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Incidence of Transfusion-Transmissible Parasites in Prospective Blood Donors

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Abstract: This study was conducted to determine the prevalence of transfusion transmissible parasites among intending blood donors in Our Lady of Apostles (OLA) hospital in Jos, Jos North Local Government Area of Plateau State. Blood transfusion is a lifesaving medical intervention. Still, it also risks transmitting infectious parasites such as Plasmodium spp, Trypanosoma cruzi, Babesia spp, Leishmania spp, and Toxoplasma gondii. The transmission of parasitic organisms through blood transfusion is relatively rare. This is because there are strict checkpoints at every step of the transfusion process to check the integrity of the blood before a transfusion is made. Blood samples were collected from 25 intending donors and screened for malaria parasites. Out of the 25 donors, 6(24%) tested positive for malaria, consisting of 4(30.8%) males and 2(16.7%). This study reveals a significant malaria prevalence among intending blood donors in OLA hospitals. The findings highlight the rigorous screening and blood testing of blood donors to ensure the blood supply's safety and prevent malaria transmission through blood transfusion. Our findings suggest that routine screening for transfusion transmissible should be implemented, especially in endemic regions.

Keywords: Transfusion Transmissible Parasites; Blood Donation; Safe Blood; National Blood Service Commission (NBSC); Toxoplasma Antigen Detection; World Health Organization(WHO); Trypanosoma Cruzi.

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1. Introduction

Transfusion Transmissible Parasites (TTPs) are those parasites that can be transmitted through blood transfusion. Transfusion Transmissible Parasites are a class of Transfusion Transmissible Infections (TTIs) made up of blood-borne viruses, parasites, bacteria, and prions. Blood transfusion is a clinical aseptic procedure carried out to restore one or more functions of blood in an individual who has clinically manifested the signs and symptoms of anaemia [14]. Parasitic infections are one of the adverse effects of blood transfusion, which should be considered; this is because if blood infected with parasites is transfused to an individual needing blood, the repercussions will be fatal [3]. For parasites to be transmitted through transfusion, parasitic agents must be present in the bloodstream of donors in a sufficient load to be susceptible to the recipient, cause infection without clinical symptoms, survive in the storage duration of blood and blood components, and relatively have a long incubation period. [12].

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Nearly 120 million units of blood are donated every year worldwide. Blood cannot be stored indefinitely, necessitating the constant need for blood donation. Maintaining safety and ensuring that blood donated and used for transfusion is of its best quality is vital for proper healthcare service to protect the donor, recipient, and healthcare staff [15].

Because unsafe blood transfused can contain pathogens such as parasites, the World Health Organization (WHO) has directed that the most common parasitic organisms implicated in transfusion transmissible infections such as Plasmodium spp, Trypanosoma cruzi, Babesia spp, Leishmania spp. and Toxoplasma gondii which causes malaria, Chagas disease, babesiosis, leishmaniasis and toxoplasmosis respectively should be screened in blood donors found in endemic regions [16].

Historically, transfusion-transmissible parasites (TTPs) dominated the transfusion safety agenda but are now rare in developed countries [17]. However, constant vigilance is required to counter the risk of established and newly emergent pathogens in the era of mass international travel. There is a small risk of infectious products entering the blood supply if a donation is made during the window period early in the course of infection before a detectable antibody response. These window periods have been reduced significantly by adding antigen testing and nucleic acid testing (NAT) [11].

The major cause of morbidity and mortality in Sub-Sahara Africa is malaria, caused by a protozoan of the genus Plasmodium, which is transmitted by the female anopheles mosquito. Malaria is endemic in Nigeria, as over 95% of the entire population is at risk [15].

An estimated 81% of all annual global malarial cases, as well as 91% of all global deaths that are a result of malaria, occur in Africa. Therefore, monitoring the prevalence of malaria parasitemia is an integral part of any preventive and control measures to curb the spread of malaria [5].

For a donor to be considered fit for blood donation, he/she must meet the standard criteria for a donation, such as age, weight, health, hemoglobin level, travel history, behavior, pulse, temperature, and blood pressure. Any blood donor who does not meet one of the conditions mentioned is deferred and unfit for blood donation. Pregnant and breastfeeding women are not considered donors.

According to the National Blood Service Commission (NBSC), an estimated 1,230,000 units of blood are collected across several facilities each year, 90% of which are from paid commercial donors. Owing to the risk of transfusion of unsafe blood in Nigeria, NBSC seeks to reduce blood-borne transfusion transmissible parasites and reduce “preventable” deaths due to emergencies involving blood transfusion by ensuring a safe and adequate blood supply in the country [18].

