The COVID-19 pandemic and blood utilisation in South Africa

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Background. The COVID-19 pandemic, first reported in December 2019, affected every sector of every country worldwide. Health services were the first to experience the direct impact. Blood services were advised to decrease blood utilisation in anticipation of reduced blood collections. The South African National Blood Services (SANBS) saw a substantial decline in blood demand following the institution of strict national lockdown measures, but the impact of the epidemic and various mitigation strategies remained unknown.
Objective. This retrospective study reviews red blood cell (RBC) utilisation during a 4-year period from 2019 to 2022 in the South African (SA) population, stratified by public and private healthcare sectors.
Methods. To measure the impact of COVID-19, blood utilisation pre COVID-19 was compared with an acute COVID-19 period and a post-acute period. Each period covered 450 days. Blood utilisation was evaluated against the background of reported COVID-19 cases and national lockdown regulations.
Results. With the onset of the COVID-19 pandemic, overall RBC utilisation dropped by ~17%. The initial decline was more pronounced in the public sector. Overall, utilisation recovered to pre-COVID-19 levels in the post-acute COVID-19 period, but at different rates in the public and private sectors.
Conclusion. There was a significant change in RBC utilisation during the course of the COVID-19 pandemic, much more pronounced in the public sector, which services 85% of the SA population. During the post-acute COVID-19 period, blood utilisation recovered, but at a much slower rate in the public sector. The COVID-19 pandemic accentuated the differences in blood utilisation patterns between the public and private healthcare sectors in SA, and each sector's resilience in adapting to the challenges of the epidemic.

Keywords: COVID-19, blood utilisation, South Africa, blood products, healthcare systems

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COVID-19 was first reported in December 2019 in Wuhan, China. By 30 January 2020, the Director-General of the World Health Organization (WHO) declared COVID-19 to be a public health emergency of international concern.[1] Fears around the potential impact on blood donations, the sustainability of the blood supply and the transfusion needs of COVID-19 patients arose around the world.[2-5] The Asian Association of Transfusion Medicine, realising the potential impact of the epidemic on blood availability and utilisation very early in the pandemic, released an aide mémoire on COVID-19.[6] It included recommendations for blood services to keep in close contact with clinicians and to manage both blood stocks and blood utilisation. Globally, blood services urged hospitals to decrease blood utilisation by as much as 25% in preparation for the anticipated reduction in blood collections.[7,8]

Locally, South Africa (SA)'s first COVID-19 case was reported on 5 March 2020, and the country went into lockdown level 5 (Table 1) on 26 March 2020.[9] This entailed a shutdown of most of the economy, with the exception of essential workers and services, and the implementation of stay-at-home orders and nationwide curfews. In addition, all alcohol sales were banned, and non-emergency healthcare services halted. During this time, the SANBS noted a significant, but not unexpected, decline in blood collections, as most blood drives at schools, tertiary and corporate institutions had to be cancelled. However, the available blood inventory initially remained stable, as there was also a substantial decline in the demand for red blood cell (RBC) products by both private and public hospitals during this time.

Although lockdown levels were relaxed during the course of the pandemic, curfews, limitations on public gatherings and intermittent alcohol bans remained in place to varying degrees. The ability of the blood services to collect sufficient blood also remained strained, as they had to continuously adapt to a rapidly changing environment, including increased COVID-19-related staff absenteeism. Mitigation strategies included a nationwide, reinforced education campaign on patient blood management, as well as expanding marketing campaigns urging the general public to donate blood.[10,11] However, the extent to which these efforts addressed what was assumed would be altered blood utilisation patterns was unclear.

Little published information is available on general blood utilisation patterns in sub-Saharan Africa, and even less on the impact of the COVID-19 pandemic on these patterns. Several retrospective studies have evaluated the in-hospital transfusion needs of COVID-19 patients and, separately, the impact of the epidemic on blood donation.[2-5] Despite the paucity of research on how the

epidemic affected national blood demand, utilisation and supply patterns, it is evident that the initial strict lockdown measures led to a general decrease in blood utilisation. However, the specific impact of the epidemic on blood demand at a local level remains unclear. Specifically, the extent to which the epidemic, and the various mitigation strategies implemented by the SA government and the blood transfusion services, impacted the utilisation of RBC products in the different healthcare sectors is unknown. SANBS, as the custodian of the blood supply chain from donation to patient issue for almost 90% of the country, had the unique opportunity to describe the impact of COVID-19 on national blood utilisation. We therefore conducted a retrospective analysis of RBC issues for the period January 2019 - December 2022.

