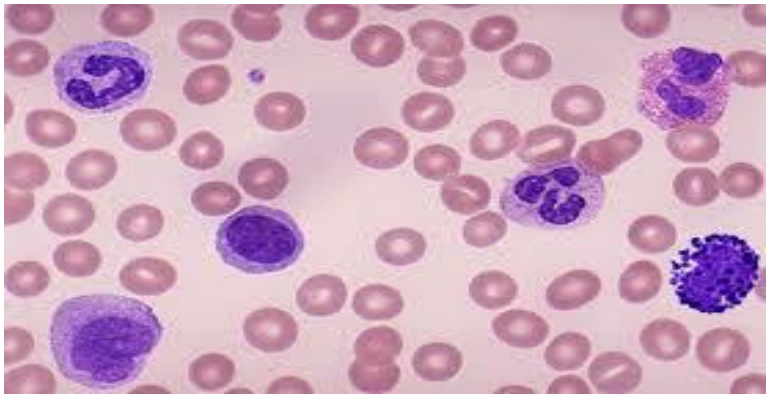

Figure 5: Different white blood cells as seen under the microscope

The lymphocytes are key parts of the body's immune system. There are two kinds; the B.lymphocytes produces antibodies which destroy foreign bodies. T.cell lymphocytes direct the activity of the immune system. The monocytes are the largest kind of white cells and they have the ability to enter the tissues and turn into even larger cells called macrophage. These macrophages eat foreign bacteria and destroy damaged, old and dead cells of the body itself. This is equivalent to environmental sanitation we conduct in our environment.

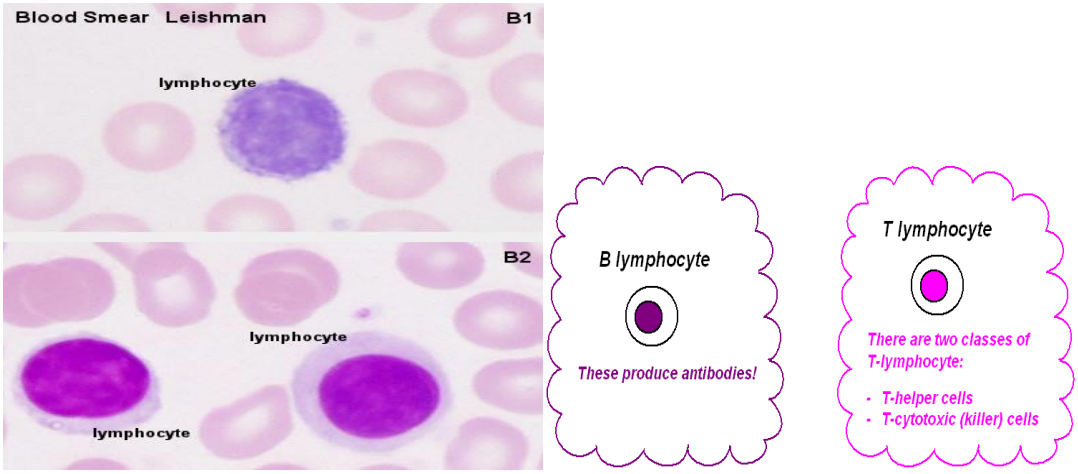

Figure 6: Lymphocytes as seen under the microscope

The blood cells called **platelets** (thrombocytes) help blood to clot in several different ways, when bleeding occurs, platelets clump together to help form a clot. When they are exposed to air (as they would be by wound),platelets starts breaking down and release a substance in the blood stream. This substance starts a chain of chemical events that eventually causes a protein in the blood called **FIBRINOGEN** to turn into a different substance called **FIBRIN** which forms long threads. These threads tangle up red blood cells to help form a clot or seals over the wound. In their resting state, platelets look like two plates stuck together (hence, the name). When 'activated' and helping to form a clot, they change shape and look like roundish blobs with tentacles. They measure two to three microns and constitute the smallest kind of blood cells.

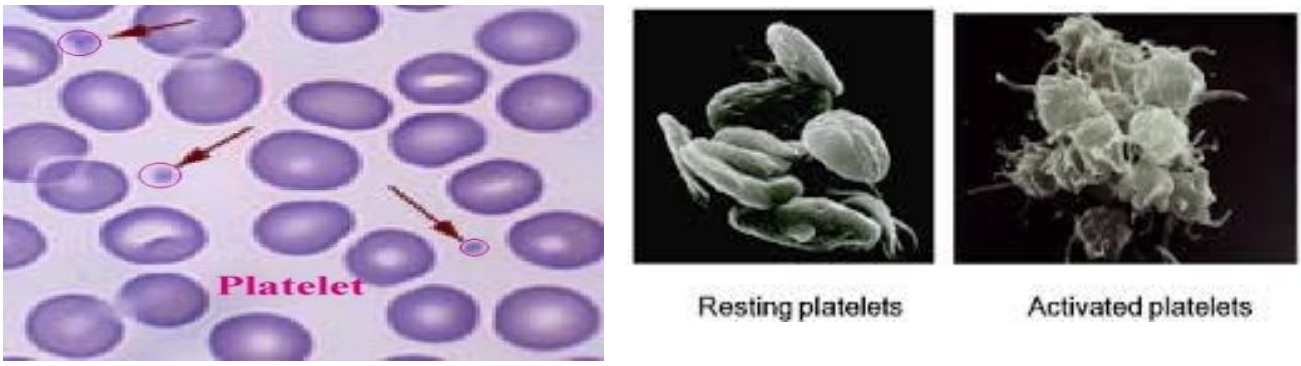

Figure 7: Platelets under the microscope

Plasma is a clear, straw-coloured liquid that carries the blood cells and various hormones, nutrients and so on. It makes up a little more than half of the total blood volume. Plasma is about 90 percent water. Much of the other ten percent comprises various kinds of protein molecules, including enzymes, clotting agents, immunoglobulin (part of the immune system) and proteins that carry hormones, vitamins, cholesterol and other things the body needs. Plasma also contains sugar (glucose) and electrolytes like sodium, potassium and calcium as well as other things like the aforementioned hormones, vitamins and cholesterol.

Blood performs many important functions within the body including:

a) Supply of oxygen to tissues (bound to haemoglobin, which is carried in red cells)
b) Supply of nutrients such as glucose, amino acids and fatty acids (dissolved in the blood or bound to plasma proteins)
c) Removal of waste such as carbon dioxide, urea and lactic acid.
d) Immunological function including circulation of white blood cells and detection of foreign material by antibodies.
e) Coagulation, which is one part of the body's self-repair mechanism.
f) Messenger functions including the transport of hormones and the signaling of tissue damage
g) Regulation of body pH (the normal pH is in the range of 7.35 – 7.45) (covering only 0.1 pH unit.
h) Regulation of core body temperature.
i) Hydraulic functions.

4.0 MY RESEARCH CONTRIBUTIONS

Ag Vice Chancellor Sir, in the year 2000, the millennium development goals were launched by the United Nations. The millennium development goals were a commitment amongst countries of the world to ensure the accelerated development of all countries during the first fifteen years of the new millennium. The aim of the initiative was to narrow the gap between developed and developing countries, ensuring more equitable distribution and use of the world's resources (UN, 2005).

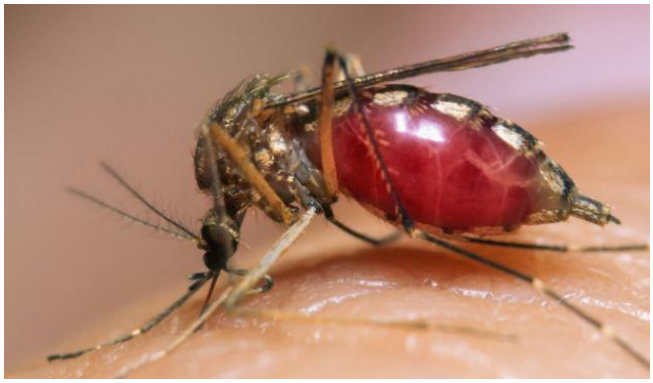

Figure 8: Mosquito having a blood meal on human body

In order to contribute my quota towards achieving the millennium goals, my doctoral research work (Ph.D) entitled **"Interactions of nutritional, biochemical, haematological and host genetic factors in childhood subclinical malaria infection"** was aimed at addressing millennium goal 4 which is the reduction of child mortality. Besides this, my research efforts also addressed millennium goals 5 and 6 which are: The improvement of maternal health and the reduction of the incidence and prevalence of HIV/AIDS, malaria and other diseases.

All these are issues which relate to the blood. The results of these findings have been published in reputable international journals and many presented in conferences both local and international. In this lecture, the major findings/issues as it relates to blood all through my research journey will be discussed under the following headings:

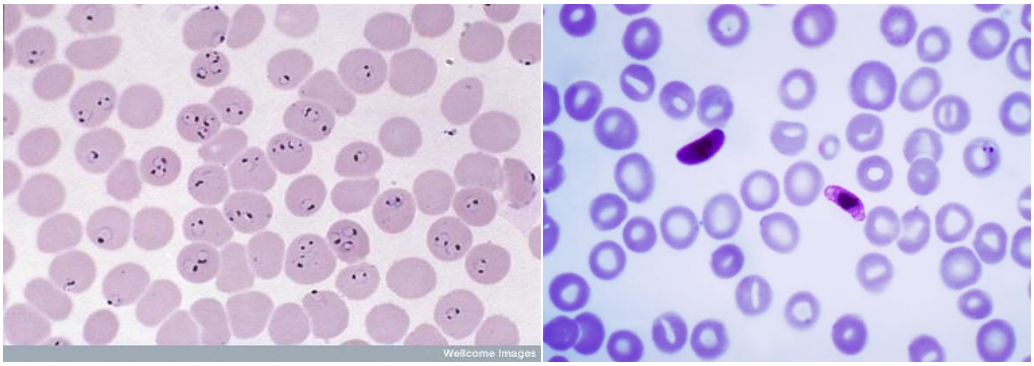

Figure 9: A stained blood film showing malaria parasite (*P.Falciparum*)

4.1 STUDIES RELATED TO MILLENIUM DEVELOPMENT GOAL 4: PREVENTION OF CHILD MORTALITY

4.1.1 ANAEMIA, IRON DEFICIENCY AND IRON DEFICIENCY ANAEMIA IN CHILDREN UNDER 5 YEARS OF AGE

Definition

Anaemia is defined as a haemoglobin concentration lower than the established cut-off defined by the World Health Organization. The cut-off ranges from $110g^{L-1}$ for pregnant women and for children 6 months – 5 years of age to $120g^{L-1}$ for non-pregnant women to $130g^{L-1}$ for men (WHO, 2003).

Anaemia remains one of the most extensive pandemics affecting mostly developing countries. About 3.5 billion persons are affected by anaemia in developing countries (UNACCN, 2000). The presence of anaemia in children under five years of age is of particular relevance because it negatively impacts mental development and future social performance. Children suffering from iron

deficiency anaemia during the first two years of life have slower cognitive development and poorer school performance and work capacity in later years (Sayed *et al*., 1999).

A high prevalence of iron deficiency anaemia (13.75%) was reported by Jeremiah *et al*., (2007a). This high prevalence of iron deficiency anaemia among apparently healthy children under the age of five years in this part of the world may justify the need for the introduction of a broad intervention programme for this highly vulnerable group. The same study also evaluated the clinical utility of iron parameters for the diagnosis of iron deficiency anaemia. The combination of serum ferritin, haemoglobin and transferrinsaturation determinations proved more useful in a resource limited setting (Jeremiah *et al*., 2007).

WHO statistics show that 30 – 90% of children under 5 years of age in malaria endemic area have anaemia, 5 – 15% of severe anaemia in children under 5 years in endemic areas is due to malaria and 8 – 15% of child deaths are caused by severe anaemia due to malaria (WHO, 2003).

In a survey of two hundred and forty children in Port Harcourt, sixty six (27.5%) were parasitized with plasmodium falciparum. The prevalence of iron deficiency anaemia (define as Hb <11g/dl, serum ferritin, 12ng/µl and transferrin saturation, 16g%) in this study population was 3.75%. the prevalence of iron deficiency anaemia among the parasitized children was 9/66 (13.6%). Their mean parasite density (3.35×10^3 parasites μl^{-1}) was higher than the mean parasite density of the entire study population (1.16×10^{-3} parasites μl^{-1}) (Jeremiah *et al*., 2007b).

The study concluded that
1) Subclinical malaria infection exerts significant effects on iron indicators
2) Children under 5 years of age constitute a high risk group in malaria – endemic regions of developing countries
3) There was a high prevalence of subclinical malaria and a low prevalence of iron deficiency anaemia (Jeremiah, 2007b).

4.1.2 MICRONUTRIENT-IRON

Iron is an essential nutritional element and plays a critical role in oxidative metabolism, cellular growth, oxygen transport and storage (Boldt, 1999). Iron deficiency is defined as a condition in which there are mobilizable iron stores and in which signs of a compromised supply of iron to tissues, including the erythron are noted (Boldt, 1999). The more severe stages of iron deficiency are associated with anaemia (WHO, 2001).

A baseline iron status of apparently healthy children in Port Harcourt, Nigeria, using four biochemical iron indicators; serum iron (SI), total iron binding capacity (TIBC) transferrin saturation (TS) and serum ferritin revealed significant lower values in the under-fives when compared with children 5 to 8 years. The prevalence of iron deficiency among the participants by single ferritin (<15 ng/µl) and transferrin saturation (<16%) gave a prevalence rate of 7.5% (Jeremiah et al., 2008a). It was concluded that iron deficiency is more pronounced among children under five years of age than the other age groups (Jeremiah et al., 2008a).

in order to reduce child mortality, emphasis should be placed not only on the treatment of malaria in infected children, but on regular screening for subclinical malaria among apparently children and proper iron supplementation based on laboratory test results.

One of the most pronounced problem in controlling the morbidity and mortality caused by malaria is the limited access to effective diagnosis and treatment in areas where malaria is endemic. The most widely used routine method of microscopy (the gold standard) needs laboratory infrastructure and expertise. Rather than providing the needed infrastructure and employment of qualified medical laboratory scientists, policy makers have shifted emphasis to rapid diagnostic test kit (RDT) as a means of providing urgent results for treatment. Jeremiah et al., (2007c) evaluated one of the rapid diagnostic test kits, the SD Bioline among the asymptomatic malaria infection children using the Giemsa stain microscopy as the gold standard.

The SD Bioline was 47% sensitive and 100% specific with a positive predictive value of 100% and negative predictive value of 83.2%. Efficiency of the test kit was 85.4%. More worrisome in this study was the fact that the SD Bioline sensitivity was 100% when the parasitaemia was higher than 1,000 parasites µl but decreased with lower parasitaemia levels. It means therefore that with a threshold of 1000 parasites/µl among these subclinically infected subjects, the RDT could be useful only in patients heavily infected with *P.falciparium* malaria (Jeremiah et al., 2007c).

While the objective remains rapid diagnosis for rapid treatment, I wish to recommend that the task of diagnosing the malaria infection which is a major cause of anaemia be left to those who have been trained to do so using the gold standard. Assigning the role of diagnosis to untrained persons will not only hamper the progress in tackling the menace called malaria but exposed this vulnerable group to more danger.

4.1.3 MALARIA AND NUTRITION: RISK OR BENEFIT-WHERE IS THE BALANCE?

Another issue of concern is the existence of malaria and malnutrition in malaria endemic tropic regions of the world. Malnutrition is a serious global issue and each year, some 24 million babies are born too small to lead healthy lives because their mothers were either ill or malnourished (UNICEF, 1998, Fernandez *et al.,* 2002).

The relationship between malaria and malnutrition remains unclear and controversial. Malnutrition appears to influence susceptibility to malaria and affects the course of the infection (Nyakeriga *et al., 2005*). On the other hand, malnutrition is said to protect against malaria infection (Nyakeriga *et al.,* 2005).

The nutritional status of these asymptomatic malaria infected children were evaluated using anthropometrical indices 17.5% of the children were underweight (WFA Z < -2), 3.75% were stunted (HFA Z < -2) and 36.36% were wasting (WFH Z < -2). Children who are underweight were found to be at a higher risk of acquiring malaria than the well-nourished children (RR = 1.02, X^2 = 0.320, P < 0.02, 95% CI 0.34 – 2.37). Under nutrition was more prominent in the children below 5 years than older children (RR = 3.625, X^2 = 10.36, P < 0.006, 95% CI = 1.81 – 5.43).The haemoglobin value of the parasitized children (10.8 ± 1.9g/dl) was significantly lower than the non-parasitized group (11.3 ± 1.7g/dl) (P < 0.01).