1.1. Aim and Objectives of the research

The aim and objectives of the research are:

- To determine the prevalence of transfusion transmissible parasites among intending blood donors in Our Lady of Apostles Hospital Jos, Nigeria.
- To compare the rapid test and microscopy technique of malaria diagnosis in Our Lady of Apostles Hospital Jos.

2. Transfusion Transmissible Parasites (TTPs)

In the early days of blood transfusion, the two major problems were preventing blot clotting and knowing if one blood is compatible with another. Great difficulties were often encountered because the blood used for transfusion was not compatible with that of the patient [14].

A breakthrough occurred when Karl Landsteiner discovered the ABO blood group system in 1900 and the Rhesus factor in 1937 alongside Alexander S. Wiener. The ABO system is the most important of all blood groups in transfusion. It is the only blood group system in which individuals have antibodies in their serum to the antigens absent from their red blood cells’ surface [9].

ABO blood group system may result in immediate lysis of the donor’s red blood cells. This produces a very severe, if not fatal, transfusion reaction in the patient. Testing to detect ABO incompatibility between donor and potential transfusion recipient is the foundation on which all other pretransfusion testing is based.

During the past decades, major blood safety improvements have been achieved in developed and developing countries. However, even in these countries, there is still a residual risk of transmitting several pathogens, such as parasites.

As the blood donation and transfusion rate increases, the probability of transmitting transfusion transmissible parasites increases. The transmission of parasitic organisms through transfusion is relatively rare. Malaria is one of the major transfusion transmissible parasites in tropical countries such as Nigeria. In contrast, babesiosis and Chagas' disease pose the greatest threat to donors in the USA. In both cases, this is due to the increased number of potentially infected donors [7].

The following parasites have been reportedly transmitted through blood transfusion:

- Plasmodium spp.
- Trypanosoma cruzi
- Babesia spp.
- Leishmania spp.
- Toxoplasma gondii

Plasmodium spp: Plasmodium is a genus of unicellular eukaryotic obligate protozoan parasites that cause malaria. The parasite infects vertebrates; four species are known to infect man: P. falciparum, P. vivax, P. malaria, and P. ovale. Plasmodium is the most important of all tropical diseases regarding morbidity and mortality. Worldwide, two billion people are at risk, and 1.5 – 2.7 million die every year. The incidence of malaria is increasing due to the resistance of vectors to insecticides and drug-resistant parasites, and the disease is prevalent in tropical Africa [19].

Nigeria accounts for about 27% of the global malaria burden, with an estimated 68 million cases and 194,000 deaths due to the disease in 2021. Most individuals affected are children from 5 years of age downwards [20].

The life cycle of all malaria species follows a similar trend, and the parasite undergoes an indirect life cycle as it completes its development in two different hosts: the intermediate host, which is man, and the definitive host, which is the female anopheles mosquito [21]. Asexual reproduction occurs in man (schizogony), and sexual reproduction (sporogony) occurs in the female anopheles mosquito.

Schizogony: it is divided into four stages: primary exoerythrocytic schizogony, erythrocytic schizogony, gametogenic, and secondary exoerythrocytic schizogony:

- **Primary exoerythrocytic schizogony:** a man gets infected when an infected female anopheles mosquito bites a man during a blood meal, releasing sporozoites into the bloodstream through its saliva. After 1 hour, the sporozoites penetrate the hepatocytes (liver cells) and develop into merozoites. On maturity of the merozoites, the hepatocyte ruptures and releases the merozoites into circulation.
- **Erythrocytic schizogony:** the merozoites infect the red blood cells and increase passing through the developmental stages of trophozoite, schizont, and back to merozoites as the red blood cell lyses portraying the clinical symptoms of malaria. This is because the parasite feeds on the hemoglobin in the red blood cell.
- **Gametogony:** after successive red blood cell reinfection with merozoites, some merozoites develop into either a microgametocyte (male) or macrogametocyte (female).
- **Secondary exoerythrocytic schizogony:** this occurs mostly in *P. vivax and P. ovale* when sporozoites get into the hepatocytes and remain inactive (hypnozoite) for a long period, which can cause a relapse in the disease when the sporozoites become active.

Sporogony begins in humans during gametocyte formation. An uninfected female anopheles mosquito becomes infected during a blood meal from a patient. The mosquito picks up both the sexual and asexual forms of the parasite, but only the gametocytes can survive in its lumen. The microgametocyte develops by exflagellation and forming eight filamentous microgametes. The macrogametocyte matures to a macrogamete. Fertilization occurs when a microgamete fuses with macrogamete, forming a zygote and then developing into an ookinete. The ookinete penetrates the epithelial lining of the mosquito's stomach to lie between its external border and the peritrophic membrane and develops into an oocyst. Many sporozoites develop within the oocyst, which ruptures the oocyst on maturity and invades every part of the mosquito except the ovaries. The sporozoites are concentrated in the salivary glands of the mosquito. When it goes for a blood meal, the sporozoites are transmitted into man's bloodstream through its beak, and the cycle is repeated.

