Transfusion Medicine Reviews 29 (2015) 35–44

Contents lists available at ScienceDirect

Transfusion Medicine Reviews

journal homepage: www.tmreviews.com

The Use of Rapid Diagnostic Tests for Transfusion Infectious Screening in Africa: A Literature Review

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ARTICLE INFO

Available online 28 September 2014

Keywords:
Blood safety
Blood transfusion
Point-of-care technology
Transfusion-transmitted viruses
Africa

ABSTRACT

Infectious risk associated with blood transfusion remains a major public health challenge in Africa, where prevalence rates of the major transfusion-transmissible infections (ie, hepatitis B, hepatitis C, human immunodeficiency virus, and syphilis) are among the highest in the world. Resource-limited blood services often operate with minimal predonation screening safeguards, prompting exclusive reliance on laboratory testing to mitigate infectious risk. Transfusion screening with rapid diagnostic tests (RDTs) has been adopted in areas that lack the capacity to support the routine use of more sophisticated technologies. However, uncertainty surrounding the performance of some RDTs in the field has spurred debate regarding their application to blood donation screening. Our review of the literature identified 17 studies that evaluated RDTs for the infectious screening of blood donors in Africa. The review highlights the variable performance of available RDTs and the importance of their use in a quality-assured manner. Deficiencies in performance observed with some RDTs underscore the need to validate test kits prior to use under field conditions with locally acquired samples. Suboptimal sensitivities of some available tests, specifically hepatitis B virus rapid assays, question their suitability in single-test algorithms, particularly in high-prevalence regions. Although RDTs have limitations, many of which can be addressed through improved training and quality systems, they are frequently the only viable option for infectious screening in resource-poor African countries. Therefore, additional studies and specific guidelines regarding the use of RDTs in the context of blood safety are needed.

Contents

Conflict of interest: There are no conflicts of interest to disclose.

Funding: Partial funding support was provided by the UCSF Global Health Sciences masters program and the Joseph Drown Foundation.

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http://dx.doi.org/10.1016/j.tmrv.2014.09.003
0887-7963/

Blood transfusion is a critical therapy for an array of clinical indications. In contrast to high-resource settings, where the risk of transfusion-transmitted infections (TTIs) has been virtually eliminated, transfusion-associated risk remains a major public health challenge in resource-limited countries [1,2]. Transfusion-transmitted infections are of particular concern in Africa, where the prevalence of the major TTIs in blood donors (ie, hepatitis B virus [HBV], hepatitis C virus [HCV], human immunodeficiency virus [HIV], and syphilis) are among the highest in the world and the need for blood is substantial [3,4]. Many African blood services operate in the absence of safeguards, such as recruitment of low-risk donors, prompting reliance on laboratory testing as the sole means to mitigate the risk of TTIs [5].

Although most African countries report infectious screening of blood, existing testing may be incomplete or fail to meet the World Health Organization (WHO)–recommended standards [5,6]. Laboratory screening is complicated by deficiencies in infrastructure, transportation, training, financial support, and quality systems. Highly sensitive, yet expensive and technically demanding laboratory screening methods (eg, nucleic acid testing [NAT]) are not routinely available in resource-constrained settings [7]. Even automated serologic testing platforms require formal training, reagent management, and rigorous quality systems to ensure output reliability.

Given the barriers to automated testing, many resource-limited countries are resorting to rapid diagnostic tests (RDTs) for TTI screening. Although quality RDTs hold promise for increasing the safety of the region's blood supply, uncertainty surrounding the performance of some RDTs in the field has spurred debate regarding their application to TTI screening [8–12]. An improved understanding surrounding the conditions of their use and reasons underlying deficient RDT performance is needed. Therefore, we sought to review the existing literature on performance and operational characteristics of RDTs for transfusion screening in Africa to inform the reader with recommendations for their use.

