BACKGROUND: Access to a safe, adequate blood supply has proven challenging in sub-Saharan Africa, where systemic deficiencies spanning policy, collections, testing, and posttransfusion surveillance have long been recognized. Progress in transfusion safety in the early 2000s was in large part due to intervention by the World Health Organization and other foreign governmental bodies, coupled with an influx of external funding.

STUDY DESIGN AND METHODS: A review of the literature was conducted to identify articles pertaining to blood safety in sub-Saharan Africa from January 2009 to March 2018. The search was directed toward addressing the major elements of the blood safety chain, in the countries comprising the World Health Organization African region. Of 1380 articles, 531 met inclusion criteria and 136 articles were reviewed.

RESULTS: External support has been associated with increased recruitment of voluntary donors and expanded testing for the major transfusion-transmitted infections (TTIs). However, the rates of TTIs among donors remain high. Regional education and training initiatives have been implemented, and a tiered accreditation process has been adopted. However, a general decline in funding for transfusion safety (2009 onwards) has strained the ability to maintain or improve transfusion-related services. Critical areas of need include data collection and dissemination, epidemiological surveillance for TTIs, donor recruitment, quality assurance and oversight (notably laboratory testing), and hemovigilance.

CONCLUSION: Diminishing external support has been challenging for regional transfusion services. Critical areas of deficiency in regional blood transfusion safety remain. Nonetheless, substantive gains in education, training, and accreditation suggest durable gains in regional capacity.

INTRODUCTION

Blood transfusion is a lifesaving therapy that is included on the World Health Organization (WHO) list of essential medications. In sub-Saharan Africa (SSA), blood transfusion is critical to the treatment of diverse pathologies including malaria-associated anemia, obstetric hemorrhage, and trauma. However, access to a safe and adequate blood supply remains an enduring public health challenge in much of SSA.

A WHO strategy of universal safe blood transfusion has focused on five main areas: 1) development of nationally coordinated blood transfusion services, 2) exclusive collection from voluntary nonremunerated blood donors
(VNRBDs), 3) quality-assured donation testing, 4) reduction of inappropriate clinical use of blood, and 5) implementation of quality systems and standards. Efforts to address these areas of deficiency in the early 2000s were spurred by external funding, much of which was provided through the US President’s Emergency Plan For AIDS Relief (PEPFAR). Given increased exposure and robust external support, the outlook for transfusion safety in SSA from 2000–2010 appeared to be bright. We sought to review subsequent developments and challenges to regional transfusion safety in SSA.

METHODS

A literature search was conducted of the PubMed database to identify articles published January 2009 to March 2018 that address the major elements of the blood safety value chain in SSA (Fig. 1). This was achieved using the following search terms either alone or in combination: “sub-Saharan Africa,” “blood,” “transfusion-transmitted infections,” “transfusion guidelines,” and “hemovigilance.” Articles published in English were included in the primary analysis; older articles were included for background and historical perspective. SSA was defined as the WHO African region: the latter encompasses 47 African countries; 26 are categorized as low income, 13 as low middle income, 7 as upper middle income, and 1 as high income (e.g., Seychelles). The search was expanded to “gray literature” including websites of governing bodies (e.g., the WHO website). A total of 1380 articles were identified; 531 met inclusion criteria, and those abstracts were screened for relevance, yielding 136 articles that were reviewed in full, 100 of which were included in this analysis.

Fig. 1. Flowchart summary of selection process.
RESULTS
Organization and management: situational analysis and oversight

There have been continued gains toward establishment of national blood transfusion services (NBTSs) in SSA. However, national frameworks alone do not guarantee functionality: in 12 countries with NBTSs, only half had published standards for blood collections, processing, testing, and distribution. National guidelines and applicable blood safety policies and governmental and legislative support are still lacking in much of SSA.

Blood availability and donor recruitment

Blood shortages remain frequent in Africa, where more than 40 countries still fail to attain the WHO’s donation goal of 10 units/1000 population. Shortages occur despite a 19% increase in whole blood (WB) donation in 12 African countries from 2011 to 2014, posing complex health risks. Indeed, a quarter of peripartum maternal deaths in SSA have been ascribed to inadequate access to blood transfusion. Similarly, delayed transfusion has been associated with increased mortality in cases of pediatric malaria-associated anemia; one study reported a 52% mortality in severely anemic children who were not transfused within 8 hours of diagnosis (n = 3170). Nonetheless, the theoretical transfusion needs to contend with malaria-associated anemia in SSA alone would exceed the total estimated blood supply.

An increase in VNRBDs in SSA has occurred. However, even when increased, it has not necessarily been sustained. Replacement donation (RD), the major alternative to VNRBD, remains contentious given its presumptive elevated infectious risk. The WHO supports VNRBD exclusively, despite a voluntary donor pool that is insufficient to meet demand. Furthermore, the data supporting the use of VNRBDs over RDs may be confounded by donor status (i.e., first-time vs. repeat donation), where the probability of infection in a repeat donor is lower given prior screening for transfusion-transmitted infections (TTIs). Inclusion of repeat donors in analyses of VNRBDs artificially lowers the TTI prevalence, as illustrated by a Zimbabwe-based study where human immunodeficiency virus (HIV) rates in repeat VNRBDs were 0.42% compared to 1.29% in first-time VNRBDs. When controlling for repeat status, the prevalence of TTIs in first-time VNRBDs and RDs does not seem different, as observed in Cameroon, Ghana, and Guinea. With continued blood shortages and the high cost of VNRBD blood units (i.e., two to three times that of RD), this questions the ethics of abandoning RD in lieu of a viable alternative.

Donation in SSA is consistently dominated by males of secondary school age. This is ascribed to targeted recruitment in view of perceived good health and low infectious risk, which imposes recurrent shortages during school recesses. Women remain underrepresented in the donor pool, in part due to cultural perceptions that men are healthier and iron-deficiency anemia and pregnancy restrict donation capacity. Studies to characterize the sociocultural motivators for or deterrents against blood donation are few. Major drivers include altruism, family obligation, or monetary and nonmonetary incentives such as free health screenings or gifts. Regional health risks affect donor eligibility: in the South and East AFRO region, rates of deferral for medical conditions, for example, low weight and anemia (10.5%), exceed those for high-risk behaviors (1.5%). Although a pattern of medical deferral is not unique to SSA, its effect is more pronounced given higher rates of endemic anemia (e.g., due to malnutrition, iron deficiency, and parasitic infection).

