IMPACT OF THE COVID-19 PANDEMIC ON BLOOD TRANSFUSION SERVICE: A CASE STUDY FROM KOLKATA, INDIA

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ABSTRACT

BACKGROUND:

The emergence of coronavirus disease (COVID-19) has posed a significant threat to public health all over the world and it has been a difficult challenge for blood banks in India to cope with the situation. In this study, the effect of the COVID-19 pandemic on the blood transfusion service of India has been assessed.

METHOD:

The present study is conducted in a stand-alone community blood bank situated in the city of Kolkata, India. A comparative evaluation of supply, demand, and utilization of blood components by analysing pre-pandemic and post-pandemic data from 2017 to 2020 has been presented.

RESULT:

As no blood donation camp could be organized due to the country-wide lockdown along with restrictions in mobility and large gatherings during the initial period after the outbreak of the pandemic, a significant reduction of 80.35% in blood collection was observed. The demand for the Packed Red Blood Cell was decreased by 75% due to the postponement of elective surgeries and non-urgent clinical interventions. Blood utilization patterns also changed as 40% of the Packed Red Blood Cell was issued to thalassemia patients during this period.

CONCLUSION:

Based on the evaluation of blood bank performance under pre-pandemic and post-pandemic conditions, recommendations such as spreading public awareness, maintaining sufficient safety stock, proper training of blood banking staff, communicating with nearby hospitals, donors, and medical professionals have been identified to be helpful to mitigate the adverse effects of extreme situations such as a pandemic.

KEYWORDS

blood bank, pandemic, COVID-19, blood transfusion, healthcare policies.

INTRODUCTION

Coronavirus disease (COVID-19), caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), was first reported on 31st December 2019 at Wuhan city of Hubei province in China [1]. COVID-19 was identified as a public health emergency of international concern on 30th January 2020, and it was declared a global pandemic on 11th March 2020 by World Health Organization (WHO) [1, 2]. COVID-19 affected 231 countries and territories, with over 685 million confirmed cases worldwide. The first case

of COVID-19 in India was identified in Kerala on 27th January 2020. The government of India took a number of measures in an attempt to restrict the spread of the virus. A country-wide 21-day lockdown was announced on 25th March 2020, extending until 31st May 2020 in four phases [3]. Despite taking all possible restrictions, the virus transmitted rapidly, affecting 10 million people during 2020. Figure 1 displays the number of daily new COVID-19 cases in India during 2020.

FIGURE 1: NUMBER OF DAILY NEW CASES OF COVID-19 IN INDIA DURING 2020
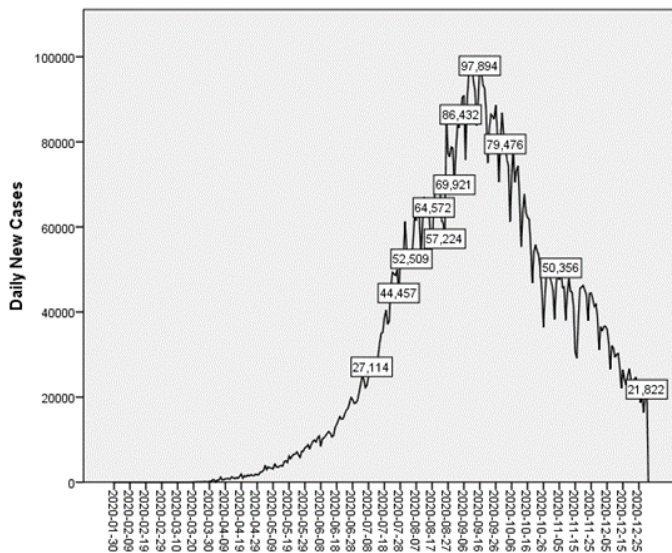
The onset of the COVID-19 pandemic disrupted the social and economic system of India and created panic among the population [4]. Most importantly, it has a severe detrimental effect on the healthcare system of the country [5].

A blood bank is an integral part of any healthcare facility, ensuring the smooth functioning of the entire system. Blood transfusion therapy is vital for various blood disorders like thalassemia, sickle cell anaemia, haemophilia, along with cancer, postpartum haemorrhage, and different surgical procedures. Rapid improvement in blood banking in the last few decades has led to a sharp increase in demand for blood components [6]. Blood is treated as a 'drug' in India under the Drug and Cosmetics Act 1940. Unlike central blood banking system of some countries, India has a mixed blood banking system with a total of 3321 licensed blood banks, including central blood banks, hospital blood banks, and stand-alone community blood banks catering to a diverse population [7]. Although the availability of safe blood increased from 4.4 million units in 2007 to 12.5 million units by 2019-20, the annual clinical requirement is estimated at 14.6 million units of blood components [8]. The

uncertain nature of supply and demand, variation of blood groups in the population, perishability, and different therapeutic usage of different blood components make the blood banking system very complicated [6]. The COVID-19 pandemic added more complexity to an already complex system creating a major imbalance in the supply and demand of blood, causing frequent shortages in various parts of the country [9-11].