It was therefore concluded that the presence of under nutrition places children (especially below 5 years of age) at higher risk of malaria related morbidity. Children in malaria endemic areas like ours need adequate nutrition to withstand the negative impact of malaria (Jeremiah & Uko, 2007a, Jeremiah *et al*., 2008b)

Interactions of malnutrition, iron deficiency and malaria were also evaluated in the same study. The mean parasite density was 1.14 x 10^3 parasites μl^{-1} and the risk of malaria infection was higher in iron replete children than those who were iron deficient (RRR = 0.33, X^2 = 2.825, P < 0.05. This provided an observational support than iron deficient children are to some extent protected against malaria infection, Jeremiah *et al.,* 2008b).

4.1.4 HOST GENETIC FACTORS, AND MALARIA

Plasmodium falciparum has been called “The protection strongest known force for evolutionary selection in the recent history of human genome” (Kwiatkowski, 2005). Thus, it has been hypothesized that *P. falciparum* has shaped the distribution of ABO blood groups in man, i.e. the current worldwide distribution of ABO groups is consistent with an effect from *P. falciparum* and that certain blood groups protect humans from the lethal effect of *P. falciparum* infection (Cserti, and Dzik, 1997).

Malaria has also been hypothesized as the evolutionary driving force behind sickle cell disease, glucose – 6 – phosphate dehydrogenase (G6PD) and other red blood cell defects like Duffy null phenotype (Kwiatkowski, 2005). It has been reported that HbS homozygote suffer from sickle cell disease but heterozygotes (HbAS) has a 10 – fold reduced risk of severe *P. falciparum* malaria (Hill *et al.,* 1991). Deficient G-6-PD enzyme activity has also been shown to correlate with protection against severe malaria in Nigerian children (Gillies *et al.,* 1967).

As the *P. falciparum* prevalence in this study population of asymptomatic parasitized children was 27.5%, our null hypothesis therefore, was that for any given genetic marker, the percentage of individuals with *P. falciparum* parasitaemia should be 27.5% and the percentage with no parasite should be 72.5% and if a given genetic marker has an association with asymptomatic parasitaemia, it would cause a significant deviation from the null hypothesis. The null hypothesis was tested with chi-square. Based on this, a significant positive association was found to exist only between blood group O, Rh D negative and *P. falciparum* malaria. This association is a positive one in that 33 in group O subjects were expected to be parasitized but more (45) were observed to be parasitized and out of the five in Rhesus D negative group expected, nine were parasitized (Jeremiah *et al.,* 2010a).

This positive association does not mean that group O persons are protected against malaria but vice versa. Similarly, no association was found to exist between haemoglobin electrophoretic phenotypes and *P. falciparum* malaria. No association was also found to exist between G6PD status and *P. falciparum* parasitaemia (Jeremiah *et al.,* 2010a). Reduced parasite replication in G6PD deficient erythrocytes is thought to be the mechanism of protection (Luzzato *et al.,* 1969), but the parasite appears to counter this by manufacturing G-6-PD itself (Usanga and Luzzatto, 1985).

Even though, in our study, no significant association between AS phenotype and malaria was established, because the difference between the expected and observed counts was not significant, a number of mechanisms have been proposed to mediate the protection afforded by HbAS; these include accelerated sickling of parasite infected HbAS erythrocytes, poor parasite invasion and growth rates in HbAS erythrocytes, and enhanced phagocytosis of infected erythrocytes but the relative contribution of any or all of these in vivo is not known (Abu-Zeid *et al.,* 1991).

Glucose 6 phosphate dehydrogenase is an enzyme in the hexose monophosphate shunt responsible for the generation of reduced glutathione. This reduced

glutathione protects sulphydryl group of haemoglobin and the red cell membrane from oxidation by the oxygen radicals. Defect in this shunt leads to inadequate protection against oxidation, resulting in oxidation of sulphydryl groups and precipitation of haemoglobin as Heinz bodies and in lysis of the red cell membrane (Frank, 2005).

4.1.5 WHITE BLOOD CELL COUNT, AS A TOOL FOR ESTIMATING MALARIA BURDEN

Quantification of malaria parasites yields clinically useful information and is usually done by quantifying malaria parasites against blood elements (RBCs) or white blood cells (WBCs) in thin and thick smears stained with Giemsa. Since calculation of parasite density is very crucial for estimating herd immunity and for determining end points in field trials for interventions such as a malaria vaccine, impregnated bed-nets and chemo-suppression, proper methods need to be developed to ensure accurate diagnosis (Peterson *et al.,* 1996).

Most reports of the estimation of parasite density in malaria centers on the comparison of methods using RBC and WBC, the number of fields/white blood cells or differences in reader technique with little or no consideration of parasite density based on individual patients' WBC counts. The assumed count of $8.0x10^9$/L is conventionally used worldwide (Peterson *et al.,* 1996; O'Meara *et al.,* 2006).

This assumed count of $8.0x10^9$/L conventionally used was compared in our study with the actual WBC count, obtained from the individual subjects. It was observed that the parasite density using the assumed count of $8.0x10^9$/L might result in over estimation of the parasite burden in children. It is absolutely necessary that the total WBC count of individual patients be determined and used in the calculation of parasite density whenever it is required for treatment (Jeremiah and Uko, 2007b).

4.1.6 MALARIA INFECTION AND EFFECT ON PLATELET COUNT

During the last decade, platelet count is being evaluated as a predictor and prognostic feature of malaria infection (Imbert *et al.,* 2003). Thrombocytopenia is a well-known complication of acute and severe malaria infections (Imbert *et al.,* 2002, Essien and Oruamabo, 1996). Most reports on thrombocytopenia in malaria are centered on adults and children with symptomatic malaria while there was little information on asymptomatic parasitaemia in apparently healthy children. This led to the determination of platelet counts in the cross section of children used in our study.

Our results revealed that the median platelet count was $115x10^9$/L (1QR 97.5-190). Thirty three out of the 240 (13.75%) of the children had thrombocytopenia (i.e. platelet count less than $100x10^9$/L). the reduction was more pronounced in children under 5 years and also at higher parasite counts. An inverse relationship was established between parasite density and platelet count (y = 0.017x + 96.2, r = -.2). We concluded that thrombocytopenia is not only a feature of acute malaria infection but also of subclinical malaria infection in the tropics and might be a useful indicator of malaria infection in children (Jeremiah and Uko, 2007c).

5.0 STUDIES RELATED TO MILLENIUM DEVELOPMENT GOAL 5: PREVENTION OF MATERNAL MORTALITY

5.1 ALLOIMMUNIZATION TO PLATELET AND HLA ANTIGENS

Alloimmunity is an immune response to foreign antigens (alloantigens) from members of the same species. Alloimmunity evoked in mothers during pregnancy is recently recognized condition of potential and substantial clinical importance in neonatal medicine (Mueller – Eckhardt, *et al.,* 1989; Aster, 1993; Dreyfus *et al.,* 1997). In this condition, it seems that the mother generates antibodies against integrin adhesion molecules on the surface of foetal platelets. Alloimmunity develops in the mother if foetal platelets bear integrin adhesion molecules (glycoproteins) inherited form the father. If sufficient numbers of foetal platelets cross into the maternal circulation, then the mother forms alloantibodies. It is thought that with repeated pregnancies with the same partner, maternal antiboedies can reach a level sufficient to cross into the foetal circulation where they impaired foetal platelet function and even evoke neonatal thrombocytopenia in a condition known as neonatal alloimmune thrombocytopenia (Santoso and Kiefel, 1998; Roberts and Hurray, 2008).

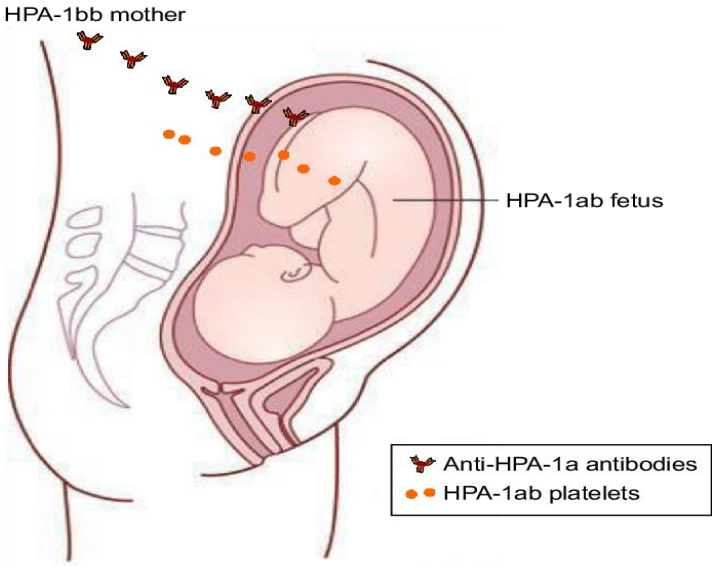

Figure 10: Alloimmunization due to Platelet antigens

Human leukocytes class 1 antigens are expressed variably on platelets and alloimmunzation to the HLA results in refractoriness to random donor platelet transfusion. Refractoriness is manifested by the failure to achieve a rise in the circulating platelet count one hour after transfusion of adequate number of platelets. This refractory state is often associated with lymphocytotoxic HLA antibodies (Phelan, 2005).

The background given above triggered our interest to embark on studies relating glycoprotein adhesion molecules and human leukocyte antibodies in pregnant mothers and multiparous women. The platelet specific and HLA class 1 antigens are carried on the platelet membrane glycoproteins which often occur in pairs e.g. GP 1a/11a, 111a or 1b/IX referring to the alpha and beta chains of each molecules. The female population anywhere in the world forms part of the blood donor pool and majority of them are multiparous women. Although these women could be good long term donors, the multiple pregnancies exposes them to the risk of developing higher than usual titres of HPA and HLA antibodies to the foetal antigens of paternal origin.

We hypothesized that in a typical African setting where the cultural beliefs encourage multiple pregnancies, the proportion of these antibodies could be high among multiparous women thus rendering them “dangerous blood donors”.

Our studies involved two groups of subjects, one hundred and forty four (144) pregnant women and one hundred multiparous women. Among the 144 pregnant women studied, 87 (eighty seven) (60.5%) were found to possess antibodies in their circulation.
Among the positive samples, sixty (60) had platelet glycoprotein specific antibodies (41.7%) and 27 had HLA class 1 antibodies (18.8%). In 39.6% of the pregnant women, both platelet specific antibodies and HLA class 1 antibodies appeared. The prevalence of platelet specific glycoprotein antibodies were obtained as follows: GP 11b / 111a, 12(8.3%), GP 1a/11a. 35 (20.8%), GP 1b/IX 18 (12.5%) and GP IV 9 (6.3%). The prevalence of each platelet antibody subgroup was obtained as follows: anti-HPA-1a, -3a, -4a (4.2%), anti HPA-1b, -3b, -4a (4.2%), anti HPA-5a and anti GP 1b/IX occurred in the proportion of 12.5% respectively. Anti HPA-5b was 8.3% prevalent while anti GP IV was 6.3% prevalent. This study revealed a high prevalence rate of human platelet and cytotoxic antibodies in our obstetric population. This calls for the establishment of platelet serology research laboratory in our tertiary health care institutions.

Among the 100 multiparous women studied, no anti-glycoprotein 11b/111a (anti-HPA-1a, -3a, -4a) antibodies were detected. However, prevalence of anti-glycoprotein 1a/11a (anti-HPA-5b) was 30% and at anti-glycoprotein 1a/11a (anti-HPA-5a) was 18%. HLA class 1 antibody was prevalent to the proportion of 22.0%. Parity was found to exert significant influence on the development of HPA antibodies (Fisher's exact test = 11.683, $P < 0.05$; 13.577, $P < 0.01$). The outcome of these studies revealed:

1. A high prevalence of anti-HPA-5b antibodies.
2. Significant influence of the number of previous pregnancies on the occurrence of anti-HPA-5b and anti-HPA-5a.
3. The complete absence of anti-HPA-1a on the GP 11b/111a complex. (Jeremiah *et al.,* 2011b, Jeremiah *et al.,* 2010).

When we compared the two studies, it became very obvious that there is a wide difference in the development of anti-HPA-5b between antenatal women and multiparous women. The prevalence of anti-HPA-5b among multiparous women was 30% while 12% prevalence of anti-HPA-5b was observed among antenatal women. This is a clear indication that parity had a significant influence on the development of antibodies to platelet glycoproteins.

Interestingly, a very high prevalence of HLA class 1 antibodies was observed among the two groups: 18.8% in antenatal women and 22.0% among parous women (Jeremiah and Oburu, 2011; Jeremiah *et al.,* 2010). The most serious consequences of the presence of platelet antibodies and HLA class 1 antibodies are the possibilities of the occurrence of clinical disorders known as Fetomaternal alloimmune thrombocytopenia (FMAIT), platelet refractoriness (PR), post transfusion purpura (PTP) caused by anti-HPA antibodies and transfusion related acute lung injury (TRALI) caused by anti-HLA class 1 antibodies.

In course of this study, we encountered a woman (one of the subjects in the multiparous study) who had nine pregnancies and lost all either in utero or after birth. The result of her sample revealed the presence of all 5 anti-HPA antibodies (platelet antibodies) and also the presence of HLA class 1 antibodies. It was logical to conclude that the antibodies from the women must have been passing into the child resulting to the clinical condition called fetomaternal alloimmune thrombocytopenia (an equivalent and haemolytic disease of the new born). This is a pathetic story which goes a long way to expose the poor state of our health facilities. For up to nine pregnancies, the cause of this woman's foetal wastages could not be unraveled. At the long run, it would be attributed to one uncle or in-law somewhere who vowed she would never give birth to any child.

This pathetic story and incident led us into another study on the Pattern and prevalence of neonatal thrombocytopenia in the same facility, UPTH, Port Harcourt. Our findings revealed a very high prevalence of 53.0%. Mild thrombocytopenia (platelet count 51-100x10^9/L) was found in 39.4% of the neonates. 12.1% had moderate thrombocytopenia (platelet count 30-50 x 10^9/L) while severe thrombocytopenia (platelet count < 30x10^9/L) was detected in 1.5% of the neonates. Of these 84.84% of the cases occurred within 72 hours (early onset). The most common clinical diagnosis among the neonates were birth asphyxia (33.3%) followed by neonatal jaundice (19.7%), neonatal sepsis (16.7%), low birth weight (13.6%), anaemia and bleeding (6.1%) and other clinical condition (10.6%) (Jeremiah and Oburu, 2010). Physiologically, a healthy feotus has a platelet count of greater than 150x10^9/L by the second trimester of pregnancy and only 2% of term infants are thrombocytopenic at birth (Roberts and Murray, 2008).

The major mechanisms underlying neonatal thrombocytopenia, accounting for about 75% of cases, has been attributed to impaired platelet production while increased platelet consumption and / or sequestration accounts for the remainder of cases. Newborns who suffer hypoxia or acidosis after birth trauma often develop thrombocytopenia. Bacterial infection causes endothelial damage, thus accelerating destruction of platelets and their removal by the reticulo-endothelial system. (Roberts and Murry, 2008).This is due to hypoxic injury caused to fetal megakaryocytic which cause the progenitor cell to be driven toward the erythroid series at the expense of leukocytes and platelets.

Laboratory evaluation is vital to providing clues to the kinetic mechanisms of the infant-thrombocytopenia. Introduction of mean platelet volume (MPV), which is the measure of the average size of circulating platelets, could be useful to assess when thrombocytopenia caused by reduced production or accelerated destruction of platelets. In reduced production, the MPV is normal (7.5 – 9.5 fl) while in accelerated destruction, the MPV is elevated (> 10 – 12fl). Larger platelets are evident when the bone marrow is stimulated to produce more immature platelets to respond to increased platelet utilization.

The percentage of reticulated platelets (RPs) is another indicator of the platelet kinetic mechanism RPs are newly produced platelets that have a higher RNA content than do older platelets. RP% is low (< 2%) when production is low and high (.10%) when platelets are being consumed at an accelerated rate.

Another useful parameter is the measurement of plasma thrombopoietin (Tpo) growth factor. Thrombopoeitin (Tpo) receptors on megakaryocytic progenitors,

megakaryocytes and platelets. When platelet production is abnormally low, few megakaryocytes are produced and plasma Tpo is high.

5.2 ALLOIMMUNIZATION TO RED BLOOD CELL ANTIGENS

The red blood cell (RBC) alloantibodies other than naturally occurring anti-A or anti-B are called unexpected RBC alloantibodies. Immunization to RBC antigens may result from pregnancy, transfusion, transplantation or from injection with immunogenic material. Prenatal immune haematologic care of pregnant women requires the investigation of unexpected RBC antibodies in their sera during pregnancy. When RBC antibody screening is positive, it is usually practice to determine specificity of the antibody, its clinical importance and the ability to cross the placenta and cause HDN.

With a reported high incidence rate of neonatal jaundice in Port Harcourt to the tune of 21.4% in outborn and 16.4% in inborn babies (Eneh and Oruamabo, 2008), we embarked on the first study of frequencies of maternal red cell antibodies in Port Harcourt using Diacell and Diapanel reagents from Diamed.

