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Parvovirus B19 and blood transfusion

Abstract

Parvovirus B19 is a common human pathogen that is responsible for a wide range of clinical manifestations, including erythema infectiosum (fifth disease), arthropathy, and fetal hydrops. Infection with Parvovirus B19 can cause significant morbidity in certain patient populations, including pregnant women and individuals with underlying hematologic or immune disorders. This review highlights the importance of screening of Parvovirus B19 infection, particularly in high-risk populations.

Keywords: parvovirus B19, blood safety, transfusion-transmitted infections, screening

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Introduction

Parvovirus B19 infections are very widespread, particularly among children.[1,2] The most well-known symptom caused by B19 is erythema infectiosum, also known as the "Fifth disease."[3] In general, healthy people experience no serious consequences from B19 infections, but in patients with weakened immune systems or blood disorders, the infection can cause significant problems.

The goal is to make blood and blood products safer by reducing the risk of transmitting infectious agents. This has resulted in various screening tests, such as those for hepatitis B, hepatitis C, and HIV, which have greatly reduced transmission risk.[4] However, testing all blood products for viruses like B19 and cytomegalovirus would be costly.

Infection by parvovirus b19 virus (b19v)

Parvovirus B19 is a non-enveloped DNA virus with a particle size of 20 to 30 nm 5 and relies on erythroid precursor cells in the bone marrow for replication. This replication leads to the destruction of these cells. B19 is primarily spread through coughing but can also be transmitted through blood transfusions or from an infected pregnant woman to her fetus. In the Western world, it is estimated that 50% of 15-year-olds have had a B19 infection[5], with even higher rates in the elderly (80-100%).[1]

B19 infection during pregnancy can have serious consequences, such as a 10% increase in prenatal mortality and a 3% increase in the risk of hydrops fetalis in the second trimester.[6,7] B19 can also cause an aplastic crisis in patients with congenital hemolytic anemia.[2,5] For individuals with cellular immunodeficiency, such as those with HIV or who are on immunosuppressive drugs after an organ transplant, B19 can persist and cause long-lasting bone marrow damage and red blood cell aplasia, 2 among other cell types.[8] Studies of patients with seemingly healthy immune systems suggest that B19 infections can persist for extended periods.[9,10] B19 has been shown to persist in bone marrow [9] and synovial membrane [11] but not in the blood, which raises concerns about potential B19 infection in recipients of bone marrow transplants. Chronic infections are treated with intravenous immunoglobulin, which is based on anti-B19 antibodies.

Prevalence of b19v in blood donations and plasma pools

The prevalence of B19 in blood donations varies, with reports ranging from 0.03% to 0.6%.[12–16] The DNA of B19 can be found in over 60% of plasma pools used for plasma products production.[17,18] The high viral levels in some pools may be due to a small number of highly infected donations. The infectivity of plasma given to individual patients depends on the level of the viral titer.[19] This has led researchers to conclude that the reduced infectivity of plasma with low levels of B19 DNA is due to the binding of anti-B19 antibodies to the viral particles.[17,20]

Screening of b19v

The diagnosis of B19 infection is typically done through serological screening tests that detect antibodies against the virus, which remain present throughout an individual's lifetime. 7 More recent tests involve detecting B19 viral DNA through methods such as dot-blot testing and nucleic acid amplification testing (NAT), which is expressed in terms of the number of viral DNA copies (genome copies).

Despite the low prevalence of B19V in blood donors, the transmission of B19V through blood transfusions is rare. As a result, screening blood donors for B19V infection is not a standard practice. However, some countries such as Japan, Germany, and the Netherlands have taken measures to reduce the risk of B19V transmission and make blood transfusions safer.

