
COVID-19 Challenges and Corresponding Implemented Measures of Blood Banks: A Systematic Review

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ABSTRACT

Background: The COVID-19 pandemic started in December of 2019 and unfortunately, it continues to affect millions of lives today. The healthcare sector was particularly affected straining its performance and resources, in which one of the most affected areas was the blood banking operations. Due to the high transmissibility of the virus several concerns regarding safety on staffs and patients became an issue affecting blood banking procedures leading to decrease in supply of blood products which resulted in hampering the demand for transfusion.

Objective: This study aimed to identify the concerns of and the associated measures implemented on blood banking facilities in response to the COVID-19 pandemic on safety, demand and supply of blood products.

Search Methods: The authors used the PRISMA framework to systematically search and review relevant literatures electronically from PubMed, Sciencedirect, ProQuest, and ClinicalKey databases.

Selection Criteria: Based on the PRISMA framework, relevant articles were included using keywords such as blood banking in relation to COVID-19 and blood banking concerns and measures undertaken in response to COVID-19. Out of 1,965 journal articles examined, 1,915 (97%) were excluded for they are not related to the research subject, being duplicates, and having abstracts only and not of full texts articles.

Data Collection and Analysis: The articles undergone three screening processes; first, three independent reviewers collected all data regarding the search results from the databases and select journal titles that were relevant to the topic, as well as filtering out duplicate journals, those that were not journal articles, and those with no abstracts; second; the researches review the abstracts which contain keywords and concepts related to the scope of this study; third; articles' full texts are reviewed by seven independent reviewers to determine if they have useful information wherein, they must contain relevant concerns and measures of blood banks in response to COVID-19, which are then categorized into safety issues, supply and demand for blood products.

Result and Conclusion: The data show that in maintaining blood supply, measures of increasing the donor recruitment by setting programs and strategies encouraging blood donation and decreasing the utilization of blood products by canceling or postponing elective surgeries were commonly undertaken. In addressing the demand for COVID-19 Convalescent Plasma (CP) treatment, different organizations and agencies regulate blood banking functions to allow CP treatment. Lastly, to prevent blood wastage due to decreased blood demand, coordination with other blood banks was needed to balance the supply. The implications of the detailed concerns and measures may serve as a reference for other blood banking facilities to adopt in their practice and operations in dealing with similar challenges.

Key words: Transfusion medicine, convalescent plasma therapy, safety protocols, blood supply, blood product demand

The COVID-19 pandemic brought about predicaments in the blood supply of blood banks

and the safety of the staff, donors, and patients resulting in massive cancellation of blood drives.¹ At the same time, anxieties and fear of contracting the SARS-Cov2 virus has driven donors away from the blood bank. Analyzing the trends of blood banking practices in response to the COVID-19 pandemic

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may address the laboratories' challenges and build awareness regarding the ongoing protocols. With over 187,000,000 confirmed cases as of July 2021 and varying numbers of new cases every day, the COVID-19 pandemic ensued a global public health crisis that significantly burdened different sectors of various countries, most especially blood banking services. The crisis started as an outbreak in Wuhan City of China. The agent of the COVID-19 was identified to be a member of the Coronaviruses (CoVs) known to cause respiratory diseases to humans. The rampant spread of the virus had claimed and affected lives all across the globe causing the World Health Organization to declare it as a public health emergency of international concern.

Most studies investigated the specific challenges and interventions done by blood banks, hospitals, and laboratories. These studies agreed that the impact of the pandemic to blood banking was the supply of blood products. Volunteer donors were kept away from blood drives due to the psychological impact of COVID-19² and stay-at-home orders.³ In the US, the National Blood Supply exhibited a 25% decrease in centers with a ≥ 3 -day supply and a 350% increase in centers with a ≤ 1 -day supply.³ The Mediterranean Region had up to a 75% decrease in blood supplies in the first month of the pandemic.⁴ Blood waste peaked at 54% in hospitals due to cancellations of elective and non-urgent surgeries. Interventions were made to counter the decline in supply and encourage donations. Staff functioned at a smaller number of duty changeovers with quarantine leave (Arcot, 2020), new protocols and guidelines were developed in transfusion practices, and the criteria in deferral of donors and discarding of blood were adjusted.⁵ Most studies discussed the interventions done to protect the donors, recipients, and staff of blood drives and laboratories. However, minimal research investigated the outcomes or effectivity. Although there were studies that project the wastage and deficits of blood supply in months, no available studies illustrate the supply, demand, and waste data over a year. Generally, there are no sufficient studies that associate the effect of the interventions to the long course status of blood supplies. In terms of safety, studies generally cited concerns as a hypothetical threat to prevent but failed to cite the incidence rates before and after measures were in place. Commonly various studies tended to focus on a specific aspect of concerns and measures in blood banking or in a specific locality rather than a comprehensive synthesis and analysis of such.

Due to various concerns regarding safety, supply, and demand brought by the COVID-19 pandemic in the practice of blood banking, several blood banks adaptive measures in addressing such concerns in the new normal were reported.^{6,7} Collating these measures can be of great help to other blood banking facilities affected by the pandemic. Hence, the study aims to determine the concerns and measures undertaken by the blood bank facilities/laboratories on the following aspects during the COVID-19 pandemic: 1) safety, 2) demand, and 3) supply. Moreover, this study may serve as a reference regarding the common and emergent concerns and measures adopted by blood banking facilities in response to the pandemic outbreak of the COVID-19 virus.

MATERIALS AND METHODS

This is a systematic review that collated the reports of previous studies on blood banking concerns and measures implemented in response to COVID-19.

