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Research Article

Transfusion Transmitted Parasitic Infections

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Introduction

Transfusion-transmitted parasitic infections refer to the transmission of parasitic pathogens from an infected blood donor to a recipient through the process of blood transfusion [1]. Parasites causing these infections can include protozoa, helminths, and other microorganisms that, when present in the blood of an infected donor, can be transferred to the recipient during the transfusion procedure [2]. Parasites that are transfused via blood transfusion includes:Plasmodium species (malaria), Trypanosoma cruzi (Chagas disease),Babesia species, and Leishmania species .Blood transfusion pose a significant risk of transmitting parasitic organisms from an infected donor to a recipient [3]. The incidence rates across the world are difficult to calculate given the asymptomatic and often latent nature of the disease prior to clinical presentation. Every blood transfusion therefore carries a potential risk for transmissible diseases [4]. Transmission of diseases still occurs, primarily because of the inability of the test to detect the disease in the 'window' phase of their infection, high cost of screening, a lack of funds and trained personnel, immunologically variant viruses, non-seroconverting chronic or immuno silent carriers and inadvertent laboratory testing errors [5]. Currently the transfusion transmitted infections are divided into four divisions namely, viral, bacterial, parasitic and emerging. However, this paper will focus on the transfusion transmitted parasitic infections [6].

Epidemiology of transfusion transmitted parasitic infections

- **Malaria:** Malaria is a vector-borne disease caused by five Plasmodium species in humans [7]. Globally, 219 million cases were reported from 90 countries with 435,000 deaths in 2017 [8]. Malaria is one of the first reported transfusion-transmitted infections (TTIs) [9] and more than 3000 cases of transfusion-transmitted malaria (TTM), in total, were reported worldwide [10]. Malaria is more common in tropical and subtropical areas, such as sub-Saharan Africa, Southeast Asia, and parts of South America.
- **Babesiosis:** Transfusion-transmitted babesiosis (TTB) was first identified in New England in 1980 and has an estimated incidence of 1 per 18,000 transfusions in endemic states. Babesiosis is the most prevalent TTPIs after malaria and endemic in parts of the North America continent. This disease is caused by the intraerythrocytic protozoan parasites of the genus Babesia. The actual rate of transfusion-transmitted babesiosis (TTB) is unclear in the world, but more than 200 cases have been reported only in the USA [11].
- **Leishmaniasis:** The transmission of leishmaniasis by blood transfusion is relatively rare and only 14 cases of transfusion-transmitted leishmaniasis (TTL) with other controversial evidences have been reported in the world [12].
- **American Trypanosomiasis:** Chagas disease is endemic in 21 countries in the Americas and affects approximately 6 million people. In the Americas, Chagas disease show an annual incidence of 30,000 new cases average, 12,000 deaths per year, and approximately 9,000 newborns become infected during gestation [13]. The total number of transfusion-transmitted chagas disease (TT-CD) is not exactly clear, although it is estimated to be between 300 and 800 in the past decades [14].
- **Toxoplasma Gondii**: Toxoplasmosis is a zoonotic disease caused by Toxoplasma gondii (T. gondii), an obligate intracellular protozoan parasite [15,16]. The parasite infects a wide range of warm-blooded animals and humans in different parts of the world. It is estimated that up to one-third of the world's human population is infected with this parasite [17].

Types of transfusion transmitted parasitic infections

The following are the various types of parasitic infections that can be transmitted via blood transfusion.

Malaria, Chagas' disease, Babesiosis, Leishmaniasis and Toxoplasmosis:

Malaria

Malaria is caused by Plasmodium parasites and can be transmitted through blood transfusion. It is prevalent in inter-tropical areas [19].

Transfusion-transmitted malaria (TTM) is an accidental *Plasmodium* infection caused by whole blood or a blood component transfusion from a malaria infected donor to a recipient [20]. Infected blood transfusions directly release malaria parasites in the recipient's bloodstream triggering the development of high-risk complications, and potentially leading to a fatal outcome especially in individuals with no previous exposure to malaria or in immunocompromised patients [21]. Severity of the symptoms vary in different patients; some might be asymptomatic if they have partial immunity due to previous exposure to malaria. The symptom of malaria includes Headache, fever, chills and sweating, fatigue and weakness, anaemia, vomiting, jaundice, enlargement of spleen and liver etc. [22].

