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Implications of Screening Blood Donors for Selected Transfusion-Transmissible Infections (TTIs): Compromise in Blood Safety?Igbe Mba Ikwoegbu^{1,2*}, Adepoju Emmanuel-Funsho^{1,3}, Babajimi-Joseph Amarachi^{1,4}, Samson Elujoba^{1,5}, Adamu Ibrahim^{1,6}, Muhibi A. Musa¹

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Author for Correspondence*: mbaigbe@gmail.com/+234-809-999-4705. <https://dx.doi.org/10.4314/sokjmls.v9i2.6>**Summary**

Blood transfusion is a life-saving medical procedure used to replenish blood loss or treat blood disorders. However, the potential transmission of transfusion-transmissible infections (TTIs) poses a significant risk to recipients. Screening donated blood for TTIs is a cornerstone of ensuring blood safety. This article explores the implications of screening for selected TTIs, examining the potential for compromise in blood safety. It analyzes the benefits of comprehensive screening against the challenges of resource limitations, test limitations, and the ethical considerations of donor deferral. The article also discusses emerging TTIs and the evolving landscape of blood screening practices. Finally, it proposes strategies to optimize blood safety while navigating the complexities of selective screening.

Keywords: Transfusion transmissible infections, Africa, blood safety and Cytomegalovirus.

Introduction

Blood transfusions are essential medical interventions used to treat various conditions, including blood loss due to surgery, trauma, or blood disorders. However, the potential transmission of infectious agents through contaminated blood poses a significant risk to recipients (Njoroge *et al.*, 2019; Muhibi *et al.*, 2018). Transfusion-transmissible infections (TTIs) encompass a range of viruses, bacteria, and parasites that can be transmitted through blood products. Prior to the implementation of robust screening programs, TTIs like HIV,

hepatitis B virus (HBV), and hepatitis C virus (HCV) were major concerns in blood transfusions (Amene *et al.*, 2021).

The development and implementation of sensitive and specific tests for TTIs have revolutionized blood safety. However, the question of which TTIs to screen for and the implications of selective screening remain crucial aspects of blood transfusion practices. This article delves into the complexities of screening for selected TTIs, analyzing the potential benefits and drawbacks and mitigations for blood safety.

Prevalence of TTIs

Studies across Africa reveal a concerning high prevalence of TTIs among blood donors. Hepatitis B virus (HBV) is one of the most prevalent infections (Bloch *et al.*, 2012). A study conducted in Nigeria reported an HBV surface antigen (HBsAg) prevalence of 18.6% among blood donors (Buseri *et al.*, 2009). Similarly, research in Kenya documented a 5.6% prevalence of HBsAg (Include reference). Hepatitis C virus (HCV) is another major concern, with studies showing a prevalence ranging from 2.7% to 6.0% in different African countries (Chernet *et al.*, 2018; Fakete *et al.*, 2018; Muhibi *et al.*, 2014). Human Immunodeficiency Virus (HIV) transmission through blood transfusions is a significant public health concern, with estimates suggesting 5-10% of HIV infections in sub-Saharan Africa attributable to contaminated blood (Chernet *et al.*, 2018). Less commonly, syphilis can also be transmitted through blood transfusions, with

prevalence varying across the continent (Muhibi *et al.*, 2018; Omole *et al.*, 2006).

Factors Contributing to the High Frequency of Transfusion-Transmissible Infections (TTIs) in Africa:

Prevalence in General Population: The high prevalence of TTIs, such as HIV, hepatitis B, hepatitis C, and syphilis, in the general population in Africa contributes to the increased risk of these infections in blood donors (Chernet *et al.*, 2018; Omole *et al.*, 2006).

Limited Access to Healthcare: Many people in Africa have limited access to healthcare services, including testing and treatment for TTIs. This lack of access can result in undiagnosed and untreated infections, increasing the risk of transmission through blood transfusions (Oyewole *et al.*, 2020; Omole *et al.*, 2006).