Criteria for Considering Studies this Review

Types of Studies

Cross-sectional studies published in full text from 2019 to 2021 related to blood banking and COVID-19. Those Studies in abstract form were not eligible in this review. We included studies which contain concepts on "blood banking concerns due to COVID-19" or "blood banking interventions/measure/mitigation practices in response to COVID-19" which were broadly defined.

Types of Participants

Blood bank Laboratories/Facilities

Types of Intervention

The authors collated articles on blood banking concerns and measures undertaken in response to COVID-19.

Types of Outcome Measures

Specified concerns and measures regarding the blood banking which fall under the aspects of "safety issues" or "health risks" and "supply and demand of blood products".

- Safety - the reduction of risk of infection or complication due to COVID-19 among blood donors, recipients, and laboratory staff

- Blood Supply - the acquisition, availability and access to blood products in a blood bank facility

- Demand for blood products - the need for blood products by patients in therapy

- Implemented Measures - the interventions or changes in blood banking practices/ services in response to COVID-19 challenges

- Concerns – challenges faced by the blood banking facilities that affected its normal operation due to COVID-19 pandemic.

Search Methods in Identification of the Study

The PRISMA guidelines were utilized in searching and gathering information from different journals systematically.

Search Strategy

An electronic search for relevant articles was done using databases such as Pubmed, ScienceDirect, ProQuest, and ClinicalKey. The search terms such as blood bank, blood transfusion, blood products, convalescent plasma, COVID-19 or COVID, Sars-cov-2, as well as safety, demand, and supply were used. Union and intersection of the search terms limited to the English language were done.

Selection of the Studies

Search results were screened by three independent reviewers. The screening process involved manual checking of journal titles and review of the full texts for their relevance to the objectives of this study, as well as filtering out of duplicate journals and articles which are only available in abstract form. After thorough screening, a total of 50 articles were eligible to be included in the study (Figure 1).

Data Collection

Three reviewers independently gathered all data regarding the search results from the databases. The Mendeley Web importer was used to extract

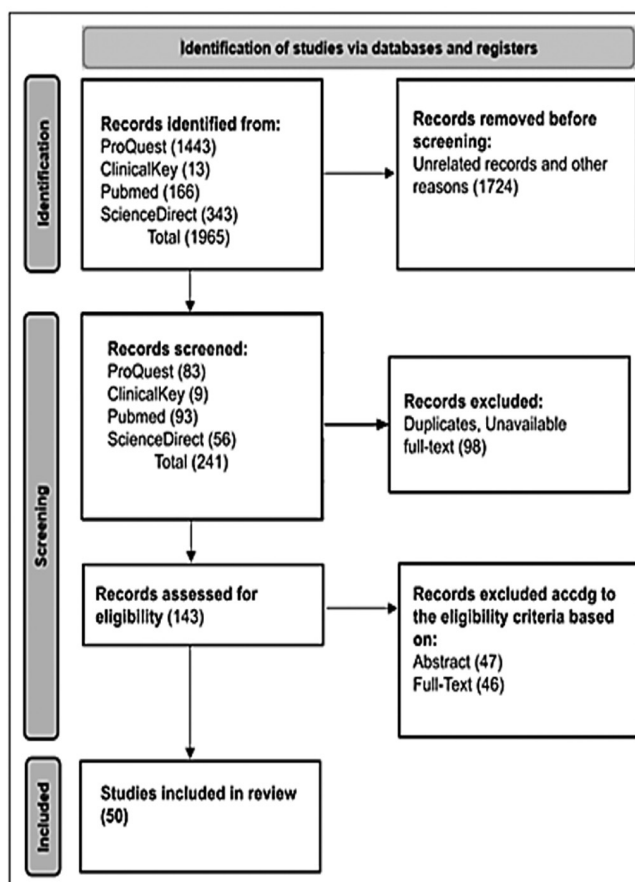


Figure 1. Identification, screening, and selection of studies using the PRISMA 2020 flow diagram.

the journal articles and their data, then all were consolidated in Google sheets. However, those articles retrieved from the Clinical key, due to a special function, the data had to be imported in an Excel file directly. The concerns and measures extracted from each journal were enumerated in Google sheets and subcategorized into the 3 Aspects (Safety issues, and Supply and demand for blood products).

RESULTS

Out of 1,965 journal articles examined, 1,915 (97%) were excluded and only 50 were included in the study. The 1,915 articles were excluded due to reasons of being not related to the research subject, being duplicates, and having no abstracts or full texts, among others (Tables 1, 2, 3). Various concerns and measures from the articles were extracted and were subcategorized under safety, supply and demand. Figure 2 shows the number of journals citing each aspect, with the blood supply aspect being the most cited subject.

Table 1. Screening 1. Titles relevant to subject matter, unduplicated search results, availability of abstracts.						
	SEARCH RESULTS		EXCLUDED		INCLUDED	
Database.	No.	% Total Result	No.	% Database Result	No.	% Database Result
PROQUEST	1443	73.44%	1404	97.30%	39	2.70%
CLINICALKEY	13	0.66%	6	46.15%	7	53.85%
PUBMED	166	8.45%	99	59.64%	67	40.36%
SCIENCEDIRECT	343	17.46%	313	91.25%	30	8.75%
TOTAL	1965	100.00%	1822	92.72%	143	7.28%

Table 2. Secondary screening. Abstracts contain terms or concepts relevant to the study such as “blood banking concerns due to COVID-19” or “blood banking interventions/measure/mitigation practices in response to COVID-19”					
	SCREEN 1 INCLUDED	EXCLUDED		INCLUDED	
Database	No.	No.	% Database Screen	No.	% Database Screen
PROQUEST	39	18	46.15%	21	53.85%
CLINICALKEY	7	1	14.29%	6	85.71%
PUBMED	67	23	34.33%	44	65.67%
SCIENCEDIRECT	30	5	16.67%	25	83.33%
TOTAL	143	47	32.87%	96	67.13%