Mode of transmission

Malaria parasites are naturally transmitted by the infective bites of female *Anopheles* mosquitoes during their blood meal [23].

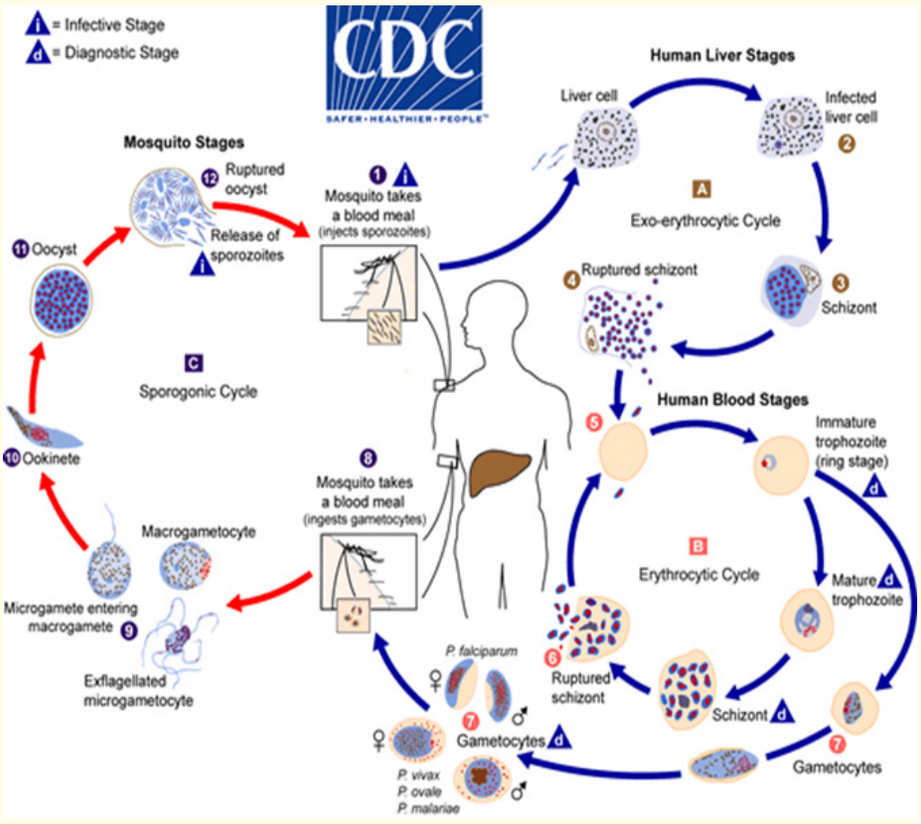

Figure a: Life Cycle of Malaria.
Source [23]

Babesiosis

Babesiosis is caused by Babesia parasites and can be transmitted through blood transfusion. It is mainly found in certain regions of the United States [24]. Babesiosis is parasitic disease caused by Babesia parasites and can be transmitted through blood transfusion, and rarely through perinatal transmission or organ transplantation [25]. Unlike the malaria parasite, *Babesia* spp. circulate in a natural tick-reservoir host cycle and are usually transmitted to humans through the bite of an infected tick. Most naturally occurring infections are asymptomatic or exhibit mild features. In a splenic, elderly, or immunocompromised patients a severe malaria-like illness with hemolytic anemia and renal failure can occur. *B. microti* organisms can survive at 4°C and at 25°C [26].

Mode of transmission

Bite of infected ticks.

Life cycle

Humans enter the cycle when bitten by infected ticks. During a blood meal, a *Babesia*-infected tick introduces sporozoites into the human host. Sporozoites enter erythrocytes and undergo asexual replication (budding) . Multiplication of the blood stage parasites is responsible for the clinical manifestations of the disease. However, human to human transmission is well recognized to occur through blood transfusions [27].