3. Methods of transmission

The following ways can transmit malaria:

- From the bite of an infected female anopheles mosquito.
- By transfusing blood from infected individuals.

- Through organ transfer.
- By sharing syringes or needles contaminated with malaria-infected blood.
- By vertical transmission from mother to unborn infant before or during delivery.

3.1. Medical laboratory testing methods

There are two methods of diagnosing malaria: microscopy and rapid diagnostic tests.

Microscopy is the golden standard for establishing the presence of malaria parasites in the blood. This is done by preparing thick and thin films on different or the same slides. The thick film is prepared using about six microliters of blood sample and spread to an area of about $1cm^3$. For the thin film, about three microliters of the blood sample are placed towards the edge of the slide, a spreader slide held at an angle of 45° is made to have contact with blood on the specimen slide, and the blood spreads along the edge of the spreader. Maintaining the angle, the spreader is pushed forward fast, gently, and smoothly. The thin film should have a tongue shape. The thick film is dehaemoglobinized, and the slide is placed in distilled water for 5 – 10 minutes and air dried. The thick and thin film are stained with Leishman stain and examined under an oil-immersion lens. The thin film is examined first; if parasites are found, the thick film is unnecessary. The thick film should be examined if parasites are not found in the thin film. However, if parasites are seen in the thick film and their identity is unclear, the thin film should be reexamined thoroughly.

Rapid Diagnostic Tests (RDTs): Rapid diagnostic test assays are based on antigen-antibody reactions. They are made of monoclonal antibodies that detect malaria antigens in the sample. Depending on the kit, 2 – 50 µl of finger prick blood specimen is collected. The blood is mixed with a buffer containing hemolysis in a well or sample pad. An antigen-antibody complex is formed if a malaria antigen is present in the sample. The antigen-antibody complex moves up the kit by capillary action toward the detection lines. The complex will be immobilized at the corresponding pre-deposited line of capture and will be visually detectable. Depending on the kit, there are two or three pre-deposited lines for capture. The first line is the control line marked (C); the second line is the test line marked (T), which detects all malaria species and becomes visible in any species present. The third line is mainly specific to the species Plasmodium falciparum. The average time for the rapid diagnostic test varies from 5 – 15 minutes.

3.2. Prevention and Control

The following are ways of preventing malarial infection:

- Sleeping under insecticide-treated bed nets.
- Use mosquito repellent according to the instructions indicated on the product.
- Wearing clothes that cover most of the body.
- By destroying mosquito larvae using larvicides or larva predators such as fish.
- Spraying insecticide kills the adult mosquito.
- Oil is applied to the water surface, which suffocates the larvae and pupae.
- By draining all forms of standing water around the house.
- Window nets can be used to prevent the entry of adult mosquitos into the house.
- By getting effective treatment if one develops malarial symptoms.

3.3. Trypanosoma cruzi

Trypanosoma cruzi is a parasitic protozoan flagellate that causes the disease known as Chagas disease. It was discovered accidentally by Carlos Chagas, a Brazilian, in the intestine of a triatomine bug when he investigated malaria in 1909 on April 14. He named the parasite Trypanosoma cruzi after his mentor Oswaldo Cruz. The parasite is endemic in Central and South America. Chagas disease affects about 6 – 7 million people throughout the Americas. Leading to approximately 12,000 deaths every year. The WHO recognized Chagas as a neglected tropical disease in (NTD) 2005. This was instrumental in strengthening prevention, early diagnosis and treatment, comprehensive care, psychological follow-up, information, education, and public awareness. In May 2019, the 72nd World Health Assembly established World Chagas Disease Day, celebrated annually on April 14 (WHO, 2024).

The parasite Trypanosoma cruzi completes its life cycle in two hosts: the man, the definitive host, and various triatomine bug species that act as the intermediate host. It has various mammalian reservoir hosts, such as wood rats, opossums, armadillos, and raccoons.

Man becomes infected when an infective bug comes for a nocturnal blood meal. The bug tends to pass out stool containing the metacyclic trypomastigote, the infective form of T. cruzi, immediately after each blood meal. The bug's saliva contains an irritant that makes the person scratch and smear the feces, introducing parasites into the bloodstream. The metacyclic trypomastigotes invade the cells of the reticuloendothelial system and other tissues, particularly the muscle and nervous tissue, where they are transformed into the amastigote form. These amastigotes are divided by binary fission, passing through the promastigote and epimastigote form and back to the trypomastigote. They are released into the bloodstream, where an uninfected bug becomes infected when it feeds.