Biological testing and pathogen reduction of blood products

Biological testing of blood donation for HIV, hepatitis B and C viruses (HBV, HCV), and syphilis has expanded greatly, in large part through external funding support. However, in 2016 only 6 of 46 surveyed African countries reported 100% screening coverage for the major TTIs; much of the testing was also performed using rapid diagnostic tests (RDTs).

Given the low cost and relative ease of use, RDTs are widely used for donor screening in SSA, despite being shown repeatedly to have lower sensitivities and specificities than enzyme immunosorbent assay and nucleic acid testing (NAT). In one study of 12 African countries, the average sensitivity for HBV RDT was reported to be 47.4%. Sensitivities of RDTs decrease proportionately to viral load; the respective sensitivities of HBV and HCV RDTs decreased from 93.8% to 51.5% and 90.6% to 40.6%, with sequential decrements in viral load. Low specificities of RDTs also contribute to unnecessary disposal of blood products. However, RDTs may still have a role in certain settings (e.g., trauma). High-performance serologic testing and NAT are the cornerstone of TTI screening. However, the associated costs and technical complexity have limited their use in SSA. Unlike serology, NAT has the ability to detect occult HBV infection as well as preserocconversion “window” phase infections. Cited costs of HIV, hepatitis B surface antigen, and HCV enzyme-linked immunosorbent assay are $5.7, $3.6, and $3.6/unit respectively; in contrast, corresponding RDTs cost $0.62, $0.50, and $0.40/unit. The cited costs do not factor in the purchasing power parity; that is, $5.7 in Nigeria is the equivalent of $97.38 in the United States. Namibia introduced NAT in 2004, contracting the South African Nation Blood Service for a fee. Following the relocation of NAT to Namibia in 2014, the Namibian Blood Transfusion Service estimated that 28% of blood service expenditure was diverted to NAT testing, spurring a budget crisis and downsizing of operations. The crisis could only be averted in 2017 following blood product price increases of up to 65%.

Most pathogen inactivation (PI) technologies (i.e., in high-income countries [HICs]) are approved for platelets and plasma. In contrast, WB and red blood cells (RBCs) constitute
the major prescribed products in SSA. Examples of PI use in SSA are few,\textsuperscript{36} having largely been confined to emergency use (e.g., Chikungunya outbreak in Reunion 2005\textsuperscript{37}). A clinical trial in Ghana demonstrated a significantly reduced incidence of transfusion-transmitted malaria (TTM) in those who received Mirasol (Terumo BCT)\textsuperscript{38} pathogen-inactivated WB (4%) as compared to untreated standard WB transfusions (22%).\textsuperscript{39} PI could benefit regional blood safety; however, obstacles to broader implementation include costs, infrastructure, technical complexity, and the need for skilled personnel.\textsuperscript{40}

**Transfusion-transmissible infectious disease marker rates (Table 1)**

**HIV**

Despite being a major priority in SSA, the incidence of HIV attributable to transfusion in SSA is uncertain. Historically, a statistic of 5\% to 10\% of new cases was cited, a claim for which a 2016 review found no primary support.\textsuperscript{41} Instead, the findings suggested that only 1\% of new HIV infections are attributable to transfusion—a figure complicated by a lack of published HIV prevalence data in blood donors and deficient posttransfusion surveillance.\textsuperscript{41} Additionally, the rates of pre-seroconversion “window period infections” are not widely available yet, likely because new infections are given near exclusive reliance on antibody-based screening.\textsuperscript{42}

**Hepatitis viruses**

Donor screening for HBV and HCV has increased since the early 2000s, with a concomitant decrease in donor prevalence.\textsuperscript{43} However, 23\% of global burden of HBV is in SSA.\textsuperscript{44} HBV-reactive donors are concentrated in West Africa, where six countries reported donor HBV prevalence above 10\%.\textsuperscript{42} Occult HBV infection, HBV DNA in the absence of detectable hepatitis B surface antigen, remains unaddressed, particularly given absent hepatitis B core antibody testing and NAT of blood donors in most of SSA.\textsuperscript{4} Reported rates of donor occult HBV infection range from 10.6\% to 17\% in Nigeria.\textsuperscript{32,44}

From 2000 to 2011, regional decreases in HCV prevalence were observed. Nonetheless, 14 of 29 African countries reported an increase in donor HCV prevalence, despite dedicated donor selection and educational efforts.\textsuperscript{43} Hepatitis E virus, although not as common as HBV and HCV, is endemic throughout northern and eastern Africa. Donor seroprevalence is cited as 26\% in one South African study (n = 300).\textsuperscript{45} Hepatitis E virus is transfusion transmissible and can lead to fulminant hepatitis in high-risk groups (e.g., pregnant women and those with preexisting liver dysfunction).\textsuperscript{36,47}

**Human T-cell lymphotropic viruses 1 and 2**

Human T-cell lymphotropic viruses 1 and 2 (HTLV1/2) are oncogenic retroviruses implicated in the development of adult T-cell leukemia/lymphoma and HTLV1-associated myelopathy/tropical spastic paraparesis.\textsuperscript{48} Few prevalence data are available for HTLV1/2 in SSA; when available, estimates are frequently based on accessible populations (e.g., blood donors and pregnant women).\textsuperscript{49} A review found that the HTLV1 prevalence in healthy volunteers ranged from 0\% (Zambia) to 13.07\% (Gabon); more recently, a seroprevalence of 2.1\% was reported among pregnant women in Gabon.\textsuperscript{51}

The epidemiology of transfusion-associated HTLV1/2 in SSA is uncertain. However, evidence of transfusion transmission is suggested by the high seroprevalence among transfusion recipients in Mali, HTLV1 seroprevalence in multitransfused patients was 6.4\% higher than that observed in blood donors, and a dose-dependent increase in HTLV1 prevalence by number of transfusions was observed in recipients.\textsuperscript{48} Nonetheless, with the exception of Gabon, there is virtually no screening for HTLV1/2 in SSA.\textsuperscript{24} Such may be informed by a paucity of regional transmission data, limited surveillance that suggests low prevalence of HTLV1/2, and high rates of false positivity of enzyme immunosorbent assays (in part due to cross-reactivity with malarial antigens).\textsuperscript{52,53}

**Herpesviruses**

Cytomegalovirus (CMV) is transfusion transmissible and can lead to serious and even fatal infection in immunocompromised hosts.\textsuperscript{54} Although CMV risk is largely eliminated by leukoreduction,\textsuperscript{55} neither leukoreduction of blood products nor CMV testing of blood donors is widely used in SSA.\textsuperscript{36} Furthermore, CMV testing is impractical given the high seroprevalence in the general population. In a Nigerian blood donor study (n = 184), 97.4\% of subjects were CMV immunoglobulin G positive and 52.6\% were CMV immunoglobulin M positive.\textsuperscript{57}