Table 3. Final screening. Full-Text available, Full-text contain relevant information regarding SAFETY (Patient, Donor, Staff), SUPPLY and/or DEMAND for blood products.					
	SCREEN 2 INCLUDED	EXCLUDED		INCLUDED	
Database	No.	No.	% Database Screen	No.	% Database Screen
PROQUEST	21	14	66.67%	7	33.33%
CLINICALKEY	6	2	33.33%	4	66.67%
PUBMED	44	19	43.18%	25	56.82%
SCIENCEDIRECT	25	11	44.00%	14	56.00%
TOTAL	96	46	47.92%	50	52.08%

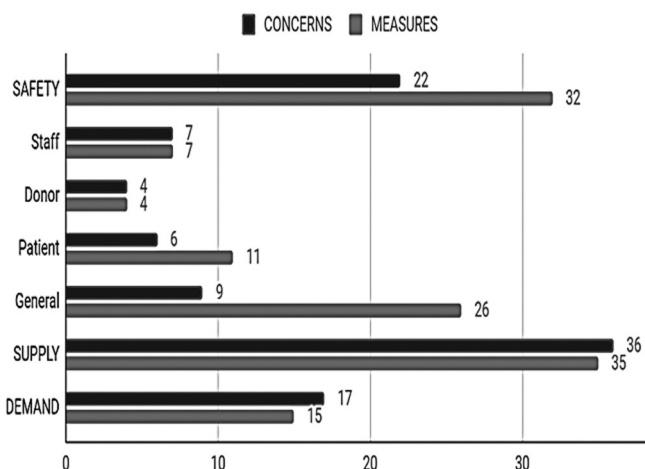


Figure 2. Number of journals containing concerns and measures in blood banking.

Safety Concerns

The safety concerns were classified into three: general safety, staff safety, and patient safety as seen in Table 4. Concerns involved in general safety were as follows: five out of 9 articles (56%) mentioned that the possible transmission of SARS-CoV-2 was a primary problem. With this, ensuring the safety of people was the obvious concern for blood banking facilities (3 of 9 articles, 33%). An article focused on centers having inadequacy in implementing measures (11%). For staff safety, a total of 7 articles cited the following factors. The lack of PPEs for staff (4 of 7, 57%) and the risk of exposure and/or infection of personnel (4 of 7, 57%) were factors most frequently mentioned. Along with these, factors such as the incompetency of staff (3 of 7, 43%), the lack of knowledge regarding COVID-19 (2 of 7, 29%), the unqualification of staff in performing pretransfusion testing (1 of 7, 14%), and the psychological issues due to the pandemic (1 of 7, 14%) became the prime concerns affecting the safety of staff inside the blood banking facilities as seen in Table 4. Furthermore, for donor safety, four articles mentioned that the concern of donors was primarily the safety in going to blood banking facilities. While for patient safety, the biggest concern would be the theoretical transmission of the virus via blood components (4 of 6, 67%), and another concern would be the possibility of aggravating medical conditions after transfusion of convalescent plasma (2 of 6, 33%).

Safety Measures

With regards to measures in general safety, 26 articles were included and of which, measures such as following the general preventive measure protocol (16, 61.5%), implementation of stringent blood banking protocols (11, 42%), use of platforms to promote safety (3, 12%), evaluation and improvement of healthcare, health policies and guidelines (1, 3.8%) and effective communication (1, 3.8%), were used by blood banking facilities in order to address safety issues due to the pandemic. Furthermore, development of safety guidelines specifically for COVID-19 (1, 3.8%) and training of staff to follow specific guidelines (1, 3.8%) during the pandemic was also done in order to help the assurance of safety in blood banking facilities. While for staff safety, implementation of general infection control guidelines such as the cleaning, sterilization and

disinfection of work environment and the use of BSL-2 laboratory for COVID-19 specimens (4 of 7, 57%), safety and security training for all personnel (3 of 7, 43%), as well as the rotational duty and shifting in order to ensure safety and prevent over-fatigue of the personnel (2 of 7, 29%). Moreover, for donor safety, four articles contributed the following measures: conducting lectures and instruction to donors (1, 25%), implementation of triage (1, 25%), and qualification of donors (1, 25%), and ensuring that donors are healthy at the time of blood collection (1, 25%) were some of the strategies done by laboratories in order to ensure that donors were safe amidst collecting blood from them. According to 11 articles relating to patient, in order to guarantee patient safety, protocols ensuring quality blood products (11, 100%), new blood donation guidelines from the FDA (1, 9%), and the use of systems for traceability of blood products (1, 9%) were established during the course of the pandemic. These are all seen in Table 5

Supply Concerns

Blood banking facilities were faced with challenges of decreased or limited supply of the blood products due to several factors brought by the COVID-19 pandemic. Out of the 50 research articles, 36 articles mentioned the different concerns that greatly affect the supply of blood products. The decrease in blood donation was the major concern for the supply of blood products (18 of 36, 50%), followed by the trouble in recruiting donors due to various issues of the donors (13 of 36, 36.1%) which was due to psychological barriers that discourage them to donate, as seen in Table 6. The general decline of blood supply (11 of 36, 30.6%) was also noted although reasons unspecified, but indicated that there was in fact a decrease in stocks of O and AB blood types, or blood products in general, and that seasonal shortages contributed as well. Another concern would be the limited literature on blood donation and blood supply during the COVID-19 pandemic (9 of 36, 25%) wherein during the infancy of the search for treatment, convalescent plasma therapy was still under investigation with the lack of evidence to support any specific treatment to combat COVID-19. With the health sector being overwhelmed, the decline in the number of staff (3 of 36, 8.3%) which may affect the capacity of which the laboratory can accommodate donors and process blood products. The insufficient resources and cutting of funds (3 of 36, 8.3%)