This study aims to identify the problems being faced by a blood bank situated in the city of Kolkata, India, and the policies being taken to maintain a steady supply of blood while ensuring the safety of the blood donors, patients, and the blood bank staff during the COVID-19 pandemic. The findings will be advantageous for suggesting potential measures to address any such emergency situation in future. This study is intended to answer the following research questions (RQs)

RQ1. What is the impact of the COVID-19 pandemic on the supply, demand, and utilization pattern of blood products?
RQ2. What strategies were followed by the blood bank to ensure the continuous supply of safe blood during the pandemic?
RQ3. What measures were taken by the blood bank management to ensure safety in the blood bank during the pandemic?

In order to address the aforementioned research questions, pre-pandemic and post-pandemic data is collected for comparative analysis, and discussions are carried out with the blood bank management officials and medical officers of a stand-alone blood bank located in Kolkata, India.

LITERATURE REVIEW

As blood banks all over the world faced adversity caused by a pandemic for the first time, researchers analysed its impact on the blood banking systems of different countries. American Red Cross, the single blood supplier in the United States, estimated that 4,600 blood drives were cancelled with a loss of 143,600 units of blood [12]. Loua et al conducted a survey in 37 countries of the WHO African region and reported a drop of 12.1% in blood donation in 21 countries [13]. Another survey conducted by Al-Riyami et al in 15 countries in eastern Mediterranean region showed that the blood supply decreased by 10-75% during the first month of the pandemic [14]. In China, Wang reported a 67% decrease in the number of whole blood

donors in Zhejiang province, whereas Leung and Lee observed a noticeable drop in blood collection at a regional blood centre [15, 16]. Similar studies reported a significant reduction in the supply of blood at King Abdulla Hospital in Saudi Arabia, Iranian Blood Transfusion Organization, the Brazilian blood bank network, and blood banks in Italy and India [17-20, 9]. Senapati et al reported a 56% reduction in transfusion sessions in a haematology centre in India [21]. Pál et al also observed a decrease in blood product usage during the first months of the pandemic in a blood centre in Hungary [22]. Vasconcelos et al reviewed research papers related to the impact of natural disasters and pandemics and highlighted the lack of emergency plans for any extreme situation [23]. However, researchers recommended various preventive measures and discussed the best practices that have emerged in blood transfusion services during the pandemic by presenting contingency planning in the event of predicted shortage, types of blood supply interventions, and blood campaigns using bloodmobiles [24-27].

No study has been found to have considered the impact of the COVID-19 pandemic on all aspects of the blood banking system. A holistic approach is taken in this paper to capture the changes in the blood supply, demand, and utilization of blood components of an Indian blood bank during the pandemic.

PROCESS MAP OF BLOOD BANK SYSTEM
In a typical Indian blood bank, blood is collected from voluntary non-remunerated healthy donors in blood donation camps, blood mobile, and in the blood bank after fulfilling a number of eligibility criteria set by the National Blood Transfusion Council of India. The collected blood is then transferred to the blood bank, and recommended tests are performed to screen out the contaminated blood units. The useful Whole Blood (WB) units are then typed into a particular blood group (A+, B+, O+, AB+, A-, B-, O-, AB-), and blood components, i.e. Packed Red Blood Cell (PRBC), Fresh Frozen Plasma (FFP) and Platelet are prepared, to be stored under appropriate conditions. Upon receiving a request from the physician, the compatible blood component is issued to the patient after cross-matching and blood grouping following the FIFO (First In First Out) issuing policy. Figure 2 displays the process map of a typical blood bank in India.

MATERIALS AND METHODOLOGY

Case study method is used in this research to identify the consequences of COVID-19 pandemic on the blood banking sector of India. A systematic approach was taken to collect data regarding various activities of blood banking and draw meaningful insights about the effect of the pandemic using numerical and graphical descriptive statistical methods [17, 19, 22].