Human herpesvirus type 8 (HHV8) is the causative agent for Kaposi sarcoma, multicentric Castleman disease, and primary effusion lymphoma. The prevalence of HHV8 in SSA was historically cited as 20\% to 80\%;\textsuperscript{56} recent estimates range from 17.6\% (South Africa) to 37.3\% (Uganda).\textsuperscript{59} Studies have produced contradictory results on its risk of transfusion transmission.\textsuperscript{58} Older studies have attributed seroconversion in transfusion patients to natural acquisition.\textsuperscript{50} However, a 2012 Ghanaian study documented seroconversion in a previously seronegative patient following transfusion of HHV8 contaminated WB.\textsuperscript{61}

**Chikungunya, Zika, and the Arboviruses**

Only dengue virus, West Nile virus, and Ross River virus (not endemic to SSA) have been definitively shown to be transmitted by transfusion.\textsuperscript{52} Data pertaining to transfusion-associated arboviral risk in SSA are lacking, despite periodic regional outbreaks.\textsuperscript{63,64}

Chikungunya virus (CHIKV) has raised intermittent concern for transfusion services, given frequent outbreaks in SSA during which modeling data have projected rates of viremic donations as high as 150 per 10,000.\textsuperscript{65} During a 2011 outbreak of CHIKV in Congo, 34.4\% of blood donors (n = 517) were shown to be CHIKV immunoglobulin G positive.\textsuperscript{66} Nonetheless, no cases of transfusion transmitted CHIKV have yet to be reported.
Current data suggest that Zika virus (ZIKV) does not pose significant risk to the blood supply in Africa. However, there are data that support virulence of the African strain, challenging previous assumptions that African ZIKV was low risk (cf. Asian strain). In Guinea-Bissau six infants with microcephaly were reported to be born to mothers who had been infected with an African ZIKV strain during pregnancy. No cases of transfusion-transmitted ZIKV have been reported in SSA, and donor screening is not currently being undertaken.

**Table 1. HIV seroprevalence and epidemiological trends in the sub-Saharan blood donor population**

| Pathogen | Blood donor seroprevalence | Trends over time† | Scope of study | n |
|----------|-----------------------------|-------------------|----------------|---|
| HIV | Botswana - LNS: 1.4% (2014); 7.5% (2003)6 | § | Country-wide | NA |
| | Burkina Faso - Ouagadougou: 2.1% (2009)19 | | Multiple regional BBs | 30,364 |
| | Burkina Faso - LNS: 1.8% (2009)101 | | Multiple regional BBs | 31,405 |
| | Burkina Faso - Koudougou: 2.34% (2009)111 | | Single BB | 4,520 |
| | Cameroon - Yaoundé: 2.9% (2009)19 | | Multiple regional BBs | 2,887 |
| | Cameroon - Edéa: 4.1% (2011–2012)112 | | Single BB | 543 |
| | Côte d’Ivoire - LNS: 0.3% (2014); 1.6% (2003)6 | ‡ | Country wide | NA |
| | DR Congo - Kinshasa: 0.8% (2009)19 | | Multiple regional BBs | 480 |
| | DR Congo - Bukavu: 1.6% (2011)113 | | Multiple regional BBs | 595 |
| Equatorial Guinea - Bioko Island: 7.83% (2011–2013)114 | | Multipl |
| | Eritrea - LNS: 0.18% (2006–2009)115 | | Country-wide | 29,501 |
| | Ethiopia - LNS: 0.8% (2014); 3.6% (2004)6 | ‡ | Country wide | NA |
| | Ethiopia - Jijiga: 1.4% (2014); 6.4% (2010)116 | ‡ | Single BB | 676 (2010); 2,752 (2014) |
| | Ethiopia - Hawassa: 1.6% (2009–2013)17 | | Single BB | 6,337 |
| | Ethiopia - Gonder District: 2.24% (2010–2012)117 | | Multipl |
| Gabon - LNS: 2.54% (2009); 3.07% (2011)118 | † | Single BB | 7,570 (2009); 9,992 (2011) |
| Ghana - Damongo: 3.9% (2009)119 | | Single hospital | 846 |
| | Ivory Coast - Daloa: 3.48% (2009)19 | | Multiple regional BBs | 14,257 |
| Kenya - LNS: 0.7% (2014); 1.5% (2003)6 | ‡ | Country-wide | NA |
| | Mali - Bamako: 2.58% (2009)19 | | Multipl |
| Mozambique - LNS: 5.2% (2014); 8.6% (2003)6 | ‡ | Country-wide | NA |
| Mozambique - Tete: 8.5% (2009)120 | | Single hospital | 679 |
| Namibia - LNS: 0.4% (2014); 0.6% (2003)6 | ‡ | Country wide | NA |
| Niger - Niamey: 1.4% (2009)19 | | Multiple regional BBs | 2,962 |
| Nigeria - LNS: 1.6% (2014); 3.8% (2005)6 | ‡ | Country-wide | NA |
| | Nigeria - Osogbo: 3.1% (2007–2008)121 | | Single BB | 1,410 |
| | Nigeria - Abeokuta: 6.2% (2013)6 | ‡ | Single hospital | 130 |
| Rwanda - LNS: 0.5% (2014); 1.1% (2003)6 | ‡ | Country wide | NA |
| Rwanda - Kigali: 1.0% (2009)19 | | Multipl |
| South Africa - LNS: 1.13% (2012–2015)122 | †, || | Country-wide | 397,640 |
| Tanzania - LNS: 1.3% (2014); 4.8% (2005)6 | ‡ | Country-wide | NA |
| Uganda - LNS: 1.1% (2014); 2.0% (2003)6 | ‡ | Country-wide | NA |
| Zambia - LNS: 3.5% (2014); 6.9% (2003)6 | ‡ | Country-wide | NA |

Specific locations are provided in italics if stated in the publication. Study interval included in parenthesis. † First-time donors. ‡ Trends over time are only included when seroprevalence was included at two time points within the same study. § † = seroprevalence increase; ‡ = seroprevalence decrease. †, || Nucleic acid testing data included. BB = blood bank; DRC = Democratic Republic of the Congo; LNS = location not specified; NA = not available.