Alloantibodies were identified in the sera of 17 of the 500 (3.4%) pregnant women. The specificity of the antibodies was as follows: anti-C, 6 (1.2%), anti-E, 3 (0.6%), anti-Jsb 3(0.6%) and anti-K. 5(1.0%). No anti-D was identified despite 8.6% of the study population being Rhesus D (RhD) negative. The distribution of the antibodies occurred independent of the blood groups of the participants (χ^2 = 4.050, P = 0.670).

Maternal serum is screened to make sure pregnant mother has no antibodies to react with the foetal cells. HDFN is caused by the mother IgG antibodies crossing the placenta and attaching to the baby's RBCs. It is therefore necessary to know as early as possible in the pregnancy whether HDFN can be a possibility. Determining the specificity of an unexpected alloantibody is important in prenatal testing (Jeremiah *et al.,* 2011c).

As a follow up to the study on maternal alloantibodies, we evaluated the clinical utility of the antibody screening procedure as a surrogate to antiglobulin cross matching procedures.

The blind antiglobulin cross-match was performed on all samples and five (2.0%) were found to be incompatible while 254 (98.0%) were compatible. Taking incompatible results as positive and compatible as negative, the performance indices of the antibody screening procedure was obtained as follows: Sensitivity (41.6%), specificity (100%), positive predictive value (PPV) (100%), negative predictive value (NPV) (97.1%), efficiency (48.6%). The study did not show the

type and screen to reach the expected safety level of 99.0%. Its usefulness was however shown through the detection of unexpected antibodies in 3.4% of the subjects.

We concluded that with a high specificity obtained, the detection and identification of these antibodies would help select blood in advance for patients undergoing surgery to reduce the incidence of haemolytic transfusion reactions (Jeremiah and Mordi, 2011).

5.3 RHESUS NEGATIVE ALLOIMMUNIZATION

A sensitized Rh negative mother produces anti-Rh IgG antibodies that cross the placenta and the risk factors for antibody production has been reported to include second and later pregnancies, feto maternal incompatibility in ABO system, paternal zygosity, maternal toxaemia and antigen load. RhD antigen associated haemolytic disease occurs when the maternal antibodies to the RhD on the foetal/infant red cells crosses the placental barrier to cause acquired immune-mediated haemolysis of the newborn (James *et al.,* 2011).

The overall strategy of the study of haemolytic disease of the newborn (HDN) include the determination of the direct test of human antiglobulin or direct Coomb test (DAT) (Dittmar *et al.,* 2001). This procedure allows us to identify the presence of anti-erythrocyte antibodies of IgG isotope, originating in maternal serum on the surface of the erythrocytes of the foetus or newborn.

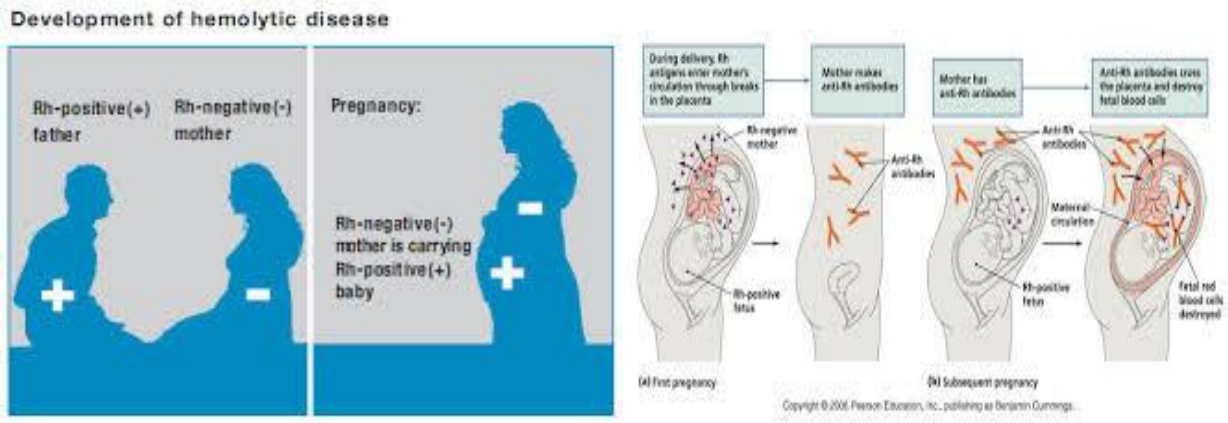

Figure 11: Development of Haemolytic Disease of the Foetus and New born (HDFN)

In order to ascertain the percentage of babies who are at risk of haemolytic disease of the newborn, we conducted a study at the University of Maiduguri Teaching Hospital to find the occurrence of the reactivity of DAT on cord blood of children born to Rh negative mothers.

Of the fifty (50) Rhesus negative mothers who were enrolled in the study, Twelve (24.0%) of the cord blood samples were DAT positive (χ^2 = 13.52, P < 0.01). the

positive DAT was found to be significantly associated with maternal age (χ^2 = 7.58, P < 0.02) and parity (χ^2 = 10.16; P < 0.01). ABO blood group was not found to be significantly associated with positive DAT. Women who were 31 years and above had a 50% positive DAT while grand multigravida (4 children and above) were more sensitized than others. A significant proportion of the mothers had previous abortion while 26.0% of the women had previously received blood transfusion.

This study clearly revealed that there is a high prevalence of positive cord blood DAT in this part of the world. The need to establish intervention programmes in terms of neonatal screening and immunoprophylaxis for the benefit and protection of the neonates, the family and health care system in Nigeria (Jeremiah *et al.,* 2013.)

6.0 STUDIES RELATED TO MILLENIUM DEVELOPMENT GOAL 6: REDUCTION OF INFECTIOUS DISESES

6.1 BLOOD: A VEHICLE OF DEATH?

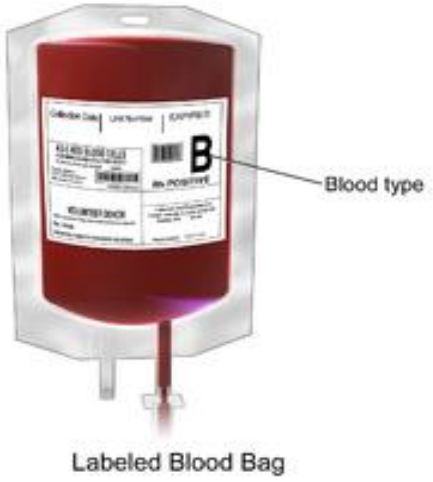

Figure 12: A labeled blood bag for transfusion

6.2 THE BURDEN OF TRANSFUSION TRANSMISSIBLE INFECTIONS

The circulation of blood in humans was first demonstrated in the year 1628 by William Harvey. This discovery gave way for blood transfusion which has become a therapeutic regimen to save lives. However, the transfusion of blood is an allogeneic transplant and as such is a medical procedure that carries intrinsic, irremovable components of risk. One of the major risks encountered in blood transfusion practice is the risk of transmissible diseases from the donor (presence of viruses, bacteria, parasites in the donor's blood).

The issue of blood safety is very critical to patient survival hence screening of donor for infectious diseases is the first approach towards ensuring safety. The donor population is divided into two groups; the general population and the pre-

selected groups. Most often, the family replacement and voluntary donors are drawn from the general population while commercial donors are mostly drawn from the pre-selected group.

Although blood transfusion saves millions of lives worldwide each year, recipient of transfusion risk becoming infected with blood borne diseases such as human immunodeficiency virus (HIV), hepatitis B virus (HBV) and hepatitis C virus (HCV) through transfusion of infected blood and blood products (UNAIDS, 2007).

The discovery that HIV, HBV and HCV could be transmitted by transfusion herald a new era in blood transfusion practice and has provoked a greatly heightened emphasis on two fundamental objectives: safety and protection of human life.(Tapko *et al*., 2007). These three viral infections are distinct but share a similar mode of transmission, primarily through unscreened and contaminated blood and blood products by contact or transfusion. Other routes include sexual intercourse and vertical transmission from mother to foetus in the immediate prenatal period (Buseh, 1991; Everhart *et al.,* 1990).

A study of transfusion transmissible viral infections among 1,500 University fresh students in Port Harcourt revealed prevalence rates of 1.7%, 2.1% and 0.1% for HIV, HBV and HCV respectively. Youth aged 21 – 30 years constituted the highest number of HIV and Hepatitis infections. Co-infection of HIV and HBV accounted for 0.2%. Age was indicated as a risk factor for the transmission of the three transmissible infections. The 0.1% prevalence of HCV in this study occurred exclusively among non-natives (outside the ethnic groups of Ijaw, Ikwerre, Ogoni and Ekpeye). (Jeremiah and Tony-Enwin, 2009).

From this epidemiological study among general population, we extended the study to the blood donors, also in Port Harcourt. The prevalence of HCV among apparently healthy blood donors and risk factors associated with the infection was determined. 300 blood donors participated in the study, males (88%) and commercial donors (63%). Fifteen of the 300 donors were positive for HCV, giving a prevalence rate of 5.0%. Age 21 – 30 years was identified as the highest risk group with 60% of the subjects with HCV infection. Twelve of the 15 (80%) HCV positive subjects were commercial donors (Jeremiah *et al.,* 2008c).

Similar seroepidemiological study of TTIs among blood donors in Osogbo, South West of Nigeria recorded prevalence rates of 18.6%, 3.1%, 6.0% and 1.1% for HBsAg, HIV, HCV and syphilis infections respectively. The highest prevalence's of HBsAg, HIV, HCV and syphilis infections occurred among commercial blood donors and those aged 18 to 47 years old, (the most sexually active age group (Buseri *et al.,* 2009).

The prevalence rates of HCV in the previous studies described above differed significantly from the earlier study by Koate *et al.,* 2005 where 2.9% was reported against 5.0% and 6.0% in recent studies. This is a clear indication that the problem is still with us hence more efforts are required to tackle it.

In a setting where a Hepatitis B virus infection isacute, HBsAg typically becomes detectable 4 to 8 weeks after infection. Shortly, thereafter, IgM anti-HBC appears in the blood. Thus the diagnosis of acute hepatitis B is generally made by the simultaneous detection of HBsAg and IgM anti-HBC (Hoofnagle, 1981). Rarely, acute hepatitis B may be diagnosed if acute HBV infection is made based on the presence of positive IgM anti-HBc titres. These patients will thus have isolated anti-HBc as the only marker of acute hepatitis B infection. Isolated anti-HBc is therefore defined as the presence of anti-HBc in the absence of detectable hepatitis B surface antigen and hepatitis B surface antibody (Ribeiro and Perelson, 2002).

In our setting, anti-HBc testing is not mandatory in our blood banks. HBsAg testing by rapid ELISA strip is used as the only screening test for HBV infection. The prevalence rates of isolated anti-HBc-IgM antibody in blood donors have not been reported prior to this study. We therefore conducted a study among 266 blood donors to test for the presence of infectious disease markers and isolated anti-HBc-IgM antibodies in the University of Maiduguri Teaching Hospital, Maiduguri.

The prevalence of various infections disease markers obtained was as follows: HBsAg (8.6%), anti-HCV (1.5%), HIV (2.6%) and anti-HBc-IgM (18.4%). There was a zero percent prevalence of syphilis in this study population. The performance indices for HBsAg were as follows: sensitivity (10.2%), specificity (91.7%), positive predictive value (PPV) (21.7%), negative predictive value (NPV) (81.9%) and efficiency (76.7%). The prevalence of anti-HBc-IgM antibody was higher among first item blood donors (21.4%). The sensitivity of HBsAg was found to be very low and as such many recent HBV infections may be missed during pre-transfusion tested. The study advocated the use of anti-HBc-IgM screening as a mandatory pre-transfusion screening test (Jeremiah *et al.,* 2011c).

In a very recent study of Hepatitis B virus profile among one hundred and three (103) blood donors in Abuja by Agbesor *et al.,* (2016), the prevalence for the five markers of Hepatitis B virus were reported as follows: HBsAg (17.5%), HBeAg (1.9%), HBsAb (17.5%), HBc IgG (55.3%) and HBc IgM (8.7%). The implication of these findings is that the Hepatitis B virus is still prevalent in both general and blood donor populations and poses serious threat to blood transfusion practice in Nigeria. More worrisome is the fact that the percentage of those with chronic infection is very high as shown in the proportion of those with HBc IgG antibody.

6.3 Transmission of Typhoid in blood

Our research tentacles were spread beyond the HIV and hepatitis transmission in a bid to ascertain the safety of our donor pool. Salmonella which is the causative agent of Typhoid fever is an endemic infections agent. Because it is blood borne, the possibility of it being transmitted through blood transfusion is real. Nsutebu *et al.,* (2002) found significant Salmonella antibody titres in more than 10% of apparently healthy blood donors in neighbouring Cameroon. It is very unlikely that there is a significant difference in the living conditions of Nigerian and Cameroonians.

A study to determine the distribution of Salmonella antibodies among donors in Nigeria and the possible implications of such finding therefore became relevant to us. Our study of 200 sample analyzed revealed that 53% were found to be widal-positive with a minimum titre of 160. Among the positive cases, reactivity was most common to *S typhi*(D) antigens (48.6%). The study confirmed that Salmonellosis is endemic in Nigeria and many of our blood donors may be Salmonella carriers (Adias *et al.,* 2010).

6.4 Transmission of Dengue virus in the blood

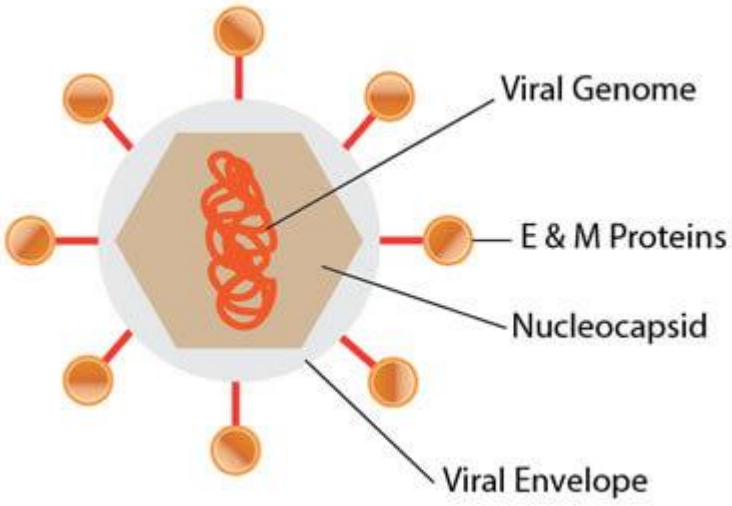

Figure 13: Structure of the Dengue virus

Dengue virus(DENV) is one of the causative agents of viral haemorrhagic fever (Halstead, 1988). The virus circulating in the blood of viraemic human is ingested by female mosquitoes (Aedes) during blood meal. The virus then infects the mosquito midgut and subsequently spreads systematically over a period of 8-12 days. After this extrinsic incubation period, the virus can be transmitted to other humans during subsequent meals; Transmission of Dengue virus without the involvement of the Aedes vector has been reported. Such transmissions occur

through needle stick injuries, mucocutaneous transmission through a blood splash to the face, vertical transmission and bone marrow transplant (Chen and Wilson, 2005). Transmission of Dengue virus through blood transfusion becomes a blood safety issue because possibility of contracting the virus through exposure to blood from non-vector sources were proven (Chen and Wilson, 2004)

A recent study carried out by Muhibi *et al*(2017) in Osogbo to ascertain the prevalence of Dengue virus in our blood donor pool revealed that 2 (2.2%) of the ninety one(91) voluntary non-remunerated blood donors were positive to anti-Dengue IgM antibodies. Even though the prevalence seems low, the study has established the presence of a virus not routinely tested in our transfusion practices. The implications of this finding is that, monitoring the trends in the prevalence of transfusion transmissible infectious agents in the blood donors should not be restricted to HIV and Hepatitis alone as it is the current practice. (Muhibi *et al*., 2017)

6.5 THE GIVE AND TAKE OF BLOOD TRANSFUSION: CONCERNS AND IMPACTS

Apart from the transfusion transmissible infections (TTIs) discussed above, this lecture will also highlight other issues that bother on blood safety.

Facts before us**:**

- There is no substitute for human blood.
- It cannot be manufactured. God holds the formula and it remains a secret.
- Animal blood cannot replace it.
- People are the only source of blood for those who need it.

In a country such as ours where there is no organized National blood transfusion service, no organized voluntary donor pool, no donor care facilities, and no comprehensive or extensive data or statistics on blood donation, the extent of the problem of iron depletion among the small number of donors available and who are often emergency blood donors is not known, the paucity of information in our local donor population makes it difficult to ascertain the true degree of the problem. We felt that determining the baseline reference values for the blood donors with special regard to gender and age would serve as a starting point to develop good baseline data and provide a basis for further studies in this part of the world.