Bugs acquire infection by feeding on an infected mammalian host. The trypomastigotes in the blood develop into amastigotes in the foregut by binary fusion, in the midgut to epimastigotes, and in the hindgut to metacyclic trypomastigote excreted in the bug's feces. The development of T. cruzi in the vector takes around 10 – 15 days.

3.4. Method of Transmission

The following are ways by which Trypanosoma cruzi can be transmitted man:

- From the faeces of an infected triatomine bug that comes for a blood meal mostly at night.
- By consumption of food contaminated with *Trypasonoma cruzi.*
- During childbirth, from mother to child.
- Through blood transfusion.
- Through organ transplants such as the kidney or heart.

3.5. Laboratory Diagnosis

The following are laboratory methods of diagnosing Trypanasoma cruzi:

- **Microscopic examination:** During the acute phase of the disease, there are more trypomastigotes in circulation, which can be detected in wet blood films or by direct microscopy after staining with Giemsa stain.
- **Xenodiagnosis:** this is done by feeding an uninfected triatomine bug with blood from a person suspected of having the parasite. The bug's feces are examined after two weeks for the presence of the parasite.
- **Immunoassay:** this employs antibodies to detect the presence of the antigens in samples like urine and serum. Ezyme-linked immunosorbent assay (ELISA) is used to screen blood and store it in the blood bank.
- **Polymerase chain reaction:** this method is used to diagnose patients suffering from the chronic stage of the disease. It is very sensitive as it can detect as few as one trypomastigotes in 20ml of blood.
- **Biopsy:** examining the biopsy obtained from the lymph nodes or muscle may reveal the presence of amastigote forms of Trypanosoma cruzi.

3.6. Prevention and Control

The following are ways of preventing Trypanosoma cruzi infection:

- Bed nets can be used in endemic areas to prevent bites from the triatomine bug.
- By spraying insecticide areas where the bugs are suspected to hide.
- By thoroughly screening blood before transfusion, T. cruzi can survive refrigerated stored blood and freezing and thawing.

3.7. Babesia spp

Babesia, also called Nuttallia, is an apicomplexan parasite that infects red blood cells. Victor Babes discovered it in 1888 in the red blood cells of cattle and sheep in Romania. It was shown that the parasite is responsible for Texas cattle fever, a cattle hemolytic disease caused by ticks. It rarely affects humans where it causes the disease babesiosis; in the United States, France, Scotland, and Ireland, Babesia microti is the most common strain of the few that have been documented to cause disease in humans [10]. However, transfusion-transmitted babesiosis is an emerging threat to the public as asymptomatic carriers donate blood, and there is no regulated test to screen blood products for this pathogen. This is why human babesiosis requires close monitoring and effective intervention measures [13].

The sporozoites, the parasite's infective stage, occur in the salivary gland of Ixodes dommini, which is a tick with a pear shape. During a blood meal, man and other vertebrate animals acquire infection when the tick inoculates the salivary sporozoites.

They enter erythrocytes and multiply asexually, and they may be spherical or oval. They may occur singly, in pairs, or in multiples of two and might be mistaken for plasmodium falciparum when stained with Giemsa stain. The intraerythrocytic parasite reproduces asexually by budding, forming merozoites and non-gametocytes.

When feeding Ixodes dominion tick larvae ingest the infected blood, the gametocytes emerge from the erythrocytes and differentiate into gametes, and pairs fuse to form a zygote within the tick's gut. These develop to ookinetes in about 14 – 18 hours after the larval thick becomes satisfied. These remain inactive until the larval thickens into a nymph and the nymph attaches to the host. Following the attachment of the nymph, each ookinete undergoes nuclear division, resulting in about 1,000 sporozoites, which are transmitted to man or other vertebrate hosts, causing Babesia infection in man, which is transmitted by blood transfusion.

3.8. Laboratory Diagnosis

The following are laboratory methods of diagnosing babesiosis:

- **Examination of blood smear:** the parasite can be demonstrated in Giemsa-stained thick and thin blood films. It may appear singly, in pairs, or multiples of two; the parasite might be mistaken for *Plasmodium falciparum* in its ring forms.
- **Serological tests: An** indirect fluorescent antibody test is used to diagnose and distinguish Babesia species. The antigens used are hamster red cells.
- **Polymerase chain reaction (PCR):** PCR detects Babesia DNA accurately in a single day.

3.9. Prevention and Control

The following are ways of preventing *Babesiosis* infection:

- Use repellents by applying them to your skin and clothes according to label instructions.
- Avoid leaf litter and bush where ticks live when outside in tick areas.
- Remove any ticks from your clothing and nymph before going inside.
- Do a full-body tick check with a mirror, noting areas like behind the knees, groin, underarms, and scalp.
- Remove attached ticks quickly with fine-tipped tweezers, pulling straight out steadily.

