

COVID-19 Impact on Nigeria's National Blood Service Commission - Lessons for Low- and Middle-Income Countries (LMICs)

Adaeze Chidinma Oreh, Christopher Irechukwu, Felix Biyama, Agatha Nnabuihe, Andrew Ihimekpen, Daniel Oshiam, Tariere Bozegha, Ijeoma Leo-Nnadi, Omosigho Izedonmwun, Elton Oga, Eneye Jimoh Suberu, Kingsley Odiabara, Omale Joseph Amedu

Department of Planning, Research and Statistics, National Blood Service Commission Headquarters, Abuja, Nigeria

Abstract

Background: In February 2020, Nigeria officially announced its first case of COVID-19. As numbers rose, government-led non-pharmaceutical interventions such as lockdowns, curfews, restrictions on mass gatherings and other physical distancing measures ensued, negatively affecting blood donor mobilisation activities. **Objectives:** We aimed to assess the blood service activities across 17 National Blood Service Commission (NBSC) centres in Nigeria, including number of blood donations, mobile blood drives, blood units screened, screening outcomes, number of hospitals NBSC provided services to and number of blood units discarded over the study period. **Materials and Methods:** A retrospective descriptive study was conducted to determine the impact of the COVID-19 pandemic on blood services in 17 NBSC centres in Nigeria, comparing from January–December 2019 (pre-COVID-19) to January–December 2020 (peri-COVID-19). **Results:** Mobile blood donation drives declined by 100% in the first 2 months following government-imposed lockdowns, the number of all blood donations and voluntary blood donations declined by 9.8%. The number of blood units screened declined by 11.9%, while the number of blood units that screened positive for transfusion-transmissible infections reduced by 28.6%. Discarded blood units reduced by 3.1%, while a 32.6% increase was observed in the number of hospitals that NBSC issued blood for transfusion. **Conclusions:** The COVID-19 pandemic affected NBSC operations in Nigeria. However, by strengthening hospital linkages and employing innovative strategies, NBSC ensured continuity of operations, thereby significantly managing the challenges of COVID-19 to voluntary blood donor recruitment and the availability of safe blood for transfusion.

Keywords: Blood donation, blood donors, blood transfusion, coronavirus, COVID-19, National Blood Service Commission, Nigeria, severe acute respiratory syndrome coronavirus-2

INTRODUCTION

The novel coronavirus, designated 2019-nCoV, was first reported from Wuhan, China, in late December 2019. As of 27 March 2020, over 509,164 cases had been confirmed globally, with 23,335 deaths; 2419 cases had been confirmed in Africa, with 39 deaths.^[1] At the time, about 136 countries across the world had local transmission of the virus in communities, whereas 58 countries were recording only imported cases. Africa's statistics were different; however, as about 27 countries had solely imported cases of COVID-19, as compared to 12 countries that reported active local transmission. The World Health Organisation risk assessment of the global level was 'high'.^[1]

Against a backdrop of the severe acute respiratory syndrome coronavirus (SARS-CoV) outbreak in 2002 and the middle east

respiratory syndrome coronavirus outbreak in 2012,^[2] global and national public health institutions were on high alert, as the 2019-nCoV is the third coronavirus to emerge in humanity in the past two decades.^[3]

In response to the fears of an unchecked spread of the virus, and concerns for the fragile health systems in many African countries, nationwide lockdowns and curfews were instituted, international borders were closed and economies were effectively shut down, beginning from Morocco, Rwanda, South Africa, Ghana and Zimbabwe.^[4,5] Nigeria similarly followed suit.

Address for correspondence: Dr. Adaeze Chidinma Oreh,

Department of Planning, Research and Statistics, National Blood Service Commission, 39, Abidjan Street, Wuse Zone 3, Abuja, Nigeria.
E-mail: azoreh@yahoo.com

Received: 22-10-2021,

Revised: 25-11-2021,

Accepted: 07-12-2021,

Published: 28-01-2022

Access this article online

Quick Response Code:



Website:
www.npmj.org

DOI:
10.4103/npmj.npmj_720_21

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Oreh AC, Irechukwu C, Biyama F, Nnabuihe A, Ihimekpen A, Oshiam D, *et al.* COVID-19 Impact on Nigeria's National Blood Service Commission - Lessons for Low- and Middle-Income Countries (LMICs). Niger Postgrad Med J 2022;29:6-12.