In line with this objective, Jeremiah and Koate conducted a study to establish the reference percentiles of haematoligical and biochemical iron values of blood donors in Port Harcourt, Nigeria. The parameters studied were serum ferritin (SF), serum iron (SI), Total iron binding capacity (TIBC), Transferrin saturation (TS), haemoglobin (Hb), packed cell volume (PCV), white blood cells (WBC) and

Erythrocyte sedimentation rate (ESR). The study provided the reference percentiles and further revealed anaemia in 10.4% and iron deficiency anaemia in 6.0% in the study population respectively. This prevalence of 10.4% anaemia and 6.0% iron deficiency anaemia was considered high. This led us to further on blood donors mention below.

Blood donation has serious impact on iron status of donors as it results in a substantial (200 – 250mg) loss of iron at each collection procedure during which upto 425 - 475µl of whole blood are withdrawn and subsequent mobilization of iron from body stores. Chronic iron deficiency is therefore a well-recognized complication of regular blood donation it follows therefore that an increase in the frequency of blood donation is liable to result in excessive iron loss and development of iron deficiency anaemia.

Jeremiah and Koate (2010) conducted study on three hundred and forty eight unselected consecutive whole blood donors, comprising 96 regular donors, 156 relative of patients and 96 voluntary donors in Port Harcourt. It was surprising to note that anaemia was present in 13.7% of the study population; iron deficiency was present in up to 20.6% of the population while iron deficiency anaemia accounted for 12.0%. The regular or commercial donors were found to be most adversely affected. Interestingly, anaemia, iron deficiency and iron deficiency anaemia were present almost exclusively among regular blood donors, all of whom were over 35 years old. We concluded that, it would be necessary to review the screening tests for the selection of blood donors in our facilities.

Blood donation does not only affect iron status, it also impact positively on the wellbeing of donors. In a study by Adias *et al.,* (2012), it was reported that repeat whole blood donation correlates significantly with reduction in body mass index (BMI) and lipid profiles and also lead to increased gamma glutamic transferase (GGT) activity among blood donors. This implies that repeated blood donation may play a very significant role in reducing the incidence of heart disease. This is a very serious health benefit to explore. So when next you have an opportunity to donate blood, do so and your heart will thank you.

The report from this study leaves behind a caution to blood donors who engage in unhealthy life style of alcohol consumption. Gamma glutamic transferase (GGT) is an enzyme which is present in hepatocytes and biliary epithelial cells. Its elevation above 50µl is the most sensitive marker of hepatobiliary disease. In the above reference study by Adias *et al.,* (2012)the GGT level was significantly high and this correlates significantly with low density lipoproteins ($r = 0.891$, $P < 0.001$). The message is clear that alcohol consumption can lead to the destruction of hepatocytes. In order to ensure a safe donor pool which you are already involved,

a healthy lifestyle of no or less alcohol intake, smoking etc. If we do this, we will together ensure a safe donor pool and minimize consequences on the blood recipients.

Most studies on blood donors such as those reported above are centered on the selective evaluation of red blood cell parameters with little or no regard to white blood cells and platelets. In a study conducted in Port Harcourt and reported by Jeremiah *et al.,* (2011), subclinical leukopenia was encountered in a cross section of Nigerian blood donors. The study reported 18.8% of anaemia and 12.5% leucopenia (absolute count below $2.0x10^9$/L).

We therefore concluded that regular blood donation do not only affect red blood cells. First time blood donor would be most preferable when the concentrated white blood cell component of blood needs to be prepared.

Another serious issue bothering on blood transfusion safety is that of storage of whole blood considering our peculiar environment where power supply is epileptic in nature. Have you ever wondered what happens to the blood in the bag stored to be transfused to a recipient who could be anybody's relative. Preservation and long term storage of red blood cells is needed to ensure a readily available, safe blood supply for transfusion purposes but considerable evidence exists that whole blood storage may result to storage lesions with the release of bioactive substances by leukocytes. These substances include: histamine, lipids, cytokines and they may exert direct effect on metabolic and physical changes associated with the senescence such as membrane reticulation, decrease in cell size, increase in cell density, alteration of cytoskeleton, enzymatic desilylation and phosphatidylserine exposure. Jeremiah and Moore-Igwe (2012) reported storage related haematological and biochemical changes of CPDA-1 whole blood in our resource limited setting.

The study revealed that the granulocytes were drastically reduced from 1.93 x 10^9/L on day 1 to $0.38x10^9$/L on day 7. Erythrocyte sedimentation rate (ESR) increased from 2.90 mm/hr on day 1 to 6.60mm/hr on day 7. The biochemical parameter of sodium (Na) decreased significantly from 137.38mEq/L on day 1 to 135 mEq/L on day 7. At the end of 28 days, it was discovered that there were significant changes in the WBC (differential and absolute leukocytes), MPV, PDW and ESR. Among the biochemical parameters, albumin and potassium ere also significantly affected. There were no significant changes observed in haemoglobin and other haematological parameters.

We concluded that, if whole blood should be stored beyond one week, it ought to be leukodepleted to avoid immunomodulation which may further result to adverse transfusion reactions.

7.0 IMMUNOHAEMATOLOGY- BEDROCK OF TRANSFUSION MEDICINE PRACTICE

7.1 PHENOTYPE FREQUENCIES OF BLOOD GROUP ANTIGENS

It is interesting to know that every one of us have something to give to the next person especially when life is involved. Everyone may need to take from somebody what you do not have or need to sustainlife. More interestingly, these things we have to give are naturally inherited and deposited on our red blood cell membrane. As the saying go "All fingers are not equal" so is everyone not sufficient in possessing all he needs to survive. Remember, God gave your blood as a gift but once given, it becomes a key to either life or death.

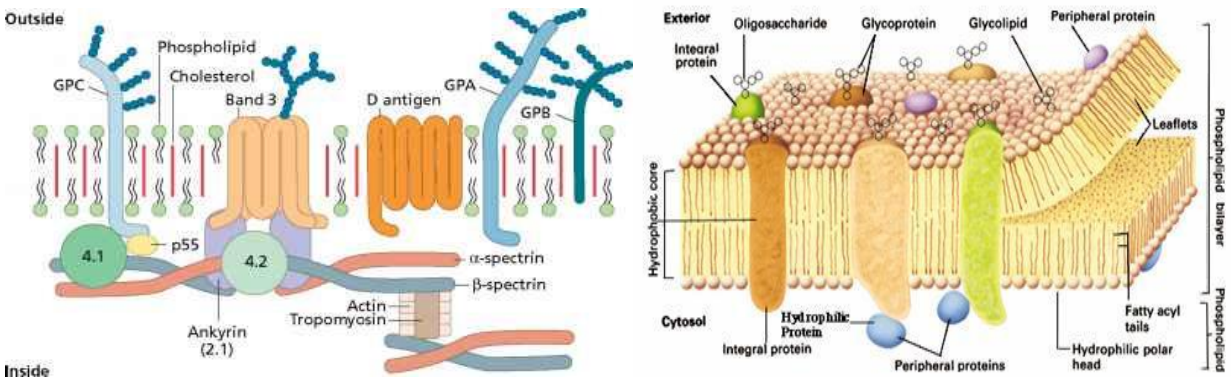

Figure 14: Structures of the red cell membrane

This will take us to another branch of haematology called **IMMUNOHAEMATOLOGY.**

Immunohaematology is the application of the principles of immunology to the study of red cell antigens and their corresponding antibodies in the blood for the purpose of resolving problems and to predict a successful transfusion outcome. The membrane of the human red cells (RBC) contains a variety of blood group antigens. The most important and best known of these is A and B antigens, which are actually complex oligosaccharides that differ in their terminal sugar. On RBCs, they are mostly glycosphingolipids. The antibodies against red cell antigens are called agglutinins (antibodies) and individuals are divided into four major groups A, B, AB and O accordingly to the presence of these antigens and agglutinins (Conteras and Lubenko, 2001, Knowles and Poole, 2002).

In addition, human red cells that contain antigen D are known as Rhesus Positive while those without antigen D in their RBCs are Rhesus negative (Knowles and Poole, 2002). The clinical relevance of these blood group systems elate to the capacity of alloantibodies (directed against antigens not possessed by the individual) to cause destruction of transfused red cells (ABO antibodies) or to

cross the placenta and give rise to haemolytic disease of the foetus and newborn (HDFN) (Knowles and Poole, 2002).

7.2 FREQUENCIES OF ABO ANTIGENS

The study of the frequencies of the blood group antigens and antibodies is the foundation of the blood transfusion medicine. It affords us the opportunity to know what we have and how it is spread in our population. These antigens are known to differ in various population and ethnic groups.

The first independent study on these blood groups in Port Harcourt revealed as follows: blood groups A (22.9%), group B (17.1%), group AB (4.84%) and group O (55.1%). These frequencies appear stable and consistent with previous published data (Jeremiah, 2006). Another independent study among first antenatal clinic attendees provided the following frequencies also in Port Harcourt, blood group A (26.67%), group B (18.33%), group AB (2.22%) and group O (52.78%) (Jeremiah, 2005). ABO antigen frequencies among premarital couples in Port Harcourt were not too different. The following blood group distribution was obtained; group A (22%), B (14%), AB (0%) O (64%) (Jeremiah *et al.,*2007). Serological blood grouping can also reveal genotypes and family relationships (Bukar *et al.,* 2016).

7.3 FREQUENCIES OF RHESUS ANTIGENS

Since the discovery of the Rhesus systems in 1940, more than 40 antigens have been discovered making it the most complex RBC antigen system (Race and Sanger, 1997). In addition, the frequency of Rhesus antigens has been fund to vary between racial groups. Rhesus blood group system remains the most complex and polymorphic of the blood group systems. Antibodies developed against these antigens have been known to vary between racial groups (Knowles and Poole, 2002).

Rhesus antigen frequencies in Port Harcourt were first determined in 2003 among different ethnic group using a study population. Five Rhesus antigens, D, C, c, E and e and their probable genotypes were determined using standard serologic protocols.

The most frequently occurring antigen was fund to be c (99.8%), followed by e (98.7%), then D (95.0%), E (20.5%) and finally C (17.7%). The antithetical antigens Ee was found to be statistically significant in the Ijaw ethnic group when compared with other ethnic groups (Ikwerre, Ekpeye, Ogonis) (Jeremiah and Buseri, 2003). Nine Rhesus phenotypes were found to occur in the study population as follows: DcCee (60.9%), DCcee (14.6%), DccEe (17.7%), DCeEe (1.9%), DccEE (1.1%), DCcEE (0.3%), dccee (3.1%), dCcee (1.0%) and DCCee (0.3%).

Out of these nine probable phenotypes two of them DCCee and DccEE occurred among the Ekpeye ethnic group and was completely absent in the other groups (Jeremiah and Buseri, 2006).

Determination of individuals Rh phenotypes can be a useful tool in forensic, genetic and anthropological study. For instance, a high frequency of the DCCee phenotype (0.471%) has also been found in eh Gypsies (Roms) from Slavakia which resemble closely the relevant frequencies reported from different Indian populations (Bernasovsky *et al.,* 1994). Probable frequencies are also useful tool in forensic medicine and in cases of disputed paternity.

The most common sets of Rh phenotypes are CDe, cde and cDE. One (0.2%) of the study population were found to be c negative while 20(5.0%) were D negative. D negative individuals are usually prone to alloimmunization if transfused with a D positive blood.

Similar results were obtained among the Ibibios, Efik and Ibo ethnic nationalities in Calabar as follows: Rh c (100%), e (96.38%), D (96.38%), E (15.22%) and C (3.62) for the Ibibios, c (100%), e (95.6%), D (96.7%), E(21.98%) and C (0%) for the Efiks and c (100%), e (94.29%), D (91.43%), E (28.57%) and C (2.86%) for the Ibos. Forty (5.56%) were found to be D negative while all were found to possess the c antigen. The most frequently occurring Rh phenotype was Dccee with a frequency of 73.61%. These studies further demonstrate the variability of the Rh blood group phenotypes in Nigeria and Africa (Jeremiah and Odumody, 2005).

7.4 Rh 17 AND M PHENOTYPE FREQUENCIES

In my research career, serological testing of blood samples was not limited to the routine ABO and Rh D antigens. There are several other antigens of clinical importance which were investigated. One of such is Rh 17 antigen and M antigens which belong to the MNSs systems and the second of the blood group to be described (Pittiglio, 1983).

Rh 17 antigen is a high frequency antigen among the white population produced by all non-deleted Rh genes (Issitt and Anstee, 1998). Race *et al.,* (1954) first reported the existence of cells lacking products of the C/c and E/e gene. The absence of C/c and E/e genes lead to the considerable enhance expression of D, attributable to lack of competition from other Rh genes. (Issitt and Anstee,1998). The phenotype concerned was considered to be the result of homozygosity for a rare gene that was called D-. The corresponding antibody anti-Rh 17 which occurs in individuals with various deletion phenotypes such as D – has been reported as a cause of mild to fetal haemolytic disease of the newborn (HDN) and other

complications such as loss of pregnancy and maternal haemorrhaging (Issitt and Anstee, 1998). Rh 17 also occurs in individuals with variant expression of the e antigen and is sometimes noted as anti-Rh 17 like. Such variants of the e antigen are known to be common in blacks when compared with other races.

The M antigen belongs to the MNSs systems and was the second of the blood groups to be described (Pittiglio, 1983). It's corresponding antibody, anti-M has been reported to cause haemolytic disease of the Newborn (HDN) providing the maternal antibody was of the IgG type (Contreras and Lubenko, 2001).

The two antigens (Rh 17 and M) investigated in our study are of clinical significance because of the roles they play in haemolytic disease of the Newborn, transfusion reaction and compatibility testing. Prevention of alloimmunication due to these antigens may be achieved if the frequencies in the Nigerian population are known. This study happened to be the first to be published in Nigeria. The reagents for the antigens were donated by the New York Blood Center, USA as MIMA-51 and MIMA-103 for Rh 17 and M respectively.

The frequency of Rh 17 antigen was found to be 99.5% in our obstetric study population of 400 pregnant women and 61% for M antigen. 0.5% of the population was Rh 17 negative. The distribution of the antigens among the various tribes shows a significant pattern for Rh 17 alone ($X^2 = 12.395$, $P < 0.05$). The results from this study confirm that Rh 17 phenotype is of high frequency in Nigeria while M phenotype is not (Jeremiah and Jeremiah, 2004). A high frequency antigen has been defined as one present in 99% of a population.

7.5 UNCOMMON Rh PHENOTYPES ENCOUNTERED

Apart from the importance of the Rh antigen in blood transfusion and Haemolytic disease of the Newborn, Rh proteins are involved in transporting ammonium across the RBC membrane (Dutta, 2006). It follows that RBCs which lack Rh antigens will have abnormal shape, increased osmotic fragility and shortened life span resulting in haemolytic anaemia that is usually mild in nature (Daniels, 2005). These patients are also at risk of adverse reactions because they may produce antibodies against several of the Rh antigens. The D antigen contains over 30 epitopes. Variation of the D phenotype arise when these epitopes are weekly expressed or missing resulting in uncommon phenotype which are usually very rare. These uncommon phenotypes have not been reported in Nigeria but were encountered in course of our research study of Rh phenotyping of antenatal women. These uncommon Rh phenotypes among 374 subjects were: Rh_{null} 7 (1.9%), D - - or Exalted D 16 (4.3%), Phenotypes without Rh D reactivity, - C – (2.9%), -Cc (0.3%), -C- (0.3%), Ee (0.5%) and –E- (0.3%).

The frequencies of the Rh antigen were as ffollows: C (82.0%), e (54.0%), C (24.3%) and E (20.1%) while the frequencies of the antithetical antigens were DD/Dd (91.2), Cc (19.5%), cc (84.5%), Ee (13.9%), ee (54.3%), CC (25.1%), EE (19.8%) and dd (10.4%). The most frequently occurring Rh phenotype was Dccee (25.8%). RhD negative was found to be significantly associated with HDN outcome ($\chi^2 = 6.605$, P = 0.01).

The results revealed a high presence of uncommon Rh phenotypes in our population especially Rh null phenotypes and calls for the introduction of molecular studies to establish reasons for deletions and Rh null phenotypes among Nigerian and Africans in general (Jeremiah *et al.,* 2012).

8.0 HAEMORHEOLOGY

Blood is a dynamic fluid and its flow is dependent on a number of factors. Haemorheology, the study of blood and its relation to the vessels in which it is contained is fast assuming greater importance in modern medicine; however, considering the importance of understanding the factors involved in vivo, the subject has only been superficially explored. Many pathologic conditions like cardiovascular diseases, hyupertension, renal disease, rheumatoid arthritis, obstructive sleep apnea syndrome (OSAS) and Myeloma which were common in old age have in recent time become relatively more common in young adults. These diseases have been linked to increased blood viscosity, the hyperviscosity syndrome, which in turn affects the red cell mass, size, haematocrit and protein composition mostly the IgG3 and IgG4.