The study was conducted in a well-known stand-alone community blood bank located in Kolkata, India. The blood bank acts as a common inventory to many hospitals in the region and has provided blood components to 5,319 patients in 2019. Additionally, the blood bank supplies blood to more than 100 thalassemia patients on a regular basis. Data regarding blood collection, blood component processing, testing, and daily demand for different therapeutic practices have been collected from the blood bank registry books from 2017 to 2020. The data regarding supply and demand is aggregated on monthly basis and described using time series graphs, means, and standard deviation, whereas different categorical data is described using percentages and frequencies with the help of SPSS version 22.0.

Discussions were carried out with management officials and medical officers about the preventive measures that were taken to contain the spread of the COVID-19 virus at each stage of blood banking and to ensure the timely availability of safe blood during the pandemic. Permission for conducting the study and collecting data for academic and research purposes was obtained from the authority of blood bank. In order to maintain confidentiality, the name of the studied blood bank is not mentioned in the paper. Moreover, data regarding daily stocks of blood components of all blood banks of India are available in the Centralized Blood Bank Management System of India at eRaktKosh (https://www.eraktkosh.in). This work does not involve any human research subjects or human participants.
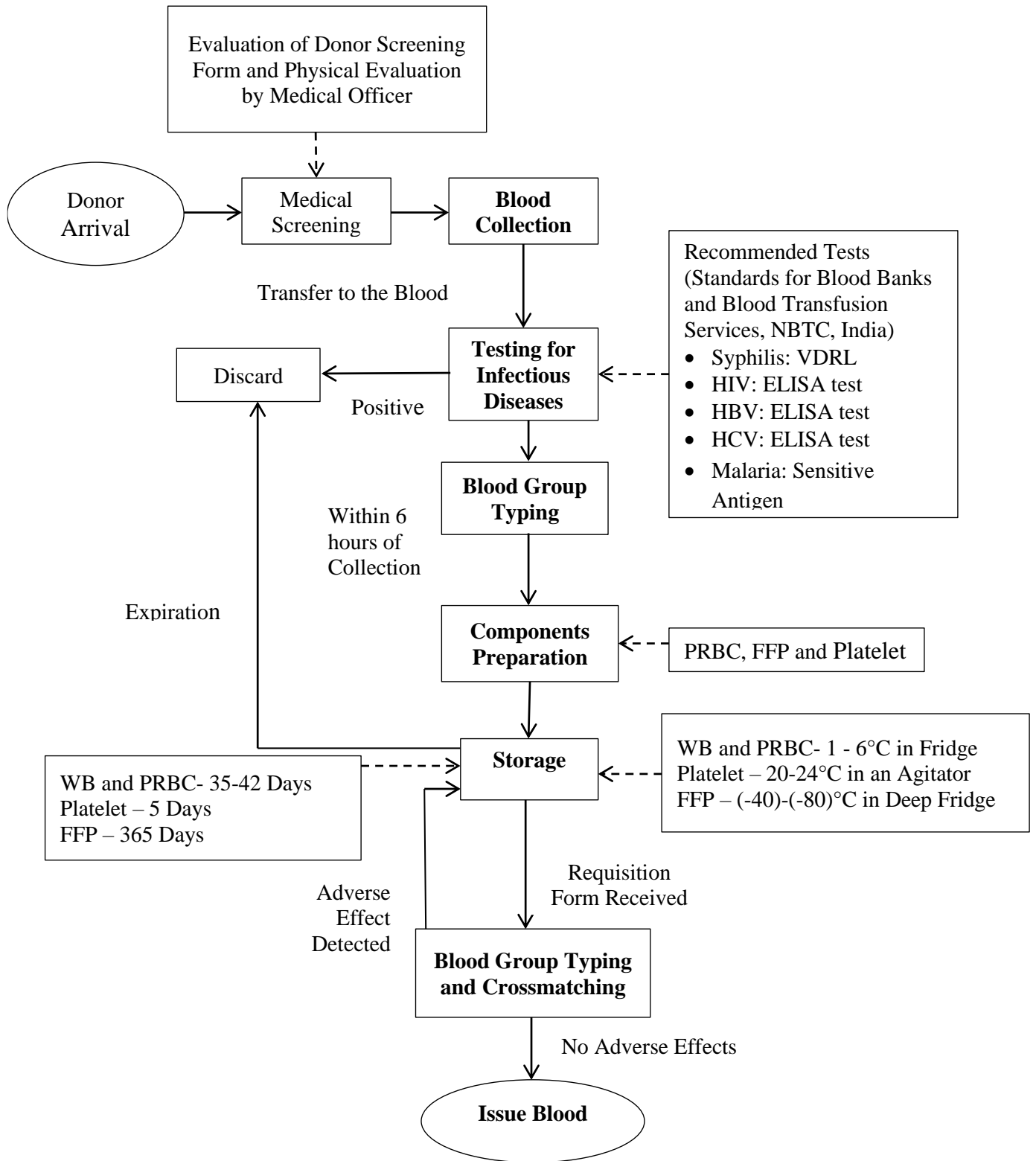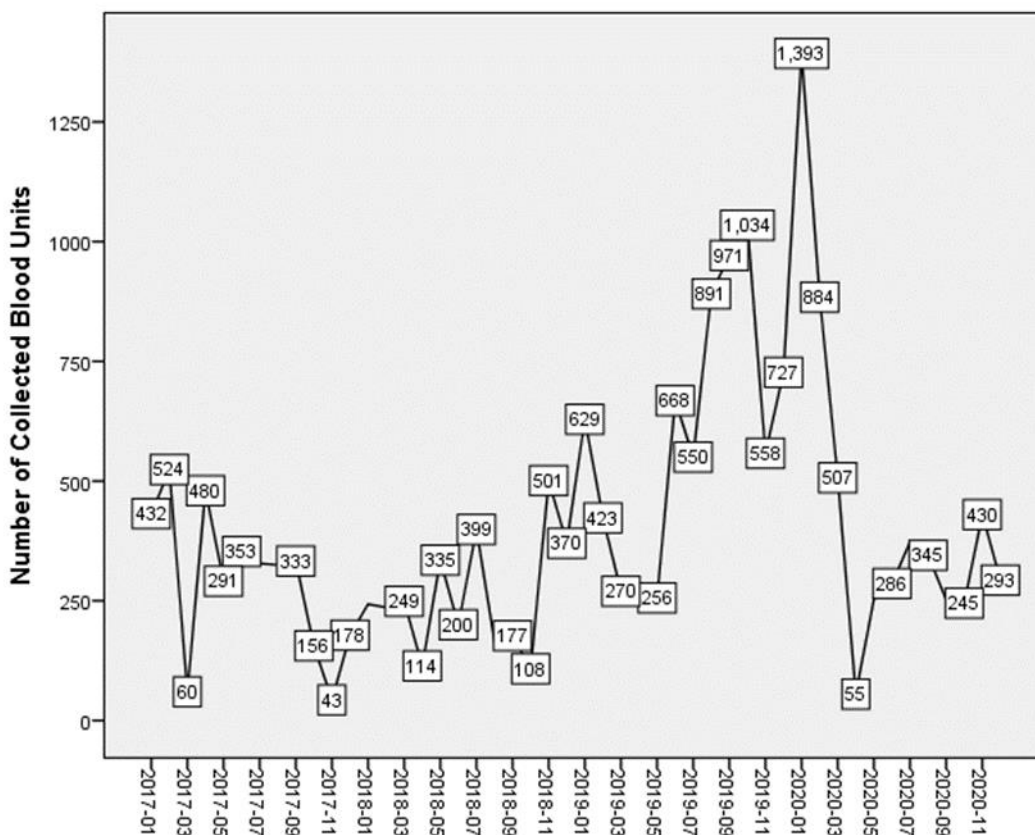
RESULTS