These restrictions raised concerns globally for the effect on the availability of blood for transfusion, especially in African countries that have always been challenged by low rates of voluntary blood donation.^[6] The Pan American Health Organisation had released a warning during the early days of the pandemic, that shortages in safe blood supplies would be experienced due to reduced number of voluntary blood donors in response to COVID-19 preventive measures.^[7] For many African countries, even long before the outbreak of COVID-19, voluntary blood donations have been plagued by myths and misconceptions about ill health and even death following blood donations. Coupled with the nutritional anaemia somewhat prevalent in many African communities,^[8] a large pool of potential voluntary blood donors have been ineligible to donate blood voluntarily.^[6,9] It has also been reported that in many developing countries, amongst young populations, a wide gap often exists between awareness of voluntary blood donation and an actual commitment to donating blood.^[10-13]

Nigeria is currently one of the countries with the highest rates of maternal deaths in the world, and almost a quarter of these deaths are due to haemorrhage.^[14-16] In addition, the country's burden of sickle cell disease ranks amongst the highest globally, with approximately 150,000 babies born with the disease each year, and up to 70%–90% of such children dying before the age of five.^[17] Other conditions such as malaria, cancer and trauma from road traffic accidents, conflict and insurgency make it exigent for sustainable safe blood supplies to be available to save millions of lives.

The National Blood Service Commission (NBSC) is the Nigerian institution responsible for coordinating, regulating and ensuring the provision of safe blood in the country through operations in all six geopolitical zones, with blood centres in 17 states in Nigeria.

Nationally mandated lockdowns were announced on 30 March 2020 and physical distancing measures such as the restricting of mass gatherings severely limited the organisation of blood donation drives across the country. Despite the COVID-19 pandemic, safe blood and blood components continued to be required for transfusions of patients with other pressing health conditions. Blood shortages would therefore endanger the lives of many such patients, causing them to either die or suffer needlessly.

This paper aimed to generate substantial evidence that would be vital for effective planning for the optimal management of blood supplies to avoid blood shortages and devise innovative means of recruiting voluntary and unpaid blood donors safely even during infectious disease outbreaks. This is necessary given the huge gaps in safe blood supplies that infection prevention and physical distancing measures could create. The review and analysis of activities in Nigeria's National Blood Service would therefore provide a holistic and comprehensive view of how the COVID-19 pandemic affected blood donation and blood drive activities in the country. This could then proffer efficient mechanisms for the management of safe blood

supplies not only during the COVID-19 pandemic, but also during other similar public health emergencies in the future.

MATERIALS AND METHODS

Study design, period and settings

We conducted a retrospective analysis of routinely collected blood services data from the NBSC in Nigeria, to determine the impact of the COVID-19 pandemic across the seventeen blood services centres across the country, comparing from January–December 2019 (pre-COVID-19) to January–December 2020 (peri-COVID-19).

Nigeria is administratively divided into 36 states plus the Federal Capital Territory, which are zoned across six geopolitical areas: South-South; South-West; South-East; North-East; North-West and North-Central. Each of these zones has the presence of NBSC represented as zonal and state centres [Figure 1].

Ethics approval

Ethical approval for this study was obtained from the NBSC Research Ethics Committee. The investigation was not considered to be research on human subjects. Therefore, individual consent from blood donors and recipients was not sought, as personal individual data were not used in this study, only global data from routinely recorded departmental registers.

Data source and collection

Registers of the 17 zonal and state blood centres were reviewed by trained monitoring and evaluation officers and programme analysts for the number of mobile blood drives conducted, number of people spoken to in groups (sensitised), number of people who willingly submitted to donate blood (recruited), number of recruited donors who completed donor forms and had their vital signs reviewed by a counsellor (counselled), number of donors deferred, number of donors bled, the number who had failed bleeds, number of safely screened blood units issued to various hospitals for transfusion, number of hospitals served and the number of blood units that expired and were discarded over the study period.

Data analysis

The data were subsequently tabulated on a spreadsheet and compared to data from the preceding year (2019), and the differences were noted and analysed using Statistical Package for the Social Sciences (SPSS) version 25, IBM Armonk, New York, USA.

The ShapiroWilk test of normality was used to determine the distribution of data, and correlation analysis was done to ascertain the relationship between 2019 data and 2020 data. Correlation scale <0.5 signified a weak relationship, 0.5 moderate relationship and >0.5 strong relationship. The *P* values were generated from *t*-test analysis, and *P* < 0.05 was considered statistically significant.

