

# Transfusion research priorities for blood services in sub-Saharan Africa

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## Summary

Evidence to support many blood transfusion policies and practices in sub-Saharan Africa (SSA) is weak or lacking. SSA cannot extrapolate from wealthy countries' research findings because its environment, users and structures are very different and SSA has critical blood shortages. SSA needs to generate its own evidence but research funds are very scarce and need to be carefully targeted to match need. This study aimed to define this need by determining research priorities for blood services in SSA. Thirty-five stakeholders representing diverse blood services' interests and expertise participated in a workshop. An adapted 'consensus development method' was used to identify, agree and justify research priorities under five themes through small group and plenary discussion, and cumulative voting. Research priorities covered traditional research areas, such as clinical use of blood and infection screening, but also highlighted many new, under-researched topics, mostly concerning blood service 'systems', such as economics, blood components and regulation. Lack of electronic information management systems was an important hindrance to the blood services' ability to generate robust research data. This study has identified and prioritised novel research that will help blood services in SSA to address their own needs including their most urgent problem: the lack of access to adequate blood supplies. To catalyse this research blood services in SSA need to enhance their capacity to conduct, commission and manage research and to strengthen their collaborations within and beyond Africa.

**Keywords:** blood transfusion, blood services, Africa, research.

The World Health Organization (WHO) has set out global standards for blood transfusion services (WHO, 2016). These state that there should be universal access to safe and effective blood and blood products for transfusion, which should

be used appropriately, and that blood donor and patient safety should be ensured. To achieve universal access, there must be enough blood available to meet the needs of the population and it must be accessible to those who need it. WHO has been committed to these standards for 40 years and although there have been major improvements in blood safety in sub-Saharan Africa (SSA), driven largely by the human immunodeficiency virus (HIV) epidemic, progress in achieving standards relating to adequate supplies and universal access, has been disappointing.

WHO recommends a clear process for producing guidelines and recommendations (WHO, 2012). Some international transfusion guidelines, particularly those relating to reducing HIV infection risk, are based on published evidence, but, for others (for example recommended targets for units collected/1000 population), evidence is lacking. Policy makers and national blood services need to understand how recommendations have been derived and the strength of evidence that supports them. This information informs transfusion research at national level so that international guidelines can be adapted to the national context and solutions found to local problems.

Despite a 25% increase in the global number of blood donations from 2004 to 2014, lethal blood shortages are still widespread across Africa (Dzik, 2015; WHO, 2015a). For example, a review found that 26% of women with obstetric haemorrhage in Africa who reached hospital died because there was no blood available (Bates *et al*, 2008). Mortality among children with severe anaemia who wait more than 8 h for a transfusion is 52%; 90% of deaths occurred within 2.5 h of arrival in hospital (Kiguli *et al*, 2014). The ongoing serious blood shortages indicate that current strategies to provide adequate blood for transfusion in SSA are not working. Research on how to increase donations and reduce wastage within blood banks and hospitals is urgently needed to identify novel and context-specific solutions to the problem of blood shortages. Improving blood supplies involves motivating new donors and retaining existing donors, maximising the sensitivity of infection screening while simultaneously minimising discards through false positivity, efficient stock management to optimise storage and transport and minimise outdating, and appropriate clinical use of blood.

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1 Many high-income countries have achieved sufficiency of  
2 blood supplies by centralising collection, testing and distribu-  
3 tion, using electronic records to register and recall donors,  
4 and through electronic tracking of blood from donor to  
5 recipient. Sophisticated haemovigilance systems, hospital  
6 transfusion committees and specialised practitioners to over-  
7 see appropriate clinical use of blood have also contributed.  
8 For poorer countries in SSA these approaches may not be  
9 feasible, affordable or even appropriate because the context  
10 and pattern of blood donations and usage in SSA is very dif-  
11 ferent from more wealthy regions. In SSA around 75% of  
12 blood is used by children and pregnant women for emergen-  
13 cies whereas 76% of blood in high-income countries is used  
14 electively in patients over 65 years mostly for oncology and  
15 surgery (WHO, 2015a). A substantial proportion of blood in  
16 SSA is transfused as whole blood whereas in high-income  
17 countries whole blood is processed into red cells, plasma and  
18 other components and products (Loua, 2016). At least a  
19 third of donors in SSA are family members so blood is often  
20 donated and used within a hospital (Loua, 2016). Superstitions  
21 and misperceptions surround the giving and receiving  
22 of blood. A lack of electronic systems makes it difficult to  
23 recall donors regularly, and to track blood units from donor  
24 to recipient. For these reasons, blood service models and  
25 interventions that work in high-income countries are unlikely  
26 to be transferable to, or appropriate for, most countries in  
27 SSA.