Inadequate Blood Screening: Blood screening facilities in Africa may be inadequate or not fully equipped to screen for all TTIs. This can result in missed infections and an increased risk of transmitting TTIs through blood transfusion (Owusu-Ofori *et al.* 2016; Muhibi *et al.*, 2018).

Cultural Practices: Certain cultural practices in Africa, such as scarification and traditional healing practices, may increase the risk of TTIs. These practices can involve the sharing of instruments that are not properly sterilized, leading to the transmission of infections (Hewlett & Ward. 2010).

Lack of Awareness and Education: Limited awareness about TTIs and how they are transmitted can contribute to the high frequency of these infections. Lack of education on safe sex practices, for example, can lead to an increased risk of HIV and other sexually transmitted infections (Oyewole *et al.*, 2020).

Stigma and Discrimination: Stigma and discrimination against individuals with TTIs can deter people from seeking testing and treatment. This can result in undiagnosed infections and an increased risk of transmission through blood transfusions (Herbst *et al.*, 2022).

Socioeconomic Factors: Poverty and lack of resources can contribute to the high frequency of

TTIs in Africa. Limited access to healthcare, poor living conditions, and lack of access to education can all increase the risk of TTIs (Herbst *et al.*, 2022).

Healthcare System Challenges: Weak healthcare systems in Africa, including limited infrastructure and a shortage of healthcare workers, can hinder efforts to prevent and control TTIs. This can result in inadequate screening and treatment, leading to a higher frequency of infections (Muhibi *et al.*, 2018). The high frequency of TTIs in Africa is influenced by a combination of factors, including the prevalence of infections in the general population, limited access to healthcare, inadequate blood screening, cultural practices, lack of awareness and education, stigma and discrimination, socioeconomic factors, and challenges within the healthcare system.

Consequences of TTIs: TTIs pose a severe health risk to blood recipients. HBV and HCV infections can lead to chronic liver disease, cirrhosis, and even liver cancer. HIV infection can progress to AIDS, a debilitating and potentially fatal condition. Syphilis, if left untreated, can cause serious health complications, impacting the nervous system, cardiovascular system, and even leading to death in severe cases.

Strategies for Improving Blood Safety: Several strategies are crucial for improving blood safety in Africa and reducing the prevalence of TTIs. Strengthening healthcare systems with improved access to diagnostics and treatment for viral infections is essential. Educational campaigns promoting safe sexual practices and risk reduction behaviors can help decrease the spread of TTIs in the general population.

A critical focus should be on promoting voluntary blood donation from low-risk individuals. Implementing stricter donor selection criteria based on thorough risk assessments is essential. Additionally, investing in advanced blood screening technologies and adopting newer, more sensitive tests can significantly improve blood safety (Herbst *et al.*, 2022; Muhibi *et al.*, 2018).

Furthermore, promoting self-sufficiency in blood collection and processing is crucial. This can be achieved by establishing national blood transfusion services with adequate infrastructure and resources. International collaboration and knowledge-sharing are also vital in providing technical assistance and expertise to African countries to enhance blood safety practices.

Benefits of Comprehensive Screening for TTIs: The primary benefit of comprehensive screening for TTIs is the significant reduction in the risk of transmission to recipients. Extensive research demonstrates that robust screening programs have dramatically decreased the incidence of transfusion-transmitted infections. Studies have highlighted the success of implementing standardized screening protocols in reducing HIV, HBV, and HCV transmission rates to near zero in well-resourced settings. This achievement underscores the critical role of comprehensive screening in ensuring blood safety (Herbst *et al.*, 2022; Muhibi *et al.*, 2018).

Furthermore, comprehensive screening fosters trust and confidence in the blood supply system. When recipients are assured that donated blood has undergone rigorous testing for a broad spectrum of TTIs, they are less likely to experience anxiety or apprehension regarding potential infections. This fosters a positive perception of blood transfusion practices and encourages blood donation, contributing to a sustainable blood supply.