3.10. Leishmania spp

Leishmania is a single-cell protozoan parasite that is responsible for the disease leishmaniasis. The genus Leishmania is widely distributed in nature and has several species. Sandflies of the genus Phlebotomus spread them in the old world and Lutzomyia in the new world. Leishamania passes their life cycle in two hosts: vertebrate and invertebrate host, the vertebrate host being mammals in which the parasite resides within the phagolysosomal system of mononuclear phagocytic cells and the invertebrate the sandflies [2]. The World Health Organization estimates about 1.5 million cases of cutaneous leishmaniasis and 500,000 cases of visceral leishmaniasis occur annually in 82 countries. Estimates have indicated that there are about 350 million people at risk for acquiring leishmaniasis, with 12 million infected. The Americas have elevated leishmaniasis cases, accounting for about two-thirds of the worldwide disease burden [8].

The parasite exists in two forms: the amastigote in the cells of the reticuloendothelial system of the vertebrate host and the promastigote found in the digestive tract of the sandfly. Amastigotes of the parasite are found in the patient's bloodstream, free and phagocytosed by polymorphonuclear leucocytes and monocytes. During a blood meal, the sandfly takes them up and reaches its midgut, where they transform into promastigotes and increase exponentially. After 6 – 9 days of ingesting infected blood, the parasites block the buccal cavity.

When the sandfly goes for another blood meal, it regurgitates the promastigotes in the wound caused by its beak. These are now engulfed by nearby macrophages and change into amastigotes in the cytoplasm of the cells. Here, the amastigotes multiply slowly for months; the parasitized macrophages are set free into circulation to go to the reticuloendothelial centers.

The amastigotes are now taken up by Kupffer's cells in the liver and multiply simply by binary fission till the cells become packed with about 50 – 200 or more parasites. The infected cell ruptures and parasites are released into circulation to infect other cells. A blood-sucking sandfly draws these amastigotes and those within the cells during the meal, and the cycle is repeated.

3.11. Laboratory Diagnosis

The following are laboratory methods of diagnosing leishmaniasis:

- **Blood film examination:** when blood films are stained with Giemsa stain, the amastigote form of the parasite may be seen inside circulating monocytes and, less often, neutrophils in the stained peripheral blood by thick film. It is often missed by thin film due to the small number of Leishmania parasites in the peripheral blood.
- **Molecular methods:** this involves using DNA probes, Polymerase chain reaction (PCR), isoenzyme, and monoclonal antibodies to identify promastigotes.
- **Needle Biopsy:** a needle can obtain biopsy samples from deeper tissues, lymph nodes, liver, bone marrow, and spleen. A touch smear impression stained with Giemsa stain was made to demonstrate the amastigote form of the parasite. However, bleeding might continue from the puncture wound in the soft and enlarged spleen, resulting in death. A spleen puncture should not be performed in a person with hemorrhagic diathesis and leukemia.

The following are ways of preventing Leishmaniasis infection:

- Vector control is achieved by eliminating breeding sites, insecticides, and insect repellants.
- Wear long sleeves and personal protection by avoiding outdoor activities during peak sandfly hours.
- Using screens on the windows and doors.
- Avoid going to areas having high sandfly density.
- By ensuring early diagnosis and treatment.

3.12. Toxoplasma gondii

Toxoplasma gondii is a parasitic apicomplexan protozoan that causes toxoplasmosis. It was discovered by Nicole and Manceaux in 1908 in Tunisia in a rodent, Ctenodactylus gundi. It is distributed worldwide, and 70% of all individuals are exposed to it at some point in their lives; meanwhile, most symptoms show no symptoms. The felids (cats) are the only definitive hosts in which the parasite can undergo sexual reproduction [4]. Toxoplasma gondii can cause severe neurologic and ocular disease when transmitted congenitally and in immunosuppressed persons. Because of the ability of its cyst to survive in extreme conditions, it is one of the causes of miscarriages in pregnancy and a leading cause of congenital disabilities in newborns. The parasite manipulates the rodent behavior and enhances the likelihood of transmission to its definitive host because rodents are mostly prey to cats [1].

Toxoplasma gondii is an obligate intracellular parasite in the reticuloendothelial and other nucleated cells. It has three main stages of life: tachyzoites, tissue cysts, and oocysts, which are all infective to man. The tachyzoites and tissue cysts are asexual (schizogony) forms in man and other mammals. At the same time, cats are the only mammals supporting the parasite's three forms, i.e., schizogony and sporogony. The life cycle can occur in two different ways, which are:

- Enteric life cycle
- Exoenteric cycle

Enteric life cycle: This occurs in domestic cats and other wild cats, and it involves both asexual reproduction (schizogony) and sexual reproduction (sporogony) within the mucosal epithelium of the small intestine. The cat gets infected by consuming any form of the parasite. They invade the mucosal cells of the small intestines and multiply asexually before the sexual phase begins, with male and female gametocytes forming male and female gametes, respectively. An oocyst develops when the male and female gametes fuse by fertilization and exit from the cell into the lumen and is passed out in the faeces, where it becomes infective after a few days. It can remain infective for about one year.