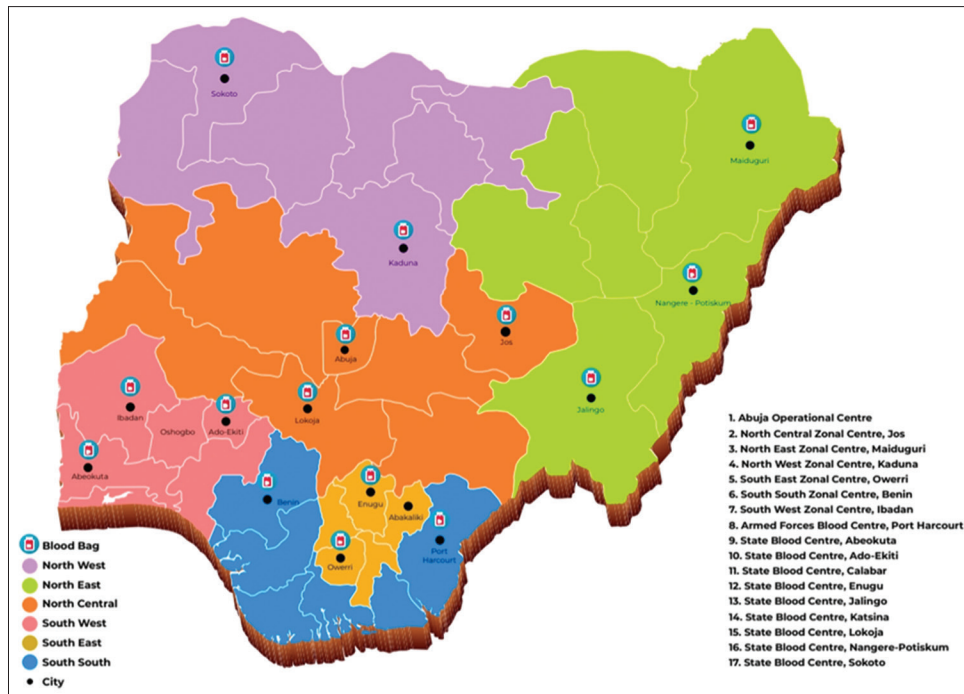


Figure 1: Distribution of National Blood Service Commission centres across Nigeria

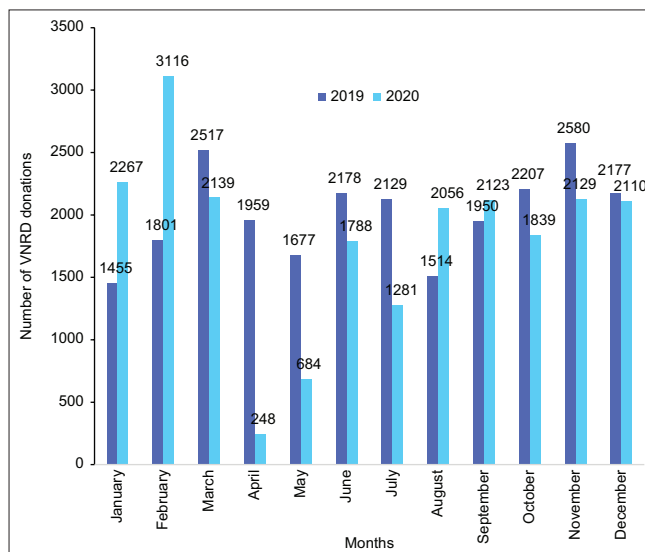


Figure 2: Comparison of monthly voluntary non-remunerated blood donor donation at National Blood Service Commission centres in Nigeria 2019 and 2020

RESULTS

Following lockdown measures, curfews and restrictions on mass gatherings around the country as a response to the COVID-19 pandemic, blood donation drives, public mobilisation activities and operations regularly conducted by the NBSC were greatly affected [Table 1]. A total of 22,116 blood donations were made in 2020 compared to 24527 donations in 2019 signifying a 9.8% decrease [Table 1].

No blood drives were held in April and May 2020, representing a 100% decline from 2019 [Table 2]. During the study period, a

total of 23,657 voluntary blood donors were counselled in 2020, compared to 25,374 in 2019 (a 6.8% decline) [Table 1]. A total of 21,780 voluntary blood donations were collected in 2020 compared to 24,144 in 2019, accounting for an average decline of 9.8% that was highest in April (87.3%) and May (59.2%) [Table 1 and Figure 2]. Autologous blood donations however increased by 250% in 2020 compared to 2019 (more than tripled) [Table 1].