28 To address the lack of evidence from SSA to underpin  
29 their policies and practices, blood services in SSA need to  
30 conduct or commission research. Without a clear strategy to  
31 guide their research priorities, there is a risk that the scarce  
32 resources available for transfusion research will not be  
33 focused on the region's needs and may be unduly influenced  
34 by the agendas of external donors. This paper describes an  
35 inclusive and comprehensive process that identified blood  
36 transfusion research priorities in SSA, and some initial steps  
37 towards translating these research priorities into actions.

## 38 **Materials and methods**

### 39 *Identifying transfusion research needs in SSA*

40 The process for identifying transfusion research priorities was  
41 adapted from the consensus development method for clinical  
42 guideline development (Murphy *et al*, 1998). This involves  
43 face-to-face discussions using a process that takes into  
44 account the need to: set clear tasks and questions; carefully  
45 select participants; structure interactions; and synthesise indi-  
46 vidual judgements. A two-day workshop was convened in  
47 Pretoria, South Africa for 35 participants (Appendix 1).  
48 From our experience of a previous similar workshop, this is  
49 a sufficient number to ensure that individual opinions are  
50 unlikely to have undue influence on decisions, and any bias  
51 was further reduced by incorporating a voting system (see  
52 later). Participants had long-standing track records of

conducting, promoting or using research in SSA and  
included blood service directors, researchers, clinicians, fun-  
ders, policy makers, commercial organisations and non-gov-  
ernmental organisations. To enhance the credibility and  
widespread acceptance of the outcomes, the participants were  
selected for their diverse perspectives, experiences and geo-  
graphical location, and reflected the full range of key charac-  
teristics of the population that would need to engage with  
the new research priorities (Murphy *et al*, 1998).

The first meeting to identify transfusion research priorities  
had been held in Mombasa in 2008 and had been attended  
by several of the same participants (Mapako *et al*, 2008). At  
that meeting participants had grouped research topics under  
five themes - biological safety; blood donors; hospital use of  
blood; supply and distribution; and systems and financing.  
For the Pretoria workshop, participants were divided into  
five groups of 6–8 people to maximise heterogeneity of  
expertise and geographical location because the goal was to  
explore areas of uncertainty (Murphy *et al*, 1998). All groups  
considered each of the five research themes, and the topics  
within that theme, in turn. They decided if these topics were  
still relevant. They judged whether there were any new  
research topics needed and if there were additional topics  
that did not fall within one of the five themes.

After discussing a theme, each group presented a summary  
of their discussions to all participants. Through plenary dis-  
cussions, the research topics and specific research questions  
associated with each research topic were refined and agreed.  
These discussions produced a long list of 5–10 research ques-  
tions for each theme but no indication of priority. A cumu-  
lative voting system was used to provide an indication of  
which research questions participants felt were most impor-  
tant within each theme. The research questions were written  
on a flip chart and each participant was provided with three  
sticky notes, or votes, for each topic. Each participant was  
asked to use all 3 of their votes and could allocate between 1  
and 3 votes to those research questions they considered a  
priority. Through this process an indication of the distribu-  
tion of participants' judgements, rather than just a 'central  
tendency', could be documented (Murphy *et al*, 1998).

### 40 *Promoting research priorities and uptake of research 41 results*

Workshop participants brainstormed a list of funders who  
may be interested in supporting blood services research. They  
also considered ways of creating a community of transfusion  
researchers in SSA and reducing their isolation by enhancing  
their research networks. One of the most challenging aspects  
of research is to ensure that the results are disseminated and  
used to influence practice and policies so a session was  
devoted exploring communication channels and to agreeing  
actions to be taken by the participants to keep up the  
momentum behind blood services research in SSA. Specific  
short and medium term actions were agreed and progress on

these in the year since the workshop was followed up through meetings or using emails and Skype/telephone calls.