The onset of COVID-19 pandemic and the rapid increase in the number of infected people have significantly affected the entire healthcare industry in India. Challenges faced by the blood bank under study at the time of the pandemic is discussed in detail, and related data has been presented in this section.

IMPACT ON BLOOD COLLECTION

Figure 3 displays the monthly collected units of blood from 2017 to 2020. It shows a sharp reduction in blood donation after the outbreak of the pandemic in the blood bank under study. Total blood collection decreased by 20.90% in 2020 compared to 2019, with a significant reduction of 80.35% during April 2020 (first month of lockdown) compared to March 2020.

Figure 4 displays the expected number of donors to the actual number of blood donors to the useful blood units from 2017 to 2020. Out of 7,016 expected donors from 97 planned blood donation camps during 2020, only 5,395 donors turned up for the blood donation. Notably, 80.5% of the donor is male, whereas only 19.5% is female. 197 blood units were discarded due to the presence of different reactive agents in the blood, making 96% of the collected blood units safe to be transfused to the patients.

The blood bank encouraged the blood recipients to get a donor from their family or friends. A total instance of 174 replacement donations was noted during the pandemic in 2020 in the blood bank under study. Blood was collected by only replacement donation in the blood bank itself during April 2020.

Table 1 shows group-wise distribution of collected blood from 2017 to 2020. In 2020, 36.92% of the collected blood is of type B+, followed by 28.85% with type O+, which is similar to previous years.