An 11.9% decline was also observed in the number of blood units screened between January and December 2020, compared to 2019. Two thousand three hundred and forty-four (2,344) blood units screened positive for transfusion-transmissible infections (TTIs) out of the 21,580 blood units screened in 2020 (11.1%), compared to 3284 out of 24,483 blood units screened in 2019 (13.4%). The number of blood units that screened positive for TTIs such as human immunodeficiency virus (HIV), hepatitis B, hepatitis C and syphilis was least in the months immediately following the outbreak of COVID-19 in Nigeria (April $n = 11$ [4.4%] and May $n = 61$ [8.8%]) compared to 283 (13.6%), 464 (15.0%) and 303 (14.4%) blood units screened in January, February and March 2020, respectively. The most frequently occurring TTI was hepatitis B, followed by hepatitis C, HIV and lastly, syphilis. However, while the number of TTI-positive blood reduced for hepatitis B, hepatitis C and syphilis, the number of HIV-infected blood units increased by 9.7%.

A total of 6123 hospitals accessed blood from the NBSC in 2020, compared to 4619 in 2019. This signified a 32.6% increase in the number of hospitals served over the study period and a statistical significance of $P = 0.01$. However, the number of screened blood units issued to hospitals declined by 14.2% from 19,277 blood units in 2019 to 16,537 units in 2020, with April and May 2020 being the worst affected with

Table 1: Comparison of blood service activities by National Blood Service Commission in 2019 and 2020

| | 2019 | 2020 | Percentage change |
|------------------------------------|-----------|--------|-------------------|
| All blood donations | 24,527 | 22,116 | -9.8 |
| VNRDs | 24,144 | 21,780 | -9.8 |
| FRDs | 381 | 329 | -13.6 |
| Autologous donors | 2 | 7 | 250.0 |
| Donors counselled | 25,374 | 23,657 | -6.8 |
| Donors deferred | 2130 | 1854 | -13.0 |
| Male donors | 18,000 | 16,583 | -7.9 |
| Female donors | 6630 | 5610 | -15.4 |
| Blood drives | 304 | 327 | 7.6 |
| Failed bleeds | 206 | 169 | -18.0 |
| Blood units screened | 24,483 | 21,580 | -11.9 |
| Expired blood units | 1560 | 1991 | 27.6 |
| TTI-positive units | 3284 | 2344 | -28.6 |
| Discarded blood units | 5206 | 5043 | -3.1 |
| Hospitals served | 4619 | 6123 | 32.6 |
| Blood units issued for transfusion | 19,277 | 16,537 | -14.2 |
| Community members sensitised | 1,765,899 | 69,220 | -96.1 |

VNRD: Voluntary non-remunerated blood donors, TTI: Transfusion-transmissible infection, FRDs: Family replacement donors, NBSC: National Blood Service Commission

Table 2: Number of mobile voluntary blood donation drives conducted by National Blood Service Commission in 2019 and 2020

| Months | 2019 | 2020 | Percentage change |
|--------------------------|-------|------|-------------------|
| January | 12 | 38 | 216.7 |
| February | 22 | 55 | 150.0 |
| March | 26 | 38 | 46.2 |
| April | 24 | 0 | -100.0 |
| May | 12 | 0 | -100.0 |
| June | 25 | 17 | -32.0 |
| July | 26 | 15 | -42.3 |
| August | 17 | 27 | 58.8 |
| September | 26 | 20 | -23.1 |
| October | 27 | 31 | 14.8 |
| November | 46 | 48 | 4.3 |
| December | 41 | 38 | -7.3 |
| Total | 304 | 327 | 7.6 |
| Mean | 25.3 | 27.3 | |
| Median | 25.0 | 29.0 | |
| SD | 10.1 | 17.5 | |
| Correlation (<i>r</i>) | 0.397 | | |
| <i>t</i> -test statistic | 0.406 | | |
| <i>P</i> | 0.692 | | |

SD: Standard deviation, NBSC: National Blood Service Commission

896 and 598 units issued to hospitals, respectively, compared to 1762 and 1414 units in the same months of 2019.

A 27.6% increase in blood units that expired was observed in 2020 – 1991 blood units (9.0% of all donated blood) compared to 1560 (6.4% of all donated blood) in 2019 [Table 1].

Overall, number of blood donations, blood units screened and blood units issued to hospitals reduced between January and December 2020 compared to the same period in 2019, while number of hospitals served and expired blood units increased in 2020 compared to the same period in 2019.