Exoenteric cycle: humans, mice, rats, sheep, cattle, and certain birds, which are intermediate hosts, acquire infection by ingesting contaminated food and water with cat's feces containing sporulated cysts and also by ingestion of undercooked meat containing tissue cysts. In the duodenum, the oocysts release sporozoites, and tissue cysts release bradyzoites. These pass through the gut, circulate in the body, and invade various tissues, forming tachyzoites, multiplying, breaking out, and spreading the infection to another organ, forming tissue cysts infective to definitive and intermediate hosts.

3.13. Laboratory Diagnosis

The blood (buffy coat), sputum, bone marrow, cerebrospinal fluid, and biopsy material from lymph nodes, brain, and spleen are required for diagnosis. The following are laboratory methods of diagnosing toxoplasmosis:

- **Microscopic examination**: smears and sections stained with Giemsa or a special periodic acid-Schiff stain may show the tachyzoites of Toxoplasma gondii in the smear having crescent-shaped and in section round to oval.
- **Polymerase chain reaction**: toxoplasmal DNA can be detected in the blood and CSF by PCR.
- **Toxoplasma antigen detection**: ELISA can detect toxoplasma antigen in the blood and CSF.

The following are ways of preventing toxoplasmosis infection:

- By washing hands with soap and water after coming in contact with pets, farm animals, and animal faeces,
- By not eating undercooked meat.
- By not drinking untreated water.
- By proper screening of blood before transfusion.
- By proper screening of organs before transplant.

3.14. Implications of Testing and Screening of TTPs in Blood Transfusion

Although the risk of transfusion transmissible parasites today is lower than ever, safe blood supply remains a priority subject to contamination with known yet-to-be-identified human pathogens. Only continuous improvement and implementation of donor selection, sensitive screening tests, and effective inactivation procedures can eliminate or reduce the risk of acquiring transfusion-transmissible parasites. Up-to-date information regarding parasites that can be transmitted via blood components is necessary; thus, the collaboration of all parties involved is crucial for protecting a secure blood product from known and emerging pathogens [6].

Screening for blood parasites also provides an important opportunity for notification and linkage to the care of donors. This is because the donor's health status must be ascertained as to whether he or she meets the required conditions to be qualified as a donor. Some blood-borne parasites are geographically distributed and depending on the rules set out by the Blood Transfusion Agency in each country, if a donor fails to meet the criteria, he or she will be deemed unfit for blood donation and will be deferred.

In Nigeria and Sub-Saharan Africa, malaria is an endemic disease. The National Blood Service Commission (NBSC), acting through the National Blood Transfusion Service (NBTS), has directed that all blood donation facilities in the country should thoroughly screen for malaria parasites in the donor's blood before transfusion because the transfusion of malaria in infected blood may not only compound the already deplorable health of the recipients but may also be fatal. However, sometimes, this is not the case, as the long-standing concern about transfusion-transmitted hepatitis and human immunodeficiency virus (HIV) has overshadowed the fact that other diseases like malaria can be spread by transfusion of blood components [3].

4. Materials and Method

4.1. Materials and reagent

- Malaria test kit (Bioline^{TM} Malaria Ag P.f test kit)
- Pasteur pipette
- Field's stains A and B
- Clean, grease-free glass slide
- Cotton wool
- 70% alcohol
- Needle and syringes
- Immersion oil
- Microscope
- Hand gloves
- EDTA Bottles
- Tourniquet

Study Area: The study was conducted in Our Lady of Apostles Hospital Jos North Local Government Area.

Study Population: A total of 25 intending blood donors aged 18 to 65 years who came to donate blood at Our Lady of Apostles Hospital laboratory during the blood donation campaign participated in the study. All blood samples were collected within July 2024.

Sample Size: A total of 25 blood samples were collected from blood donors at Our Lady of Apostles Hospital laboratory, Jos, and analyzed for Malaria parasites.

Sample Collection: Venipuncture blood samples were collected for RDT kits and for making a thick film for microscopic observation.