Methods

Study setting and population

SANBS delivers blood through manned blood banks as well as unmanned validated, temperature-monitored emergency fridges geographically distributed throughout the SANBS service area. Prior to 2019, SANBS issued on average 766 000 RBC products per year. The unmanned emergency fridges are managed by the blood banks, and are stocked with group O red cell products to supply red cell concentrates in life-threatening situations at hospitals, or hospitals without 24/7 blood banks that tend to emergency and obstetric patients. Following dedicated efforts to increase collections to fully meet the country's demand, the number of units issued increased to 842 000 in 2019. This study covers RBC products issued between 2019 and 2022 to both the public and private sector hospitals. SANBS services eight of the nine provinces in SA, covering approximately 53.6 million people (89.9% of the population), of whom ~65% reside in urban areas.[12] Data on RBCs issued were operationally collected, and include patient-specific information, hospital, blood bank and health sector identification.

The majority (66) of the SANBS blood banks are situated in public hospitals, 9 in private hospitals and 8 near, but not on, specific hospital premises. Both the blood banks and the emergency fridges are managed by SANBS as the last stage in a near vein-to-vein blood service. Each blood bank services the hospitals within a particular geographical area surrounding the blood bank. Off-site hospitals are serviced with cross-matched blood by making use of courier services and hospital ambulance/transport systems for the collection of specimens and delivery of blood products.

Blood products and services are ordered by completing a SANBS blood requisition form, along with a patient blood specimen for cross-matching, detailing the type, volume, number of products required and the entity responsible for payment of products and services. The form includes only minimal clinical information, such as the (free text) diagnosis, ICD-10 code (which is poorly completed by clinicians) and the medical specialty responsible for the patient's care, as well as the entity responsible for payment of blood products and services, namely a provincial Department of Health (public) or private insurance or private capacity (private). The specified medical specialty acts as an indirect indication of the reason for the blood request, but it does not provide a precise clinical diagnosis. Additional red cell products may be ordered telephonically within 72 hours of the original request without the need to send a new crossmatch specimen.

Table 1. Restrictions on human movement, alcohol sales and retail activities per lockdown level*

	Lockdown level				
Characteristic	**5**	**4**	**3a and b**	**2**	**1**
Date	26 March - 30 April 2020	1 May - 31 May 2020	1 June - 17 August 2020	18 August - 20 September 2020	21 September - 28 December 2020
Curfew	No non-essential movement	20h00 - 05h00	23h00 - 04h00	23h00 - 04h00	00h00 - 04h00
Gatherings	Public gatherings prohibited Schools closed No sport events Churches closed	Public gatherings prohibited Schools closed No sport events Churches closed	50 people indoors 100 people outdoors 50 people at funerals Schools open Sports events – no spectators Churches open	50 people indoors 100 people outdoors 50 people at funerals Schools open Sports events – no spectators Churches open	50% capacity to maximum of 250 indoors 500 maximum outdoors 100 maximum at funerals Sports events – no spectators Churches open
Sale of alcohol	Not permitted	Not permitted	Limited to certain days and specific hours	Limited to certain days and specific hours	Unrestricted, except during curfew hours
Human movement	International, interprovincial, inter-district movement prohibited Intra-city travel for essential shopping and emergencies only	International, interprovincial, inter-district movement prohibited Intra-city travel for essential shopping and emergencies only	International and interprovincial movement prohibited Inter-district and intra-city travel for work, essential shopping and emergencies only	International movement prohibited Interprovincial, inter-district and intra-city travel allowed; leisure travel allowed	No restrictions on movement outside of curfew hours
Retail and commerce	Essential goods and services only	Essential services, office supplies and stationery, clothing and similar, food industry for delivery only	As for level 4, as well as clothing and hardware industries, food industry for delivery only	All retail permitted; food industry delivery and takeaway	All retail permitted; food industry open with strict COVID measures

*Limitations within lockdown levels changed over time and between 'hot spots' and non-hot spots. Adapted to highlight factors that may also have influenced non-COVID-related hospitalisations, and therefore blood utilisation. These restrictions were instituted during 2020. During 2021, various adjustments to these levels with fewer restrictions were instituted (not shown in table).