Provoked by the knowledge mentioned above, I independently conducted a research on the baseline assessment of some haemorheological factors in young adult Nigerians in Port Harcourt. Parameters like Blood pressure (SBP and DBP), haemoglobin (Hgb), packed cell volume (PCV), erythrocyte sedimentation rate (ESR) and whole blood viscosity (BV) were estimated. The results obtained revealed that a linear relationship exists between blood viscosity, haemoglobin and packed cell volume while a negative correlation existed between erythrocyte sedimentation rate (ESR) and dystolic blood pressure. Linear relationship between haemoglobin and blood viscosity could constitute cardiovascular risk if not checked (Jeremiah, 2002).

Several years later, I and my student conducted a similar study using a larger sample size of 300 students of a tertiary institution in Port Harcourt. This time, we added plasma viscosity platelet count and fibrinogen as additional parameters.

Our findings revealed positive correlations between packed cell volume (PCV) and whole blood viscosity, plasma viscosity and PCV, ESR and fibrinogen and WBV and fibrinogen (Ken-Ezihuo *et al.,* 2016). These results are similar to the previous study earlier reported.

Most recent study conducted on blood donor has provided enough evidence on the positive impact of donation on blood haemorheology. The relative plasma viscosity of male blood donors aged 25 to 40 years on the 1st day of donation was significantly reduced on the 7th day of post donation. The haematocrit value also decreases after the donation.

The study concluded that blood donation is an excellent way to reduce the viscosity of blood which can be beneficial to the circulatory system by reducing the risk of heart disease (Bukar *et al.,* 2016). Considering the enormous benefits derived from blood donation, I sincerely recommended that, provided you are found fit to donate blood, do not hesitate to do it. By so doing, you will save a life and also reduce the risk of heart disease and consequently prolong your life. You can still donate blood up to sixty years of age and your heart will thank you.

9.0 STUDIES ON COAGULATION AND FIBRINOLYTIC DISORDERS

One of the branches of haematology vital for human existence is coagulation and fibrinolysis. In a normal haemostatic process, the cessation of blood loss following injury involves the formation of a physical plug of aggregated platelets at the site of injury, which is further stabilized by the protein fibrin that is produced locally, in response to the injury by the coagulation cascade (Hoffbrand *et al.,* 2002).

Further activation of the coagulation cascade produces thrombin, an enzyme that cleaves fibrinopeptides A and B from fibrinogen to form fibrin monomers. Thrombin activates factor XIII, which then catalyses cross-linking between the D-domains of adjacent fibrin monomers, thus stabilizing the fibrin polymer. The activation of the coagulation cascade, which is necessary for the formation of the fibrin clot, is accompanied by activation of the fibrinolytic system which involves the breakdown of the fibrin (Fibrinolysis). Derangements in these physiological processes can lead to thrombotic disease in certain disease condition and pregnancy.

In a cross section of one hundred and twenty (120) pregnant women assessed for D-Dimer concentrations, prothrombin time, activated partial thromboplastin time, platelet count, haemoglobin and haematocrit. It was observed that 10% of the pregnant women had elevated D-Dimer levels over 500ng/ml, and at risk of

thrombosis. There was also a marked depression of platelet count among the pregnant women. The antenatal care for pregnant women needs to be upgraded to include haemostatic parameters for a wholistic care (Jeremiah *et al.,* 2012a).

Normal pregnancy has also been found to exert significant increase in most coagulation parameters as reported by Buseri *et al.,* (2008). The parameters studied were platelet, prothrombin time, activated partial thromboplastin time (aPTT), factor VIII assay and Fibrinogen. Derangements in these coagulation parameters could result to hypercoagulable state in some women if not properly checked. Increased maternal age was also identified as a risk factor for hypercoagulability in pregnancy. It follows therefore that coagulation parameters should form part of the test protocols in routine antenatal care.

9.1 IMPACT OF ANTI RETROVIRAL THERAPY ON FIBRINOLYTIC MARKERS

Another group of people we studied was HIV infected adults on antiretroviral therapy. We conducted a short term study tagged (START) project, an acronym that stands for Short Term Anti-RetroviralTherapy.

The main purpose of anti-retroviraltherapy is to improve the prognosis of patients infected with HIV by decreasing the incidence of opportunistic infection and subsequent hospitalization and mortality. However, several studies have suggested that highly active antiretroviral therapy (HAART) results in a higher incidence of cardiovascular events (Passalaris *et al.,* 2000).

In a normal fibrinolytic system, thrombin converts fibrinogen to active fibrin plasmin then degrade the cross-linked fibrin into soluble degradation products by the tissue type (tPA) and theurokinase type plasminogen. It is the t-PA that is mainly responsible for the dissolution of fibrin formed in the circulation and the normal process of fibrinolysis can be inhibited either by antagonizing plasma through alpha-2-antiplasmin or by specific plasminogen activators (PAI) of which there are 3 types. Elevated plasma t-PA indicates inhibited endogenous fibrinolysis and occurs when free t-PA released into the blood from endothelial cells forms a complex with circulating PAI-I. Elevated t-PA levels can predict cardiovascular disease.

The START project had three objectives:

a. To determine the values of fibrinolytic parameters within the first three months of ART.
b. To determine the period before changes in these parameters are noticeable.

c. To assess the dangers associated with late commencement or non-commencement of ART.

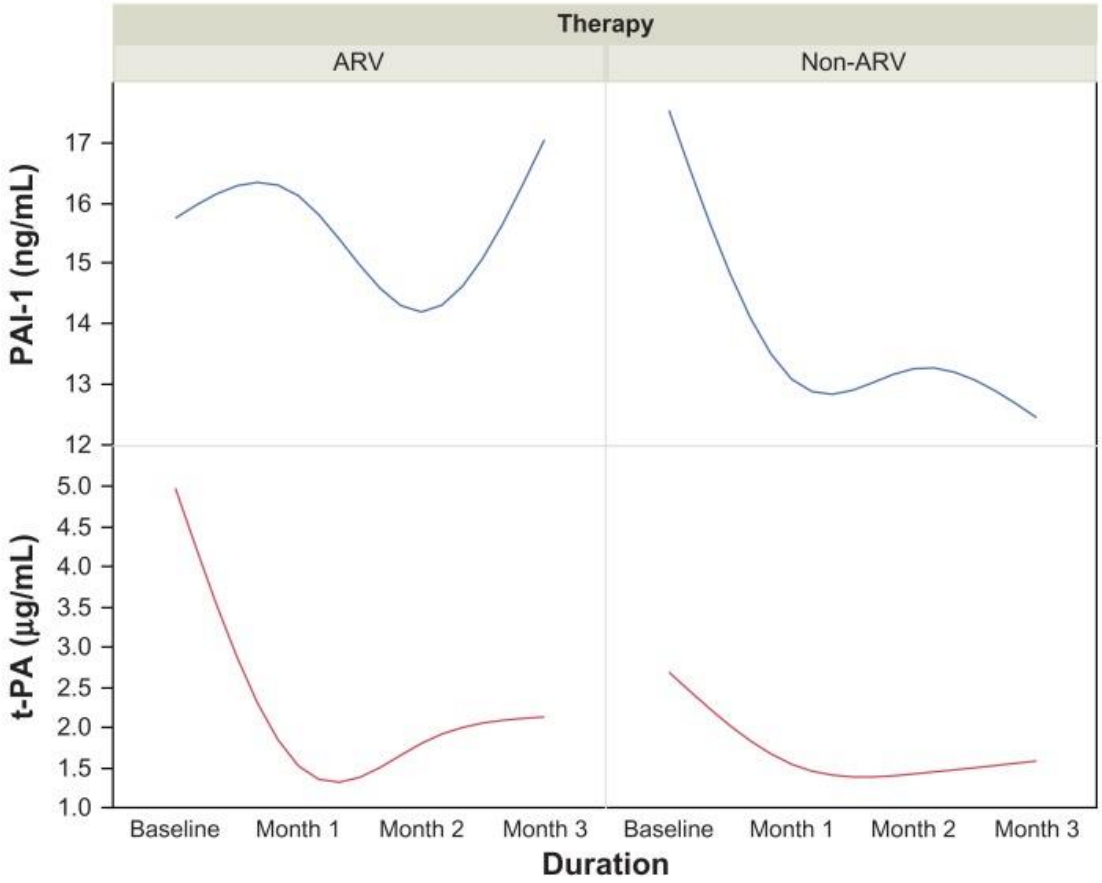

Figure 15: Effect of ART on fibrinolytic markers

Our study revealed a progressive increase in PAI-1 and steady decline in t-PA concentrations within three months of commencement of ART and this could predispose patients to thrombotic disorders earlier than is expected. This is an example of a crystal ball study aimed at predicting the onset of thrombotic disorders in HAART patients. The study advocated pre-thrombotic assessment during therapy to prevent untoward consequences (Jeremiah *et al.,* 2012b).

10.0 STUDIES RELATED TO HAEMATOLOGY GENERAL PRACTICE

10.1 STUDIES ON IN VITRO PRESERVATION OF BLOOD AND QUALITY OF HAEMATOLOGICAL TEST RESULTS

The quality of the haematology test results and blood film examination depends largely on the anticoagulants used in the preservation in vitro. Anticoagulants are substances responsible for the removal or inactivation of blood clotting factors thereby inhibiting coagulation in specimen. In the specific field of in vitro diagnostics, anticoagulants are commonly added to tube either to maintain blood

in the fluid state for haematological testing or to obtain suitable plasma for coagulation and clinical chemistry analyses. Unfortunately, no universal anticoagulant that could be used for evaluation of several laboratory parameters in a sample from a single test tube is available so far. ethylenediamine tetracetic acid (EDTA) is a polyprotic acid containing four carboxylic acid groups and two amino groups with lone pair electrons that chelate calcium and several other metal ions.

Historically, EDTA has been recommended as the anticoagulant of choice for haematological testing because it allows the best preservation of cellular components and morphology of blood cells (Giuseppe *et al.,* 2008). For various purposes, a number of different anticoagulants are available. One of these and the most commonly used in haematology laboratory is EDTA which exists as sodium or potassium salts of which 1.2mg of the anhydrous salt is used per milliliter of blood and the dipotassium salt is used at a concentration of 1.5±0.25mg/ml of blood and is usually the anticoagulant of choice (Dacie & Lewis, 1991, Elizabeth *et al.,* 2000).

If anti-coagulated blood is allowed to stand in the laboratory for 6 – 12 hours before films are made, degenerative changes occur according to Dacie and Lewis, (1991). Chen *et al.,* (1999) also reported that the values of haemoglobin, haematocrit, mean cell volume and leukocytes percentage collected in Disodium EDTA tubes were significantly higher than those collected in tripotassium EDTA.

In our typical setting, most time blood samples are not analyzed immediately when they have to be transferred from one place to another. The electric power supply in Nigeria is not stable. Also in the rural areas, where there is no constant power supply, there is often no refrigerated temperature storage of blood sample. The stability of haematological parameters and reliability of the results produced are therefore in doubt, due to different storage conditions thereby raising crucial issues on the internal quality control of our tests and results.

To answer several questions that agitated our minds, Jeremiah and Kana (2010) conducted a comprehensive study to ascertain the influence of the type of EDTA anticoagulants and storage conditions on the stability haematological parameters.

Our results indicated that blood stored in K_2EDTA exhibited changes in PCV and the eosinophil values after 24 hours of storage while neutrophil, basophils and MCHC decreased significantly in their values after 24 hours of storage. The PCV and eosinophil values of blood stored in K_3EDTA increased significantly at 6 and 24 hours respectively. Similar effects were noticed with Na_2EDTA anticoagulant.

The summary of our findings indicated that clinically useable results may be obtained for some haematological parameters in whole blood specimen stored at room temperature for up to 2 days. Also, all differential counts must not be performed after 6 hours at room temperature. The study also confirms and recommends depotasium (K_2EDTA) EDTA anticoagulant as a routine anticoagulant of choice in a developing country like ours.

A similar comparative study of the effects of the anticoagulant trisodium citrate, normal saline and whole blood stored in EDTA on the erythrocyte sedimentation rate (ESR) was conducted by Emelike *et al.,* (2010) for the purpose of identifying a suitable substitute for trisodium citrate in the event of scarcity of resources. The study concluded that the use of normal saline and EDTA whole blood cannot be a good substitute for Trisodium citrate in the estimation of ESR. The study also recommended that since ESR is time dependent, the conventional time of 1 hour should be maintained.

In a related study, Jeremiah and Emelike (2010) determined the ESR values using trisodium citrtate and classified the ESR values as follows: mild elevation of ESR (20 – 50 mm/hr) (8.85%), moderately evaluated (ESR 51 – 99mm/hr) (3.38%), No extreme elevation (ESR > 100mm/hr) was observed in our study population. The ESR is a relatively non-specific test that is often ignored during the diagnosis and monitoring of disease.

With the advent of automated machines in our hospital settings, much of the tests routinely done manually are now being run by automated machines. In our NDUTH, an automated machine Sysmex KX-2IN is used to perform most haematological test but most times, the machine breaks down or there is power outage, and this impact negatively on the quality of results and turn-around time. It became necessary to validate our manual methods as a quality check on our skills and efficiency of the methods.

10.2METHODS VALIDATION STUDY

One of the methods validated was haemocytometry which is used for the total white blood cell count and platelet count. A blind count of white blood cells was done and compared with the results obtained from the automated machines. The results obtained were very impressive. The manual haemocytometry correlated strongly with the automated machine Sysmex and could conveniently serve as a complimentary method to Sysmex KX-2IN. The skill of the Medical Laboratory Scientist was also not in doubt. The results were as reliable as those produced by Sysmex KX-2IN. (Izibeya and Jeremiah, 2016).

11.0 BREAKING NEWS

A group of Scientists from the Niger Delta University, Wilberforce Island have reported that the single nucleotide polymorphism in the chemokine receptor 5 (CCR5) gene which results in defective CCR 5 gene that confers protection from HIV infection in the homozygous state is absent among the Ijaws in Nigeria. The implication of this finding is that individuals in this part of the globe have no protection from the dreaded HIV infection which others have when exposed (Zifawei *et al.,* 2016). The research was carried out on the Ijaws of the Niger Delta but will be extended to other tribes in due course. The full paper is available at http://www.scirp.org/journal/ojbd or http://dx.doi.org/10.4236/ojbd.2016.64009.

The study was carried out at the Molecular Biology Laboratory in the Medical Laboratory Science Department of the Niger Delta University with Zifawei Kenneth as a Principal investigator under my supervisionand directed by Professor Tatfeng Mirabeau.

This finding also serve as a caution for both young and old, men and women to remain faithful to their partners or adopt total abstinence to reduce the prevalence of this disease in our locality.

The cystein cystein chemokine receptor 5 (CCR5) gene is a co-receptor for human immunodeficiency virus (HIV). It facilitates the virus entry into the cells and mediates infection. They are expressed in memory or effector T cells, monocytes or macrophages and immature dendritic cells (Opperman, 2004).

CCR5 has been documented as a co-receptor in HIV infection. A sequence deletion of this gene at 32 bp is believed to reduce the risk of HIV infection when exposed. However, this deletion is reported in a lower percentage of the African population. No study has been encountered in Nigeria that reported the nucleotide sequence of this gene. This study therefore breaks the ground and is thus the first to report the absence of single nucleotide polymorphism in this CCR5 gene in Nigeria.

RECOMMENDATIONS

Ag Vice Chancellor Sir, ladies and gentlemen, based on the issues discussed in this lecture and the outcome of research works done. I wish to recommend as follows:

1. To achieve and sustain the millennium development goals 4, 5, and 6, diagnostic protocols for screening of anaemia in children and pregnant

women should be reviewed. The current practice where malaria parasite test is done by untrained persons will not help to eradicate the disease but rather increase the burden since at a certain threshold the kits fail to detect the malaria. The goal standard of blood film examination by qualified and licensedprofessionals should be encouraged.

2. Our Teaching Hospitals and other tertiary health institutions should create research and reference laboratories in immunohaematology, platelet serology, cytogenetics and molecular haematology for proper diagnosis and problem solving in cases of alloimmunization, blood group genotyping and cancer studies.
3. Everyone has the responsibility to keep his or her blood free from infectious agents because whatever goes into the blood does not come out. Someone may need your blood to survive tomorrow.Know your health status by having your blood checks regularly KEEP IT HEALTHY.
4. For the benefit of the patients and effective health care delivery, the Medical Laboratory Services and especially the haematology and Blood transfusion should not be underutilized, undervalued and politicized. Until the country learns to value the laboratory and the professionals in that sector, the nation's health care systems will continue to suffer setbacks. We will continue to travel abroad to run the tests we would have done here and who knows, it may cost you several weeks or months to get your results and return to work.
5. Finally,the National Blood Transfusion Service which is supposed to solve the issues of blood safety, availability and research should be given priority attention and square pegs put in square holes for effective health care delivery in Nigeria.

CONCLUSION

Ag. Vice Chancellor Sir, distinguished ladies and gentlemen, in concluding this lecture, I wish to take you back to the Holy Bible in Leviticus 17:11 "***For the life of the flesh is in the Blood*"**.