**Ebola**

Cases of transfusion-transmitted Ebola have not been reported, likely due to donor self-deferral given the severity of clinical infection coupled with brief asymptomatic viremia. However, the scale of the 2014–2016 epidemic in West Africa highlights the potential threat to the blood supply as well as the role for transfusion services in outbreak responsiveness. Specifically, convalescent plasma was considered as a possible treatment for Ebola, illustrating the need to build capacity for collections, processing, and
testing ahead of outbreaks. However, given formidable cost and logistical barriers to sourcing convalescent plasma, this is unlikely to be adopted widely during future outbreaks.

Syphilis
The WHO recommends universal screening for Treponema pallidum; this has been questioned—at least in HICs—given the spirochete’s inability to survive beyond 4 days of cold storage. This argument may not hold true in SSA, where fresh WB transfusions occur frequently and transfusion-transmitted syphilis has been described. Following a case of transfusion-transmitted syphilis in Ghana in 2011, investigation showed that 57% of donations in that hospital were stored for less than 4 days.

Unreliable supply chains and fluctuating costs of reagents complicate T. pallidum screening. For example, 77% of Ghanaian services that do not screen for T. pallidum cite reagent costs as the major reason for failing to do so. RDTs in use for syphilis screening suffer from low specificity, contributing to unnecessary blood product disposal. After introduction of an RDT in a Ghanaian hospital led to a rise in product disposal, reflexive testing by rapid plasma reagin was implemented: only 29 of 182 RDT-positive products were confirmed by rapid plasma reagin, thus reducing the rate of unnecessary disposal by 79%.

Bacterial contamination
Bacterial contamination of blood products and associated septic transfusion reactions remains a major, unaddressed risk in SSA, where limited screening has been enacted. In one study in Zimbabwe, 3.1% of 196 products (e.g., RBCs, platelets, and WB) were found to be contaminated with various bacterial species (Staphylococci spp., Bacillus spp., and Escherichia coli). In seven studies in SSA published between 2009 and 2015, the rates of bacterial contamination ranged from 3.1% (Zimbabwe) to 17.5% (Ghana). Furthermore, a Ugandan study concluded that Gram stain, which is most commonly used for screening, is insensitive, thereby failing to identify clinically significant levels of bacterial contamination.

Malaria
Malaria is highly endemic in SSA, where repeat exposure induces “semi-immunity,” characterized by high-titer antibodies and low parasitemia. Semi-immunity does not necessarily extend to all transfusion recipients; a large proportion—notably children and the immunocompromised—lack sufficient antibodies to protect against TTM.

Donor screening is challenging. Donors are typically asymptomatic at time of donation. In Cameroon, 6.5% of asymptomatic donors were found to be parasitemic at the time of donation based on peripheral blood smear, a likely underestimate given the low sensitivity of microscopy. Although TTM incidence is largely unknown, a Ghanaian study showed the rate of transmission to previously uninfected transfusion recipients to be 28%. Laboratory measures, when undertaken, are typically performed by microscopy or RDT, neither of which is adequately sensitive. Highly sensitive serologic and molecular testing would increase cost up to 12 times that of microscopy and, given the high seroprevalence, would further erode the donor pool. Other strategies such as PI are promising but far exceed the resource capacity in much of SSA.

Filaria: the nematodes
Research regarding transfusion-related filariasis is scarce. A publication in 2010 contradicted Wiwantitkit prior suggestion that donor screening for microfilariae was necessary. A 2010 letter to the editor cited a pediatric case of transfusion-transmitted Mansonella perstans in Chad; the infection cleared expeditiously following transfusion without development of any symptoms. This suggests that adult worms rather than microfilariae (which are transfusion transmissible) are responsible for clinical infection. Given blood shortages and limited transfusion-associated risk, testing for nematodes in SSA is not indicated.

Rational blood use
Good clinical transfusion practice is impeded by a general lack of training and absence of guidelines, contributing to inappropriate or overtreatment. One study in Tanzania found that 17% of requested units were deemed inappropriate. A survey of seven African countries found that none of the participating countries had any personnel who were exclusively trained in transfusion medicine, and only one had standing operational protocols. The level of training among prescribers also varies greatly. In some cases, nurses act alone to prescribe transfusion.

Access to educational programs improves transfusion practices and helps to build a skilled workforce: One program in Tanzania increased the number of local hematologists from 1 to 18 within 10 years. Training programs are few in SSA, and access is limited to large urban centers (e.g., transfusion medicine diploma for physicians in South Africa and advanced diploma in donor care nursing in Ghana). The African Society for Blood Transfusion (AISBT) has promoted education and training over the past 5 years, having established a pool of educators to provide training on the AISBT standards, basics of blood safety, and to prepare transfusion services for accreditation.