Study design

Ethics clearance was obtained from the SANBS Human Research Ethics Committee (ref. no. 2021/0562). Small-volume paediatric red cell products were excluded from the study. In our analysis to assess the impact of the COVID-19 pandemic, blood utilisation was compared between the 450 days pre-COVID-19 period, the 450-day acute COVID-19 period running until the tail-end of the third wave (driven by the Delta variant in SA) and the 450 day post-acute COVID-19 period, during which time most economic activities resumed and a 'new normal' had developed (Table 2). Blood utilisation was evaluated against the background of reported COVID-19 cases and national lockdown regulations, which significantly affected the movement of the population and the services (both health and economic) that could be accessed. From previous work, it was clear that the significant difference in usage patterns between the private and public healthcare sectors necessitated a stratified analysis.[13]

South African lockdown levels

Varying restrictions (Table 1) were imposed during different lockdown levels. COVID-19 lockdown in SA started on 26 March 2020 with a total lockdown of all economic and social activities, with the exception of essential services. These lockdown measures continued until the lifting of compulsory mask-wearing on 21 June 2022. Varying restrictions were imposed during different lockdown levels. These included movement restrictions, limited onsite work arrangements and intermittent bans on tobacco and alcohol product sales. The latter was implemented as it was believed it would decrease trauma-related hospital admissions (and therefore also blood utilisation), thereby increasing bed availability for serious COVID-19 cases. Table 1 provides a high-level summary of various limitations and restrictions applied during different lockdown levels.

Data collection and statistical analysis

Operational data are routinely extracted to the SANBS data warehouse, from where they were used for this analysis.

The monthly trend in RBC utilisation by health sector between 2019 and 2022 against the background of reported COVID-19 cases and lockdown levels implemented is shown in Fig. 1.

The National Department of Health regularly published reports of COVID-19 cases on their website throughout the pandemic. These daily updates were accessed and analysed for the present study.[14] Monthly RBC utilisation was calculated from the average daily usage for that month multiplied by 30. This was done to compensate for the different number of days in different months.

RBC products issued between the pre-COVID (1 January 2019 - 26 March 2020), the acute COVID (27 March 2020 - 20 June 2021) and the post-acute COVID-19 period (21 June - 13 September 2022) were analysed. Frequencies of RBC products issued are shown for each of the periods (Fig. 1). To measure the impact of COVID-19 on blood utilisation, the percentage change in blood products issued between the pre-COVID-19 and acute COVID-19 and then the pre-COVID-19 and post-acute COVID-19 periods was calculated. These differences were compared between healthcare sectors and clinical disciplines, and grouped into medical, surgical and other, as well as compared by patient demographics, including gender and age group. Medical, intensive care, haematology/oncology, paediatrics and infectious complications were grouped under 'medical'. Gynaecology and obstetrics, general surgery, orthopaedics, trauma, cardiothoracic

Table 2. RBC product utilisation during pre-COVID, acute COVID and post-acute COVID periods and percentage change from pre-COVID

	Study period			% change from pre-COVID	
	Pre-COVID	Acute COVID	Post-acute COVID		
Descriptive variable	1 January 2019 - 26 March 2020	27 March 2020 - 20 June 2021	21 June 2021 - 13 September 2022	To acute COVID*	To post-acute COVID*
Days, *n*	450	450	450		
Adult RBC products, *n*	1 051 852	970 034	1 053 097	–7.8	0.1
Healthcare sector, *n* (%)					
Public	647 683 (61.6)	586 691 (60.5)	635 056 (60.3)	–9.4	–1.9
Private	404 169 (38.4)	383 343 (39.5)	418 041 (39.7)	–5.2	3.4
Gender, *n* (%)					
Female	651 669 (62.0)	589 600 (60.8)	638 164 (60.6)	–9.5	–2.1
Male	374 227 (35.6)	354 088 (36.5)	387 217 (36.8)	–5.4	3.5
Unknown	25 956 (2.5)	26 346 (2.7)	27 716 (2.6)	1.5	6.8
Age, years, *n* (%)					
<1	7 557 (0.7)	7 988 (0.8)	8 424 (0.8)	5.7	11.5
1 - 12	44 938 (4.3)	20 197 (2.1)	24 059 (2.3)	–55.1	–46.5
13 - 24	100 438 (9.5)	99 367 (10.2)	108 020 (10.3)	–1.1	7.5
25 - 45	345 530 (32.8)	362 130 (37.3)	387 296 (36.8)	4.8	12.1
46 - 70	301 043 (28.6)	328 655 (33.9)	354 562 (33.7)	9.2	17.8
≥71	124 867 (11.9)	128 111 (13.2)	146 404 (13.9)	2.6	17.2
Unknown	152 882 (14.5)	23 586 (2.4)	24 332 (2.3)	–84.6	–84.1
Specialty group					
Medical	560 011 (53.2)	509 519 (52.5)	556 195 (52.8)	–9.0	–0.7
Surgical	420 286 (40.0)	393 403 (40.6)	427 436 (40.6)	–6.4	1.7
Other	71 555 (6.8)	67 112 (6.9)	69 466 (6.6)	–6.2	–2.9