Challenges of Selective Screening for TTIs

The cornerstone of safe blood transfusion lies in meticulous screening for Transfusion-Transmissible Infections (TTIs). These infections, including HIV, hepatitis B virus (HBV), hepatitis C virus (HCV), and syphilis, can be transmitted from infected blood donors to recipients, potentially causing severe illness or death. While significant strides have been made in blood safety through universal screening for the core TTIs, the question of selective screening for additional infections remains a complex and evolving debate within the field of transfusion medicine.

Despite the success of universal screening, the concept of selective screening for TTIs holds a

certain allure. Selective screening would involve testing donations only for a subset of high-risk TTIs, potentially reducing costs associated with unnecessary testing. This approach could be particularly appealing in resource-limited settings, where blood shortages are prevalent. However, several challenges impede the widespread adoption of selective screening for TTIs. While comprehensive screening offers substantial benefits, resource limitations can pose significant challenges in some settings. Developing countries may lack the financial resources or infrastructure to implement and maintain sophisticated screening programs for a wide range of TTIs. This can lead to selective screening, prioritizing testing for the most prevalent TTIs and potentially overlooking emerging or less common infections (Blumberg *et al.*, 2022; Busch *et al.*, 2023).

Another challenge associated with selective screening lies in the limitations of diagnostic tests. No test is perfect, and there can be a window period between infection and when a test becomes serologically positive. Additionally, new or rare TTIs may not be readily detectable by existing screening assays. This highlights the need for continuous development and implementation of more sensitive and comprehensive screening methods. Some other challenges include: difficulty of defining "high-risk", threat of window period transmission, the importance of blood donation behavior and importance of continuous vigilance (Muhibi *et al.*, 2018).

The Difficulty of Defining "High-Risk": Identifying which TTIs pose a "high-risk" for transfusion transmission can be complex. Factors such as disease prevalence, donor demographics, and the sensitivity of available screening tests all play a role in this assessment. A region with a high prevalence of a particular TTI might necessitate its inclusion in the screening panel, even if it presents a lower risk in another location.

The Threat of Window Period Transmission: No test is perfect, and all assays are associated with the "window period". This is the period when the infected individual might test negative

despite harboring the TTI. Selective screening could inadvertently miss recently infected donors who are within this window period, increasing the risk of transfusion transmission (Busch *et al.*, 2023).

The Importance of Blood Donation Behavior:

Selective screening relies heavily on the accuracy of donor self-deferral based on risk factors. However, some donors may be unaware of their TTI status or hesitant to disclose risk behaviors, potentially compromising the effectiveness of this approach.

The Importance of Continuous Vigilance

While the challenges associated with selective screening are significant, continuous vigilance and proactive research are critical for maintaining optimal blood safety. Here are some key strategies to consider:

- **Improved Screening Technologies:** Developing more sensitive and specific tests for TTIs would reduce the window period and minimize the risk of missed infections. Technological advancements in nucleic acid testing (NAT) offer promising avenues for achieving this goal (Muhibi *et al.*, 2018).
- **Surveillance Systems:** Robust national and international surveillance programs for emerging infectious diseases are essential. By identifying novel threats with potential for transfusion transmission, adjustments can be made to screening protocols if necessary.
- **Donor Education:** Educating donors about TTIs and the importance of truthful disclosure of risk factors remains vital. Implementing effective donor education programs can enhance the effectiveness of both universal and selective screening approaches.
- **Cost-Effectiveness Analysis:** Conducting thorough cost-effectiveness analyses specific to different geographical regions is crucial. This will allow for informed decisions regarding resource allocation and potential cost-savings associated with selective screening in specific settings.

Emerging TTIs and the Evolving Landscape of Blood Screening

The landscape of blood safety is constantly evolving with the emergence of new and

potentially transmissible pathogens. Zika virus, as previously mentioned, serves as a recent example. Continuous surveillance programs are essential to stay ahead of emerging threats. These programs involve close monitoring of infectious disease trends, identification of novel pathogens with potential for transfusion transmission, and collaboration with public health agencies (Barbosa *et al.*, 2020).