Table 4. Concerns regarding safety in blood banking facilities

Concerns	Number of articles	Percent
<u>General Safety</u>		
1. Possible transmission of SARS-CoV-2	5	56%
• Possible transmission in blood donation centers, transfusion centers and blood drives • Possible transmission due to exposure to asymptomatic patients • Possible transmission of virus due to poor ventilation and prolonged exposure to high concentrations of aerosols • Possible transmission of virus due to blood product distribution from or return to the transfusion service		
2. Concerns regarding in ensuring safety	3	33%
• Concerns with regards to ensuring safety of staff and blood donors • Concerns regarding the safety of blood donation and the blood products • Concerns regarding the safety of blood products		
3. Centers have inadequate measures to mitigate risk of infection	1	11%
<u>Staff Safety</u>		
1. Lack of personal protective equipment (PPE)	4	57%
• Threat for processes due to lack of PPE		
2. Laboratory personnel at risk due to possible exposure and/or infection	4	57%
• Staff were at risk due to the possible spread of infection • Staff may be infected due to frequent contact with potentially infected blood specimens • Laboratory personnel may be infected with SARS-CoV-2 during laboratory processes • Staff were at risk of aerosols or droplets transmission of the virus due to laboratory processes • Staff may be exposed to asymptomatic personnel • Staff may be exposed to infected individuals including family members		
3. Incompetency of the staff	3	43%
• Inadequate training in handling COVID-19 patients • Staff did not perform measures		
4. Lack of knowledge with regards to COVID-19	2	29%
• Lack of knowledge regarding the disease and its causative agent		
5. Laboratory personnel were unqualified to perform pretransfusion testing of COVID-19 patients	1	14%
6. Psychological issues to staff of blood banks that arose due to pandemic	1	14%
<u>Donor Safety</u>		
1. Donors were concerned of safety by going to blood banking facilities	4	100%
<u>Patient Safety</u>		
1. Theoretical risk of transmission of SARS-CoV2 due to potentially infected blood products	4	67%
2. Possible aggravation of medical conditions	2	33%
• Aggravation of Antibody-Dependent Enhancement (ADE) after CP transfusion • Aggravation of some medical conditions after CP transfusion		

Table 5. Measures implemented regarding safety in blood banking facilities

Measures	Number of articles	Percent
<u>General Safety</u>		
1. Following general preventive measure protocol imposed	16	61.5%
• Checking of body temperature, handwashing, physical distancing, and wearing of personal protective equipment • Installation of physical acrylic barrier		
2. Stringent Blood Banking protocols	11	42%
• The National Accreditation Board for Hospitals & Healthcare Institutions (India) and other such organizing bodies accredits, regulates, and oversees blood banks function in the collection and transfusion process of plasma products to COVID-19 patients ensuring the safety of both donor and recipient • Inclusion and exclusion criteria for both donors and recipients • Use of standardized donor selection • Use of updated laboratory biosafety guidelines specific for COVID-19 • Strict adherence to the SOP • temporary isolation of blood for 14 days after collection and delaying its release • Donation as scheduled to prevent crowding		
3. Use of platforms to promote general safety	3	12%
• Provision of an online appointment and questionnaire fill-in service through SNS • Development of Call back system		
4. Evaluation and improvement of healthcare, and health policy planning and financing	1	3.8%
5. Effective communication strategy	1	3.8%
6. Developed a safety guideline specific for COVID-19	1	3.8%
7. Training staff to follow special guidelines during the pandemic	1	3.8%
<u>Staff Safety</u>		
1. General infection control guidelines	4	57%
• Cleaning, sterilization and disinfection of work environment • COVID-19 specimens should be handled in a BSL-2 laboratory		
2. All personnel receiving safety and security training	3	43%
3. Rotational duty and shifting	2	29%
<u>Donor Safety</u>		
1. Lectures to donor about the importance of post donation reporting	1	25%
2. Implementation of triage during reception of donor	1	25%
3. Donors were instructed to inform the staff of any exposure to virus after donation	1	25%
4. Donor must be healthy at the time of donation	1	25%
<u>Patient Safety</u>		
1. Implementation of protocols to ensure quality blood from donors	11	100%
• Donor screening • People with recent travel to certain countries were deferred • Implemented measures to prevent transmission • Recruitment of donors were based on an approved CCP criteria • Pharmacists were tasked to be more involved in the CP treatment for recipients due to risks of drug constituents in donor plasma		
2. FDA released new blood donation guidelines	1	9%
3. Use of systems for establishment of traceability of blood products	1	9%