FIGURE 3: MONTHLY BLOOD COLLECTION

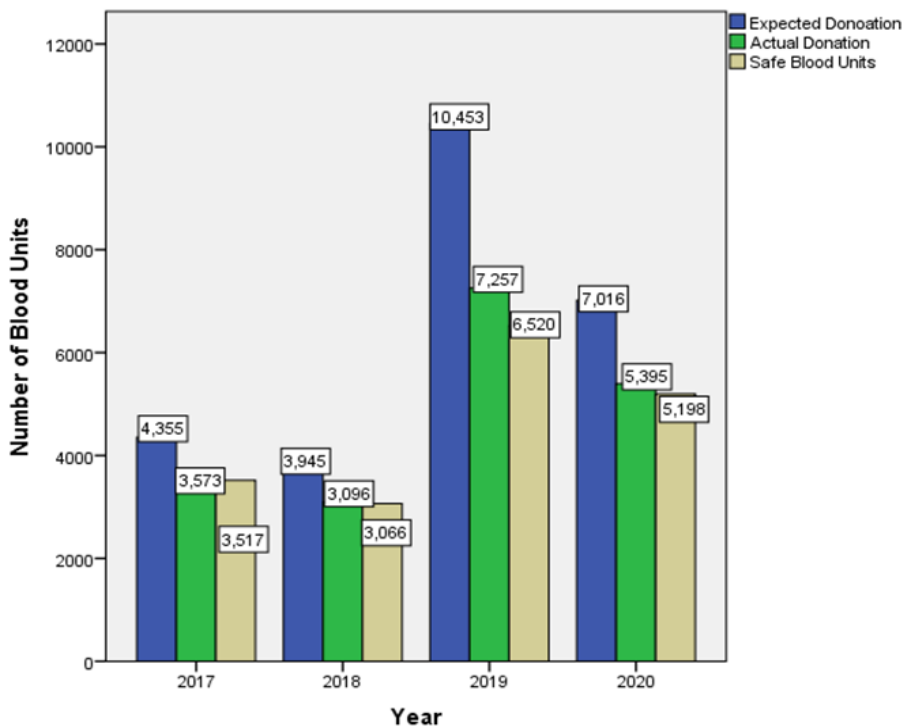**FIGURE 4: EXPECTED VS ACTUAL VS SAFE BLOOD DONATION**

TABLE 1: GROUP-WISE DISTRIBUTION OF COLLECTED BLOOD DURING 2017 TO 2020

Year	Blood Units Collected	Group-Wise Distribution of Collected Blood (in %)							
		A+	B+	AB+	O+	A-	B-	AB-	O-
2017	3540	21.97	38.92	9.93	30.32	0.68	1.03	0.29	0.85
2018	2967	22.89	37.78	8.32	30.39	0.69	1.17	0.28	0.93
2019	7098	20.93	37.75	9.34	29.38	0.64	1.07	0.16	0.74
2020	5227	21.52	36.92	10.06	28.85	0.69	0.96	0.27	0.73

Deficiency in blood supply affected the inventory levels of the blood components. The stock level of PRBC dropped by 92.59%, and that of FFP dropped by 43.17% in April 2020 compared to March 2020. It is noteworthy that there was no stock of PRBC for 3 days, and the stock was lower than ten units for 13 days in 2020. Shortage of rare blood groups was also a major concern during this period.

IMPACT ON DEMAND OF BLOOD COMPONENTS
The demand for different blood components is usually very uncertain in nature. During the pandemic, the demand pattern became even more unpredictable and an overall decrease in demand for blood components was observed. Figure 5-8 displays the monthly demand of WB, PRBC, FFP, and Platelets from 2017 to 2020. Figure 6 shows a 75%

reduction in demand for PRBC, and Figure 7 shows an 80% reduction in the demand for FFP in April 2020 compared to March 2020.

In the blood bank under study, 5,162 units of PRBC, which is 89% of the acquired blood components, were issued to the patients in 2020. Table 2 shows the mean daily demand and the standard deviation of the daily demand of PRBC. The high standard deviation of daily demand of PRBC shows the highly uncertain nature of demand.