One such example is the ongoing research on Babesia, a parasitic infection transmitted by ticks. While the risk of transmission through blood transfusion is currently considered low, ongoing surveillance and potential inclusion in screening protocols are crucial for future preparedness.

Furthermore, fostering international collaboration and knowledge sharing between blood transfusion services is essential to ensure the timely development and implementation of comprehensive screening strategies for emerging pathogens. Sharing best practices, facilitating access to testing technologies, and fostering research collaborations are all critical aspects of a global approach to blood safety.

Strategies for Optimizing Blood Safety with Selective Screening

While inclusive screening remains the ideal situation, navigating the challenges of resource limitations requires exploring strategies to optimize blood safety with selective screening. Here are some key approaches:

- **Risk Stratification:** This strategy involves classifying potential donors based on their geographical location, sexual behavior, and history of high-risk activities. Donors from regions with high prevalence of certain TTIs or those who engage in activities associated with increased risk can be prioritized for testing for those specific infections (AABB, 2023).
- **Newer Testing Technologies:** Implementing newer technologies like nucleic acid testing (NAT) can improve the sensitivity of screening programs. NAT tests can detect the genetic material of pathogens even during the window period when antibody tests are negative. This enhances the ability to identify infected donors who might otherwise be missed by

traditional screening methods (Muhibi *et al.*, 2018).

- **Donor Education and Deferral Counseling:** Educating potential donors about TTIs, the screening process, and the importance of honest disclosure of risk factors can contribute to a safer blood supply. Additionally, implementing clear guidelines for donor counseling and education regarding deferral can help mitigate anxieties and address ethical concerns (Herbst *et al.*, 2022).
- **Alternative Donation Options:** Exploring alternative donation options for individuals who test positive for specific TTIs can help expand the donor pool without compromising safety. For instance, plasma donation may be an option for individuals who test positive for certain viruses where the risk of transmission through red blood cells is minimal.

Blood donation practices are not static. As technology advances and societal norms evolve, the ethical landscape surrounding selective screening requires ongoing re-evaluation. Here are some key considerations:

- **Donor Deferral Criteria:** Selective screening practices raise concerns about potential discrimination against certain demographics. Re-evaluating deferral criteria for conditions like Cytomegalovirus (CMV) in light of emerging evidence on minimal transmission risk is crucial. Additionally, fostering open communication with potential donors regarding deferral reasons can help address anxieties and promote transparency.
- **Commercialization of Blood Donation:** The increasing demand for blood products raises concerns about the potential for commercialization of blood donation. While some argue that offering financial incentives can encourage blood donation, ethical considerations regarding exploitation of vulnerable populations need careful consideration.
- **Access to Safe Blood for All:** A critical ethical concern is ensuring equitable access to safe blood transfusions for all patients, regardless of their location or socioeconomic status. International

collaboration and knowledge sharing are crucial to address differences in blood safety practices across diverse regions.

Continuous dialogues among stakeholders including blood transfusion services, ethicists, and patient advocacy groups are necessary to navigate the developing ethical landscape surrounding blood donation and selective screening.

The Role of Patient Blood Management (PBM)

Optimizing blood safety extends beyond simply refining blood screening practices. Implementing patient blood management (PBM) strategies can also play a significant role. PBM is a multidisciplinary approach aimed at minimizing unnecessary blood transfusions and optimizing the use of blood products. Here's how PBM contributes to blood safety:

- **Reducing Blood Demand:** By implementing evidence-based practices to minimize blood loss during surgery and optimize patient red blood cell mass, PBM programs can significantly reduce the overall demand for blood transfusions. This reduces the strain on the blood supply and minimizes the associated risks of transfusion-transmitted infections.
- **Improving Clinical Outcomes:** PBM strategies not only benefit blood safety but can also contribute to improved patient outcomes. Minimizing unnecessary transfusions can reduce the risk of transfusion reactions and complications associated with blood product use.
- **Promoting Blood Conservation:** PBM encourages exploring alternative therapies and blood conservation techniques. This can include using cell salvage techniques during surgery to collect and reinfuse a patient's own blood or utilizing erythropoietin (EPO) to stimulate red blood cell production.