Table 6. Concerns regarding supply of blood products

	Concerns	Number of articles	Percent
1.	Decreased blood donation due to newly imposed policies - Decreased blood donations due to social distancing, stay at home orders, and closing of universities - Increased blood drive cancellations - Decrease in donors due to restrictive measures concerning displacement - Stringent donor selection criteria - Blood donations were thought to be against the social distancing protocols	18	50%
2.	Donors' issues - Difficulty in recruiting blood donors - Decreased donor attendance - Psychological barriers that discourage people to donate blood - Lack of repeated donations - Limited access to convalescent plasma - Challenges in maintaining stable and sufficient supply due to reduced donor recruitment	13	36.1%
3.	General decline of blood supply - Decreased blood donations (reasons unspecified) - Decreased supply (general) - Seasonal shortages of blood supply	11	30.6%
4.	Limited literature on blood donation and blood supply during the COVID-19 pandemic - Convalescent plasma were still under investigation or study - COVID-19 has no specific treatment; lacking evidence	9	25%
5.	Declining number of staff - Decrease in the availability of staff that process and collect blood - Quick increase in blood collection volume can fatigue experienced staff - Donors exceeded the donor center's ability to collect blood because of staff fatigue	3	8.3%
6.	Inadequate resources and cutting of funds - Insufficient resources allocated by National Blood Transfusion Services by governments - Drastic cut in partner funds to be able to produce quality-assured blood and blood components - Procurement of reagents that came abroad was hampered due to the lockdowns - Limitations of the collection and processing of Convalescent Plasma	3	8.3%
7.	Challenges in the place of collection - Inability to collect blood outside administrative regions - Decreased in-house collections	2	5.6%
8.	Quality of the blood products - Expanded frozen platelet stocks were hemostatic - Increased number of outdated blood units	2	5.6%
9.	Small excess capacity in blood supply due to consolidation and price competition	1	2.8%

wherein government agencies and private partners cut fundings to blood banking services as well as the consequence of imposed lockdowns to the access to reagents all contributed to the hampered capability of blood banks to provide their services. Challenges in the places of collection (2 of 27, 5.6%) also became one of the concerns because some cannot collect blood outside their regions and in-house collections were not permitted. Another reason for the decline in blood products was the quality of the blood products (2 of 27, 5.6%) itself deteriorated with the increasing number of outdated blood units. Many hospitals launched different protocols to conserve blood products because despite their availability, they were only limited and acquired from external blood suppliers. Therefore, blood suppliers went through consolidation and price competition resulting in small excess capacity in the blood supply chain (1 of 27, 2.8%)

Supply Measures

Out of the 50 articles, 35 mentioned the following supply measures applied in blood banks as seen in Table 7. Due to numerous concerns stated regarding the supply of blood products, there were various programs, campaigns, and platforms (22 of 35, 62.9%) launched that are used to improve donor recruitment such as the use of various media channels, mobile blood drives, infographics and other strategies to improve donor recruitment. Adjustments and strategies in handling various blood products (18 of 35, 51.4%) were also observed such as splitting platelet units into two doses to minimize platelet shortage, cancellation of elective surgical and non-urgent medical operations, etc. These were practiced in order to conserve blood products. Since many people are afraid to go out and donate blood, some use influence and initiative to motivate and take action (9 of 35, 25.7%), some medical staff have been taking the lead to donate blood and some of the patients' family members and friends were also requested to participate in blood donation. Technological advancements were useful in the midst of the pandemic, so the use of technology and other web-tools (4 of 35, 11.4%) were applied and it has provided a good impact. Technology made it easier for the donors to search effortlessly for an appropriate date and time for donation and there are also 24-hour hotlines to assist both individuals and groups. Collaboration and team-up (4 of 35, 11.4%) was also practiced between the health authorities,

blood suppliers, and couriers wherein different organizations, religious and charity foundations have joined together in order to mobilize a large number of donors in a short period of time. There were also some storage recommendations for clinical use of different blood products for preservation (2 of 35, 5.7%). Issuance of special authorization and appointment letter for donors (2 of 35, 5.7%) was also done in order to authorize donors to bypass strict guidelines implemented regarding disallowing people to go out unless they are frontliners.

Demand Concerns

A total of 36 articles out of 50 (72%) discussed the various concerns and measures done in blood banking facilities regarding the demand for blood products as what is shown on Tables 8 & 9. Out of the 36 articles, 20 articles (55.6%) were involved regarding the concerns in blood banks. These concerns were focused on increased demand for Convalescent Plasma treatment, reasons for decreased demand for transfusion, and blood product wastage concerns. An example of a concern during the pandemic was the increased demand for convalescent plasma treatment which led to a wide range of research regarding CP therapy and alternative treatments (9 of 20, 45%). This was supported by the premise that antiviral therapy in its infancy was unavailable or perhaps costly in countries that don't provide it for free. During the pandemic, there was also a decreased demand for blood transfusion (9 of 20, 45%) due to several reasons such as the imposed lockdown in which decreased road traffic accidents in need for transfusion, the cancellation of medical procedures as means to minimize the blood consumption with the limited supply of blood banks, and for the aspect of CP treatment, it may be considered as expensive for others. Secondary to the decreased demand for blood products, there were also incidences of increased blood product wastage (2 of 20, 10.0 %) in blood banks due to consecutive cancelation of surgeries.

Demand Measures

Out of the 36 articles, 16 articles (44.4%) stated to have utilized different measures in response to the demand for blood products among blood banks in the pandemic as seen in Table 6. The following measures were applied in blood banking to mitigate the challenges brought by the pandemic and to

Table 7. Measures implemented regarding supply of blood products.