4.2. Method of Collection

The patients were allowed to sit on a chair comfortably with their arms supported. The veins were inspected elevated, and a tourniquet was placed on the upper arm; the ante-cubital fossa vein was cleaned with 70% alcohol and allowed to air dry before puncture was made, and dry sterile disposable syringes and needles were used to collect various blood. The arm was held firmly before the needles were inserted into the veins. As soon as the needle was inserted into the veins, blood was carefully drawn, the tourniquet was loosened, the syringe was withdrawn from the vein, and the puncture site was covered with dry cotton wool to halt bleeding. The needle was detached, and the blood was delivered carefully from the syringe into commercially made EDTA Bottles and gently mixed. All sharps were discarded into the sharps container.

4.3. Processing of Samples

4.3.1. Rapid Diagnostic Kit Test Procedure for Bioline^{TM} Malaria Ag P.f test kit

- The blood in the EDTA tubes was gently mixed to obtain a uniform sample.
- A disposable inverted cup (5µl) was dipped with its circular end into the sample.
- The 5µl of blood was dispensed into the round specimen well for each sample.
- Four drops of the diluent assay were dispensed into the assay diluent well.
- The results were read after 15 minutes.
- The negative samples were those that had a single line only in the "C" result window, while those that were positive had two lines in the "C" and "P.f" result window.

4.3.2. Procedure for Making Thick Blood Film

- A small drop of each sample that tested negative with the RDT was placed at the center of the pre-cleaned, grease-free labeled slide.
- Using the edge of another slide, the drop was spread in a circular pattern until it was the size of a dime ($2cm^2$).
- The thickness of each film permitted a newsprint to barely read underneath.
- The thick films were allowed to air dry and were not fixed.

4.3.3. Procedure for thick film staining using Field's Stain A & B;

- Each slide was placed into Field's stain A for 3 seconds.
- It was rinsed with distilled water.
- Each slide was placed in Field's stain B for 3 seconds.
- It was rinsed with distilled water.
- It was allowed to air dry.

4.3.4. Microscopic Examination

- A drop of immersion oil was applied to the stained, thick blood film area.
- The thick blood film for the malaria parasite was examined under the microscope using an x100 objective lens.

5. Results

This study's findings are represented in tables 1 to 3 below. Table 1 shows that out of the 25 donors whose samples were tested, 13 (52%) were males and 12(48%) were females. The age group 18 – 27 for males was the highest with six donors, followed by 28 – 37 with four donors. For the females, the age group 18 – 27 had eight donors, followed by the age group 28 – 37 with two donors. The study showed donors aged 18 – 27 participated more than any other group.

Table 1: Age and Gender Distribution of Donors

Age (Years)	Male (%)	Female (%)	Total
18 – 27	06(42.8)	08(47.2)	14(100)
28 – 37	04(66.7)	02(23.3)	06(100)
38 – 47	01(50.0)	01(50.0)	02(100)
48 – 57	02(66.7)	01(23.3)	03(100)
TOTAL	13(52.0)	12(48.0)	25(100)

Table 2 is on the gender-related prevalence of malaria, which shows that out of the 13 tested male donors, 4(30.8%) tested positive while 9(69.2%) tested negative. Of the 12 tested female donors, 2(16.7%) tested positive, while 10(83.3%) tested negative. The study showed that 6(24%) donors tested positive while 19(76%) tested negative. It also showed that more males (4) tested positive than females (2).

Table 2: Gender-Related Prevalence of Malaria

Gender	Malaria Positive (%)	Malaria Negative (%)	Total
MALE	04(30.8)	09(69.2)	13(100)
FEMALE	02(16.7)	10(83.3)	12(100)
Total	6(24.0)	19(76.0)	25(100)

Table 3 shows a correlation between the age and prevalence of malaria in donors. It shows that of the tested donors of the age group 18 – 27, 3(60%) and 2(40%) male and female respectively tested positive while only 1(100%) male donor tested positive in the age group 28 – 37. The study showed that of the six positive donors, 4(66.7%) were male and 2(33.3%) females.

Table 3: Age-Related Prevalence of Malaria

Age (Years)	Male (%)	Female (%)	Total
18 – 27	3(60.0)	2(40.0)	5(100)
28 – 37	1(100)	0(0)	1(100)
38 – 47	0(0)	0(0)	0(0)
48 – 57	0(0)	0(0)	0(0)
TOTAL	4(66.7)	2(33.3)	6(100)

6. Discussion

This study was carried out to determine the prevalence of transfusion transmissible parasites among intending blood donors in OLA Hospital Jos, Plateau State, Nigeria. Among the five transfusion transmissible parasites, which are Plasmodium spp, Trypanosoma cruzi, Babesia spp, Leishmania spp, and Toxoplasma gondii discussed in this article, only Plasmodium spp, which causes malaria, was tested because of the setting's location in which malaria is an endemic disease. The other parasites were not tested because of their almost no incidence or due to the geographical location of the study.