## Results

### Research themes and topics for SSA blood services

For each of the five themes, the research questions that emerged as the top five priorities are presented in Tables I–V with a synopsis of participants' justification for each topic given in the text. Topics introduced since 2008 (Hassall & Bates, 2015) are indicated. The percentage of votes for these priorities compared to the total number of votes cast for the whole theme provide an indication of the extent of agreement between participants about the importance of the five priority topics. The total votes do not represent all votes cast for the theme since some votes were for research questions that were not ranked in the top five priorities.

#### Justifications for topics covered by research questions regarding biological safety (Table I).

- Transfusion-relevant outbreaks: the Ebola outbreak in west Africa posed a major challenge for the blood services, particularly in terms of lack of knowledge, expertise and systems for handling highly infectious samples, and for recruiting survivors and producing convalescent plasma
- Infection screening: Over the last few years the major knowledge gaps in infection screening have shifted towards systems to support better testing rather than focusing on the screening tests themselves. Research topics therefore included comparative evaluations of combined testing kits, of pre- versus post-donation testing strategies, and mechanisms for establishing quality assurance systems across the different health service tiers

Table I. Biological safety.

Research question	Total votes cast for this theme = 78
What challenges do new/emerging/epidemic infections (e.g. Ebola) present for blood supply/safety?	10
What is the value/relevance of existing screening for transfusion-transmitted infections in SSA (e.g. hepatitis C, malaria, syphilis)?	9
What is the significance of bacterial contamination for blood safety?	9
What is the role of pathogen inactivation for blood safety in SSA (e.g. for malaria, hepatitis and emerging infections)?	9
How can donor recruitment strategies be used to increase blood safety?	9
Total	46 (56%)

SSA, sub-Saharan Africa.

- Malaria: The burden and impact of malaria in the blood supply in SSA is poorly understood. There is no 'gold standard' test for screening donor blood. More evidence is needed about the infection risk to recipients and the likelihood of semi-immune recipients developing malaria from a transfusion. Estimates are needed about how rejection of malaria-positive donors may exacerbate blood shortages, and evidence is needed so policies can be adapted to account for differing malaria endemicities
- Bacterial contamination: This was considered to be under-reported and under-recognised. More data are needed to establish the prevalence, causes and clinical significance of bacterial contamination, along with evaluations of interventions to minimise risks to recipients.
- Hepatitis B virus (HBV) vaccination: Investigations into the impact of HBV vaccination on HBV prevalence in younger blood donors and the potential impact on blood screening strategies are needed (*new*).

#### Justifications for topics covered by research questions regarding blood donors and blood donation (Table II).

- Motivating and retaining donors. It is important to gain a better understanding of how to tailor motivational messages and recall mechanisms [e.g. Short Message Service (SMS), social media, phone calls] for the different types of blood donors (e.g. school children versus adults; first-time versus repeat donors). Innovative mechanisms to promote blood donation, such as social media, peer-motivators and incorporating blood transfusion information in school curricula need evaluating (*new*). Better knowledge about deterrents to becoming a first time donor, factors which contribute to donor attrition, including during the transition period after leaving school, and the role of parental consent (*new*).
- Types of blood donors. Participants recognised the need for a more nuanced understanding of the difficulties in clearly

Table II. Blood donors and blood donation.

Research question	Total votes cast for this theme = 79
How can social media be utilised to recruit/retain blood donors?	12
Are African and Western ideas of altruistic blood donation in conflict?	9
How can improved donor care improve blood donation?	6
What strategies are effective in retaining secondary school donors?	5
What incentives are appropriate/effective in recruiting and retaining blood donors?	5
Can successful youth donor recruitment strategies (e.g. Pledge 25) be adapted for other donor groups?	5
Total	42 (53%)

defining some of the different types of blood donor (i.e. family, replacement, voluntary, repeat, regular, professional), as these may be perceived differently in Africa from other cultures. Some of these definitions may be less important now that more rigorous screening processes have improved the safety of blood across all donor types.