Measures	Number of articles	Percent
1. Programs, campaigns, and platforms used to improve donor recruitment • Use of text messages and/or phone calls for recruiting donors. • Use of various media channels to recruit donors. • National, provincial, and municipal governments released official blood donation proposals to the citizens. • Use of questionnaires to increase donation intention and actual donation. • Infographics were distributed as a guide to reduce unnecessary usage. • Mobile blood drives. • Invested in campaigns focusing on specific populations and extra blood collections. • Recovered COVID-19 patients were donor sources for convalescent plasma therapy (CPT). • Convalescent plasma program • In-house, hospital-based blood donor program. • Free access to CCP. • Promoting the importance and safety of blood donation and reorganization of hospital activity decreases RBC transfusion. • Utilization of social media and contacting volunteers to increase number of donors	22	62.9%
2. Adjustments and strategies in handling various blood products • Splitting platelet units into two doses to minimize platelet shortage. • Platelets were cold-stored to reduce waste. • Reduced maximum surgical blood ordering for liver disorders. • Apheresis should be used to collect Convalescent plasma. • Use of iron, folic acid, vitamin B12, EPO, and erythropoietin-stimulating agents to control blood shortage. • Transfusion-sparing strategies were implemented such as patient blood management (PBM). • Monitoring of RBC transfusion twice a month. • Additional phlebotomist staff were added. • Cancellation of elective surgical and non urgent medical operations. • Serological means were developed to recruit CCP donors. • Donor should preferably live in the same area as the intended recipient. • The FDA released CP donor criteria, and allowed its use for patients under certain conditions • Altering the blood donor eligibility criteria such as reducing deferral criteria to expand availability of donors • Proposal of inclusion and exclusion criteria for convalescent donors	18	51.4%

3. Influence and initiative to motivate and take action • Medical staff taking the lead to donate blood. • Prepare and deliver blood products to some hospitalized COVID-19 patients. • Plasma donation was purely voluntary. • Patient's family members and friends were requested to come forward and donate blood. • Requests to the community to donate blood regularly • Extended opening hours, and opening on Saturdays and/or holidays. • Motivate voluntary blood donors to donate. • Majority of convalescent donors may be best sought in the general population.	9	25.7%
4. Use of Technology and Other Web-tools • Used a registry of COVID-19 tested patients in the recruitment of CCP donors • Use of web-based tool called British Columbia Transparent Inventory provides detailed hospital blood inventories and blood supplier inventory data • Scheduling system that allows donors to easily search for an appropriate donation time and location, as well as make the appointment online using mobile phones. • 24-hour hotline to assist both individuals and groups	4	11.4%
5. Collaboration and Team-up • Collaboration between health authorities, the national blood supplier, and local couriers for alternative arrangements. • Tie-up with Non-Governmental Organizations, military/paramilitary services, religious and charity foundations as they have the power to mobilize a large number of donors in a short period of time. • Supply all equipment, reagents and fungibles necessary for the continuity and smooth running of activities at the transfusion level. • Appointment of committee that monitors stock and communicates the need of a regional blood center • Encouraging associations working in the field of blood donation to provide assistance to blood transfusion centers, in particular awareness-raising and transportation of donors from their homes to the center. • Sharing and transfer of blood components from hospitals with surplus to those with shortage. • Organization of activities at the level of donation biological qualification laboratories.	4	11.4%
6. Storage Recommendation for Clinical use • Banking CP below -25C according to EDQM or FDA guidelines was recommended for clinical use.	2	5.7%
7. Issuance of special authorization and appointment letter for donors • Issues special authorization for blood donors to go to blood centers • Appointment letter for voluntary blood donors	2	5.7%

Table 8. Concerns present regarding the demand for blood products.

Concerns	Number of articles	Percent
1. Increase demand for CP treatment for COVID-19 • Demand of Convalescent Plasma Services and Components • Convalescent Plasma was the only Antibody-based Treatment Available • Other Therapeutic Methods, Antivirals and Vaccines were Still Under Investigation or Study • Demand in Treatment for COVID-19 • Antiviral Agents were limited and maybe expensive as therapy, hence Convalescent blood products as therapy may prove to be more feasible	9	45 %
2. Decrease demand for transfusion • Decline of Blood Collection and Transfusion Demand • Issuance of Blood Products for Surgery or Trauma were few due to imposed lockdowns that led to less road traffic accidents, but majority were issued to medical patients, obstetrics and gynecology and ICU units (Africa) • Cancellation medical procedures • Convalescent Plasma was Expensive • Decline of transfusion rates of as RBC, Whole blood, Cryoprecipitate, FFP, and platelets	9	45 %
3. Increase blood product wastage	2	11.1 %

Table 9. Measures implemented regarding demand of blood products.

Measures	Number of articles	Percent
1. Convalescent Plasma treatment implementation in Blood Banks • The National Accreditation Board for Hospitals & Healthcare Institutions (India) and other such organizing bodies accredited blood banks for the transfusion of plasma products to COVID-19 patients • FDA approval for Expansion access program (EAP) for CP treatment to treat numerous patients in need of therapy	7	43.7 %
2. Efficient utilization of resources • Reduction of elective surgeries, medical treatment, admissions, and routine practices have decrease demands for blood products • Redistribution of blood for centers in need, active inventory management, and proper utilization of blood donation to minimize wastage • Rescheduling, postponing, and shifting of elective operations and other invasive procedures to regulate blood usage and blood demand	6	37.5 %
3. Minimizing wastage • Limiting the blood product standing orders of a facility with its blood supplier • Transferring RBC units to the facility with the highest transfusion volume to minimize wastage	1	6.3 %
4. Assurance to patients • Blood components from Convalescent plasma donors with negative tests are safe to transfuse.	1	6.3 %
5. Prospective review of all transfusion orders and inventory • Prospective review of all transfusion orders was initiated to identify necessity of blood	1	6.3 %