RBC = red blood cell.
*RBC usage in pre-COVID period is taken as the baseline.

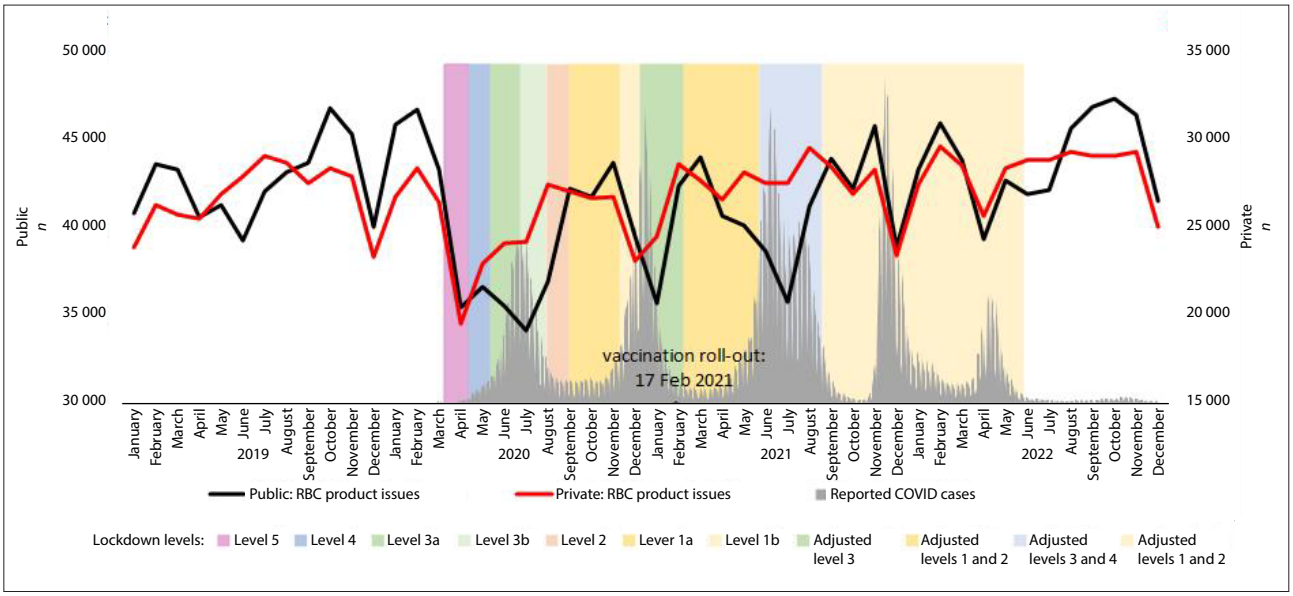

Fig. 1. RBC utilisation by healthcare sector and month between 2019 and 2022, against the backdrop of reported COVID-19 cases and instituted lockdown levels. (RBC = red blood cell.)

surgery and burns were grouped under 'surgical'. 'Other' includes requests where no discipline was indicated, and/or disciplines not included above.