DISCUSSION

The COVID-19 pandemic has strained global healthcare systems, and the shift in focus of healthcare to SARS-CoV-2 has compounded pre-existing challenges in effective healthcare delivery.^[18] In many developing countries, the management of maternal and child conditions, trauma, road traffic accidents and chronic illnesses requiring blood transfusion has been largely constrained due to insufficiencies in available safe, quality blood and blood products. Blood safety is an essential part of quality healthcare, providing patients with life-saving benefits and greatly improving health outcomes.

Maintaining a steady supply of screened blood and blood products during the COVID-19 pandemic has been a worldwide challenge. The rate of spread of the virus which led to government-mandated preventive measures compelled social isolation and physical distancing in ways that negatively affected blood donations in various countries, namely Brazil, China, India, Italy, Iran, Sudan and the United States of America.^[19-29]

In this study, blood donations, screening and issuance to hospitals were analysed across the 17 NBSC centres spread across Nigeria from January to December 2020 and compared to the same period in 2019. Analysing the trend of blood service activities in NBSC over the study period led to several conclusions. A decline of 9.8% was observed across all blood donations – voluntary, family replacement and autologous blood donations in 2020 compared to the same period in 2019 [Table 1]. However, autologous blood donations which according to NBSC policy require written consent from a managing physician before a scheduled surgical procedure increased by 250%. This was likely due to fears and uncertainties surrounding COVID-19 infection, with more individuals opting to donate their blood for storage preoperatively.

In 2019, and between January and March 2020, all blood units donated were collected in either NBSC fixed blood donation centres or during mobile blood donation campaigns for voluntary blood donors. However, in April and May 2020 – the months hit the hardest by COVID-19 restrictions – all blood units collected were at NBSC fixed blood centres, as no blood donation drives took place during those months, leading to an over 96% reduction in communities directly sensitised. These reductions in blood units collected also led to similar declines in blood units available to be screened for transfusion purposes. This decline is of greater impact considering the 130.4% increase in the number of blood drives that took place in the first 2 months of 2020 compared to 2019 owing to an organisational commitment to increased community recruitment of voluntary blood donors [Table 2].

The lockdown measures, curfews and bans on mass gatherings prevented many regular voluntary donors from going to nearby blood centres to donate blood due to fear, panic and disruptions in transport services.^[30] Coupled with an unprecedented rapid spread of a largely unknown virus, many people were frightened by the pandemic, and feared possible infection in blood centres.^[29] While the drop in blood donations recorded in this study was significantly lower than that recorded in China (67%) and Saudi Arabia (39.5%), it is somewhat closer to the declines reported in Italy (10%) and Brazil (17%) during COVID-19, and findings reported during the 2003 SARS outbreak in Hong Kong (16.9%).^[19,24,28,31,32]

The higher observed decline in family replacement donors compared to voluntary unpaid donors was likely due to the motivation of voluntary donors to give blood following calls and reminders by blood centre staff. Therefore, despite movement restrictions and prevalent fears and anxieties surrounding the COVID-19 pandemic, voluntary blood donors would still make their way to the blood centres to donate blood. This finding is in keeping with observations noted in Brazil, where telephone and social media were vital in voluntary blood donor recruitment to replace cancelled mobile blood drives.^[19]

While this study revealed slight reductions in the proportions of blood that screened positive for hepatitis B, hepatitis C and syphilis, perhaps owing to reduced number of blood donors, these declines were not statistically significant. However, a nearly 10% increase in the proportion of blood donors who screened positive for HIV was observed. These transfusion-transmissible infection screening results emphasise the need for continuous public education for the prevention of HIV/AIDS and other infections to ensure that voluntary non-remunerated blood donations continue to be regarded as a safe category of blood donors.^[33-35]

Overall, a 32.6% increase in the number of hospitals served by the NBSC was observed in this study. This is in contrast to findings reported from the NBSC North-Central Zonal Centre in Jos, and prior reports from India.^[22,36] Movement restrictions during lockdowns in response to the pandemic hampered the movements of blood donors and potential recipients both to NBSC centres and to hospitals. More blood units therefore lost their viability in blood banks, increasing blood units' expiry and discard by 27.6% in 2020 compared to 2019. Lowered blood demand during the pandemic due to reduced hospital admissions; declines in trauma injuries following lockdowns, social distancing and deferred elective surgeries, led to blood transfusions being reserved solely for critical emergencies.^[28,37,38]

To limit the number of blood units expiring in the NBSC blood banks, the NBSC greatly increased communication with hospitals, rapidly expanding its network of linking hospitals, and arranging for the safe transfer of required blood units to facilities without compromising the cold chain and viability of the blood and blood products. This resulted in a substantial increase in the number of hospitals that received blood screened

by NBSC over the study period. Challenges that hospitals faced recruiting blood donors owing to donor fears of infection and a paucity of emergency preparedness systems in place may have contributed to this.^[39] These findings highlight the importance of the NBSC Hospital Linkage Programme, an initiative that relies on continuous communication and collaboration between the National Blood Service and hospitals across the country so that safely screened blood units are made available for use in partner hospitals based on established need.