In September 1997, the Japanese Red Cross (JRC) implemented a receptor-mediated hemagglutination assay as a screening test for B19V in all donated blood. This screening test was used until 2007. To improve assay sensitivity, in 2008 the hemagglutination test was replaced by a chemiluminescent enzyme immunoassay. The sensitivity of this new test was estimated to be approximately 106.3 IU/mL for genotype samples and 106.4 IU/mL for B19V DNA-positive donor samples. [21]

In the year 2000, Germany introduced screening for B19V DNA in blood donors by using a minipool real-time NAT (testing of up to 96 donations in a minipool format). Blood products with B19V DNA virus load ≥105 IU/mL were discarded, while minipools with B19V DNA virus load <105 IU/mL were not separated, and all blood products were released. Donors were not informed about their B19V infection and were able to give subsequent donations.[22]

The Health Council of the Netherlands has implemented measures to ensure the safety of blood products administered to patients who are at risk of B19 infection. They have made a distinction between two types of blood products in their committee: cellular blood products and plasma products.[23] The distinction between cellular blood products and plasma products has been made based on the frequency of prescription and the number of donors involved in producing these

products. Cellular blood products, which are prescribed frequently, are either made from a single donor or a small number of donors and are given to a limited number of patients. Conversely, plasma products, which are prescribed less often, are made from plasma pools obtained from many donors and are given to a larger group of patients such as coagulation factors.[5]

The Committee suggests using a risk-group approach, where B19-virus safe blood products are given to patients who may be at risk for B19 infection complications. This approach guarantees that these patients receive the most secure blood products. Patients who are not in the risk groups should receive cellular blood products that were not tested for B19V or for which no evidence of B19V DNA was found. Plasma products are tested for B19V DNA, and if found, are discarded.[24] The risk-group approach adopted by the Netherlands Committee of the Health Council helps to ensure that blood products with the highest level of safety are administered to those who may have complications from B19V infection, while other patients receive blood products without any evidence of B19V infection. This approach aligns with the previous methods used in blood transfusion medicine to prevent CMV transmission.

The "B19-virus safe" label is given to cellular blood products if the donor has been found to have IgG antibodies against B19 in two different blood samples taken at least six months apart. This double testing is to ensure that the virus has been removed from the blood. The "B19-virus safe" blood products are recommended for pregnant women, patients with haemolytic anaemia, and patients with cellular immunodeficiency who do not have detectable antibodies to B19. Anti-B19 antibody testing is not recommended for pregnant women in emergency situations due to the need for immediate blood transfusion and the lack of time for testing. [25]

Patients who do not fall into the risk group should continue to receive cellular blood products that have been manufactured according to current safety protocols. However, the risk-group approach suggested for cellular products cannot be applied to plasma products, due to their widespread production and use. Instead, measures must be taken to reduce the levels of infection in these plasma pools. The Committee recommends identifying and excluding highly infected donations prior to pooling. For the final plasma pools, a maximum limit of 104 genome copies of B19 per ml is proposed. This limit is consistent with the maximum limit recommended by the American Food and Drug Administration (FDA).[22]

Technical innovations, such as the inactivation of microorganisms[26] and the use of nanofiltration[27] to decrease the number of viral particles in the final product, present additional possibilities for making blood products safe from B19 virus. It is recommended to integrate these techniques into regular blood bank procedures. However, there is always a certain level of risk associated with blood product treatment, even though the "standard" blood products are very safe.

Summary and conclusion

In conclusion, Parvovirus B19 is a well-recognized transfusion-transmitted infection that can pose a significant risk to certain patient populations, particularly those with underlying hematologic disorders. Blood safety measures have been implemented to reduce the risk of transmission, including screening for Parvovirus B19 antibodies in blood donors and using pathogen reduction technologies to reduce the viral load in blood products. Despite these measures, cases of transfusion-transmitted Parvovirus B19 continue to occur. Clinicians should be aware of the potential for Parvovirus B19 transmission through blood products and consider the risk-benefit of transfusion in high-risk patient populations. With ongoing efforts to improve blood safety and management of transfusion-related infections, it is hoped that the risk of transfusion-transmitted Parvovirus B19 can be minimized and patient outcomes improved.

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Conflicts of interest

The author declares that there is no conflict of interest.

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