To estimate the proportion of the population served by public and private health sectors, we utilised multiple data sources. We incorporated official mid-year population estimates from Statistics SA (Stats SA), along with health data from Stats SA's annual household surveys. Additionally, we used medical insurance membership data obtained from the Council for Medical Schemes' annual reports. These combined sources provided a comprehensive basis for our population coverage estimates across the public and private health sectors.[15,16]

Results

RBC utilisation by the different health sectors (public and private) overlaying reported COVID-19 cases and different lockdown periods is shown in Fig. 1. With the onset of the COVID-19 pandemic, overall RBC utilisation dropped by ~17%. The initial decline was more pronounced in the public sector. In addition, the public sector showed a significant decline in utilisation with each successive COVID-19 wave, while the private sector appears to have had limited to no impact after the second wave in December 2020. The public sector took longer to recover utilisation to pre-COVID levels than the private sector after each of the first three waves. Utilisation slowly recovered to pre-2020 levels in the latter half of 2022. A year-on-year comparison shows the seasonal trend in RBC utilisation, with decreased usage during the traditional SA April and December holiday periods (Fig. 2). This seasonal decline in RBC utilisation was exacerbated by the simultaneous COVID-19 waves.

Compared with the pre-COVID-19 period, RBC product utilisation decreased by 7.8% during the acute COVID-19 period (Table 2). The largest decreases were seen in the public sector (9.4%), among female patients (9.5%) and in the medical disciplines (9%). Of interest is the 9.2% increase in RBC utilisation among the 46 - 70-year-old patients during the acute COVID-19 period. Overall, RBC utilisation recovered in the post-acute COVID-19 period to pre-COVID-19 levels, with a marginal 0.1% increase. This was mainly due to the 3.4% increase in the private sector, while the public sector was still down by 1.9% compared with the pre-COVID-19 period. Utilisation in the medical group in the post-acute COVID-19 period was 0.7% below pre-COVID-19 levels, but the surgical group recovered with a 1.7% increase compared with pre-COVID-19 utilisation.

Fig. 3 demonstrates the relative percentage change from the pre- to the acute COVID-19 and the pre- to the post-acute COVID-19 periods by discipline group and healthcare sector. The private sector had a near uniform decline in all disciplines during the acute COVID-19 period, with significant increase during the post-acute COVID-19 period in all but the 'other' disciplines. In contrast, the public sector had a disproportionate decline in the medical disciplines (13.1%), with only the surgical disciplines recovering to just above pre-COVID-19 levels during the post-acute period.

The per capita RBC use in the study population was 12.1 per 1 000 in the public sector in 2020, a significant decrease from the 13.3 per 1 000 in 2019, the year before the COVID-19 outbreak ($p<0.0001$) (Table 3). In 2022, it increased to 12.9, but was still below 2019 per capita use. While the proportion of the population covered by private medical insurance decreased from 2019 (16.4%) to 2022 (15.8%), per capita utilisation increased significantly from 42.7 per 1 000 to 44.3 per 1 000 ($p<0.0001$).

Discussion

The COVID-19 pandemic has changed the fabric of society, and blood transfusion services have not been able to escape its effects. Numerous reports have shown the dramatic impact of COVID-19 on the ability of blood services to function during a respiratory infection pandemic, with far-reaching effects on staff, logistics, blood donors, as can be seen from this study, and also on blood utilisation.[17,18] Our analysis confirms that there was a significant change not only in the amounts of RBC used but also in overall blood utilisation patterns, which also differed between the two healthcare systems in SA. As expected in part, there was a general decline in the use of blood at a population-wide level. This may be variably attributed to a range of reasons, which demonstrate each in their own way the direct and indirect effects of the COVID-19 pandemic itself, or the response to the pandemic by governments, healthcare service providers, blood services and society in general.

In SA, an early and robust response by the government in terms of regulating human movement, social distancing, school closures,