Table 3 displays the PRBC demanded by the blood group from 2017 to 2020. It can be observed 35.54% of the demanded PRBC is for B+ blood group, followed by 29.5% for O+ blood group during 2020, which is similar to previous years.
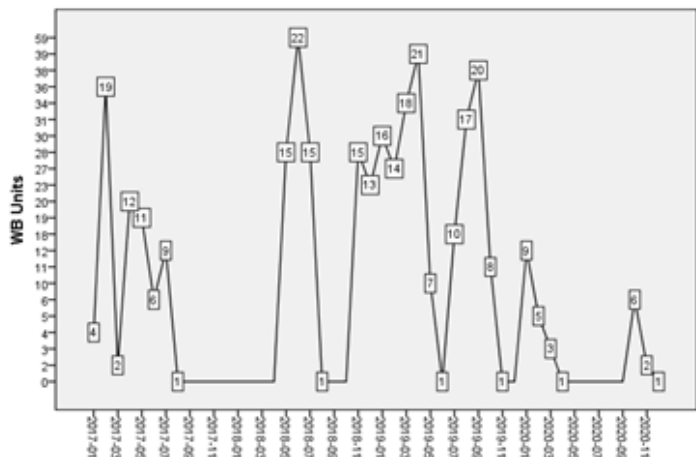
FIGURE 5: MONTHLY DEMAND OF WB

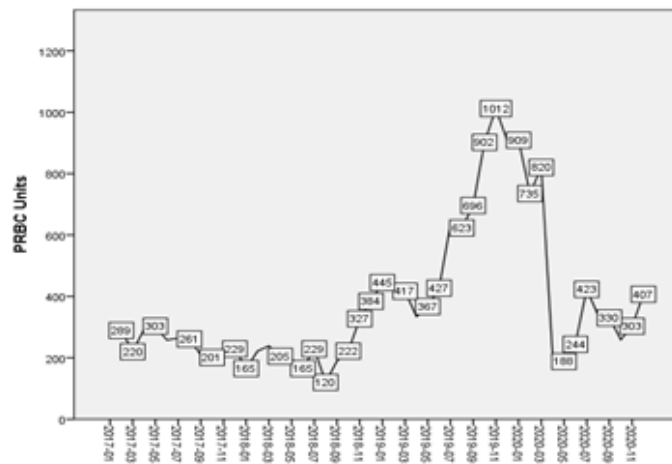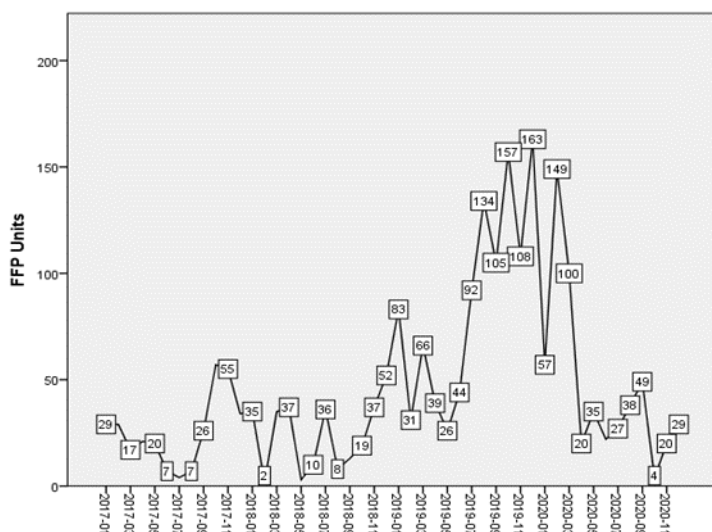## FIGURE 6: MONTHLY DEMAND OF PRBC

FIGURE 7: MONTHLY DEMAND OF FFP

FIGURE 8: MONTHLY DEMAND OF PLATELET
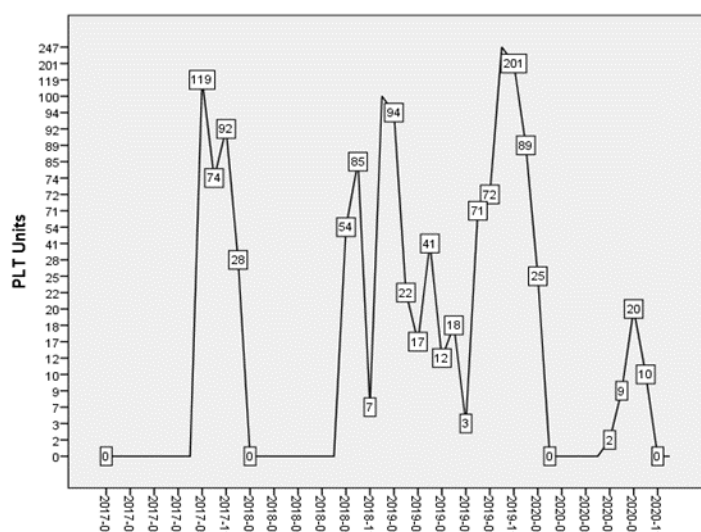
TABLE 2: VARIATION OF DEMAND OF PRBC ACCORDING TO BLOOD GROUPS DURING 2020