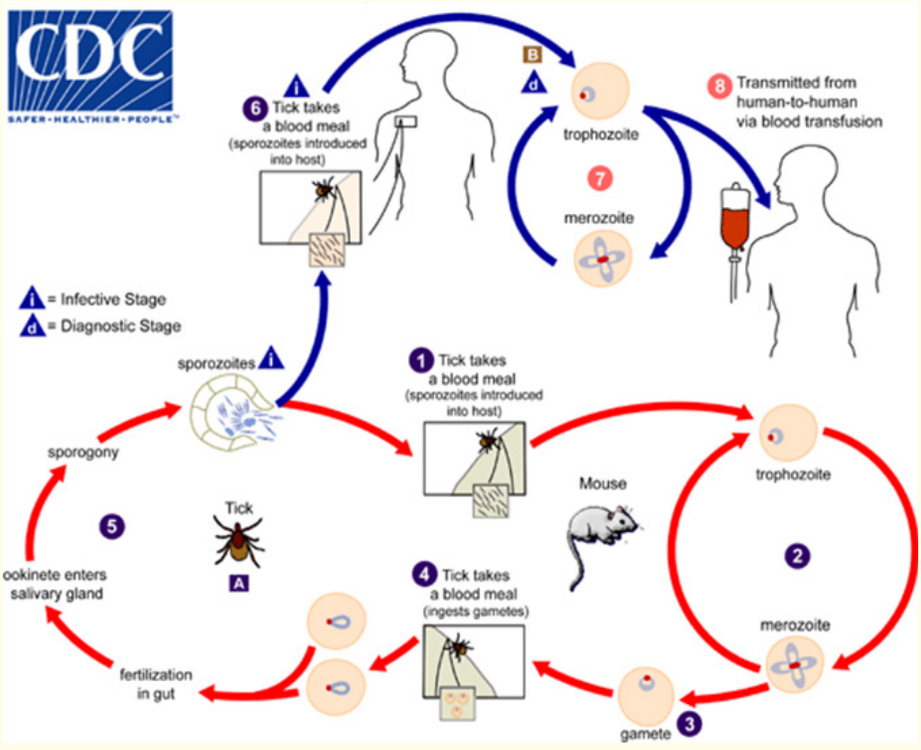

Figure b

Source [2]

Leishmaniasis

Leishmaniasis is caused by Leishmania parasites and can be transmitted through blood transfusion. It is prevalent in various parts of the world, including the Mediterranean, South America, and the Middle East [28]. Leishmaniasis is a vector-borne disease caused by protozoan parasites of the Leishmania genus. This neglected tropical disease affects humans and other mammals, transmitted through the bite of infected female sandflies [29]. There are different forms of the disease, including cutaenous, mucocutaenous, and visceral leishmaniasis each affecting various tissues and organs. Symptoms of leishmaniasis depend on what type you have. Cutaneous and mucosal leishmaniasis cause large, slow-healing ulcers. Visceral leishmaniasis causes general symptoms, like fever, weight loss and abdominal swelling [30].

Mode of transmission

Bite of an infected female sandflies.

Life cycle

Leishmaniasis is transmitted by the bite of female phlebotomine sandflies. The sandflies inject the infective stage, promastigotes, during blood meals. Promastigotes that reach the puncture wound are phagocytized by macrophages and transform into amastigotes. Amastigotes multiply in infected cells and affect different tissues, depending in part on the Leishmania species [31]. This originates the clinical manifestations of leishmaniasis. Sandflies become infected during blood meals on an infected host when they ingest macrophages infected with amastigotes. In the sandfly's midgut, the parasites differentiate into promastigotes, which multiply and migrate to the proboscis [32].

American trypanosomiasis (Chagas disease)

Chagas' disease is caused by the parasite Trypanosoma cruzi and can be transmitted through blood transfusion. It is commonly found in Latin America [33]. Chagas disease, also known as American trypanosomiasis, is a potentially life-threatening illness caused