- Donor care: Research into donor care issues, particularly how to create a conducive donation environment, evidence on the maximum frequency of blood donations (potentially limited by anaemia and iron depletion which is very prevalent in SSA) and optimising the care package and follow-up for donors, remains important
- Health screening questionnaires and algorithms for screening for transfusion-transmitted infections in SSA are predominantly based on those used in high-income countries. Their effectiveness needs evaluating in the context of SSA because of the high prevalence of transfusion-transmitted infections and different donor profiles (*new*)
- Electronic donor records: Most blood services in Africa rely heavily on manual records, which make it difficult to follow up and recall donors and to assess which donor recruitment and retention strategies work in different contexts. Donor databases are a potentially valuable resource for providing bio-information about the general population but are currently largely paper-based. Electronic donor records and tracking systems appropriate for SSA need to be developed and piloted with a view to their long-term potential as a public health resource and possibly, a bio-bank. Significant opportunities exist for sharing such systems among countries, with potential cost-savings (*new*)

*Justifications for topics covered by research questions regarding hospital management of blood and blood transfusions (Table III).*

- Haemovigilance systems are almost non-existent in SSA but are an important mechanism for improving blood

**Table III.** Hospital management of blood and blood transfusions.

Research question	Total votes cast for this theme = 92
How can the role of hospital transfusion committees be strengthened to ensure adherence to guidelines?	14
How can haemovigilance systems be implemented and sustained in SSA?	13
How does affordability and patient need influence access to blood transfusion?	11
How can countries in SSA best develop, disseminate and share clinical guidelines, audits and protocols?	11
How can adherence to clinical transfusion guidelines be monitored and improved?	9
<b>Total</b>	<b>58 (63%)</b>

SSA, sub-Saharan Africa.

and patient safety. In SSA, where resources are limited and reporting systems are weak, it may not be feasible to establish and sustain a comprehensive haemovigilance system so evidence is needed to guide targeting of resources towards priorities. Alloimmunisation, iron overload and post-transfusion follow-up for transfusion-transmitted infection, particularly in patients receiving multiple transfusions such as those with sickle cell disease, are particularly under-researched in SSA

- Patients' costs: Transfusion may be associated with explicit and hidden costs for patients but the cost and impact on patients and their families, and on clinical decisions, are unknown
- Clinical use of blood: Blood is often prescribed inappropriately but the extent and reasons for this are not known. Guidelines for clinical use of blood exist but the extent of their implementation is not known. These issues often fall under the remit of hospital transfusion committees but these committees are not common in African hospitals. There is a need for these guidelines to be tailored for use in SSA and based on evidence about the use of blood and ancillary treatments, for conditions prevalent in SSA. The usefulness of different haemoglobin 'triggers' for initiating transfusion and the role of bedside haemoglobin measurements need to be explored.

*Justifications for topics covered by research questions regarding adequate supplies and equitable distribution (Table IV).*

- Blood donation targets: National targets for blood collection need re-evaluating using up-to-date data. The targets should be tailored for SSA and match specific needs (e.g. to account for malaria burden). An estimate of unmet

**Table IV.** Adequate supplies and equitable distribution.

Research question	Total votes cast for this theme = 83
Can partnerships with commercial organisations help to develop an effective stock management model for blood services in SSA?	17
What tools/data-driven models can be used to estimate blood and blood component requirements?	16
How much blood and blood components do countries in SSA need and how can this be reliably estimated?	14
What structural gaps exist between blood banks and hospital systems that lead to ineffective management of stocks of blood?	14
Can maximum blood order schedules impact on blood stock management in SSA?	5
<b>Total</b>	<b>66 (80%)</b>

SSA, sub-Saharan Africa.

need among those who do not yet access health services is also needed.

- Blood stocks management and trends: Accurate information about requests, blood use, ordering and distribution and discards for blood and components and the ability to track trends is needed in order to instigate a system of blood ordering schedules. Current manual systems need replacing by appropriate, and transferable, information technology (IT) systems capable of producing data-driven models and tools.
- Blood components: The use of blood components (e.g. whole blood, red cells, plasma) is strongly promoted but there is little evidence from SSA about the indications for their use, about appropriate education for prescribers in component use, and about how to avoid wasting plasma due to lack of fractionation facilities (*new*).

*Justifications for topics covered by research questions regarding transfusion systems and sustainable financing (Table IV).*

- Costs and service delivery models: The costs of the individual components of the donor to recipient 'vein-to-vein' process need to be measured for different service delivery models (e.g. centralised, hospital-based and hybrid systems). The applicability and replicability of various costing models needs to be assessed from the perspectives of the blood service providers, and the donors, recipients and their families.