The Blood is life given.
The Blood is life giving,
The Blood is the Life.
The Blood preserves the Life.
Your blood is your oracle

When last did your blood speak to you?Consult it to know your health status. The issues of anaemia, malaria, alloimmunization, coagulation disorders and transfusion transmitted infections discussed in the last one hour are all life

threatening and are still with us. Remember that your blood is your life and a healthy blood makes a healthy nation. I will like to end my lecture with this quote.

"SCIENCE DOESN'T MAKE IT POSSIBLE TO KNOW THE FUTURE BUT IT CERTAINLY SHAPES HOW LIFE PROGRESSES. WHEN A DIAGNOSIS IS MADE, THE PATH TO HEALTH BECOMES CLEARER. LIVES CAN CHANGE. AND IT ALL BEGINS WITH THE LABORATORY"- ORTHO-CLINICAL DIAGNOSTICS, USA.

CHANGE BEGINS WITH THE LABORATORY

The Ag Vice Chancellor, Eminent Professors, Ladies and Gentlemen, The Oracle has spoken and will continue to speak. It is time to consult the Oracle and polish our crystal balls and stop the medical tourism abroad. I am done.

REFERENCES

Abu – Zeid YA, Abdulahi NH, Hviid L. (1991). Lymphoproliferative responses to plasmodium falciparum antigens in children with and without the sickle cell trait. *ScandinavianJournal of Imunology***34:** 237 – 42.

Adias TC, Igwilo AC, **Jeremiah ZA,** (2012). Repeat whole blood donation correlates significantly with reductions in BMI and lipid profiles and increased gamma glutamic trasnferase (GGT) activity among Nigerian blood donors, *Open Journal of Blood Diseases* **2**: 90 – 94.

Adias TC, **Jeremiah ZA,** Ilesanmi AO (2010). Distribution of antibodies to salmonella in the sera of blood donors in the South-Western region of Nigeria. *Blood Transfusion* **8:** 163 – 9.

Agbesor I, Amala S, **Jeremiah ZA** (2016). Hepatitis B virus profile among blood donors in Federal Capital Territory, Abuja. *International Journal of Science and Research*. **5** (7): 1668 – 11672.

Aster RH (1993). Platelet specific alloantigen systems: history, clinical significance and molecular biology. In: Alloimmunity and beyond. Arlington: American Association of Blood Banks S. T. Nance ed. Pp. 83.

Bernasovsky I, jurickova J, Ferak V. (1994). Population genetic study in Gypsies (ROMS) from slavakia: markers. *Anthropological Science* **102:**409 – 419.

Boldt DH (1999). New perspective on iron: an introduction. *American Journal of Medical Science* **318**: 207 – 212.

Bukar A, Ajayi OI, Obi S, Olaniyam MF, Abba A, Aladenika S, Osakue EO, **Jeremiah ZA,**Waziri G, Medugu JT, Geidam U, Audu N, Abja UM, Wurno M. (2016). Effects of blood donations on haemorheology: A study on blood Donors in Wurno Maternity Clinic, Babaldu. *Sokoto Journal of Medical laboratory Science* **1**(1): 152 – 155.

Bukar A, Obi SO, Ajayi OI, Abba A, Abja UM, Olaniyam MF, Busari O, Waziri G, Medugu JT, Audu N, Geidam U, **Jeremiah ZA**(2016). Serological blood grouping reveals genotypes and family relationships – A case report from Lemunnam District Clinic. *Sokoto Journal of Medical Laboratory Science* **1**(1): 52 – 56.

Buseh MP, Young MJ, Samson SM, Mosley JW, Ward JW, Perkins HA (1991). Risk of human immune deficiency virus (HIV) transmission by blood transfusions before the implementation of HIV-1 antibody screening. The transfusion safety study group. *Transfusion* **31**(1): 4 – 11.

Buseri FI, **Jeremiah ZA,**Kalio FG (2008). Influence of pregnancy and gestation period on some coagulation parameters among Nigerian antenatal women. *Research Journal of Medical Sciences **2***(6)L 275 – 281.

Buseri FI, Muhibi MA, **Jeremiah ZA** (2009). Sero epidemiology of transfusion transmissible infectious diseases among blood donors in Osogbo, South West, Nigeria. *Blood Transfusion* **7**(40: 293 – 299.

Chen BH, Hong JF, Chiang C. (1999). Effect of different anticoagulants, underfilling of blood sample and storage stability on selected haemogram. *Koahsiung* Journal of Medical Science. **15:** 87 – 93.

Chen L, Wilson M (2005).Non-Vector transmission of dengue and othermosquito-borne flaviviruses. *Dengue Bulletin**; 29:18***–31.

Chen LH, Wilson ME. (2004) Transmission of dengue virus without a mosquito vector: nosocomial mucocutaneous transmission and other routes oftransmission. *Clin Infect Dis* 39(6): e56-60

Contreras M, Lubenko A. (2001).Antigens in human blood. In: Postgraduate haematology. Hoffbrand AV, Lewis SM & Tuddenham EGD (eds). Arnold, New York pp. 182 – 201.

Cserti CM and Dzik WH (1997). The ABO blood group system and plasmodium malaria *Blood.* **110:** 2250 – 8.

Dacie VJ, and Lewis SM (1991). Basic haematological techniques. IN: Practical haematology. 7th edn. Pp. 37 – 66. Churchill Livingstone, Singapore.

Daniels G. (2005). The molecular genetics of blood group polymorphism. *Transplantation and Immunology* **14:**143 – 153.

Dreyfus M, Kaplan C, Verdy E, Schlegel N, Durand – Zaleski I, Tchernia G. (1997). The immune thrombocytopenia working group. Frequency of immune thrombocytopenia in newborns: a prospective study. *Blood*. **189**: 4402 – 4406.

Dutta AB (2006). Blood Banking and transfusion (Istedn). 53 – 72.

Elizabeth M, Van C, Kent B *et al.,* (2000). Comparison of Glass K_3EDTA versus plastic K_2EDTA blood-drawing tubes for complete blood counts, retriculocytes and white blood cell differentials. Laboratory haematology **9:** 10 – 14.

Emelike OF, Akpan JE, Obigwe BU, **Jeremiah ZA,** (2010). Comparative study of Erythrocyte Sedimentation Rate (ESR) using trisodium citrate, normal saline and whole blood in Ethylene diamine tetra Acetic acid EDA. *Journal of Applied Science and Environmental Management.* **14**(1):23 – 27.

Eneh AU, Oruamabo RS (2008). Neonatal jaundice in a special care baby unit (SCBU) in Port Harcourt, Nigeria: A prospective study. *Port Harcourt Medical Journal* **2:** 110 – 7.

Everhart JE, Di Bisceglie AM, Murray LM *etal.,* (1990). Risk for non A, non B (type C) hepatitis through sexual or household contact with chronic carriers *Annals of Internal Medicine* **112** (7): 544 – 5.

Fernandez ID, Himes JH, de Onis M. (2002). Prevalence of nutritional wasting in populations: building explanatory models using secondary data. *Bulletin of World Health Organization.***80:** 282 – 291.

Frank J.E. (2005). Diagnosis and management of G6PD deficiency. *American Family Physician* **72:** 1277 – 1282.

Gillies HM, Fletcher KA, Hendrickse RG, Lindner R, Reddy S, Allan N. (1967). Glucose 6 phosphate dehydrogenase deficiency, sickling and malaria in Africa children in South Western Nigeria. *Lancet***1**: 138 – 40.

Giuseppe B, Gian LS, Giuseppe L. (2008). The role of ethylene diamine tetracetic acid (EDTA) as in vitro anticoagulant for diagnostic purposes. *Clinical Chemistry and Laboratory Medicine* **45:** 556 – 576.

Hajdu SI (2003). A note from History: the discovery of blood cells. *Annals of Clinical and Laboratory Science* **33**(20: 237 – 238.

Halstead SB (1988). Pathogenesis of dengue: challenges to molecular biology.*Science* 239(4839):476-481 [PMID: 3277268]

Hill AV, Allsopp CE, Kwiatkowski, D, Anstey NM, Twamasi P. Rowe PA, Bennett S, Brewster D, McMichael AJ, Greenwood BM (1991). Common West African HLA antigens are associated with protection from severe malaria. *Nature* **352:** 595 – 600.

Imbert P, Gerardin P, Rogier C, Ka AS, Jouveniel P, Brousse V, Guyon P. (2002). A comparative study of 1990 and 2000 WHO criteria for clinical presentation, prognosis and intensive care in Dakar, Senegal. *Transactions of the royal society of Tropical Medicine and Hygience* **96:** 278 – 281.

Imbert P, Rogier C, Gerardin P. (2003). Letter to the Editor. *American Journal of Tropical Medicine and Hygiene* **68**: 380 – 381.

Issitt PD, Anstee DJ (1998). The Rh blood group system. In: Applied Blood Group Serology. Durham NC: Montgomery scientific publications. 315 – 423.

Izibeya CA, **Jeremiah ZA** (2010). Validation of haemocytometry as a complimentary method to sysmex KX-2In for the estimation of white blood cell counts in the Niger Delta University Teaching Hospital (NDUTH), Okolobiri, Bayelsa State, Nigeria. *SokotoJournal* of Medical Laboratory Science ***1***(2): 131 – 138.

Jeremiah ZA (2002). Baseline assessment of some haemorheological factors in young adult Nigerians. *Journal of Medical Laboratory Sciences.***11**(2): 74 – 78.

Jeremiah ZA and Kana I (2010). The influence of the type of Ethylene diamine tetra-acetic acid (EDTA) anticoagulants and storage conditions on haematological parameters. *Journal of Life and Environmental Sciences*. **11**(2): 676 – 688.

Jeremiah ZA and Koate BB (2009). Reference percentiles of haematological and biochemical iron values of blood donors in Port Harcourt, Nigeria. *Hematology.***14**(6):366 – 370.

Jeremiah ZAand Koate BB (2010). Anaemia, iron deficiency and iron deficiency anaemia among blood donors in Port Harcourt, Nigeria. *Blood Transfusion* **8:** 113 – 117.

Jeremiah ZA., Moore – Igwe B. (2012). Storage related haematological and biochemical changes of CPDA-1 whole blood in a Resource Limited setting. *Journal of Blood Disorders and Transfusion* **3**(3): 124 – 127.

Jeremiah ZA., Buseri FI. (2003). Rh antigen and phenotype frequencies and probable genotypes for the four main ethnic groups in Port Harcourt, Nigeria. *Immunohematology***19** (3): 86 – 88.

Jeremiah ZA, (2006). Abnormal haemoglobin variants, ABO and Rh blood groups among students of African descent in Port Harcourt Nigeria. *African Health Sciences* **6**(3): 177 – 181.

Jeremiah ZA, Adias TC, Opiah M, George SP, Mgbere O., Essien EJ (2012a) Elevation in D-dimer concentrations is positively correlated with gestation in normal uncomplicated pregnancy. *International Journal of Women's Health.* **4:**437 – 443.

Jeremiah ZA, Atiegoba AI, Mgbere O. (2011a). Alloantibodies to human platelet glycoproteins antigens (HPA) and HLA class 1 in a cross section of Nigerian antenatal women. *Human Antibodies***20:**71 – 75.

Jeremiah ZA, Biribo AA, Adias TC, Uko EK (2012). Uncommon Rh phenotypes in a cross section of Nigerian Antenatal Women: Implications for molecular genotyping of Blood Groups. *Journal of Blood Disorders and Transfusion* SIO: 001.

Jeremiah ZA, Buseri FI (2006). Comparative analysis of the ABO and Rh CDE phenotype frequencies among various ethnic groups in Port Harcourt, Nigeria. *Journal of Medical Laboratory Science.* **15** (2): 27 – 31.

Jeremiah ZA, Buseri FI, Uko EK (2007a). iron deficiency anaemia and evaluation of the utility of iron deficiency indicators among healthy Nigerian children. *Hematology***12**(3):249 – 253.

Jeremiah ZA, Buseri, FI, Uko EK and Adias TC (2008a). baseline iron status of apparently healthy children in Port Harcourt, *Nigeria Port Harcourt Medical Journal*. **2***:*156 – 160.

Jeremiah ZA, Emelike FO (2010). Clinical utility of the erythrocyte sedimentation rate test and haemoglobin electrophoretic pattern among premarital couples in Port Harcourt, Nigeria. *Orient Journal of Medicine***22** (1-4): 20 – 24.

Jeremiah ZA, Idris H, Ajayi BB, Ezimah ACU, Malah MB, Baba MM (2011c). Isolated anti-HBc-IgM antibody among blood donors in the semi-arid region of Nigeria. *Human antibodies* **20:** 77 – 82.

Jeremiah ZA, Jeremiah TA (2004). Rh 17 and M. phenotype frequencies in a Nigerian obstetric population. *Blood Bankigand Transfusion Medicine*. **2** (2): 82 – 85.

Jeremiah ZA, Jeremiah TA, Emelike FO (2010a). Frequencies of some human genetic markers and the association with plasmodium falciparum. Malaria in the Niger Delta, Nigeria. *Journal of Vector Biorne Disease.* **47**:11 – 16.

Jeremiah ZA, Mordi A, Buseri FI, Adias TC (2011c). frequencies of maternal red blood cell alloantibodies in Port Harcourt. *Asian Journal of Transfusion Science* **5** (1): 39 – 41.

Jeremiah ZA,Mordi A. (2011). Evaluation of the clinical utility of maternal alloantibody screening as a surrogate to antiglobulin crossmatch procedures in resource limited settings. *International Journal of Blood Transfusion and Immunohaematology*. **1:** 1 – 6.

Jeremiah ZA, Obazee Y, Okogun GR, Adias TC, Mgbere O, Essien EJ (2012b). Impact of short term anti-retroviral therapy (START) on some fibrinolytic markers in HIV-infected Nigerian adults: preliminary from the START study. *HIV/AIDS – Research and Polliative Care***4:** 87 – 94.

Jeremiah ZA, Oburu JE (2010). Pattern and prevalence of neonatal thrombocytopenia in Port Harcourt, Nigeria. *Pathology and Laboratory Medicine International* **2:** 27 – 31.

Jeremiah ZA, Oburu JE (2011). Survey of platelet glycoprotein specific antibodies and HLA class 1 antibodies in a cross section of Nigerian multiparous women. International *Journal of Blood Transfusion and Immunohematology* **1:** 8 – 12.

Jeremiah ZA, Oburu JE, Buseri FI (2010). Alloantibodies to HLA class 1 antigens detected in multiparous women of African descent are significantly associated with age, ABO/Rh blood Groups and Parity. *American Journal of Biomedical Sciences* **2**(3): 289 – 294.

Jeremiah ZA, Oburu JE, Erhabor O, Buseri FI (2011b) Alloantibodies to glycoprotein 1a/11a (anti-HPA-5a and – 5b) and 11b/111a (anti-HPA-1a,-3a and -4a) in Nigerian parous women. *British Journal of Biomedical Science*. **68**(1): 34 – 37.

Jeremiah ZA, Odumody C. (2005). Rh antigens and phenotype frequencies of the Ibibio, Efik and Ibo ethnic nationalities in Calabar, Nigeria. *Immunohematology*. **21**(11): 21 – 24.

Jeremiah ZA, Okon IA, Jeremiah TA (2007). Sero prevalence of HIV and frequencies of haemoglobin genotypes, ABO and Rh blood groups among premarital couples in Port Harcourt, Nigeria. *South African Family Practice.* **49**(2): 15a – 15d.

Jeremiah ZA, Pwana FE, Mgbere O. (2013). Positive cord blood direct Antiglobulin Test (DAT) is strongly associated with Parity and maternal age among Rh Negative Mothers in Maiduguri, Nigeria. *Journal of Blood Disorders and Transfusion* SIO: 002.

Jeremiah ZA,Tony-Enwin EO (2009). Sero epidemiology of transfusion transmissible viral infection among university fresh students in Port Harcourt, Nigeria. *Hepatitis Monthly* **9**(4): 276 – 281.

Jeremiah ZA, Uko EK (2007a). Childhood asymptomatic malaria and nutritional status among Port Harcourt children. *East African Journal of Public Health***4**(2): 5-58.

Jeremiah ZA, Uko EK (2007b). comparative analysis of malaria parasite density using actual and assumed white blood cell counts. *Annals of Tropical paediatrics***27:** 75 – 79.

Jeremiah ZA,Uko EK (2007c). depression of platelet counts in apparently healthy children with asymptomatic malaria infection in a Nigerian metropolitan city. *Platelets* **18**(60: 469 – 471.

Jeremiah ZA, Uko EK, Buseri FI, Jeremiah TA (2007b). Malaria iron-deficiency anaemia among asymptomatic Nigerian children. *Journal of Nutritional and Environmental Medicine* **16**(3-4): 232 – 241.

Jeremiah ZA, Uko EK, Buseri FI, Jeremiah TA (2007c). field evaluation of SD Bioline rapid malaria diagnostic test among asymptomatic malaria infected children in Port Harcourt, Nigeria. *Research Journal of Parasitology***2**(1): 39-44.