Methods

To identify relevant literature, we searched PubMed and Medline databases using combinations of the following search terms: "rapid diagnostic test," "rapid test," "RDT," "dipstick," "transfusion," "blood safety," "transfusion-transmitted infections," "TTI," "human immunodeficiency virus," "HIV," "hepatitis B," "hepatitis C," "HBV," "HCV," "syphilis," "malaria," "bacterial contamination," and "(sub-Saharan) Africa." The search was confined to English-language publications. We extended the search to the Google Scholar database and included relevant data from WHO and national blood transfusion program reports. Additional literature was identified through manual searches of reference lists of identified studies and contacting researchers in the field.

We included studies evaluating the performance of RDTs for the infectious screening of blood donors or donated blood in Africa. Studies of RDTs in alternative contexts and settings were excluded (eg, voluntary counseling and testing [VCT]). After scanning the titles and abstracts of identified records, we obtained full texts of relevant articles. A total of 390 relevant studies were identified using the search terms; 356 of these were rejected because they did not fulfill the selection criteria. Six additional articles were identified through contacts and reference list searches. After a review of the full publications, 23 studies were rejected and 17 articles were included for review.

Transfusion-Transmitted Infections

The WHO recommends mandatory screening of blood donations for the 4 major TTIs and, depending on local epidemiological evidence, all additional agents that may compromise blood safety [4,6]. However, per a blood safety report on the WHO African Region in 2010, only 95.3%, 88.9%, 90.1%, and 79.9% of blood donations were screened in a quality assured manner for HIV, HBV, HCV, and syphilis, respectively [5]. Blood is not routinely screened for other endemic pathogens (ie, bacteria, protozoa, and viruses) that may also pose infectious risk. Of note, data on blood donor seroprevalence and TTIs in Africa are limited due to incomplete surveillance and hemovigilance.

Fundamental differences between the general and blood donor populations necessitate a higher performance standard for blood donor screening tests. Specifically, blood donors are typically lower risk for TTIs than the general population, given the need to pass a risk factor questionnaire, clinical assessment, and feeling sufficiently healthy to donate blood [13–15]. However, donors in the early stages of a viral infection (eg, HIV) may have high viral loads yet lack detectable serologic markers and remain asymptomatic. In the context of bacterial or parasitic infection, the absence of symptoms may correlate with lower levels of bacteremia or parasitemia (eg, malaria) than might be encountered if an individual was symptomatic [16]. Low levels of pathogen and low antibody titers affect laboratory screening, thus requiring optimal test performance with high sensitivity to capture infected donors. Given the direct impact on blood safety, the WHO recommends a minimum sensitivity and specificity of 99.5% for assays used for transfusion screening (Table 1) [6].

HIV

Africa is disproportionately affected by the HIV epidemic. Two-thirds of all people living with HIV and 70% of all newly reported HIV infections occurring in 2012 were concentrated in sub-Saharan Africa [17]. The UNAIDS 2013 Global report estimated the HIV prevalence in the general adult population in sub-Saharan Africa to be 4.7%, ranging across the continent from 0.2% in Cape Verde to 26.5% in Swaziland [17]. Reports of HIV prevalence in blood donor populations range geographically from less than 0.1% in South Africa up to 15.4% in Mozambique [18–20].

Although sexual contact is the primary mode of transmission, HIV is readily transmitted via transfusion of an infected blood product. This prompted the US President's Emergency Plan for AIDS Relief (PEPFAR) to allocate resources to blood services as part of the program's broader HIV/AIDS initiative. PEPFAR has provided technical and financial support to national blood services in 12 sub-Saharan Africa since 2004 and 20 sub-Saharan African countries since 2010, which has contributed to a decrease in the number of HIV-reactive units and overall improvement in those blood services in PEPFAR-supported countries [21]. However, transfusions still contribute to new HIV infections in Africa, underscoring the need for improved screening on the continent [22,23].

Hepatitis B Virus

The prevalence of HBV in the general population ranges from moderately endemic in North Africa to highly endemic in regions of sub-Saharan Africa, where at least 8% of the population are chronic carriers