**Table V.** Transfusion systems and sustainable financing.

Research question	Total votes cast for this theme = 86
What sustainable cost-recovery models already exist in SSA and how can they be adopted in other countries?	22
What has been the impact on, and sustainability of, blood safety programmes of external financial donor input (and withdrawal)?	17
How can blood services transition from external donor funding (e.g. PEPFAR) to 'internal' (local) funding?	12
How can the cost of production of blood units be minimised to ensure sustainability?	8
Can a dynamic model be developed to determine a vein-to-vein cost (using established models for HIV/maternal health) of a blood transfusion?	6
<b>Total</b>	<b>65 (76%)</b>

PEPFAR, President's Emergency Plan for AIDS (Acquired immunodeficiency syndrome) Relief; SSA, sub-Saharan Africa.

- Income generation: Ways of mitigating the risk of blood services' dependence on donor funds need to be explored, and innovative sustainable financing mechanisms, such as cost recovery, tax levies and commercial sector partnerships, tested and evaluated (*new*).
- Regulation of blood services: Blood is categorised as an 'essential medicine' so blood services in SSA are increasingly subject to new regulations. These are likely to impact on many aspects of delivery and financing of blood services. Regulation of blood services is a new role for regulators in Africa, so research is needed to define the skills the regulators will need and how their role can be used to improve, and not overburden, the blood services (*new*).
- Blood service responsiveness: The recent Ebola outbreak highlighted that blood service systems in SSA urgently need strengthening so that they can respond rapidly to changing needs. More evidence is needed about how to do this effectively in different contexts and the risks and benefits of various models. Better definitions and descriptions of blood service systems, models and structures will facilitate standard-setting, sharing of best practice among blood services and consensus on common 'leading' indicators which will enable within and between country comparisons.
- Purchasing power: Potential for national or regional bulk purchasing should be investigated to improve cost-effectiveness and minimise the cost per unit of blood while ensuring that blood services are financially sustainable (*new*).
- Attracting and retaining staff: More evidence is needed about the poorly understood factors affecting attraction, motivation, retention and professional development, of blood services staff in SSA and how to formalise their career progression opportunities, as this will impact on several aspects of the blood services, including costs and sustainability (*new*).

#### *Promoting research priorities and uptake of research results*

*Financial resources to support blood services research in SSA.* Participants identified a range of funders with a reputation for supporting programmes of direct or indirect relevance to blood services. These included multi-national agencies (e.g. Global Fund, European Union, Red Cross/Crescent, World Bank), national governments and research agencies (e.g. UK, USA, France, Japan), foundations and trusts (e.g. Wellcome Trust, Bill and Melinda Gates Foundation, Rockefeller), international blood transfusion societies, universities, commercial and insurance companies, international charities (e.g. Lions, Rotary) and vertical programmes concerned with maternal and neonatal health, HIV and malaria.

1 *Strengthening research skills and communities.* Several inno-  
2 vative approaches were proposed for increasing the number  
3 of researchers and volume of blood services research in SSA.  
4 These included blood services hosting PhD students regis-  
5 tered at local universities, promoting more in-service  
6 research by blood service staff, advertising blood service pro-  
7 jects for MSc and BSc students, and ensuring that blood ser-  
8 vice issues were covered in the curricula of schools and  
9 universities. Ideas for incentives that could be used to moti-  
10 vate blood service staff to undertake research included educa-  
11 tion grants for courses to learn research skills, funding  
12 conference and workshop attendance, recognising research  
13 activities for promotion, including research experience as a  
14 recruitment criterion, public recognition of individuals'  
15 research contributions through ceremonies and newsletters,  
16 support for new researchers to develop proposals, and creat-  
17 ing a research-conducive environment within the blood  
18 services.

19 Participants recognised the importance of research for  
20 keeping up-to-date with technology and best practice, and  
21 for problem solving to make blood services more efficient.  
22 However, their main priority is to provide blood for their  
23 nation's population and they were therefore not able to  
24 invest a substantial proportion of their scarce resources in  
25 research. A potential solution that emerged from discussions  
26 was to create formal links with academic institutions. Pro-  
27 posed mechanisms to achieve this included obtaining appro-  
28 priate ethical and regulatory approvals for researchers to use  
29 blood service resources (e.g. samples, donor data, test results)  
30 to attract university researchers to work with the blood  
31 service in exchange for blood service staff teaching in the  
32 universities. Some blood services may also be able to host a  
33 research office and act as a resource for research  
34 information.