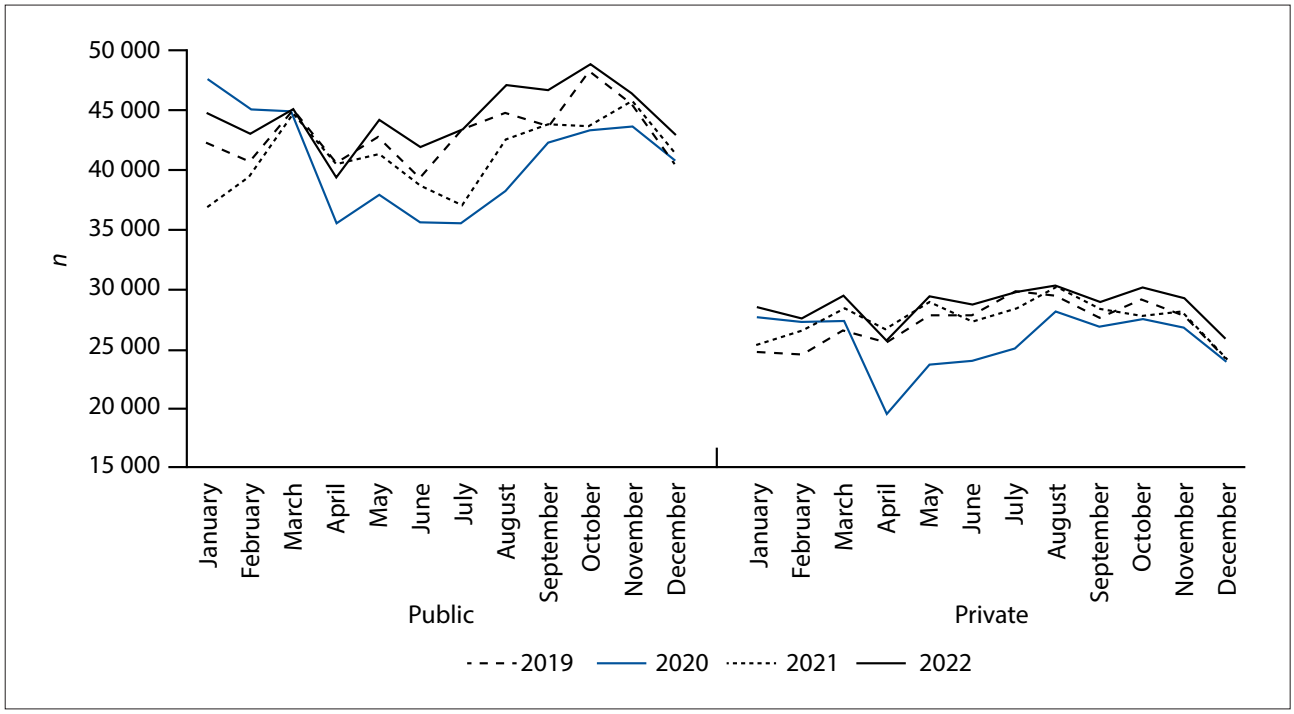

Fig. 2. Year-on-year comparison by month of red blood cell product utilisation in public and private healthcare sectors, 2019 - 2022.