improve systems and protocols in the facilities. Since antiviral treatment for COVID-19 was still on its way, implementation of Convalescent Plasma as treatment was utilized and approved by various health sectors (7 of 16, 43.7%) wherein different organizations and accrediting bodies have been prepared to implement and oversee CP treatment among blood banks, additionally the FDA approved the EAP or the Expansion Access Program in order to allow CP treatment for numerous patients even though CP treatment itself was still under investigation. Efficient utilization of resources was applied (6 of 16, 37.5%) to manage increasing and decreasing demands for blood products and services. An example of this was the reduction of elective surgeries, and the redistribution of blood among blood banks as well as inventory management. In response to the concern about blood product wastage, it was mentioned that the blood product standing orders of a facility must be reduced or managed well especially with the event of withholding of elective procedures to minimize wastage, as well as transfer of blood units to high transfusion volume facilities for efficient use and therefore reducing blood wastage (1 of 16, 6.3%). With the increasing number of COVID-19 positive cases, people were becoming more afraid and conscious of potential infection. Patients who were in need of blood transfusion were worried due to the thought that the blood from a potential COVID-19 patient may infect them through transfusion, hence giving assurances to patients (1 of 16, 6.3%) that blood components from convalescent plasma donors with negative tests was safe to transfuse were done. Lastly, the introduction of prospective review of all transfusion orders and inventory was done to monitor management of blood products and services (1 of 16, 6.3%).

DISCUSSION

Safety

The most common general safety concern was the possible transmission of SARS-CoV-2 as it can be transmitted through respiratory droplets, skin contact, and aerosols, especially in places with poor ventilation.^{5,8} With the use of other platforms like social media, and telephone calls, the convenience and safety of everyone⁹ may be addressed. Furthermore, there was also the theoretical risk of transmission during delivery of blood component units, such as in bedside transfusions.¹⁸ Donors may also pose a risk

to others, as it is possible that they are asymptomatic carriers of the virus.^{6,10} Hence, measures including the enforcement of stringent blood banking protocols, such as the modification of the eligibility criteria for both plasma donors and patients¹¹ were in place. Lastly, the inadequacy and lack of mitigating measures of blood centers were also a cause of concern.⁴ Hence, it is deemed important to implement preventative protocols such as checking of body temperature, social distancing, hand washing, and wearing of personal protective equipment.⁵ Moreover, the updates in biosafety guidelines due to COVID-19 by the WHO, the scheduling of donations, and isolation of blood products were some of the measures mentioned.^{10,12} Generally, the evaluation and improvement of healthcare through a more accurate data collection of patients, health policy planning, financing¹³ and implementation of effective communication strategies¹⁴ were also noted to aid in the betterment of the work process. Ensuring the safety of the staff working in blood centers was also a concern since they dealt with potentially-infected volunteers.¹⁵ The most common concern for staff was the lack of personal protective equipment (PPE).^{8,16,17} The frequent contact of laboratory personnel with potentially infected samples through laboratory processes was also a cause of concern.⁸ Measures done to address these concerns were having infection control guidelines which include the cleaning, disinfection, and sterilization of work environments, and provision of necessary equipment¹⁸ and PPEs to both donors and staff.¹⁰ Incompetency and inadequate training of the staff was also another concern regarding staff safety.⁸ In response to this, training and education of personnel about safety and security was enforced.^{18,19}

Possible transmission of the disease through asymptomatic carriers, which could be other personnel, can lead to employee absenteeism and decreased staff availability.^{2,20} In order to prevent infection among the employees and staff, rotational duties and shifts were implemented and observed. Workload was decreased and 40-50% and only a minimal number of staff were allowed on duty, with a second group for changeover.^{2,19} According to another study, some blood bank personnel experienced psychological issues such as, burnout, anxiety, depression, and post-traumatic stress disorder.² The study recommended treating the affected staff with patience, care, virtual courses on self-care, and online psychiatric help. For donors, the only concern was their safety from contracting COVID-19 when going

to blood banking facilities to donate blood. Some were fearful of donating blood as they may become infected with SARS-CoV-2.⁹ Encouragements coming from news channels and social media pages unconsciously created psychological barriers for them to donate blood²¹, and for others it made donors uneasy and created a sense of panic.¹⁹ However, donors were assured that if they followed the guidelines published by WHO, then it would be unlikely for them to contract COVID-19 when donating blood.¹² The implementation of triage in receiving blood donors helped reduce risk of transmission in waiting rooms.²³ Healthy patients and those who met existing FDA donor criteria were the only ones allowed to donate.⁵ Donors were instructed to report to the blood center if they were exposed to the virus, which would lead to the quarantining and recall of donated blood products, and the quarantining of staff members exposed to the donor.¹² As previously mentioned, the risk of transmission of SARS-CoV-2 due to potentially infected blood products were still theoretical as there were no reported cases of it yet.^{16,24} Even so, protective measures and guidelines from WHO¹⁰, such as practicing hemovigilance were needed to ensure safe blood donations.²⁵ Another concern for patient safety after convalescent plasma (CP) transfusion was the possible aggravation of existing medical conditions of COVID-19 patients. In COVID-19 hospitalized patients, especially those experiencing severe respiratory and systemic symptoms, are more at risk of having venous thromboembolism as well as aggravating coagulation disorders.²⁶ The theoretical risk of CP transfusion was that it could worsen patients' condition through antibody-dependent enhancement (ADE). According to one study, this was due to antibodies produced from a previous infection of coronavirus which aggravates the severity of infection when exposed to other strains of the virus.²⁷ The most commonly used measure regarding patient safety was the implementation of protocols that ensure the quality of blood products, which include donor screening,^{24,28} deferring patients that recently traveled to certain countries⁵, and following preventive safety protocols. These were complemented by the release of new blood donation guidelines by the FDA, which donors should be able to meet.⁵

Supply

Newly imposed health policies had been one of the leading causes of a decrease in the blood supply.⁵