35  
36 *Research uptake.* Uptake of research evidence to improve  
37 services is notoriously difficult so participants made practical  
38 suggestions about how this might be achieved in the context  
39 of blood services in SSA. Participants understood that to  
40 promote research uptake at national and international level  
41 and influence changes to guidelines it was important to  
42 understand the needs of the policy makers and regulators  
43 and to involve them at all stages of the research process.  
44 There are already a small number of blood transfusion  
45 research networks in SSA, such as the Francophone Africa  
46 Research Network and T-REC networks (Tagny *et al*, 2014;  
47 Bates, 2016), that have some capacity to act as dissemination  
48 channels and foci for research activities. Participants sug-  
49 gested other mechanisms for promoting research uptake  
50 including through scientific publications and through presen-  
51 tations at, for example, grand rounds, journal clubs and sci-  
52 entific research meetings. Opportunities for promoting more  
53 use of evidence within individual blood services included  
54 sharing research results with clinical collaborators, providing  
55 training for blood service decision makers in how to critically

review evidence, establishing internal mechanisms for com-  
missioning research, reviewing results and instigating evi-  
dence-based change.

*Short and medium term actions.* Several activities were  
undertaken by workshop participants in the year following  
the workshop to promote the research priorities and enhance  
research capacity in blood services research in SSA. The  
research priorities have been disseminated through presenta-  
tions at international meetings and through the websites of  
the International and African Societies for Blood Transfusion  
and the European Union. Research related to blood transfu-  
sion in SSA and published in the last 7 years has been identi-  
fied and analysed. This is being summarised for publication  
and includes information on the topics researched and their  
frequency, as well as an analysis of the researchers and col-  
laborators, and institutions and countries involved. A data-  
base of individuals involved in blood services research has  
been established and is hosted and maintained by the Inter-  
national Society for Blood Transfusion (ISBT) (2016). We  
are aware of three grants applications that have been submit-  
ted for funding, together with several student projects and  
publications that all focus on priorities identified at the  
workshop. Assessments of research capacity within blood ser-  
vices in Ghana and Zimbabwe (Mapako *et al*, 2016) have  
been carried out in order to guide blood services' strategies  
for strengthening their research infrastructure and creating a  
research-conducive environment. The ISBT devoted their  
Academy Day at the Eighth International Congress of the  
African Society for Blood Transfusion in 2016 to 'Research  
and the Young Scientist' in order to promote research  
opportunities and skills among the next generation of blood  
service professionals (<http://www.afsbtcongress.org/>).

## Discussion

This study provides a comprehensive list of research topics  
and questions that multi-disciplinary blood services stake-  
holders across SSA have identified as their most pressing  
needs. Information is provided about each topic to help  
those doing and commissioning research to appreciate the  
rationale behind each topic. Many of the priorities focus on  
traditionally common research areas, such as clinical use of  
blood and infection screening, but there is clearly a move  
away from the HIV research that predominated over the last  
two decades. Included in the list are some new and exciting  
research topics, such as the impact of HBV vaccination on  
screening strategies, culturally sensitive donor motivation  
messages using social media and messaging, and novel  
approaches to income generation.

It is striking that many of the major knowledge gaps con-  
cern blood service 'systems' such as economic costs including  
from the perspectives of patients and their families; blood  
component need, production and use, and blood service reg-  
ulation. Weak systems severely limit the ability of blood

services in SSA to respond to challenges, such as the Ebola epidemic, to address shortfalls in supply and to keep pace with new developments including growing demand for blood products for cancer care and trauma (Dzik, 2015; WHO, 2015b). Blood services research in SSA is severely hampered by the lack of robust data concerning, for example, haemovigilance, donor recall and blood tracking. Widespread reliance on manual records means that blood services in SSA do not have data about their activities and cannot demonstrate their contribution to population health or make a business case for investment. Recent efforts to introduce electronic blood service information systems in SSA should help address these issues and provide a better platform for research (<https://www.jembi.org/project/blood-safety-information-system/>).

During the workshop many examples of known effective interventions were identified which are not reaching the people or services that could benefit from them. Research into how to implement evidence-based interventions is therefore needed to understand how to deploy and scale up these interventions in different contexts and to overcome health system barriers to the delivery of policies or programmes (Hales *et al*, 2016). Implementation research should be problem-focused, action-oriented and aligned with the needs of blood services and health systems. This type of research draws on multiple disciplines and is a collaborative endeavour requiring the engagement of a wide range of stakeholders, including researchers, policy makers, opinion leaders, and private and public sectors (Peters *et al*, 2013).