Hemovigilance, quality assurance, and accreditation
Hemovigilance encompasses surveillance of all activities from donor recruitment through posttransfusion surveillance. Given limited resources, hemovigilance is a major challenge for transfusion services in SSA, where the tracking
| Pathogen | Blood donor seroprevalence | Trends over time | Scope of study | n |
|----------|-----------------------------|-----------------|----------------|---|
| HBV     | Angola - LNS: 6.74% (2010/2011); 8.68% (2000/2004) | § | Country-wide | NA |
|         | Benin - LNS: 1.65% (2010/2011); 7.51% (2000/2004) | ▼ | Country-wide | NA |
|         | Botswana - LNS: 2.21% (2010/2011); 4.21% (2000/2004) | ▼ | Country-wide | NA |
|         | Burkina Faso - Ouagadougou: 1.1.2% (2009) | | Multiple regional | BB |
|         | Burkina Faso - LNS: 13.4% (2009) | | Multiple regional | BB |
|         | Burkina Faso - Koudougou: 15.92% (2009) | | Single BB | 4,520 |
|         | Cameroon - LNS: 1.34% (2010/2011); 15.00% (2000/2004) | ▼ | Country-wide | NA |
|         | Cameroon - Edéa: 10.1% (2011–2012) | | Single BB | 543 |
|         | Cameroon - Yaoundé: 10.3% (2009) | | Multiple regional | BB |
|         | Central African Republic - LNS: 10.45% (2000/2004) | | Country-wide | NA |
|         | Chad - LNS: 7.76% (2000/2004); 10.10% (2010/2011) | ▼ | Country-wide | NA |
|         | Cote d’Ivoire - LNS: 5.31% (2010/2011); 6.93% (2000/2004) | ▼ | Country-wide | NA |
|         | DRC - Kinshasa: 6.0% (2009) | | Multiple regional | BB |
|         | DRC - LNS: 3.43% (2010/2011); 7.31% (2000/2004) | ▼ | Country-wide | NA |
|         | DRC - Bukavu: 4.8% (2011) | | Multiple regional | BB |
|         | Equatorial Guinea - Bioko Island: 10.01% (2011–2013) | | Multiple regional | BB |
|         | Eritrea - LNS: 2.27% (2010/2011); 3.60% (2000/2004) | ▼ | Country-wide | NA |
|         | Eritrea - LNS: 2.58% (2006–2009) | | Country-wide | 29,501 |
|         | Ethiopia - LNS: 3.42% (2010/2011); 4.00% (2000/2004) | ▼ | Country-wide | NA |
|         | Ethiopia - Gondar District: 3.6% (2010–2012) | | Multiple regional | BB |
|         | Ethiopia - Hawassa: 4.8% (2009–2013) | | Single BB | 6,337 |
|         | Ethiopia - Jigjiga: 6.0% (2014); 18.2% (2010) | ▼ | Single BB | 676 (2010); 2,752 (2014) |
|         | Gabon - LNS: 4.57% (2010/2011); 10.49% (2000/2004) | ▼ | Country wide | NA |
|         | Gabon - LNS: 6.20% (2011); 8.84% (2009) | ▼ | Single BB | 7,570 (2009); 9,992 (2011) |
|         | Ghana - LNS: 6.58% (2010/2011); 11.75% (2000/2004) | ▼ | Country-wide | NA |
|         | Ghana - Damongo: 7.5% (2009) | | Single hospital | 853 |
|         | Guinea-Bissau - LNS: 6.1% (2010/2011); 18.42% (2000/2004) | ▼ | Country-wide | NA |
|         | Guinea - LNS: 9.79% (2010/2011); 11.20% (2000/2004) | ▼ | Country-wide | NA |
|         | Ivory Coast - Daloa: 5.85% (2009) | | Multiple regional | BB |
|         | Kenya - LNS: 1.75% (2010/2011); 5.31% (2000/2004) | ▼ | Country wide | NA |
|         | Lesotho - LNS: 0.90% (2010/2011); 1.37% (2000/2004) | ▼ | Country-wide | NA |
|         | Liberia - LNS: 0.50% (2000/2004); 7.40% (2010/2011) | ▼ | Country-wide | NA |
|         | Malawi - LNS: 3.43% (2010/2011); 6.90% (2000/2004) | ▼ | Country-wide | NA |
|         | Mali - LNS: 11.35% (2000/2004); 14.27% (2010/2011) | ▼ | Country-wide | NA |
|         | Mali - Bamako: 13.89% (2009) | | Multiple regional | BB |
|         | Mauritania - LNS: 18.82% (2010/2011); 21.00% (2000/2004) | ▼ | Country-wide | NA |
|         | Mozambique - Tete: 10.6% (2009) | | Single hospital | 679 |
|         | Mozambique - LNS: 5.30% (2010/2011); 9.78% (2010/2011); 2.41% (2000/2004) | ▼ | Country-wide | NA |
|         | Namibia - LNS: 9.78% (2010/2011); 2.41% (2000/2004) | ▼ | Country-wide | NA |
|         | Niger - LNS: 11.78% (2010/2011); 20.00% (2000/2004) | ▼ | Country-wide | NA |
|         | Niger - Niamey: 18.96% (2009) | | Multiple regional | BB |
|         | Nigeria - Abeokuta: 10% (2013) | | Single hospital | 130 |
|         | Nigeria - Osogbo: 18.6% (2007–2008) | | Single BB | 1,410 |
|         | Nigeria - LNS: 3.00% (2000/2004); 4.12% (2010/2011) | ▼ | Country-wide | NA |
|         | Republic of the Congo - LNS: 6.40% (2000/2004); 7.35% (2010/2011) | ▼ | Country-wide | NA |
|         | Rwanda - LNS: 1.75% (2010/2011); 4.39% (2000/2004) | ▼ | Country-wide | NA |

(Continues)
of patients, products, and outcomes remains deficient. As of 2013, only 13 of 46 African countries had established a national hemovigilance system. To be effective, the latter requires uniformity of reporting, widespread adoption, and the means to extract data to guide regional policies and interventions. To this end, published data are scant, offering little evidence that nascent hemovigilance systems in SSA are functional.

Proficiency testing is also limited. Several external quality assurance studies have demonstrated suboptimal performance of infectious testing at laboratories engaged in blood donor screening.\(^{25,27,28}\) One study extrapolated that 321 (5.6%) infectious units would have been missed due to their false-negative screening results.\(^{25}\)

The AfSBT has developed a tiered stepwise accreditation system for transfusion services based on infrastructure and capacity (i.e., low, intermediate, or high resourced). This system acknowledges the heterogeneous nature of SSA blood services and allows services of different levels to be considered for certification or accreditation, according to an expected standard for a given resource level. This also provides a structured path toward higher levels of accreditation. A pool of assessors has undergone training, and assessments have already begun. Namibia was the first to reach the highest level of accreditation (2013), followed by Rwanda (2017).\(^{105}\)

### External funding for transfusion safety

From 2000 to 2015, $2.1 billion of international funding was directed toward transfusion capacity (technical support and economic aid) in SSA.\(^{101}\) By 2013, transfusion services in 36 of the AFRO region countries received foreign aid. In West Africa, external aid constituted 42% of total funding for transfusion services.\(^{4}\) The Centers for Disease Control and Prevention (through PEPFAR) dispersed funding to 19 countries in the AFRO region; other agencies also provided support, including the Global Fund, AABB, the Safe Blood for Africa Foundation, WHO, the United Nations Children’s Fund, and the United Nations Population Fund.\(^{4}\)

Despite regional transfusion services’ dependence on external support, that funding is currently in decline. The percentage of the PEPFAR budget allocated to blood safety decreased from approximately 4.5% in 2005 to less than 1% in 2014,\(^{102,103}\) highlighting the need for operational planning to buffer a continuing down trend.