This study revealed that blood donations, screening, issuance and utilisation of safely screened blood units to hospitals were negatively affected by the COVID-19 pandemic. Many countries around the world have reported difficulties in maintaining stable and adequate blood supplies not only during the current pandemic but also in previous outbreaks of other coronaviruses.^[19,20,24,26,40-42] Strategies to surmount these challenges and ensure adequate blood supplies to meet country needs will greatly rely on innovative strategies to generate public awareness in local communities. Leveraging existing community networks to communicate the benefits of regular voluntary blood donation and to challenge the societal myths and misconceptions which hinder many potential donors is vital. The successful encouragement of voluntary donors who plugged much of the gaps in blood supply following the pandemic illustrates how regular communication is the key to voluntary blood donor recruitment. Telephone calls, message reminders, the use of social media to connect with voluntary blood donors and hosting small blood drives in donors' communities have been shown to shore up available blood supplies, as our findings also attest.^[24,27,28,40,43]

Close working relationships between state, regional and national blood transfusion centres and hospitals are vital so that safe blood can be regularly transferred to hospitals, recognising the difficulties that hospitals are likely to face with mobilising blood donors wary about donating blood in hospitals during infectious disease outbreaks. This would also enhance the utilisation of screened blood and substantially minimise the expiry and wastage of blood units.

In addition, effectively optimising available blood supplies would require guidance to clinicians on the appropriate clinical use of blood and conservative methods of blood supply management in patient care such as patient blood management, and deferring elective surgical procedures, thus ensuring availability of scarce safe blood and products for critical conditions.^[28,44,45]

CONCLUSIONS

This study revealed the negative impact of COVID-19 on the operations of Nigeria's NBSC, namely blood donations, blood units screened, blood units issued to hospitals and number of blood units that were unused and thus expired.

Managing the deleterious effects of infectious disease outbreaks on blood services calls for strategic innovations to

strengthen blood service operations, extend and broaden its reach to the public and end-users and therefore effectively manage blood supply shortages. Public enlightenment and community engagement strategies to motivate regular voluntary blood donations while still ensuring the safety of blood donors and staff are important. In addition, closer collaborations with hospitals would facilitate the distribution of safe blood and blood products to facilities based on the need to save many lives.

Acknowledgements

We acknowledge with immense gratitude all blood donors who despite the uncertainties and restrictions of lockdowns donated their blood to save the lives of those in need. We also extend our appreciation to the coordinators and staff of all the NBSC zonal and state centres, who work assiduously to ensure safe blood for all in Nigeria.

This paper was presented as a poster at the XXXVIII Annual Scientific Meeting of the British Blood Transfusion Society, 13–15 September 2021, and the abstract has been published in the *Transfusion Medicine Journal* Volume 31, Issue S1, Special Issue.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest

REFERENCES

- World Health Organization. Coronavirus Disease (COVID-19) Situation Report-67 Highlights; 2020. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200327-sitrep-67-covid-19.pdf?sfvrsn=b65f68eb_4. [Last accessed on 2021 Oct 21].
- de Wit E, van Doremalen N, Falzarano D, Munster VJ. SARS and MERS: Recent insights into emerging coronaviruses. *Nat Rev Microbiol* 2016;14:523-34.
- Munster VJ, Koopmans M, van Doremalen N, van Riel D, de Wit E. A novel coronavirus emerging in China – Key questions for impact assessment. *N Engl J Med* 2020;382:692-4.
- Africa News. African Countries Applying Lockdowns over COVID-19 Spread; 2020. Available from: <https://www.africanews.com/2020/03/30/african-countries-applying-lockdowns-over-covid-19-spread/>. [Last accessed on 2021 Oct 21].
- Vaughan A. Some African countries begin to ease coronavirus lockdowns. *New Sci* 2020;246:13.
- Aneke JC, Okocha CE. Blood transfusion safety; current status and challenges in Nigeria. *Asian J Transfus Sci* 2017;11:1-5.
- World Health Organization. PAHO Warns of Potential Blood Shortages during the COVID-19 Pandemic; 2020. Available from: <https://www.paho.org/en/news/10-4-2020-paho-warns-potential-blood-shortages-during-covid-19-pandemic>. [Last accessed on 2021 Sep 28].
- Oreh AC. Is COVID-19 plasma an option for Africa? *Africa Sang* 2020;22:1-2.
- Barrett CL. Obstetric anaemia in Africa in the time of COVID-19: A call to action. *ISBT Sci Ser* 2020;15:398-402.
- Melku M, Asrie F, Shiferaw E, Woldu B, Yihunew Y, Asmelash D, et al. Knowledge, attitude and practice regarding blood donation among graduating undergraduate health science students at the university of Gondar, Northwest Ethiopia. *Ethiop J Health Sci* 2018;28:571-82.
- Ossai EN, Eze NC, Chukwu O, Uguru UA, Ukpai EC, Ihere E. Determinants of practice of blood donation among undergraduate students of Ebonyi State University Abakaliki, Southeast Nigeria. *Arch Community Med Public Heal* 2018 4(1):1-7. [doi: 10.17352/2455-5479.000032].
- Ugwu NI, Oti WJ, Ugwu CN, Uneke CJ. Voluntary non-remunerated blood donation: Awareness, perception, and attitude among potential blood donors in Abakaliki, Nigeria. *Niger J Clin Pract* 2019;22:1509-15.
- Shenga N, Pal R, Sengupta S. Behavior disparities towards blood donation in Sikkim, India. *Asian J Transfus Sci* 2008;2:56-60.
- World Health Organization. Trends in Maternal Mortality 2000 to 2017: Estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division; 2019. Available from: <https://www.who.int/reproductivehealth/publications/maternal-mortality-2000-2017/en/>. [Last accessed on 2021 Oct 21].
- Galadanci H, Dongarwar D, Künzel W, Shittu O, Yusuf M, Abdurrahman S, et al. Cesarean section and maternal-fetal mortality rates in Nigeria: An ecological lens into the last decade. *Int J MCH AIDS* 2020;9:128-35.
- Ntoimo LF, Okonofua FE, Ogu RN, Galadanci HS, Gana M, Okike ON, et al. Prevalence and risk factors for maternal mortality in referral hospitals in Nigeria: A multicenter study. *Int J Womens Health* 2018;10:69-76.
- Fraiwani A, Hasan MN, An R, Oginni T, Olanipekun GM, Obaro SK, et al. Advancing healthcare outcomes for sickle cell disease in Nigeria using mobile health tools. *Blood* 2019;134:2173.
- Arshad Ali S, Azim D, Hassan HM, Iqbal A, Ahmed N, Kumar S, et al. The impact of COVID-19 on transfusion-dependent thalassemia patients of Karachi, Pakistan: A single-center experience. *Transfus Clin Biol* 2021;28:60-7.
- Silva-Malta MC, Rodrigues DO, Chaves DG, Magalhães NN, Ribeiro MA, Martins ML, et al. Impact of COVID-19 in the attendance of blood donors and production on a Brazilian Blood Centres. *Transfus Med* 2021;31:206-12.
- Barjas-Castro ML, Baumgartner JE, Sales LN, Santos RA, Pereira FB, Castro V. Blood supply strategies facing a reference blood centre in Brazil during the COVID-19 pandemic. *ISBT Sci Ser* 2020;15:374-7.
- Leung JN, Lee CK. Impact of the COVID-19 – A regional blood centre's perspective. *ISBT Sci Ser* 2020;15:362-4.
- Raturi M, Kusum A. The blood supply management amid the COVID-19 outbreak. *Transfus Clin Biol* 2020;27:147-51.
- Grandone E, Mastroianno M, Caroli A, Ostuni A. Blood supply and transfusion support in southern Italy: Findings during the first four weeks of the SARS-CoV-2 pandemic. *Blood Transfus* 2020;18:230-2.
- Franchini M, Farrugia A, Velati C, Zanetti A, Romano L, Grazzini G, et al. The impact of the SARS-CoV-2 outbreak on the safety and availability of blood transfusions in Italy. *Vox Sang* 2020;115:603-5.
- Mohammadi S, Yazdi SM, Eshghi P, Norooznezhad AH. Coronavirus disease 2019 (COVID-19) and decrease in blood donation: Experience of Iranian Blood Transfusion Organization (IBTO). *Vox Sang* 2020;115:595-6.
- Pagano MB, Hess JR, Tsang HC, Staley E, Gernsheimer T, Sen N, et al. Prepare to adapt: blood supply and transfusion support during the first 2 weeks of the 2019 novel coronavirus (COVID-19) pandemic affecting Washington State. *Transfusion* 2020;60:908-11.
- Sayedahmed AM, Ali KA, Ali SB, Ahmed HS, Shrif FS, Ali NA, et al. Coronavirus disease (COVID-19) and decrease in blood donation: A cross-sectional study from Sudan. *ISBT Sci Ser* 2020;15:381-5.
- Yahia AI. Management of blood supply and demand during the COVID-19 pandemic in King Abdullah Hospital, Bisha, Saudi Arabia. *Transfus Apher Sci* 2020;59:102836.
- Maghsudlu M, Eshghi P, Kafi-Abad SA, Sedaghat A, Ranjbaran H, Tabatabai SM, et al. Blood supply sufficiency and safety management in Iran during the COVID-19 outbreak. *Vox Sang* 2020;116:175-80.
- Caramello V, Camerini O, Ricceri F, Ottone P, Mascaro G, Chianese R, et al. Blood bank preparedness for mass casualty incidents and disasters: A pilot study in the Piedmont region, Italy. *Vox Sang* 2019;114:247-55.
- Wang Y, Han W, Pan L, Wang C, Liu Y, Hu W, et al. Impact of COVID-19 on blood centres in Zhejiang province China. *Vox Sang* 2020;115:502-6.
- Lee CK. Impact of severe acute respiratory syndrome on blood services and blood in Hong Kong in 2003. *Transfus Med* 2020;30:169-71.
- Okocha EC, Aneke J, Ezech T, Ibeh NC, Nwosu G, Onah CE, et al. The epidemiology of transfusion-transmissible infections among