Jeremiah ZA, Uko EK, Usanga EA (2008b). Relationship of Nutritional status, sickle cell trait, Glucose – 6 – Phosphate Dehydrogenase Deficiency, iron deficiency and

asymptomatic malaria infection in the Niger Delta, Nigeria. *Journal of Medical Science* **8**(3): 269 – 274.

Jeremiah ZA, Umoh RE, Adias TC (2011). Subclinical leucopenia in a cross section of Nigerian blood donors. *Journal of Blood medicine* **2:** 79 – 85.

Jeremiah, ZA, Koate B, Buseri F, Emelike F. (2008c). Prevalence of antibodies to hepatitis C virus in apparently healthy Port Harcourt blood donors and association with blood groups and other risk factors. *Blood Transfusion***6** (3): 150 – 155.

Ken-Ezihuo S.U., **Jeremiah ZA**, Bartimaeus ES (2017). Haemorheological parameters of apparently healthy students of Rivers State University of Science and Technology, Port Harcourt. *European journal of Biomedical and Pharmaceutical Sciences.***4**(1): 78 – 83.

Knowles S an Poole G. (2002). Human blood group systems. In: Practical transfusion medicine 1st end (Murphy MF and Pamphilon DH (eds). Blackwell Science, London, UK 24 – 31.

Koate BBD, Buseri FI, **Jeremiah ZA** (2005). Sero prevalence of hepatitis C virus among blood donors in Rivers State, Nigeria. *Transfusion Medicine* **15:** 449 – 451.

Kwiatkowski DP (2005). How malaria has affected the human genome and what human genetic can teach us about malaria? *American Journal of Human Genetics* **77**:171 – 92.

Luzzatto L, Usanga EA, Reddy S. (1969). Glucose 6 phosphate dehydrogenase deficient red cells: resistant to infection by malaria parasites *Science* **164**:839 – 42.

Mega JL et al(2004) B-type of natriuretic peptide at presentation and prognosis in patients with ST- segment elevation myocardial infaction; an ENTIRE-TIMI-23 substudy. *Journal of American College of Cardiology* 44 335-9

Mueller – Eckhardt C, Kiefel V, Grubert A, *et al.,* (1989) 348 cases of suspected neonatal alloimmune thrombocytopenia. *Lancet* **1:** 363 – 366.

Muhibi MA, Adeleke MA, Shittu BT, **Jeremiah ZA** (2017) Dengue virus infection among voluntary donors in Osogbo, South Western, Nigeria. *American Journal of Biomedical Sciences* 9(3): 113-118. Doi: 10.5099aj170300113

Nyakeriga AM, Troyo – Blomberg M, Chemtai AK, Marsh K, Williams TN (2005). Malaria and nutritional status in children living on the coast of Kenya. *American Journal of Clinical Nutrition.***80:** 1604 – 10. Erratum in American Journal of Clinical Nutrition 2005:82 – 203.

Omland T (2005) B-type natriuretic peptide and long term survival in atientss with stable coronary artery disease. *American Journal of Cardiology* 95:24-8

O'Meara WP, Remich S, Ogutu B. *et al.,* (2006). Systematic comparison of two methods to measure parasite density from malaria blood smears *parasitology Research* **99:** 500 – 4.

Opperman M. (2004). Chemokine receptor CCR5: Insights into structure, function and regulation cell single **16:** 1201 – 1210.

Peterson E, Marbiah NT, New L, Gottschau A. (1996). Comparison of two methods for enumerating malaria parasites in thick blood films. *American Journal of Tropical Medicine and Hygiene***55:** 485 – 489.

Phelan DI (2005). The HLA system in: Modern Blood Banking and Transfusion Practices S edition. DM. Harmening ed. Philadelphia: FA Davis Company 431 – 444.

Pittiglio DH (1983). Modern blood banking and transfusion practices. FA Davis Company. Philadelphia 136 – 7.

Race RR, Sanger R, Selwyn JG (1954). Existence of cells lacking products of C/c and E/e genes. British *Journal of Experimental Pathology***. 32:** 124 – 5.

Race RR, Sanger R. (1975). Blood groups in man 6th ed Oxford: Blackwell Scientific Publications. 179 – 260.

Roberts I, Hurray NA (2008). Neonatal thrombocytopenia: causes and management. Achieves of Disease in childhood, Fetal and Neonatal Education 188: F339 – F364.

Santoso S, Kiefel V. (1998). Human platelet specific alloantigens: an update *Vox Sanguinis***74:** 249 – 253.

Sayed NE, Gad A, Nofal L, (1999). Assessment of the prevalence and potential determinants of nutritional anaemia in upper Egypt. *Food Nutri. Bull.***20**:417-421.

Tapko JB, Sam O, Diarra – Nama AJ (2007). Status of blood safety in the WHO African region: report of the 2004 survey. World Health Organziaiton.

UNAIDS (2007). Women and AIDS. UNAIDS point of view, UNAIDS, Geneva, 2007.

UNICEF (1998). The state of the world's children. New York. Oxford University press.

United Nations Administrative Committee on Coordination Nutrition (Acc/SCN) (2000). 4th report on the world nutrition situation. Nutrition throughout the life cycle sub committee on Geneva.

United Nations Development goals (2005). UN web services section. Department of Public information, United Nations, http://www.un.org/milleniumgoals/.

Usanga EA, Luzzatto L. (1985). Adaptation of plasmodium falciparum to glucose 6 phosphate dehydrogenase deficient host red cells by production of parasite encoded enzyme. *Nature* **113:** 793 – 5.

World Health Organization / United Nations University/UNICEF (2001). Iron deficiency anaemia, assessment, prevention and control: a guide for programme managers. Geneva.

World Health Organization. SAMC information for action leaflet. WHO Harare country / inter country office for Southern Africa. Malaria: a case management update: special edition: Anaemia.

Zifawei KO, Stowe O, Adias TC, Tatfeng YM, **Jeremiah ZA** (2016). Null single nucleotide polymorphism in chemokine receptor 5 (CC R5) genes among the Ijaw Ethnic population of Nigeria. *Open Journal of Blood Diseases* **6:** 59 – 66.

CITATIONS/LINKS OF PROF Z.A.JEREMIAH'S PUBLICATIONS IN PUBMED AS AT 4th AUGUST 2017

Elevation in D-dimer concentrations is positively correlated with gestation in normal uncomplicated pregnancy.
Jeremiah ZA, Adias TC, Opiah M, George SP, Mgbere O, Essien EJ.
Int J Womens Health. 2012;4:437-43. doi: 10.2147/IJWH.S32655. Epub 2012 Aug 31.
PMID:23071413
Free PMC Article

Impact of short-term antiretroviral therapy (START) on some fibrinolytic markers in HIV-infected Nigerian adults: preliminary findings from the START study.
Jeremiah ZA, Obazee Y, Okogun GR, Adias TC, Mgbere O, Essien EJ.
HIV AIDS (Auckl). 2012;4:87-94. doi: 10.2147/HIV.S29027. Epub 2012 Jul 10.
PMID:22815646
Free PMC Article

Subclinical leukopenia in a cross section of Nigerian blood donors.
Jeremiah ZA, Umoh RE, Adias TC.
J Blood Med. 2011;2:79-85. doi: 10.2147/JBM.S16214. Epub 2011 May 11.
PMID:22287866
Free PMC Article

Isolated anti-HBc-IgM antibody among blood donors in the semi-arid region of Nigeria.
Jeremiah ZA, Idris H, Ajayi BB, Ezimah AC, Malah MB, Baba MM.
Hum Antibodies. 2011;20(3-4):77-82. doi: 10.3233/HAB-2011-0242.
PMID:22129677

Alloantibodies to human platelet glycoprotein antigens (HPA) and HLA class 1 in a cross section of Nigerian antenatal women.
Jeremiah ZA, Atiegoba AI, Mgbere O.
Hum Antibodies. 2011;20(3-4):71-5. doi: 10.3233/HAB-2011-0241.
PMID:22129676

Frequencies of maternal red blood cell alloantibodies in Port Harcourt, Nigeria.
Jeremiah ZA, Mordi A, Buseri FI, Adias TC.

Asian J Transfus Sci. 2011 Jan;5(1):39-41. doi: 10.4103/0973-6247.75987.
PMID:21572714
Free PMC Article

Alloantibodies to glycoprotein La/LLa (anti-HPA-5a and -5b) and IIb/IIIa (anti-HPA1a, -3a and -4a) in Nigerian parous women.
Jeremiah ZA, Oburu JE, Erhabor O, Buseri FI.
Br J Biomed Sci. 2011;68(1):34-7.
PMID:21473260

Surveying Infections among Pregnant Women in the Niger Delta, Nigeria.
Buseri F, Seiyaboh E, Jeremiah Z.
J Glob Infect Dis. 2010 Sep;2(3):203-11. doi: 10.4103/0974-777X.68525.
PMID:20927278
Free PMC Article

Distribution of antibodies to Salmonella in the sera of blood donors in the south-western region of Nigeria.
Adias TC, **Jeremiah ZA**, Ilesanmi AO.
Blood Transfus. 2010 Jul;8(3):163-9. doi: 10.2450/2009.0115-09.
PMID:20671876
Free PMC Article

Anaemia, iron deficiency and iron deficiency anaemia among blood donors in Port Harcourt, Nigeria.
Jeremiah ZA, Koate BB.
Blood Transfus. 2010 Apr;8(2):113-7. doi: 10.2450/2009.0113-09.
PMID:20383305
Free PMC Article

Frequencies of some human genetic markers and their association with Plasmodium falciparum malaria in the Niger Delta, Nigeria.
Jeremiah ZA, Jeremiah TA, Emelike FO.
J Vector Borne Dis. 2010 Mar;47(1):11-6.
PMID:20231768
Free Article.

The prevalence of human immunodeficiency virus infection among TB patients in Port Harcourt Nigeria.
Erhabor O, **Jeremiah ZA**, Adias TC, Okere C.

HIV AIDS (Auckl). 2010;2:1-5. Epub 2010 Jan 14.
PMID:22096379
Free PMC Article

Sero-epidemiology of transfusion-transmissible infectious diseases among blood donors in Osogbo, south-west Nigeria.
Buseri FI, Muhibi MA, **Jeremiah ZA**.
Blood Transfus. 2009 Oct;7(4):293-9. doi: 10.2450/2009.0071-08.
PMID:20011640
Free PMC Article

HIV seropositivity and CD4 T-lymphocyte counts among infants and children in Port Harcourt, Nigeria.
Jeremiah TA, Frank-Peterside N, **Jeremiah ZA**.
East Afr J Public Health. 2009 Apr;6(1):17-21.
PMID:20000058

Reference percentiles of hematological and biochemical iron values of blood donors in Port Harcourt, Nigeria.
Jeremiah ZA, Koate BB.
Hematology. 2009 Dec;14(6):366-70. doi: 10.1179/102453309X12473408860622.
PMID:19941745

Prevalence of antibodies to hepatitis C virus in apparently healthy Port Harcourt blood donors and association with blood groups and other risk indicators.
Jeremiah ZA, Koate B, Buseri F, Emelike F.
Blood Transfus. 2008 Jul;6(3):150-5.
PMID:18705239
Free PMC Article

Childhood asymptomatic malaria and nutritional status among Port Harcourt children.
Jeremiah ZA, Uko EK.
East Afr J Public Health. 2007 Oct;4(2):55-8.
PMID:18085131

Depression of platelet counts in apparently healthy children with asymptomatic malaria infection in a Nigerian metropolitan city.
Jeremiah ZA, Uko EK.
Platelets. 2007 Sep;18(6):469-71.
PMID:17763156

Plasma levels of some blood coagulation parameters in Nigerian homozygous sickle cell patients (HbSS) in steady state.
Buseri FI, **Jeremiah ZA**, Shokunbi WA.
Hematology. 2006 Oct;11(5):375-9.
PMID:17607590

Iron deficiency anaemia and evaluation of the utility of iron deficiency indicators among healthy Nigerian children.
Jeremiah ZA, Buseri FI, Uko EK.
Hematology. 2007 Jun;12(3):249-53.
PMID:17558702

Comparative analysis of malaria parasite density using actual and assumed white blood cell counts.
Jeremiah ZA, Uko EK.
Ann Trop Paediatr. 2007 Mar;27(1):75-9.
PMID:17469736

Plasma fibrinogen levels in Nigerian homozygous (Hb SS) sickle cell patients.
Buseri FI, Shokunbi WA, **Jeremiah ZA**.
Hemoglobin. 2007;31(1):89-92.
PMID:17365009

Abnormal haemoglobin variants, ABO and Rh blood groups among student of African descent in Port Harcourt, Nigeria.
Jeremiah ZA.
Afr Health Sci. 2006 Sep;6(3):177-81.
PMID:17140342
Free PMC Article

An assessment of the clinical utility of routine antenatal screening of pregnant women at first clinic attendance for haemoglobin genotypes, haematocrit, ABO and Rh blood groups in Port Harcourt, Nigeria.
Jeremiah ZA.
Afr J Reprod Health. 2005 Dec;9(3):112-7.
PMID:16623195

Seroprevalence of hepatitis C virus among blood donors in Rivers State, Nigeria.
Koate BB, Buseri FI, **Jeremiah ZA**.
Transfus Med. 2005 Oct;15(5):449-51.
PMID:16202063

Rh antigens and phenotype frequencies of the Ibibio, Efik, and Ibo ethnic nationalities in Calabar, Nigeria.
Jeremiah ZA, Odumody C.
Immunohematology. 2005;21(1):21-4.
PMID:15783302

Rh antigen and phenotype frequencies and probable genotypes for the four main ethnic groups in Port Harcourt, Nigeria.
Jeremiah ZA, Buseri FI.
Immunohematology. 2003;19(3):86-8.
PMID:15373686

ACKNOWLEDGEMENTS

"Many there be which say of my soul, There is no help for him in God, but thou O Lord art a shield for me; my glory and the lifter up of mine head" Psalm 3:2 – 3.

To this God, who saved me, delivered me from destruction, helped me through thick and thin and lifted me to this enviable height be all the Glory and adoration now and forever more.

I wish to appreciate my parents Mr. /Mrs. Jeremiah Z. Ofarah through whom I came to this world. They did not receive any formal education but have producedeminent scholars in the family. Prominent among them is my elder brother Pastor Pius U. Jeremiah, the third and youngest graduate in the whole Asarama community. He rose in the Rivers State Civil Service and retired as a Permanent Secretary. He is my role model my mentor and my second Father on this planet earth. I celebrate you today.

My late father loved education and pushed all his children to school without discrimination. He constantly encouraged me to put up a spirited effort and finish my postgraduate programmes but unfortunately he did not live to see his second son being celebrated today as a Professor. May his soul continue to rest in peace.

To my spiritual parents, Pastor (Dr.) and Pastor (Dr.) (Mrs.) Rex Fubara-Manuel, I cherish and appreciate you for your heart of Gold. I would not be standing here if not for this Father figure over my life. He took me as his son right from my undergraduate days, supervised my marriage plans, constantly speaking into my life and destiny. Everything he spoke about me eventually came to pass, including my elevation to the rank of a Professor which he announced openly in annual convention in December, 2013 ahead of the University. Daddy and Mummy, I love you. May God continue to keep you to see more glorious days to come.

The sacrifices of my wife, Theresa A. Jeremiah and my four children deserve commendation. My desire to be what I am today caused me to pass them through different levels of hardship but the love and understanding they demonstrated towards me lightened the burden. All I say is that God will heavily bless them and lift them higher than where I am today.

Today I remember my grandmother of blessed memory, late Esther Simeon who took care of me at home during my primary school days while my parents were at various fishing settlements looking for money to train us. May her soul rest in peace.

My Elder Sister, Mrs. Adela S. Aman (nee Jeremiah) is one woman who has played a second mother role in my life. She took care of me in my infant days especially after the Nigerian Civil War when death came heavily to snatch me away through measles attack. May God bless and reward you. You will live long and reap the fruits of your labour.

To my siblings, Florah Manasseh (nee Jeremiah), Leticia Jeremiah, Isabella (nee Jeremiah). Doris U. Samuel (nee Jeremiah), Pastor Brown Jeremiah, Chief (Barr.) Kingswill A. Jeremiah – Ofarah, The Ebe-Oguile III of Asarama, Jeremiah Jnr., Friday Jeremiah, Zac Jeremiah Jnr., and Justinah Jeremiah. I love you all.

I acknowledge with love the following friends and old boys of the Great Govt. Sea School Isaka, HRH (Barr.) Appolos Nteijah, the Okan Ama of Asarama, Professor Ibibia Worika, Appolos Uneh, Dr. Ibifuro Green, Romokere Ibani, Kenneth Zifawei, Bobolaifa of Sports Unit, NDU, Dr Ebi Omu(Director of Health Services, NDU), my brother Sam Brown and many others not listed here,

I wish to sincerely acknowledge all my academic mentors, Pastor A. M. Mfiangh and Chief F. D. Abadi, for their roles in guiding me through secondary education. Late Prof. E. K. Uko of blessed memory. He was my Ph.D supervisor and mentor. It's very unfortunate that he could not live to witness today. May his gentle soul rest in peace.