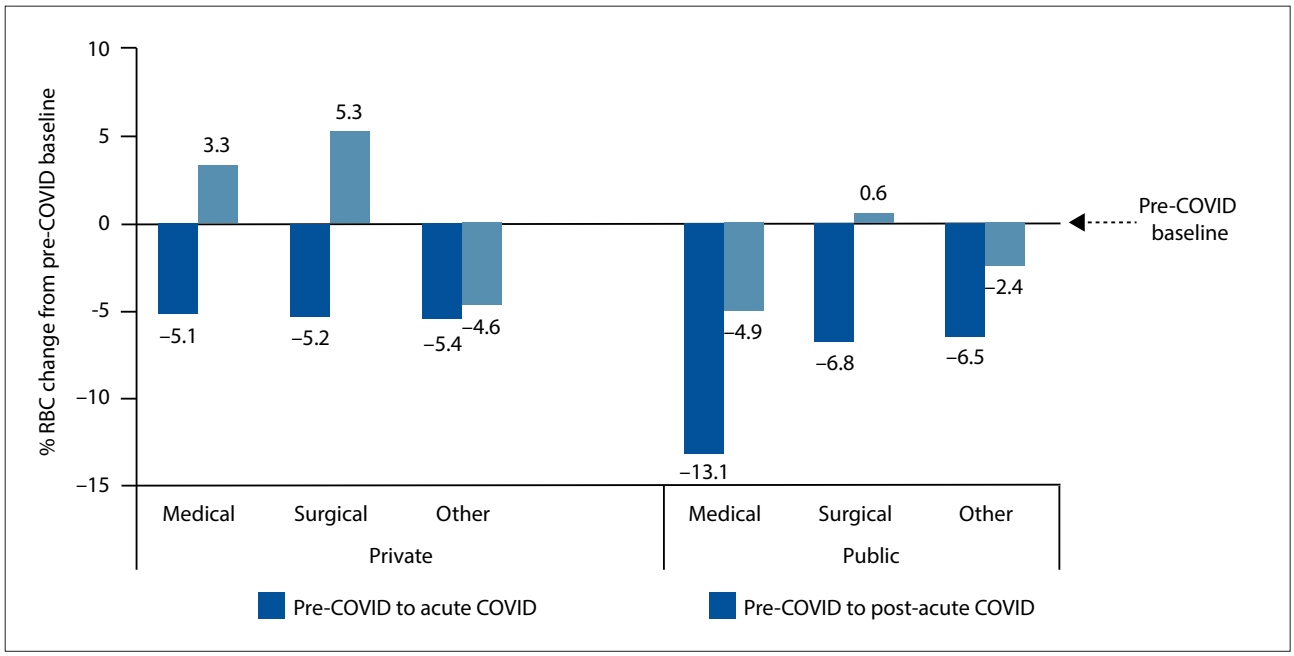

Fig. 3. Percentage change in RBC product utilisation from pre-COVID baseline to acute COVID and post-acute COVID periods per healthcare sector, by discipline group. (RBC = red blood cell.)

restrictions on alcohol use, curfews, etc., was expressed as a range of so-called 'lockdown levels', also called 'sheltering in place' in other regions. In terms of blood services, the lockdown measures had some positive impacts, on limiting the spread of the pandemic and initially decreasing both trauma and elective surgical procedures. However, they also had some inadvertent negative consequences on, among other things, donor and staff availability, blood drives, etc. The observed drastic reduction in surgical procedures, closure of outpatient clinics and a general hesitancy among patients to visit clinics or hospitals, where the risk of contracting COVID-19 was perceived as high, all contributed to a decrease in blood utilisation during the acute COVID-19 period.[19] The anticipated long-term consequences of treatment delays on cancer and chronic illnesses remain to be seen, but there is an impression that during periods when lockdowns were eased and COVID-19 case counts declined, patients presented at more advanced disease stages due to delays in the diagnosis of diseases, and consequently in the initiation of treatment.[20,21] This likely contributed to the rebound in utilisation seen during these periods. The effects of ongoing awareness campaigns by the blood transfusion services among the general public and healthcare workers on blood conservation and patient blood management (PBM) cannot be underestimated.

Table 3. RBC product utilisation per capita by healthcare sector (SA excluding Western Cape Province), 2019 - 2022

		Product issues by healthcare sector					
		Medical insurance, %		Healthcare sector,%		Per capita use per 1 000 population	
Year	Population ≥5 years old	Covered	Not covered	Private	Public	Private	Public
2014 - 2018*	-	14.50	85.50%	1 448 931 (38)	2 366 899 (62)	36.7	11.6
2019	46 608 827	7 621 495 (16.4)	38 987 331 (83.6)	325 252 (38.6)	516 477 (61.4)	42.7	13.3
2020	47 228 785	7 294 023 (15.3)	40 497 950 (84.7)	307 804 (38.6)	489 085 (61.4)	42.2	12.1
2021	47 969 315	7 387 274 (15.4)	40 582 041 (84.6)	331 001 (40.1)	495 425 (59.9)	44.8	12.2
2022	49 026 449	7 746 179 (15.8)	41 280 270 (84.2)	343 075 (39.1)	533 492 (60.9)	44.3	12.9

RBC = red blood cell.
*Average RBC utilisation/1 000[15] including all ages.

It is unclear how delay in seeking healthcare impacted blood utilisation. A survey conducted by the National Income Dynamics Study – Coronavirus Rapid Mobile Survey (CRAM) showed that 22% of those who needed acute care and 4% of those who needed chronic care did not seek care during the first wave of the COVID-19 pandemic in SA.[20,22] An overall decrease in the use of maternity and reproductive health services was noted in all provinces in SA during the same period.[23] The COVID-19 pandemic further disrupted and strained maternal and neonatal public health services by diverting already limited human and other resources to care for COVID-19 patients. This directly impacted the health of healthcare workers and the migration of especially maternity patients to ancestral homes in rural areas (with historically limited health resources). Data published in December 2020 showed an increase in maternal mortality of 30%, with a separate publication in June 2021 reporting an 18% increase in national maternal mortality at the facility level.[24] Although COVID-19-related deaths are included, the groups felt it likely that the indirect effects of COVID-19 significantly contributed to this increase.