Blood transfusion is one of the emergency medical procedures performed on individuals who are anemic and require restoration of their blood properties for optimum body performance. There are various causes for a need for a blood transfusion, which can be the biological cause (e.g., sickle cell disease, malaria, thalassemia, HDN, etc.) and mechanical cause (e.g., loss of blood through accidents or burns). Blood transfusion entails transferring whole blood or components from a healthy individual to another person who has shown the need for blood.

For transfusing blood, it must be screened for various transfusion transmissible infections (TTIs). Unscreened blood might contain TTIs like viruses such as human immunodeficiency virus (HIV), hepatitis B and C viruses, bacteria such as Treponema pallidum, which causes syphilis, and parasites such as Plasmodium spp, which causes malaria. If transfused into a sick person, the repercussions will be fatal. In the USA, according to the Food and Drug Administration, in 2021, the FDA received 91 reports of fatalities; of these, 60 were potentially connected to transfusions, while 31 were related to donations.

In the UK, where about 2.1 million blood products were issued in 2020, the Serious Hazard of Transfusion (SHOT) scheme reported that the risk of death related to transfusion was 1 in 53,193 and 1 in 15,142. There has been an increase in deaths related to blood transfusions from 17 deaths in 2019 to 39 deaths in 2020 in the UK.

Blood transfusion safety in Nigeria (and probably the rest of Sub-Saharan Africa) remains an uphill task due to several factors, including blood shortage, poor implantation of blood transfusion guidelines, infrastructural deficits, and high prevalence of TTIs. This stresses the importance of safe transfusion practice.

This study revealed that out of the 25 screened donors, 6(24%) tested positive for malaria. According to the WHO, the 2021 incidence of malaria in Nigeria dropped from 413 per 1000 people in 2000 to 306 per 1000 in 2021. It can be seen that the prevalence of malaria in the years 2000, 2021, and 2024 is 41.3%, 30.6%, and 24%, respectively.

The study also revealed that of the positive donors, 6(24%), the majority, 4(66.7), were males, while 2(33.3%) were females. This might be because males are more exposed to mosquito bites than females due to their way of life or because more males always turn out for blood donation than females.

6.1. Implication

As the malaria parasite can be transferred via blood transfusion, any blood donor who tested positive for malaria was deferred. Because the transfusion of such blood could endanger the life of the already ill recipient. However, sometimes, this is not the case, as the long-standing concern about transfusion-transmitted hepatitis and human immunodeficiency virus (HIV) has overshadowed the fact that other diseases like malaria can be spread by transfusion.

6.2. Limitation

The main limitation of this study was that only one of the five (Plasmodium spp, Trypanosoma cruzi, Babesia spp, Leishmania spp, and Toxoplasma gondii) discussed transfusion transmissible parasite was tested. That was Plasmodium spp, the causative agent of malaria. The other were not tested because of the setting of this study.

7. Conclusion

This study was carried out to determine the prevalence of transfusion transmissible parasites among intending blood donors in OLA Hospital Jos, Plateau State. Even though the probability of transferring known blood-borne parasites through blood transfusion is very low because of advances in diagnostic medicine. The study also shows the importance of donor screening before blood donation because it helps the donor know how well he/she is. Blood screening for transfusion transmissible parasites is not done as a single test. Still, it falls under the screening of transfusion transmissible infections, which aims to provide recipients with safe blood. One problem in the screening might arise because some blood infections can be in their window period, preventing them from being detected using routine testing assays. In the USA, approximately 4.5 million lives are saved by blood transfusions. It is also important to note that no blood should be transfused without screening.

7.1. Recommendations

Routine screening for transfusion-transmissible parasites in blood banks, particularly in endemic regions, is crucial to ensure the safety of blood supplies. Implementing such screenings can significantly reduce the risk of transmitting parasitic infections to recipients, especially in areas where these infections are prevalent. Another essential step is enhancing donor selection criteria to exclude individuals at high risk of carrying transmissible parasites. This includes improving the assessment process to identify individuals exposed to parasitic infections through travel history or other risk factors. Furthermore, improving blood collection, storage, and testing procedures is necessary to minimize contamination risk and maintain donated blood's safety and integrity. Advanced storage techniques and rigorous testing protocols help detect and eliminate parasitic infections before transfusions occur. Developing sensitive and specific diagnostic tests for transfusion-transmissible parasites is also essential. These tests can help early detection, ensuring only safe blood is used in transfusions. Coupled with this, there is a need to establish guidelines and protocols for managing transfusion-transmissible parasite-infected blood donors and recipients. This will help healthcare providers effectively handle cases where contamination has occurred. Finally, investigating alternative screening methods, such as molecular assays, is important to improve sensitivity and specificity in detecting parasites. Molecular techniques can offer more accurate detection, reducing false negatives and ensuring safer blood transfusions.

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