I wish to acknowledge my colleagues and friends who supported me one way or the other. Prominent among them are: Prof. C. K. Wachukwu, Prof T. C. Adias, Prof. F. I. Buseri, Prof. Tatfeng Mirabeau, Prof. Marycelin Baba, Dr. A. C. U. Ezinma, Prof. Dennis Agbonlahor, Prof. S. D. Abbey, Dr. Felix Emelike, Dr. Wankasi Miebi, Prof. Osara Erhabor, Prof. John Anetor, Prof. Enweani, Prof. Anthony Emeribe, Prof. China Poh, Tosan Erhabor, Prof Humphrey Osadolor, Dr Emokpae, Dr Kester Digban, Dr. George G. S., Dr. Ferdinand Ezeiruaki (my HOD) and all the lecturers in Medical Laboratory Science in both NDU and RSU. I love you.

Mrs. Alice Christianus Usen, Johnny and Grace Ubi, Peter Usen, Francis Usen, Aniekan Usen and other members of my in-law family are part of this great success story. I thank you.

To my cousin, Dr. (Mrs.) Ikawuru Jebbin (nee Okpom), the first female Medical graduate ever produced from UNIPORT and in my community Asarama, you are

the best doctor in the whole world. You gave me reason to aspire higher in life as your younger brother. God bless and keep you. You will not see shame.

To all members of the Ofarah and Simeon's families, Bright Brown, Zaccheaus Brown, Sam Brown, Dr. Titus Brown, Simeon Ubokineme, Dan Ubokineme, Engr. Adams Ukatejit, Martha Ikang, Ubokineme Simeon (my Secretary), Awajionyi Alexander, Erasmus Dan, Jacob Ubokineme, Adasi Dan, Ubene Okpom, Abraham Okpom, Ikachit Okponi. My sincere thanks go to you all for being there for me. I love you all.

Let me at this point remember my post graduate students (past and present) and appreciate you for toiling with me through the years. Prominent among them are: Mrs. Stella-Ken-Ezihuo, Koate Baribefe, Ima Kana, Justinah Oburu, Evelyn Tony-Enwin, Muhibo MA, Augustina Mordi, Ruth Umoh, Anne Atiegoba, Halima Idris, Geroge SP, Beatrice Moore-Igwe, Biribo Amos, Anne Igwilo, Pwana Florence, Leonard I, Kenneth Zifawei, Agbesor Innocent, Stowe Opuada, Ebimensei Austin Izibaya, Bukar A, Geraldine Ibeh, Anunandu Oluchukwu, Ude Enyioma Agwu Obiomah Chinwe Favour, Grace Leghemo and former M.Sc. students in Uniben, All former and present M.Sc. students in RSU, NAU, Uniben etc. I appreciate all your efforts and the chance given to me to mentor you. Dr. (Mrs.) Yetunde Obare, my first Ph.D graduate. Thank you.

To my Senior friends, Prof. N. J. Jebbin, (my inlaw) Prof. Nelson Brambaifa, Prof. Fente (my Provost), Prof. T.C.Harry, Prof. A. Egumu, Dr. Ngozi Odu, Dr. (Mrs.) Truth Martins-Yellow, Dr. Nnanna Onyekwere, Dr. Godwin Mpi, Chief Mike Ibet-Iragumma, Mrs. Olubumi Kejeh (my first haematology teacher), Dr. Paul Owajionyi Dienye, Prof Akpanim Ekpe, Dr Godwin Mpi, Barr Ibaniba Briggs-Iti, Dr(Mrs) Margaret Opiah, Dr (Mrs) Theresa Osaji. God bless you all.

The entire members of UTONRO CLUB, Asarama deserved commendation for raising an elite social group for the development of Asarama. The President Dr. Oboada Uriah, Dr. (Mrs.) Angelina K. Osu, (madam Utonro), Ebiriene Wilson, Ezekiel Otogwung, Dr. Simon Uriah, Barr. Ebiriene Aman (my bossom friend), Kpekot, O. Kpekot and all others I could not put down. I appreciate all of you.

I lack words to appreciate the REVELATION family and the best Pastors in the whole world; Pastor Obibi Jaja (ADGO), Pastor (Dr.) Innocent Abang, Pastor (Dr.) Ngim Ogbu, Pastor (Dr.) Innocent Abang, Pastor (Dr.) Emem Jaja, Pastor Itoro Isong, Pastor Martins Omang, Pastor Dickens Obeten, Pastor Sam Okon, Pastor Odion Nwon Awaji, Pastor James Akpan, Pastor Joshua Rex, Pastor Emmanuel

Orok and my colleague Pastor (Dr./Mrs.) Helena Omang. Behold, how sweet for brethren to dwell together in unity. I appreciate you for all your prayers and encouragement through the years. I love you all with the love of the Lord.

I deeply appreciate the New York Blood Centre, USA, GTI Diagnostics (USA) and Technoclone Austria for their assistance during the research days. Some reagents were given free, some were given relates. I thank you all.

Mr. Vice Chancellor Sir, I wish to appreciate the immediate past Vice Chancellor, Prof. Humphrey Ogoni, under whom I served as a Head of Department and also rose to the rank of a Professor. May the God Almighty reward you immensely and to my present Ag. Vice Chancellor, Prof. Samuel G. Edoumiekumo, thank you for making this occasion possible.

May the Lord protect and guide you all to your various destinations. I am done. God bless you.

CITATION ON

PROF. ZACCHEAUS AWORTU JEREMIAH

Ph.D, M.Sc (RSUST), FIBMS (London), MNIM, FRCPath (London),
Professor of Haematology & Blood Transfusion Science
Department of Medical Laboratory Science,
Faculty of Basic Medical Sciences,
College of Health Sciences, NDU.

INTRODUCTION

Mr. Vice chancellor Sir, I have the singular honour and privilege to introduce the 32nd inaugural lecturer of the Niger Delta University in the person of Prof. Zaccheaus Awortu Jeremiah, an internationally recognized Professor of Haematology and Blood Transfusion Science and past Head of Department of Medical Laboratory Science, Niger Delta University. Prof. Zaccheaus A. Jeremiah hails from Asarama, Rivers State and was born on the 12th of December 1964 at Asarama to late Mr Jeremiah Z. Ofara of blessed memory from the Ofara War Canoe House of Asarama and Mrs. Emy Jeremiah (nee Simeon) from the Owurong House, all of Egwebe Community in Asarama, Andoni Local Government Area of Rivers State. He is the fourth child and the second son of his parents.

Education:

Prof. Zaccheaus A. Jeremiah commenced his primary education at the State School (formerly Methodist Primary School) Asarama from 1971 to 1978. He lost 2 years of his primary education (1974 - 76) to a prolonged vacation due to financial constraints. He started his secondary education at Government Secondary School Asarama in 1978 and later proceeded to the famous Government Sea School, Isaka in 1980 where he graduated in 1983 with West African School Certificate (WASC). In 1985, he was offered an opportunity to study Mathematics in Russia but lost the offer due to late processing of papers (still financial constraints). He

was later granted admission by JAMB to study Medical Laboratory Science at RSUST (now RSU) in 1985 but again lost the offer due to financial constraints. As a stop gap measure, he proceeded to the Rivers State College of Health Science and Technology, Port Harcourt in 1985 and undertook the certificate programme in Medical Laboratory Science. He finished in 1988 and immediately proceeded to the School of Medical Laboratory Science, University of Calabar Teaching Hospital where he finished his professional training and became registered as an Associate of Institute of Medical Laboratory Science (now Medical laboratory Science Council of Nigeria). He had all his postgraduate trainings at the Rivers State University (formerly RSUST) between the year 2000 and 2006 and graduated with three certificates, PG.D, M.Sc. and Ph.D all in Haematology and Blood Transfusion Science. In 2011, he enrolled at the Royal College of Pathologists, London and after rigorous assessment, he became the second Medical Laboratory Scientist in Nigeria to be awarded the Fellow of the Royal College of Pathologists (London), (the first being Prof. D. E. Agbonlahor) on the 23rd September 2013 at London. Following this resounding success, the Institute of Biomedical Science, London admitted him a Fellow of the Institute in 2013. Professor Zaccheaus. A. Jeremiah thus became a recipient of two prestigious professional fellows in the United Kingdom.

Professional Career

On completion of his professional programme in Calabar, he proceeded to Usmanu Dan Fodiyo University Teaching Hospital, Sokoto where he completed his mandatory one year National Youth Service (NYSC) programme. He returned to Port Harcourt and commenced his career as a Lecturer with the Rivers State College of Health Science and Technology. He gained employment into the Niger Delta University Wilberforce Island in 2007 as a Lecturer I with the Department of Medical laboratory Science and rose through the ranks to the rank of a Professor in 2014.

Academic Leadership and Administrative Experience:

Prof. Zaccheaus.A. Jeremiah has had a rewarding public service and academic career with a wealth of experience in administration. He served as Deputy Head of Department and first director of School of Medical Laboratory Science in the College of Health Science and Technology, Port Harcourt between 1996 to 2005, He was a Departmental Examination Officer in the Niger Delta University from 2009 to 2013 before he was appointed Head of Department of Medical Laboratory Science in 2013. His period of headship was quite eventful as he worked assiduously to gain full accreditation from the Medical Laboratory Science Council of Nigeria. He was the “Midwife” who delivered the first batch of

graduands from the Department. He served as a member of full time equivalent (FTE) Committee of the Faculty of Basic Medical Sciences. He was also a member of the University Medical Advisory Committee. In 2013, he was appointed by the Royal College of Pathologists London in conjunction with the UNDP to serve as a Trainee mentor in the LABSKILL programme in East Africa for the training and capacity building of Pathologists and Medical Laboratory Scientists in East Africa. The programme took him to Kenya, Tanzania, Zimbabwe and Uganda.

Membership of Professional Bodies

Prof. Zaccheaus Awortu Jeremiah is a member of many professional bodies. He was the Secretary-General of the Association of Medical Laboratory Scientists, Rivers State branch from 2003 to 2006. He is a member of many international professional associations including, International Society of Blood Transfusion (ISBT), African Society of Blood Transfusion (AfSBT), International Society of Laboratory hematologists, Fellow, Royal College of Pathologists, Fellow, Institute of Biomedical Science, London, and Member, Nigerian Institute of Management.

Professor Jeremiah has served as external examiner in Postgraduate programmes at University of Calabar (2012 - 2016), Igbinedion University Okada (2015 - 2016), Ambrose Alli University (2016),Bayero University, Kano (2017) and undergraduate BMLS programme at University of Calabar (2012 – 20140, University of Nigeria, Enugu Campus (2015 - date), Usman Dan Fodio University (2010 - 2013), Abia State University Uturu, Madonna University, Elele etc.

Research and Publications

Professor Zaccheaus A. Jeremiah has supervised over 30 M.Sc. and PG.D students in hematology across the Nation's Universities. These include: Rivers state University (formerly RSUST), Ambrose Alli University Ekpoma, Nnamdi Azikiwe Univeristy, Nnewi Campus, University of Benin, Benin City. He supervised and graduated his first Ph.D student (now Dr. Yetunde Obazee) from the Ambrose Alli University. He has also supervised over 60 undergraduate BMLS students from Niger Delta University, Rivers State University and University of Maiduguri, Borno State. He has published not less than seventy (70) full length papers, 90 percent of which appeared in reputable international journals. He has actively participated in International Conferences and presented his findings in Jerusalem, Israel (2010), San Francisco, USA (2011), Raleigh, USA (2013), Addis Ababa, Ethiopia (2011), Mauritius (2014), Kenya (2012), Tanzania (2014) and many in local conferences. Professor Jeremiah served as a LOC member in the Raleigh Conference, USA.

Community Service and Awards

Professor Zaccheaus. A. Jeremiah is an ordained gospel minister with the Revelation Ministries Incorporated Worldwide and serve as a Pastor with our local branch in Port Harcourt. He was a pioneer president of the National Fellowship of Christian Medical Laboratory Science Students (NAFECMLSS), Nigeria in 1990. He has the following awards to his credit; Merit Award as the First national President of NAFECMLSS (2009), award of Excellence as National Patron (2007 - 2012) by NAFECMLSS, Life Patron Award by NAFECMLSS (2013), Award of Excellence by NIMELSA, NDU, (2012, 2013), Award of Excellence by the Revelation Ministries Incorporated (2015).

He is the House Chair of the Great Simeon's Family of Asarama. A position he has occupied for over seven years now.

Conclusion

Prof. Z. A. Jeremiah is very happily married to Mrs. Theresa A. Jeremiah, M.Sc, MISPON and the marriage is blessed with four children, 3 Ladies and 1 gentleman.

Mr. Vice Chancellor, distinguished ladies and gentlemen, please join me to welcome a pace setter, humble achiever, a disciplined and dependable family man per excellence and a Reverend Professor who has made remarkable impact in Medical Laboratory Science and Haematology within and outside the country, Professor Zaccheaus Awortu Jeremiah as the 32nd inaugural lecturer of the Niger Delta University. Thank you.

NIGER DELTA UNIVERSITY

Wilberforce Island, Bayelsa State.

Our Ref: .....NDU/VC/APT/VOL.2/532.

Office Of The Vice Chancellor

Your Ref: .....

Date: ....July 6, 2015.....

Prof. Zaccheus A. Jeremiah
Department of Medical Laboratory Sciences
Faculty of Basic Medical Sciences
Niger Delta University
Wilberforce Island, Bayelsa State.

APPRECIATION FOR SERVICE

As you are aware, a University system operates in such a way that changes are effected from time to time in the administration of units and indeed, the University itself. Such changes are consequent on such factors as the need for wider participation and the necessity not to overburden some individuals, among others.

As a new Ag. HOD is being appointed in your unit (see attached), I thank you on behalf of Council, Senate, Staff and Students for your contribution to the development of the University. I am sure that, where the need arises, you will be willing to serve the University in other capacities.

Please handover formally to your successor.

Best wishes.

Prof. Humphrey A. Ogoni
Vice-Chancellor

The Royal College of Pathologists

By these letters make it known that

Zaccheaus Awortu Jeremiah

is hereby admitted

FELLOW

so long as he shall further the objects of the College
In witness whereof the Seal of the College and the signatures
of the proper Officers have been affixed this twenty fourth day of
January in the year of our Lord 2013

President *Registrar* *Member of Council*


The
Royal
College of
Pathologists

INSTITUTE OF BIOMEDICAL SCIENCE

THIS IS TO CERTIFY THAT

Dr Zaccheaus Awortu Jeremiah

WAS ADMITTED

A Fellow

OF THE INSTITUTE OF BIOMEDICAL SCIENCE ON

7 January 2014

GIVEN UNDER THE SEAL OF THE INSTITUTE

President *Chief Executive*

THIS CERTIFICATE MUST BE SUPPORTED BY A CURRENT ANNUAL MEMBERSHIP CARD
(NO GOVERNMENTAL AUTHORITY IS REQUIRED FOR ITS ISSUE)

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TO GOD BE THE GLORY

1. To God be the glory, great things he hath done
   So loved He the world that He gave us His son
   Who yielded His life atonement for sin
   And opened the life gate that all may go in.

   Praise the Lord, Praise the Lord
   Let the earth hear His voice
   Praise the Lord, praise the Lord
   Let the people rejoice
   O come to the father, through Jesus the Son
   And give Him the glory, great things he hath done.

2. Great this He hath taught us, Great things He hath done
   And great our rejoicing, through Jesus the Son
   But purer and higher and greater will be,
   Our wonder, our transport when Jesus we see.

EPILOGUE:
GOD LIFTS ,SETS AND MAKES

A man climbing to reach the top of the mountain essentially has two groups of people to contend with. The first group of people is your peers. Those you have been relating with at the foot of the mountain. These are your friends and mostly colleagues who are never happy that you are leaving them. They struggle to pull your leg down as you struggle to climb. Sometimes they shout or whisper to you "*what are you going up there to do, it is better down here"* if you pay attention to their reasoning, they will convince and confuse you to disembark on your journey and settle down with them. The second group of persons is those high up at the top of the mountain. They are your seniors who are never happy that you are climbing up to meet them up there. They push your head with their legs to keep you pepertually at the foot of the mountains. They give you all sorts of advice to convince you that staying down there is better than going up.

What then is the force behind success that pushes a man up to a place of relevance, prominence and recognition?It can never be anyother force than GOD himself. He is the only force that can defeat these two groups of people and place a man at the top of his career despite the daunting challenges.

"*He raiseth the poor out of the dust, and lifted up the beggar from the dunghill to set them among princes and to make them inherit the throne of glory* ". 1 Sam 2:8. KJV

"*When men are cast down, then thou shalt say, There is lifting up; and he shall save the humble person*" Job 22:29 KJV

To this GOD who defeated these two groups of people in my life and provided the opportunity to celebrate this elevation today be all GLORY and HONOUR.

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