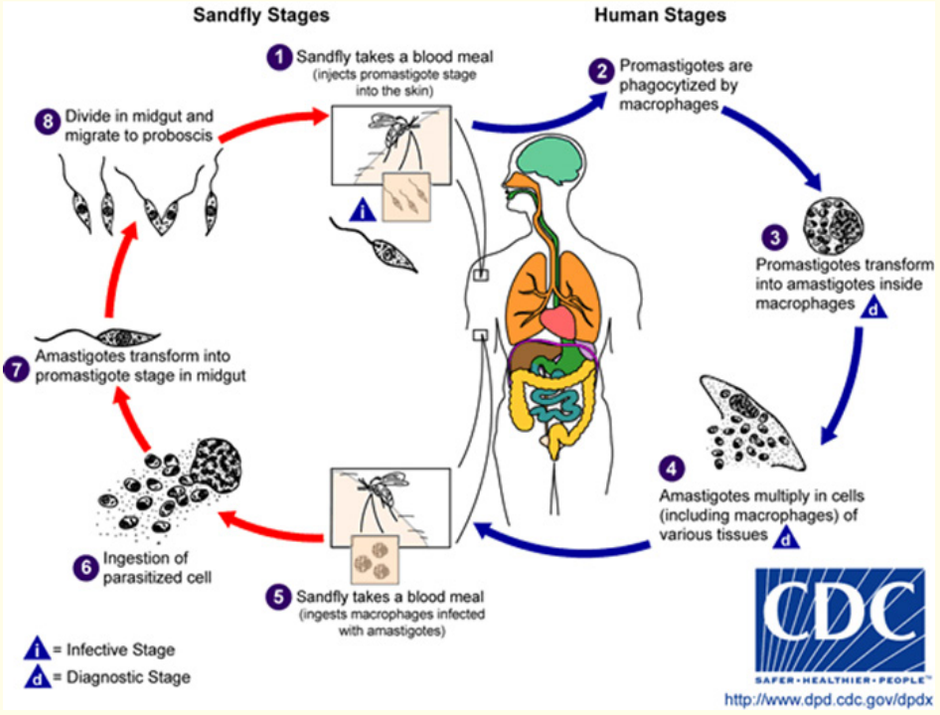

Figure c: Life Cycle of Leishmaniasis.
Source [32].

by the protozoan parasite Trypanosoma cruzi. About 6-7 million people worldwide are estimated to be infected with T. cruzi. The disease is mostly endemic in Latin American countries [35]. Asides being transmitted by blood or blood products transfusion from infected donor, T. cruzi can also be transmitted from an infected mother to her newborn during pregnancy or childbirth, or through organ transplants using organs from infected donors [36]. Signs can be a skin lesion or a purplish swelling of the lids of one eye. Additionally, they can present fever, headache, enlarged lymph glands, pallor, muscle pain, difficulty in breathing, swelling, and abdominal or chest pain. In later years the infection in those patients can cause the destruction of the nervous system and heart muscle, consequent cardiac arrhythmias or progressive heart failure and sudden death [37].

Mode of transmission

Bite of Triatomine bug.

Life cycle

The amastigotes multiply, differentiate into trypomastigotes, and are released into the circulation as bloodstream trypomastigotes. Trypomastigotes infect cells and transform into intracellular amastigotes. The clinical manifestations of acute infection can result from this infective cycle [38].

Toxoplasma Gondii

Toxoplasmosis is caused by the parasite Toxoplasma gondii and can be transmitted through blood transfusion. It is a global infection [15,39].

Toxoplasma gondii is a protozoan parasite that infects most species of warm-blooded animals, including humans, and causes the disease toxoplasmosis. Toxoplasma is an obligate intracellular parasite, which can infect human by different modes mostly by ingestion and inhalation of contaminated products. Occasionally T. gondii could be transmitted from person to person by modes of mother-to-child transmission, organ transplantation and or rarely by blood transfusion [39].

Risk factors

Transfusion-transmitted parasitic infections can pose significant risks. Here are some risk factors associated with them.