The audience for these research priorities is diverse. In addition to blood service staff and managers in SSA, it includes researchers, consumers of blood transfusion research (such as policy makers, clinicians and hospital managers), research and development funders, journal editors and conference organisers. For researchers, the list of priority topics and associated justification will help them frame their research applications and projects so that they can provide precise answers to fill the knowledge gaps. Having a list of research priorities will raise awareness of the key issues among users of research so that they can create mechanisms to promote demand for specific research and to rapidly utilise the results. Organisations that fund health research and development can focus their grant opportunities and selection processes to ensure that the neglected research areas in blood services are targeted for funding. Agencies that provide a forum for disseminating research, such as academic journal editors and conference organisers, can provide space to highlight outputs that specifically relate to the research priorities.

## References

Bates, I. (2016) T-REC project final report. Available at: <http://cordis.europa.eu/docs/results/266/266194/final1-trec-final-report.pdf> (accessed 11 November 2016).

Bates, I., Kalanda, G., McKew, S. & van den Broek, N. (2008) Maternal mortality in sub-Saharan Africa: the contribution of ineffective blood transfusion services. *British Journal of Obstetrics and Gynaecology*, **115**, 1331–1339.

Dzik, W.H. (2015) Innocent lives lost and saved: the importance of blood transfusion for children in sub-Saharan Africa. *BMC Medicine*, **13**, 22.

Hales, S., Leshner-Trevino, A., Ford, N., Maher, D., Ramsay, A. & Tran, N. (2016) Reporting guidelines for implementation and operational

A key finding of the Mombasa meeting in 2008 had been that there was extremely limited transfusion research expertise in SSA, both within blood services and in the wider research community. This meant that there were almost no individuals or institutions in SSA that could address the research gaps identified by participants. Some early steps have been taken to enhance the visibility of blood transfusion research in SSA, to disseminate the research priorities and to re-orientate research efforts towards these priorities. Since 2008 the African Society for Blood Transfusion in collaboration with the European Union-funded T-REC programme to enhance transfusion research skills in SSA, has organised several workshops and research training initiatives. These efforts have increased research capacity in SSA's blood services and raised awareness among diverse stakeholders within and beyond SSA about the importance of blood transfusion research in Africa. However much more needs to be done to ensure that blood services in SSA can generate and use locally-appropriate evidence to develop, implement and update guidelines in response to their constantly changing environment. Although blood services in SSA should drive and own the research process, partnerships with other African and international development communities were recognised to be essential for sharing and keeping abreast of the latest developments. Until the essential role of research in problem solving and challenging the status quo is addressed, the many needless deaths due to blood shortages in SSA will continue.

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## Author contributions

OH and IB designed the study; OH, TM and OH performed the research/collected data; OH, TM and IB analysed the data; IB wrote the first draft of the paper with substantial contributions from OH and TM.

## Conflicts of interest

None.