The ethics of external aid to transfusion services has been questioned. Ala et al.\(^{12}\) argued that external funding has been unintentionally misdirected into ventures ill-suited for SSA that generate, at best, poorly understood and, at worst, harmful effects. One example is exclusive support for centralized blood systems, which neglects regional hospitals ensuring timely access to blood transfusion in remote areas. In a survey of Tanzanian transfusion services, 37.5% of blood components were issued by blood banks outside of the NBTS.\(^{104}\)

### DISCUSSION

Blood transfusion safety in SSA over the past 8 years has had mixed developments (Table 2). Many of the challenges

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**TABLE 2. Continued**

| Pathogen          | Blood donor seroprevalence | Trends over time‡ | Scope of study | n    |
|-------------------|----------------------------|-------------------|----------------|------|
| **Rwanda - Kigali:** 2.76% (2009)\(^{19}\) | Multiple regional BBs |       | Country-wide | 37,000 |
| Senegal - LNS: 10.50% (2000/2004); 10.51% (2010/2011)\(^{42}\) |       |       | Country-wide | NA    |
| Sierra Leone - LNS: 5.73% (2000/2004); 11.60% (2010/2011)\(^{42}\) |       |       | Country-wide | NA    |
| South Africa - LNS: 0.12% (2010/2011); 0.28% (2000/2004)\(^{42}\) |       |       | Country-wide | NA    |
| South Africa - LNS: 0.66% (2012–2015)\(^{122,11}\)§ |       |       | Country-wide | 397,640 |
| Swaziland - LNS: 3.11% (2010/2011); 4.81% (2000/2004)\(^{42}\) |       |       | Country-wide | NA    |
| Tanzania - LNS: 5.11% (2010/2011); 11.00% (2000/2004)\(^{42}\) |       |       | Country-wide | NA    |
| Togo - LNS: 3.46% (2010/2011); 11.48% (2000/2004)\(^{42}\) |       |       | Country-wide | NA    |
| Tunisia - LNS: 1.46% (2010)\(^{123}\) |       |       | Country-wide | 19,783 |
| Uganda - LNS: 2.28% (2010/2011); 5.00% (2000/2004)\(^{42}\) |       |       | Country-wide | NA    |
| Zambia - LNS: 6.02% (2010/2011); 7.56% (2000/2004)\(^{42}\) |       |       | Country-wide | NA    |
| Zimbabwe - LNS: 0.92% (2010/2011); 1.56% (2000/2004)\(^{42}\) |       |       | Country-wide | NA    |

Specific locations are provided in italics if stated in the publication.

Study interval included in parenthesis.

‡ First-time donors.

† Trends over time are only included when seroprevalence was included at two time points within the same study.

§ \(\text{f}\) = seroprevalence increase; \(\text{i}\) = seroprevalence decrease.

|| Nucleic acid testing data included.

BB = blood bank; DRC = Democratic Republic of the Congo; HBV = hepatitis B virus; LNS = location not specified; NA = not available.
### TABLE 3. HCV seroprevalence and epidemiological in the sub-Saharan blood donor population

| Pathogen          | Blood donor seroprevalence | Trends over time† | Scope of study | n    |
|-------------------|----------------------------|-------------------|----------------|------|
| HCV               |                            |                   |                |      |
| Angola - LNS      | 0.57% (2010/2011)          | §                 | Country-wide   | NA   |
| Benin - LNS       | 0.53% (2010/2011); 3.82% (2000/2004) | | Country-wide | NA   |
| Botswana - LNS    | 0.34% (2000/2004); 0.48% (2010/2011) | | Country-wide | NA   |
| Burkina Faso - Ouagadougou | 3.2% (2009) | | Multiple regional BBs | 30,364 |
| Burkina Faso - LNS | 4.58% (2000/2004); 5.21% (2010/2011) | †                | Country-wide   | NA   |
| Burkina Faso - LNS | 6.3% (2009) | | Multiple regional BBs | 31,405 |
| Burkina Faso - LNS | 8.92% (2009) | | Single BB | 4,520 |
| Burundi - LNS     | 1.41% (2000/2004); 1.54% (2010/2011) | †                | Country-wide   | NA   |
| Cameroon - LNS    | 0.76% (2010/2011); 10.00% (2000/2004) | †                | Country-wide   | NA   |
| Cameroon - Yaoundé | 3.9% (2009) | | Multiple regional BBs | 2,887 |
| Cameroon- Edéa    | 4.8% (2011–2012)          | †                | Single BB      | 543  |
| Central African Republic - LNS | 1.20% (2000/2004) | | Country-wide | NA   |
| Chad - LNS        | 0.20% (2000/2004); 0.51% (2010/2011) | †                | Country-wide   | NA   |
| Cote d'Ivoire - LNS | 1.56% (2010/2011); 2.29% (2000/2004) | †               | Country-wide   | NA   |
| DRC - Kinshasa    | 2.0% (2009)               | †                | Multiple regional BBs | 480  |
| DRC - LNS         | 1.46% (2010/2011); 7.20% (2000/2004) | †               | Country-wide   | NA   |
| DRC - Bukavu      | 3.9% (2011)               | †                | Multiple regional BBs | 595  |
| Equatorial Guinea - Bioko Island | 3.71% (2011–2013) | | Multiple regional BBs | 2,937 |
| Eritrea - LNS     | 0.53% (2010/2011); 0.88% (2000/2004) | †               | Single BB      | 29,501 |
| Ethiopia - Hawassa | 0.6% (2009–2013) | | Single BB | 6,337 |
| Ethiopia - Gonder District | 0.8% (2010–2012) | | Multiple regional BBs | 6,471 |
| Ethiopia - Jigjiga | 0.8% (2014); 2.1% (2010) | | Single BB | 676 (2010); 2,752 (2014) |
| Ethiopia - LNS    | 0.47% (2010/2011); 2.00% (2000/2004) | | Country-wide | NA   |
| Gabon - LNS       | 0.77% (2010/2011); 5.39% (2000/2004) | †               | Country-wide   | NA   |
| Gabon - LNS       | 1.19% (2009); 6.04% (2011) | †                | Single BB      | 7,570 (2009); 9,992 (2011) |
| Ghana - LNS       | 2.40% (2010/2011); 1.00% (2000/2004) | †               | Country-wide   | NA   |
| Ghana - Damongo   | 6.1% (2009)               | †                | Single hospital | 819  |
| Guinea-Bissau - LNS | 0.70% (2000/2004); 0.80% (2010/2011) | | Country-wide | NA   |
| Guinea - LNS      | 0.60% (2000/2004); 1.07% (2010/2011) | †               | Country-wide   | NA   |
| Ivory Coast - Daloa | 6.98% (2009) | | Multiple regional BBs | 14,257 |
| Kenya - LNS       | 0.70% (2000/2004); 0.78% (2010/2011) | †               | Country-wide   | NA   |
| Lesotho - LNS     | 0.81% (2010/2011)          | †               | Country-wide   | NA   |
| Liberia - LNS     | 2.30% (2010/2011)          | †               | Country-wide   | NA   |
| Malawi - LNS      | 2.00% (2000/2004); 2.00% (2010/2011) | †               | Country-wide   | NA   |
| Mali - LNS        | 1.00% (2000/2004); 2.20% (2010/2011) | †               | Country-wide   | NA   |
| Mali - Bamako     | 3.25% (2009)              | †               | Multiple regional BBs | 17,880 |
| Mauritania - LNS  | 0.02% (2010/2011); 1.78% (2000/2004) | †               | Country-wide   | NA   |
| Mozambique - LNS  | 0.91% (2010/2011)          | †               | Country-wide   | NA   |
| Namibia - LNS     | 0.03% (2000/2004); 0.09% (2010/2011) | †               | Country-wide   | NA   |
| Niger - Niamey    | 1.42% (2009)               | †               | Multiple regional BBs | 2,962 |
| Niger - LNS       | 2.02% (2010/2011)          | †               | Country-wide   | NA   |
| Nigeria - Osogbo   | 6.0% (2007–2008)          | †                | Single BB      | 1,410 |
| Nigeria - LNS     | 1.31% (2010/2011); 1.50% (2000/2004) | †               | Country-wide   | NA   |
| Nigeria - Abeokuta | 1.5% (2013)              | †                | Single hospital | 130  |
| Republic of the Congo - LNS | 0.40% (2000/2004); 1.98% (2010/2011) | | Country-wide | NA   |
| Rwanda - LNS      | 1.97% (2010/2011); 2.83% (2000/2004) | †               | Country-wide   | NA   |
| Rwanda - Kigali   | 3.13% (2009)              | †               | Country-wide   | NA   |