Individuals who have traveled to or lived in regions endemic to certain parasitic infections are at increased risk of carrying these parasites and transmitting them through blood transfusions [40]. Inadequate screening of blood donors for parasitic infections can lead to contaminated blood products, increasing the risk of trans-

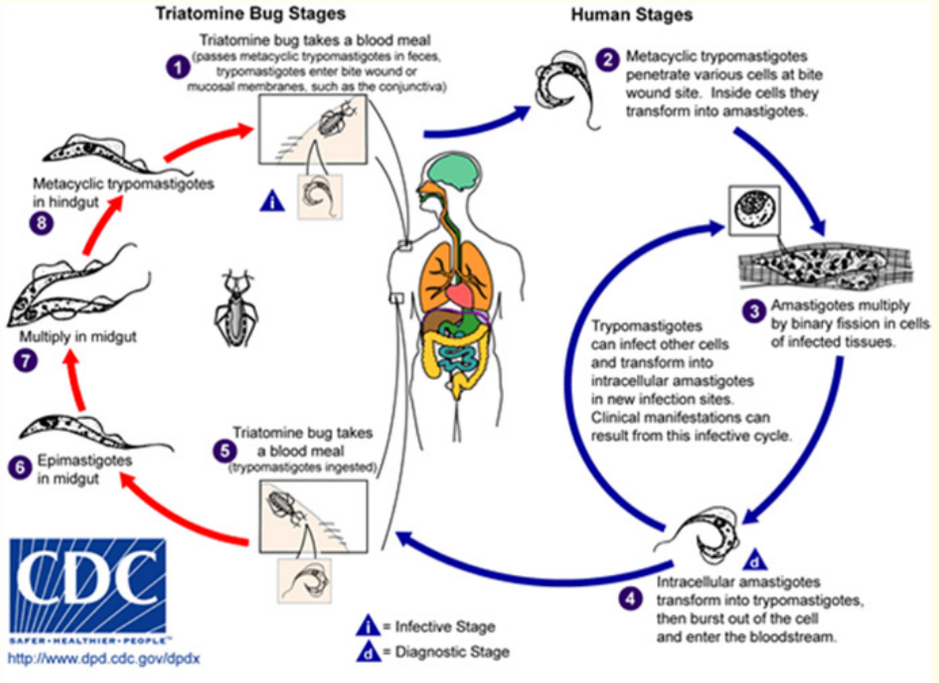

Figure d: Life Cycle of American Trypanosomiasis.
Source [38]

fusion-transmitted parasitic diseases. [41], Immunocompromised individuals, such as those with HIV/AIDS or undergoing organ transplantation, are at higher risk of developing severe complications from transfusion-transmitted parasitic infections [40], Non-inclusion of TTPI in donor screening processes [40] and Contamination of blood products during collection, processing, or storage can introduce parasitic organisms into the blood supply, increasing the risk of transmission [41].

Laboratory diagnosis

Laboratory diagnosis of transfusion-transmitted parasitic infections involves various methods, including serological tests, molecular techniques, and microscopic examination of blood smears.

Microscopic examinations

Microscopy remains the conerstone of diagnostic laboratory testing for blood and tissue parasites. The microscopic examination of thick and thin blood smears stained with Giemsa or other appropriate stains (Wright stain, Wright-giemsa stain, or a rapid stain) is used for the detection and identification of Babesia, Plasmodium and Trypanosoma species and of Filarial nematode [26,34].

- **Serological assays**: This method detects specific antibodies produced by the immune system in response to the infection. It is available as an adjunctive method for the diagnosis of a number of parasitic infections. Enzyme linked immunosorbent assay (ELISA) kits is of greatest use during the latent and chronic stages of diseases, it provides qualitative or negative results [15,41].
- **Molecular methods:** These tests are used to look for the DNA of the parasite itself. Polymerase chain reaction (PCR) is commonly used for detecting specific parasite DNA. PCR is particularly valuable for detecting low levels of parasitemia that may exist in the donor [40].

Prevention and control

There are multiple strategies to prevent the transmission of parasitic agents via blood transfusion, including donor selection and deferral (permanent or temporary), testing of blood donation and the use of leukoreduction filters, pathogen inactivation techniques, inclusion of TTPI in donor screening, proper blood processing and also by creating public awareness [41].

Conclusion

In conclusion, transfusion-transmitted parasitic infections remain a significant concern in healthcare settings worldwide. Advancement in screening technique and blood products processing should be put in place to minimize the risk of these infections,

vigilance and ongoing research are essential to further mitigate transmission. Collaborative efforts involving healthcare professionals, researchers and policy makers are necessary to implement comprehensive strategies aimed at safeguarding blood transfusion recipients from parasitic infections.

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