- research. *Bulletin of the World Health Organization*, **94**, 58–64.
- Hassall, O. & Bates, I. (2015) Workshop on blood transfusion research in sub-Saharan Africa, Pretoria. Available at: <http://www.t-rec.eu/highlights/documents/WorkshoponbloodtransfusionresearchinSub-SaharanAfricaexternal.pdf> (accessed ???).
- International Society for Blood Transfusion (ISBT). (2016) Transfusion researcher database. Available at: [http://www.isbtweb.org/fileadmin/user\\_upload/Blood\\_Transfusion\\_Network\\_Database\\_csv\\_pdf.pdf](http://www.isbtweb.org/fileadmin/user_upload/Blood_Transfusion_Network_Database_csv_pdf.pdf) (accessed ??? November 2016).
- Kiguli, S., Maitland, K., George, E.C., Olupot-Olupot, P., Opoka, R.O., Engoru, C., Akech, S.O., Nyeko, R., Mtove, G., Reyburn, H., Levin, M., Babiker, A.G., Gibb, D.M. & Crawley, J. (2014) Anaemia and blood transfusion in African children presenting to hospital with severe febrile illness. *BMC Medicine*, **13**, 21.
- Loua, A. (2016) Blood safety and availability in Africa: current status (presented at 8<sup>th</sup> International Congress of African Society for Blood Transfusions, Kigali).
- Mapako, T., Hassall, O. & Bates, I. (2008) Proceedings of blood transfusion research workshop. Mombasa. *Africa Sanguine*, **11**, 2.
- Mapako, T., Mafirakureva, N., Mutenherwa, N., Bvuma, G., Mvere, D.A., Marowa, L.M., Emmanuel, J.C. & Bates, I. (2016) A systematic approach for reviewing research capacity within Zimbabwe's national blood service. *ISBT Science Series*, **11**, 110–117.
- Murphy, M.K., Black, N.A., Lamping, D.L., McKee, C.M., Sanderson, C.F., Askham, J. & Marteau, T. (1998) Consensus development methods, and their use in clinical guideline development. *Health Technology Assessment*, **2**, i–iv, 1–88.
- Peters, D.H., Tran, N.T. & Adam, T. (2013) Implementation Research in Health – A Practical Guide. Published by Alliance for Health Systems and Policy Research and World Health Organization, Geneva, Switzerland.
- Tagny, C.T., Murphy, E.L. & Lefrère, J.J. (2014) The francophone Africa blood transfusion research network: a five-year report. *Transfusion Clinical Biology*, **21**, 37–42.
- WHO (2012) Handbook for guideline development. Available at: [http://apps.who.int/iris/bitstream/10665/75146/1/9789241548441\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/75146/1/9789241548441_eng.pdf) (accessed ??? July 2016).
- WHO (2015a). Blood safety and availability. Fact sheet N°279. Reviewed June 2015 Available at: <http://www.who.int/mediacentre/factsheets/fs279/en/> (accessed ??? November 2016).
- WHO (2015b) Regional Office for Africa Blood Safety, Laboratories and Health Technology. Brazzaville. Available at: <http://www.afro.who.int/en/clusters-a-programmes/hss/blood-safety-laboratories-a-health-technology.html> (accessed ??? November 2016).
- WHO (2016). Blood transfusion safety. Available at: <http://www.who.int/bloodsafety/en/> (accessed ??? July 2016).

## Appendix 1: List of workshop participants

Name	Organisation
Bernard Appiah	Texas A & M University, USA
Bridon M'baya	Malawi Blood Transfusion Service
Charles Ameh	Liverpool School of Tropical Medicine
Claude Tayou Tagny	Francophone Africa Blood Transfusion Research Network, Cameroon
Daniel Ansong	Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
David Mvere	National Blood Service, Zimbabwe
Denise Wellings	Liverpool School of Tropical Medicine, UK
Dora Mbanya	University of Yaounde, Cameroon
Ed Murphy	University of California, San Francisco, USA
Esther Massundah	National Blood Service, Zimbabwe
Faustine Ndugulile	Member of Parliament - Tanzania
Francis Sarkodie	Komfo Anokye Teaching Hospital, Kumasi, Ghana
Grace W. Kitonyi	University of Nairobi, Kenya
Henrik Ullum	University of Copenhagen, Denmark
Imelda Bates	Liverpool School of Tropical Medicine, UK
Jean Emmanuel	National Blood Service, Zimbabwe
Jessie Githanga	University of Nairobi, Kenya
Josephat Gathitu Muhia	Kenya Red Cross
Judith Chapman	International Society for Blood Transfusion
Lucy Asamoah Akuoko	Ghana Blood Service (Southern Area)
Lucy Marowa	National Blood Service, Zimbabwe
Magdalena Lyimo	Muhumbili University of Health & Allied Sciences, Tanzania
Mary Wanjiku Kariithi	Africa Society for Blood Transfusion, Kenya
Nigel Talboys	Terumo Corporation
Nolwazi Putuka	South Africa National Blood Service
Nyashadzaishé Mafirakureva	Health economics, University of Zimbabwe
Oliver Hassall	Liverpool School of Tropical Medicine, UK
Pete Zacharias	Safe Blood for Africa Foundation
Radhi Chikwereti	National Blood Service, Zimbabwe
Rene van Hulst	University of Groningen, Netherlands
Selina Wallis	Liverpool School of Tropical Medicine, UK
Shirley Owusu-Ofori	Ghana Blood Service (Kumasi)

## Appendix 1. (Continued)

Name	Organisation
Susan Jones	Liverpool School of Tropical Medicine, UK
Tonderai Mapako	National Blood Service, Zimbabwe
Tony Cegiela	Liverpool School of Tropical Medicine, UK

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