	A+	B+	O+	AB+	A-	B-	O-	AB-
Mean of Daily Demand of PRBC	3.16	5.03	4.18	1.4	0.11	0.14	0.11	0.02
Standard Deviation Daily Demand of PRBC	3.521	4.576	4.019	2.02	0.376	0.408	0.383	0.146

TABLE 3: BLOOD GROUP-WISE DEMAND OF PRBC DURING 2017 TO 2020

Year	Group-Wise Distribution of Demanded PRBC (%)							
	A+	B+	O+	AB+	A-	B-	O-	AB-
2017	21.22	35.36	30.54	9.68	0.77	1.16	1.00	0.27
2018	22.28	34.96	31.57	8.33	0.56	1.31	0.81	0.28
2019	21.31	36.02	30.49	9.80	0.61	0.98	0.60	0.20
2020	22.31	35.54	29.50	9.87	0.77	1.00	0.77	0.23

UTILIZATION PATTERN OF BLOOD COMPONENTS

Figure 9 displays the percentage of different clinical reasons for which blood was issued to patients from the blood bank under study during 2020. Out of 3,810 blood recipients, 50.95% of the patients were male, and 49.05% are female. 31.13% of the demanded blood component was issued to patients with chronic anaemia followed by 30.29% for thalassemia patients.

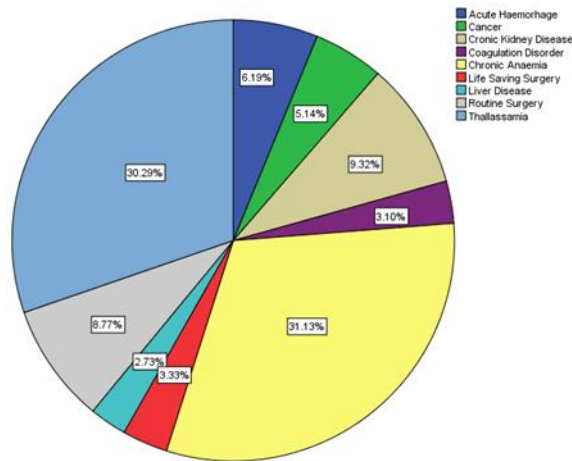**FIGURE 9: PERCENTAGE OF BLOOD DEMANDED BY CLINICAL REASON DURING 2020**

Figure 10 displays the blood component demanded for different clinical reasons during the complete lockdown period in India (April-May 2020). 40% of blood was acquired by thalassemia patients, followed by 25% for patients with chronic anaemia.

FIGURE 10: PERCENTAGE OF BLOOD DEMANDED BY CLINICAL REASON DURING APRIL-MAY 2020
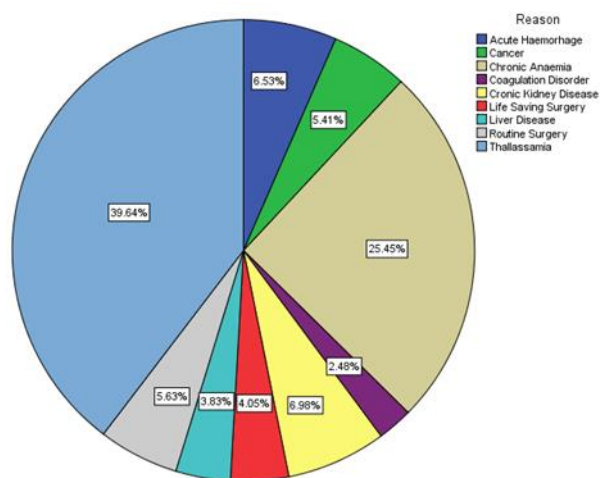
DISCUSSION

Reduction of blood donations was observed all over the world during the first few months after the outbreak of the pandemic [12-22]. Collection of blood is not very easy, and it is even more difficult during the pandemic [28]. In India, the country-wide lockdown and subsequent restriction of mobility and large gatherings led to the cancellation of planned blood drives. No blood donation camp could be arranged during the first month of the lockdown (April 2020) because of the closed educational institutes and workplaces. Moreover, several newly imposed deferral criteria and the fear of getting infected during the blood donation process led to an acute shortage of blood supply [29]. Donors were encouraged to donate blood in the blood bank with appointments to ensure safety and avoid gathering. Although voluntary blood donation is considered to be the safest practice for blood collection, replacement donation plays an important role in maintaining a sufficient inventory level of blood in this circumstance [30]. During the pandemic, the cost of personal protective equipment, face shield, face mask for the medical officers and the blood banking staff, in addition to sanitization equipment increased the cost of blood collection. Disrupted supply of consumable products was observed during this period because of the limited production, restricted transportation, and closed international borders.