(Continues)
of the preceding decade remain. Withdrawal of external aid has imposed new obstacles, with a growing need for operational sustainability in the absence of external support. Data collection and dissemination continues to mar objective assessment and evidence-based policy and practice. Despite formidable challenges, there have been positive gains, notably surrounding educational efforts and the development of accreditation standards that are tailored specifically for SSA.

External funding has enabled expanded infectious testing, establishment of nationalized transfusion services, and increased blood donation. However, these gains are not universal. Furthermore, there is a reliance on operational rather than performance indicators, detracting from what one can infer from the stated intent of regional strategies. Even with the infusion of funds, challenges that existed a decade ago (i.e., deficiencies in infectious testing, blood shortages, paucity of hemovigilance) still remain.

The high cost of blood renders safe blood to be a major burden on health services and drives decision making, independent of safety. Continued RDT use (suboptimal) and inability to implement PI (transformative yet cost prohibitive) are two examples of this. Given diminishing external aid, creative local strategies are needed to finance blood services. Given that national transfusion services are often closely associated with governmental agencies (e.g., ministries of health), taxes and health insurance could be considered as one avenue to support transfusion services indirectly.

The outcomes of external aid have been measured narrowly against the policies they sought to support. Instead, an evaluation of the impact on regional transfusion safety is needed. One example is exclusive support of VNRBDs despite inability to meet transfusion demands, coupled with evidence suggesting comparable infectious risk of RD after controlling for first-time versus repeat donor status. Efforts could be directed toward converting replacement donors to repeat donors pending expansion of the voluntary donor pool. Policy decisions, originating in HICs, may not be locally applicable or are nuanced with potential detrimental effects.

Data collection, capture, and dissemination are a major challenge. Such pertain to the composition of the donor pool (i.e., VNRBD vs. replacement), collections (i.e., by product type), infrastructure (e.g., personnel, facilities, equipment), epidemiology of the major TTIs, blood utilization and practices, and surveillance of adverse events (both donors and recipients). Even when data are available, they are often too localized to inform general policy decisions. TTI incidence and prevalence data are limited, often reflecting only single blood centers, and rates of transfusion transmission are virtually nonexistent. Estimates are often based on historical estimates that are not supported by contemporary surveillance and therefore may no longer hold true. In some cases, outdated or unsubstantiated statistics have been used to support policy decisions. The absence of accurate data weakens any economic foundation for policy change while transfusion recipients remain at unquantified risk. Region-specific research is needed, as was highlighted at a workshop in 2017 at the National Heart Lung and Blood Institute.

**TABLE 3. Continued**

| Pathogen            | Blood donor seroprevalence | Trends over time† | Scope of study | n    |
|---------------------|---------------------------|-------------------|----------------|------|
| Senegal - LNS       | 0.63% (2010/2011); 12.00% | I                 | Country-wide   | NA   |
|                     | (2000/2004)               |                   |                |      |
| Sierra Leone - LNS  | 0.67% (2000/2004); 2.20%  | I                 | Country-wide   | NA   |
|                     | (2010/2011)               |                   |                |      |
| South Africa - LNS  | 0.01% (2010/2011); 0.04%  | I                 | Country-wide   | NA   |
|                     | (2000/2004)               |                   |                |      |
| South Africa - LNS  | 0.03% (2012–2015)         | I                 | Country-wide   | 397,640 |
| Swaziland - LNS     | 0.01% (2000/2004); 0.25%  | I                 | Country-wide   | NA   |
|                     | (2010/2011)               |                   |                |      |
| Tanzania - LNS      | 0.55% (2010/2011); 8.00%  | I                 | Country-wide   | NA   |
|                     | (2000/2004)               |                   |                |      |
| Togo - LNS          | 1.83% (2010/2011); 8.04%  | I                 | Country-wide   | NA   |
|                     | (2000/2004)               |                   |                |      |
| Tunisia - LNS       | 0.37% (2010)             | I                 | Country-wide   | NA   |
|                     | (2012)                   |                   |                |      |
| Uganda - LNS        | 0.75% (2000/2004); 1.71%  | I                 | Country-wide   | NA   |
|                     | (2010/2011)               |                   |                |      |
| Zambia - LNS        | 0.93% (2010/2011)         | I                 | Country-wide   | NA   |
|                     | (2000/2004)               |                   |                |      |
| Zimbabwe - LNS      | 0.03% (2000/2004); 0.34%  | I                 | Country-wide   | NA   |
|                     | (2010/2011)               |                   |                |      |

Specific locations are provided in italics if stated in the publication.
Study interval included in parenthesis.
† First-time donors.
‡ Trends over time are only included when seroprevalence was included at two time points within the same study.
§ I = seroprevalence increase; | = seroprevalence decrease.
|| Nucleic acid testing data included.
BB = blood bank; DRC = Democratic Republic of the Congo; HCV = hepatitis C virus; LNS = location not specified; NA = not available.
There are educational and training initiatives under way. The AfSBT has broadened its efforts, striving to provide stakeholder expertise in all of the areas of deficiency across the transfusion landscape (e.g., quality assurance, data collection, rational blood use). These actions capitalize on the knowledge of those with firsthand experience of the nuanced challenges in SSA. However, access remains a barrier to education: Most training opportunities are focused in major urban centers, inadvertently excluding those residing in areas that are most in need (i.e., remote or rural settings). Lack of coordination among emerging programs also risks redundancy and fails to optimize limited resources.