More challenging to explain, but very interesting, is the different patterns of blood use displayed by the public and private sectors, respectively. Relative to the population size, the use of RBC/1 000 population prior to 2020 was between 3 and 3.5-fold higher in the private sector than in the public sector.[15] This divergence increased to 3.7-fold in 2021 before dropping to 3.4-fold in 2022. This difference is surprisingly large, even if differences in age distribution and access to care are considered. The private sector likely has more elderly patients with a known increased need, as a group, for blood transfusion.[13] Then again, there is a larger burden of HIV infection in the population serviced by the public sector (14% v. 4.3%), which can increase the need for blood.[25-27] Wong *et al.*[27] found in their population-based multimorbidity study that there was a convergence of infectious and non-communicable disease epidemics in a rural community leading to anaemia. This is likely to increase the concomitant need for blood. These underlying differences in blood demand drivers may explain, in part, the greater relative reduction of RBC use in the private sector, especially during the initial lockdown period, as the reduction happened off a much higher baseline. Despite the already very low baseline blood utilisation in the public sector, a significant further decrease was seen. As the lockdown measures were relaxed, hospital services, including elective surgery, were reactivated, which may explain the progressively smaller decreases in blood use during the subsequent periods. The overall pattern of initial rapid decline with variable return to near-normal utilisation broadly aligns with the observed changes in utilisation patterns in the USA.[29]

Our study has limitations. The lack of detailed information on individual patient diagnostic and clinical data hampers conclusive explanations of the altered utilisation patterns. The COVID-19 pandemic changed the social, economic and health environment globally. There may be some contributing factors affecting blood utilisation that were not measured in this study. Data from the Western Cape Province, which is serviced by Western Cape Blood Services, were not available for this analysis. Western Cape is the province with the highest medical insurance coverage of the population, with 25.2% of the of the population being members of medical aid schemes.[16] It is unclear if similar marked differences in COVID-19 red cell utilisation patterns exist between private and public healthcare sectors in the Western Cape.

The COVID-19 pandemic has provided valuable lessons and highlighted the need for agile contingency plans from blood services and healthcare providers alike. The impact of the epidemic should be seen as a multitude of factors that interlink, and affect any given service on several levels. From a blood collection perspective, these factors included the socioeconomic hardships of the general public as potential donors, the public's legitimate and preconceived fears of transmission risk (which impacts their willingness to visit donation sites) and the legally enforced limitations on public movement (which impacts on donors' ability to access blood donation sites). From a blood utilisation perspective, the COVID-19 pandemic appears to have impacted both the total demand for and utilisation patterns of RBC products, which were likely influenced initially by the decrease in trauma cases, and also the ability to access healthcare and available healthcare resources in SA. The COVID-19 pandemic, again, accentuated the differences in blood utilisation patterns between the public and private healthcare sectors in SA.

Conclusion

The COVID-19 pandemic's impact on blood services was multifaceted and complex, affecting both supply and demand dynamics. On the collection side, socioeconomic hardships, public fears of transmission and movement restrictions hampered donor accessibility and willingness. Concurrently, blood utilisation patterns shifted dramatically, influenced by government regulations, reduced trauma cases, altered healthcare access and resource allocation.

The pandemic particularly highlighted the stark differences in blood utilisation between SA's public and private healthcare sectors. This crisis underscored the need for a resilient and adaptable blood service system capable of responding to sudden changes in times like this.

Moving forward, sustainable service delivery planning should account for these interconnected factors. This includes strategies to maintain donor engagement during crises, flexible collection methods and improved co-ordination between healthcare sectors. Additionally, the disparity in utilisation patterns between the public and private sectors calls for a more integrated approach to ensure equitable access to blood products across all healthcare settings.

Ultimately, the lessons learned from the COVID-19 pandemic provide valuable insights for enhancing the robustness and responsiveness of blood services in South Africa, preparing the system for future challenges and ensuring consistent, efficient blood product provision across all healthcare environments.

Data availability. The study data are not publicly available as this may compromise the privacy of transfusion recipients. Reasonable, SANBS Human Research Ethics Committee-approved requests may be addressed to the corresponding author.

Declaration. None.

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