To avoid any possible transmission of COVID-19 from blood donation and blood transfusion, the apex body of the blood banking system in India, the National Blood Transfusion Council (NTBC), the Ministry of Health and Family Welfare, Government of India, developed some policies. Considering the specific condition of the blood bank, the management also took suitable measures to keep the healthcare workers safe amidst the pandemic. The studied blood bank was operated by a limited number of medical officers, laboratory technicians, and nurses. Less numbers of laboratory technicians were assigned to various tasks of the blood bank to avoid any gathering. The working hours of the blood bank were reduced by closing the blood bank services at night. Transportation was provided to the blood bank employees so that they were less exposed to any asymptomatic carrier of COVID-19. If any blood bank staff developed any symptoms of COVID-19, they were tested and quarantined for 14 days. The blood bank staff were vaccinated as soon as the COVID-19 vaccine was available.

After the initial period of the pandemic, blood donation camps were organized in a large open area, which increased the blood supply. Thermal checking, wearing of protective masks, maintaining hand hygiene for blood donors and blood bank staff, safe disposal of bio-medical waste, maintaining social distancing, and repeated sanitization of the donation area were made compulsory by the blood bank management [29]. Donors with symptoms of COVID-19 were automatically deferred in the donor screening process [1]. To avoid the spread of the virus from asymptomatic and pre-symptomatic donors during the blood donation process, donors with international travel history, possible exposure to a confirmed or suspected case of COVID-19, and donors who recovered or got vaccinated were deferred for 28 days [29].

During the pandemic, the demand for blood decreased due to the postponement of elective surgeries and non-urgent clinical interventions as per the directive from the Government of India, and reduction in the number of road traffic accidents due to the lockdown [21, 24]. The blood bank medical officials were communicating with the physicians and the blood component was acquired only if it is absolutely necessary. Preoperative anaemia management was encouraged to reduce to demand for PRBC. The blood bank strictly followed FIFO issuing policy during this period. As delay or unavailability of blood may deteriorate the health of patients, who needs regular blood transfusion, the studied blood bank prioritized the thalassemia patients. Only after ensuring sufficient stock for such patients the blood bank accepted the request for blood requisition in an emergency condition.

CONCLUSION AND RECOMMENDATION

The world faced an unprecedented challenge when COVID-19 started to spread rapidly, affecting millions of people. Years of planning to face an unforeseen pandemic failed as the healthcare industry struggled to cope with the situation. As a developing and the second-most populous country in the world, India was hit by the abruptness of the outbreak. As healthcare professionals struggled to provide appropriate care to patients affected by COVID-19, patients with other severe medical conditions strived to survive. Being one of the most essential healthcare inputs, a continuous blood supply is necessary all the time. To manage this unforeseen challenge, several policies were taken by the blood bank as well as the

Government of India to avoid any undesirable events and balance the supply and demand of safe blood. In this paper, a comparative analysis pre-pandemic and post-pandemic data captures the impact of the pandemic in a decentralized community blood bank in Kolkata, India.

A number of potential ways to ensure a continuous supply of safe blood during emergency situation have been acknowledged in this study. Spreading public awareness about different deferral criteria, the importance of blood donation, and the shortage of blood supply through different media is very important during a crisis. The blood bank must always remain informed about the local epidemiology, the health situation of the country, the policies taken by the government, and the shortage of blood components in other blood banks. Training regarding maintaining safety in blood donation camps and the blood bank should be provided to the employees. Maintaining a robust inventory level with safety stock by analysing the utilization pattern is very important in order to reduce shortages in an emergency situation. Systemic application of these methods may reduce the consequence of any future disastrous situation in the blood banking sector.

Finally, the findings presented in this study can be used to prepare a planning strategy for blood collection, considering the insights of the blood donors during any disastrous situation. Future research could also consider formulating inventory models and issuing policies reflecting the drastic change in blood supply and demand during such a period.

LIMITATION OF THE STUDY
As India is a country with diverse population, the data will vary for other blood banks depending upon its location and associated hospitals. The findings of the analysis should be interpreted carefully to identify changes so that a robust system can be formulated for any future emergency situation.

DECLARATION OF CONFLICTING INTERESTS
The Authors declare that there is no conflict of interest.

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