This review has limitations. Foremost, it is constrained by the availability of formal, published analyses: The review may be overly reliant on a relatively small number of sources. There is also an inherent reporting bias toward those transfusion services that have the ability to publish, reflecting capacity for data collection, analysis, and reporting, which is a different level of functioning than those services that are not represented. Although of variable quality and scope, some publications were included to ensure regional representation. We acknowledge that the available data lack granularity. Use of gray literature (e.g., WHO reports) also has limitations; for example, WHO data are often based on self-reporting. In short, any review without formal engagement of regional transfusion services and public health agencies is unlikely to be comprehensive. Additionally, there is a risk that publications were missed or omitted, reflecting reviewer bias.

In conclusion, many of the challenges to blood transfusion services in SSA remain. Data collection and reporting is critically lacking. Multicenter studies are needed to monitor key indicators of blood safety, as literature review is inadequate to understand real-time changes. Technological advances in HICs have outpaced the financial reserve of much of SSA, stalling the ability to contend with established risks. External funding has been instrumental to the development of many transfusions services; however, the impact of waning support is uncertain, and sustainability of previous gains are now called into question. Ultimately, this illustrates the need for regional investment to be tailored to resource limitations from the outset, while extant advances

| Pathogen | Blood donor seroprevalence | Trends over time† | Scope of study | n       |
|----------|---------------------------|------------------|----------------|---------|
| T. pallidum | Burkina Faso - Ouagadougou: 1.2% (2009)19 | Multiple regional | BBs            | 30,364  |
|          | Burkina Faso - LNS: 2.1% (2009)108† | Multiple regional | BBs            | 31,405  |
|          | Burkina Faso - Koumbou: 8.92% (2009)111† | Single BB        | 4,520          |
|          | Cameroon - Edéa: 5.7% (2011–2012)122† | Single BB        | 543            |
|          | Cameroon - Yaoundé: 9.5% (2009)19 | Multiple regional | BBs            | 2,887   |
|          | Equatorial Guinea - Bioko Island: 21.52% (2011–2013)114 | Multiple regional | BBs            | 2,937   |
|          | Eritrea - LNS: 0.49% (2006–2009)115 | Single BB        | 29,501         |
|          | Ethiopia - Hawassa: 0.5% (2009–2013)17 | Single BB        | 6,337          |
|          | Ethiopia - Jimma: 0.6% (2014); 2.4% (2010)116 | Single BB        | 676 (2010); 2,752 (2014) |
|          | Ghana - LNS: 3.7% (2014–2015)75 | Country-wide     | 91,386         |
|          | Ghana - Damongo: 4.7% (2009)19 | Single hospital  | 468            |
|          | Ivory Coast - Daloa: 4.54% (2009)19 | Multiple regional | BBs            | 14,257  |
|          | Mali - Bamako: 0.3% (2009)19 | Multiple regional | BBs            | 25,543  |
|          | Mozambique - Tete: 1.2% (2009)120 | Single hospital  | 679            |
|          | Niger - Niamey: 1.88% (2009)19 | Multiple regional | BBs            | 2,962   |
|          | Nigeria - Abeokuta: 0% (2013)18 | Single hospital  | 130            |
|          | Nigeria - Osogbo: 1.1% (2007–2008)121 | Single BB        | 1,410          |
|          | Rwanda - Kigali: 0.6% (2009)19 | Multiple regional | BBs            | 37,000  |
|          | Tunisia - LNS: 0.13% (2010)123 | Country-wide     | 19,783         |

Specific locations are provided in italics if stated in the publication. Study interval included in parenthesis.

† First-time donors.

Trends over time are only included when seroprevalence was included at two time points within the same study.

‡ = seroprevalence decrease.

BB = blood bank; LNS = location not specified; NA = not available.
TABLE 5. Major advances and continued challenges across the transfusion landscape in Africa

| TTI epidemiology | Blood product testing and pathogen reduction | Quality assurance | Education and accreditation | External funding and technical support |
|------------------|---------------------------------------------|------------------|----------------------------|----------------------------------------|
| Advances:        | Advances:                                    | Challenges:      | Advances:                  | Advances:                              |
| • Regional decrease in donor seroprevalence rates (see Table 1) | • Regional increases in blood product testing4,8,24,42 | Suboptimal testing platforms still in use (e.g., RDTs) | • Multifaceted educational initiatives96–100 | • Regional increases in many blood safety initiatives4,6,42 |
|                  | • Proof of concept application of pathogen reduction/inactivation strategies39 | Limited ability to adopt high performance alternative testing strategies given financial constraints39,33,35,105 | • Development of regional tiered accreditation system100 |          |
|                  | • Molecular testing remains the exception | • Limited access to educational programs37,99 |          |          |
| Challenges:      | • Unreliable supply chains/procurement of screening reagents34,75 | Variable and unknown quality of hemovigilance data | Lack of coordination of educational activities |          |
| • Incomplete epidemiological understanding (see Table 1; most based on limited data sets) | | Monitoring and evaluation using operational rather than performance indices | Approach to prioritization of need unclear and not assessed objectively and/or systematically |          |
| • Absence of posttransfusion surveillance with uncharacterized transfusion transmission risk41 | | Few examples of initiatives that target rural areas where there is unaddressed need | Impact assessment of decline in support has not been undertaken, formally19 |          |
| • Limited surveillance outside major TTIs | | | |          |

QA = quality assurance; RDTs = rapid diagnostic tests; TTIs = Transfusion transmitted infections.

in education and accreditation could prove instrumental in the years ahead.

CONFLICT OF INTEREST

AART and PMN received travel support from Terumo BCT; PMN is on an advisory board for Terumo BCT and is a consultant for Bio-Merieux, Inc. EMB is a co-investigator on a Terumo-sponsored clinical trial in the United States. EMB, PMN, and AART are investigators on a US government-sponsored grant to evaluate feasibility of implementation of Mirasol (whole blood pathogen reduction) in Uganda. EMB, JBT, and CTT all have affiliations with the African Society of Blood Transfusion.

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