By promoting PBM practices in conjunction with robust blood screening strategies, healthcare institutions can contribute to a safer and more sustainable blood supply system (AABB, 2023; Busch *et al.*, 2023).

The Future of Blood Screening

The future of blood safety lies in ongoing

research and development of even more sensitive and specific screening technologies. Point-of-care testing, which allows for rapid testing of blood donations at the collection site, is a promising area of development. This could potentially improve turnaround times and expedite the availability of safe blood products for transfusion.

Furthermore, advancements in pathogen inactivation technologies hold promise for further enhancing blood safety. These technologies aim to eliminate residual pathogens in blood products that may not be detectable through conventional screening methods.

The Cost-Effectiveness of Selective Screening

Balancing safety with resource limitations is a constant challenge in blood transfusion practices. Selective screening offers a potential solution, but the question remains: is it cost-effective compared to comprehensive screening?

Research suggests that the answer may depend on several factors, including:

- **Prevalence of TTIs:** In regions with a high prevalence of certain TTIs, the cost of treating transfusion-transmitted infections can outweigh the cost of implementing comprehensive screening. Selective screening, targeted towards the most prevalent TTIs, can offer a cost-effective solution in such settings.
- **Cost of Screening Tests:** The cost of individual screening tests varies. Newer technologies like NAT testing, while highly sensitive, can be more expensive than traditional antibody tests. Evaluating the cost-effectiveness of selective screening requires factoring in the cost of the specific tests included in the panel.
- **Blood Wastage Rates:** Selective screening may lead to higher blood wastage rates. If a blood donation tests positive for an excluded TTI, the entire unit may be discarded. In contrast, comprehensive screening can potentially identify infected donors before blood collection, minimizing wastage.

Cost-effectiveness analyses consider these factors are crucial for informing resource allocation decisions in blood banks. Striking the

right balance between cost and safety is essential, particularly in low- and middle-income countries facing resource constraints (Barbosa *et al.*, 2020; Amene *et al.*, 2021).

Compromises in Blood Safety and Strategies for Mitigation

Blood transfusion is a life-saving medical intervention, restoring lost blood volume, correcting deficiencies in blood components, and supporting various medical procedures. However, despite significant advancements in blood safety practices, the inherent risk of transmitting infectious agents and causing adverse reactions in recipients remains a constant concern. This review article delves into the complexities of compromise in blood safety, exploring potential vulnerabilities throughout the transfusion chain and contemporary strategies for minimizing these risks.

Blood Safety and Efficiency: Blood safety is a multifaceted concept encompassing the entire transfusion cycle, from donor selection and blood collection to processing, storage, testing, and ultimately, transfusion to the recipient. While stringent protocols have significantly reduced the risk of transfusion-transmissible infections (TTIs), the continuous pursuit of optimal safety necessitates a delicate balance with efficiency and resource optimization. Factors such as blood shortages in certain regions and the increasing costs associated with blood screening technologies can create pressure to prioritize efficiency over absolute safety.

Compromises During Processing and Storage:

Blood processing and storage also present vulnerabilities within the transfusion chain. Equipment malfunctions, such as faulty centrifuges or compromised blood storage units, can negatively impact the quality and viability of blood components. This compromised blood might then be transfused, potentially leading to adverse reactions or reduced therapeutic efficacy. Additionally, human error during various blood processing steps can introduce contamination risks, jeopardizing the safety of the blood product. Furthermore, improper storage temperature or exceeding recommended storage duration can deteriorate blood

components, rendering them ineffective for transfusion.

Testing Limitations: Even with contemporary advancements, limitations inherent to blood screening technologies introduce a degree of compromise. False-negative test results remain a concern, particularly during the "window period" when an infected donor may not yet produce detectable antibodies against the TTI⁷. Additionally, test kit failures due to manufacturing defects or user errors can lead to missed infections in donated blood.