- blood donors in Nnewi, South-East Nigeria. *African J Med Heal Sci* 2015;14:125-9.
34. Khawcharoenporn T, Srirach C, Chunloy K. Educational interventions improved knowledge, attitude, and practice to prevent HIV infection among HIV-negative heterosexual partners of HIV-infected persons. *J Int Assoc Provid AIDS Care* 2020;19:1-15.
35. Fonner VA, Armstrong KS, Kennedy CE, O'Reilly KR, Sweat MD. School based sex education and HIV prevention in low- and middle-income countries: A systematic review and meta-analysis. *PLoS One* 2014;9:e89692.
36. Damulak OD, Lugos MD, Ayuba Z, Ma'an VT, Jatau ED. Coronavirus pandemic: The impact on the Zonal blood service of a developing country. *Africa Sang* 2020;22:11-7.
37. Stanworth SJ, New HV, Apolseth TO, Brunskill S, Cardigan R, Doree C, *et al.* Effects of the COVID-19 pandemic on supply and use of blood for transfusion. *Lancet Haematol* 2020;7:e756-64.
38. Dhiman Y, Patidar GK, Arora S. COVID-19 pandemic - response to challenges by blood service commissions in India: A review report. *ISBT Sci Ser* 2020;15:365-73.
39. Gehrie E, Tormey CA, Sanford KW. Service commission response to the COVID-19 pandemic. *Am J Clin Pathol* 2020;154:280-5.
40. Teo D. Blood supply management during an influenza pandemic. *ISBT Sci Ser* 2009;4:293-8.
41. Kim KH, Tandi TE, Choi JW, Moon JM, Kim MS. Middle East respiratory syndrome coronavirus (MERS-CoV) outbreak in South Korea, 2015: Epidemiology, characteristics and public health implications. *J Hosp Infect* 2017;95:207-13.
42. Kasanga M, Mudenda S, Gondwe T, Chileshe M, Solochi B, Wu J. Impact of COVID-19 on blood donation and Service Commissions at Lusaka provincial blood transfusion centre, Zambia. *Pan Afr Med J* 2020;35:74.
43. Waheed U, Wazeer A, Saba N, Qasim Z. Effectiveness of WhatsApp for blood donor mobilization campaigns during COVID-19 pandemic. *ISBT Sci Ser* 2020;15:378-80.
44. Sadana D, Pratzler A, Scher LJ, Saag HS, Adler N, Volpicelli FM, *et al.* Promoting high-value practice by reducing unnecessary transfusions with a patient blood management program. *JAMA Intern Med* 2018;178:116-22.
45. Spahn DR, Muñoz M, Klein AA, Levy JH, Zacharowski K. Patient blood management: Effectiveness and future potential. *Anesthesiology* 2020;133:212-22.