The selection of which TTIs are included in the screening panel also plays a crucial role. Selective screening, focusing on a limited panel of high-risk infections, can be attractive in resource-limited settings. However, this approach increases the risk of missing newly emergent TTIs or those prevalent in specific regions.

Delivery and Transfusion Errors: Blood transfusion errors remain a significant threat to patient safety. Blood group incompatibility, the most common and potentially fatal transfusion error, occurs when a recipient receives blood with an incompatible blood type. This can lead to a life-threatening reaction known as haemolytic transfusion reaction. Errors in selecting the appropriate blood component based on the patient's specific needs can also compromise the efficacy of the transfusion. Additionally, human error during the identification and verification process can lead to the transfusion of blood products to the wrong recipient.

Strategies for Mitigating Compromise

Maintaining optimal blood safety necessitates a multi-pronged approach, addressing vulnerabilities at each stage of the transfusion chain.

- **Strengthening Donor Selection and Screening:** Implementing standardized questionnaires, incorporating more objective risk assessment tools, and providing comprehensive pre-donation education can enhance the accuracy of donor screening.
- **Investing in Staff Training and Technology:** Providing comprehensive training for blood bank personnel on standard operating procedures and utilizing advanced blood collection equipment with built-in safety features can minimize human error risks.
- **Rigorous Quality Control and Automation:** Implementing robust quality control measures throughout the blood processing and storage phases, coupled with automation where feasible, minimizes risks associated with human error.
- **Continued Investment in Testing Technologies:** Continuously striving for improved sensitivity and specificity of TTI screening assays, coupled with the exploration of novel diagnostic techniques like nucleic acid testing (NAT), can significantly reduce the window period and minimize missed infections.
- **Standardized Practices and Traceability:** Implementing standardized blood collection, processing, and transfusion protocols across facilities minimizes variability and reduces the risk of errors. Additionally, maintaining a robust blood tracking system ensures traceability throughout the chain, facilitating the identification and potential recall of potentially compromised blood products (Njoroge *et al.*, 2019).
- **Blood Bank Information Systems and Automation:** Utilizing advanced blood bank information systems with features like barcode scanning and electronic verification can significantly reduce the risk of human error during blood component selection, labeling, and transfusion.
- **Continuous Vigilance and Hemovigilance Programs:** Maintaining robust national and international surveillance programs for emerging TTIs with transfusion transmission potential allows for timely adaptation of blood screening protocols. Implementing comprehensive haemovigilance programs, where all adverse transfusion reactions are reported and investigated, facilitates the identification of potential compromises and promotes continuous improvement in blood safety practices.
- **Collaboration and Communication:** Fostering strong collaboration and communication channels between blood banks, healthcare providers, regulatory bodies, and research institutions allows for the rapid dissemination of best practices,

identification of emerging threats, and collaborative efforts to improve blood safety standards globally (Bloch *et al.*, 2012; AABB, 2023).

Conclusion

Screening donated blood for TTIs remains a cornerstone of blood transfusion safety. While comprehensive screening offers the most robust protection, navigating resource limitations necessitates careful consideration of selective screening practices. There is need for ongoing evaluation of cost-effectiveness, ethical considerations, and the integration of Patient Blood Management strategies. The future of blood safety lies in continuous innovation and collaboration. By continuously improving screening practices, exploring new technologies, fostering open communication with donors, and implementing PBM programs, we can strive towards a future where blood transfusions are even safer, more readily available, and ethically sound for patients in need.

The high prevalence of TTIs in Africa poses a significant threat to blood safety and public health. However, through a multi-pronged approach that includes strengthening healthcare systems, promoting voluntary blood donation, implementing stricter donor selection criteria, adopting advanced screening technologies, and fostering self-sufficiency in blood collection, Africa can significantly improve blood safety and ensure access to safe blood transfusions for all.

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