This particular problem, however, was addressed by some countries through the government's granting of special authorization to blood donors to bypass travel restrictions.¹⁹ Issues affecting donor attendance also posed a threat to the blood supply. In fact, Canada and the United States reported a 10-30% decrease in donor attendance²⁰ while Saudi Arabia reported a decrease of 39.5% in its donor attendance.¹⁷ Zhejiang, China was able to report a noticeable drop of 67% in blood donations in the beginning of the COVID-19 outbreak due to citizens being afraid of getting infected.¹⁵ To counter the negative effects of a decreased blood donor attendance, certain countries came up with solutions. In India, they came up with a voluntary council that sent letters to donors urging them to donate blood.²⁹ Family members of some patients were contacted to encourage them to donate blood as well.¹⁹ Moreover, in King Abdullah Hospital in Saudi Arabia, regular donors were messaged in their private social media accounts to be able to encourage them to donate blood.³⁰ With the issue regarding the decrease in "in-house" blood collections, the use of messages, phone calls, various media channels, questionnaires, and official proposals for blood donation were done to encourage more people to donate.³¹ Some studies mentioned certain adjustments and strategies that can be done in order to deal with the decrease in blood supply. For one, elective and non-urgent medical operations were canceled and the maximum surgical blood ordering for liver disorders was reduced.³² There was also the practice of dividing platelet units into two⁵ as well as the use of alternative agents (iron, folic acid, vitamin B12, EPO, EPO-stimulating agents) for red cell transfusion¹⁰ all to conserve blood supply. Another concern was that there was only limited literature on blood donation and supply during the COVID-19 pandemic.⁹ For instance, convalescent plasma therapy, a blood component, was still being studied.³³ The decline in staff assigned in processing blood products also affected the blood supply negatively because they had to self-isolate upon exposure to infected patients.²⁰ Staff also experienced fatigue due to some blood donation facilities increasing their blood collection volume.¹⁶ Because of these, blood banks had additional phlebotomists added¹⁶ and rotational duties and shifts¹⁹ were also implemented to minimize staff exposure and infection. Fund reductions and inadequate resources were also one of the problems that affected the blood supply negatively. Places with travel restrictions affected the deliveries of needed

reagents.² An insufficient allocation of resources was also taken note of.¹⁷ Canada dealt with this through the collaboration of health authorities, local couriers as well as national suppliers to be able to find alternative arrangements to transport blood products smoothly.¹⁸ An increase in the number of outdated units was also noted and professionals dealt with this by preparing and delivering blood products only to those that require it such as hospitalized and confirmed COVID-19 patients¹⁴ as well as redistributed to other hospital 4 with high transfusion volume.

The most common concern regarding demand in blood banks was the increased demand for convalescent plasma (CP) treatment, and the decrease in demand for blood products. The demand for COVID-19 treatment such as antiviral drugs was high, and unfortunately, it was still not yet available.¹⁰ The only available antibody therapy available for COVID-19 is convalescent plasma transfusion.²⁶ Its wide use and promising status come from its success in previous pandemics such as SARS, MERS, and Ebola.³⁴ Clinical trials were ongoing to determine CP treatment's effectiveness. It was found from a collaborative trial of US FDA and Mayo Clinic that CP transfusion to severe COVID-19 patients had 14.9% mortality with TRALI and TACO as the most common causes of mortality.²⁶ On the other hand, according to a clinical trial funded by the Kuwait Ministry of Health, CP treatment in moderate to severe patients had high survival rates.³⁴ Around the world, various organizations and agencies have created measures in implementing CP treatment for COVID-19 patients. One of which is the Organizing Committee of the International Society of Blood Transfusion Working Party on Global Blood Safety. In April 2020, they released a document that seeks to regulate CP therapy in regards to its donation, preparation, quality assurance, safety evaluation, and efficacy.³⁵ The ongoing clinical trials for CP treatment among COVID-19 patients was approved by the FDA and this allowed more than 30,000 individuals to undergo the treatment.²⁸ Moreover, in this clinical trial, the safety and advantage of CP treatment was confirmed. The issue of blood wastage was also one of the problems in blood banks since there was a cancellation of non-urgent medical procedures.⁵ Blood banks dealt with this problem through the limiting of blood product orders, rescheduling of surgeries⁵, initiating prospective reviews for transfusion¹⁶, as well as the sharing of blood products from one blood center to another.⁴

It was taken note of that blood transfusion demand for COVID-19 patients was low. However, 36.8% of COVID-19 patients in the ICU were in need of blood transfusion due to gastrointestinal bleeding.¹⁰

Limitation

The study focused on the challenges and measures implemented by blood banking facilities in response to the COVID-19 pandemic. Specifically, the study addresses the interventions such as safety among staff, patients, and donors, compromising the supply and demand of blood products. The available journals limit the study for review and the data and results they provide relevant to the matter. The study's limitations are that several points in the PRISMA checklist (study risk of bias assessment, effect measures, synthesis methods reporting bias assessment, certainty assessment) were not applicable due to the limits of available data.

Implications

The study does not assess the extent of effectiveness of each measure implemented by the different Blood banking facilities and which among these measures applied is more reliable in preventing or reducing COVID-19 infection among patients and staffs. Due to the lack of complete information about the COVID-19 virus and its volatile character, the blood banking facilities applied various techniques on how to use proper actions to improve blood banking operations in maintaining enough supply of blood products, like convalescent plasma CP, and how to address the demand that resulted to complex approaches to handle the situation. However, by determining and classifying all possible concerns or issue properly and identify what are the appropriate measures applied, it would help the blood banking facilities identify which among these are effective on their respective facilities. This could help them strategize efficiently to improve their Blood banking policies that would address the challenges in the aspect of safety, supply and demand of blood products during pandemic like the COVID-19. This will also help future researchers, to investigate the actual cases and incidences of COVID-infection of staff before and after safety measures were placed, since the majority of studies focused on the infection in the laboratory as a hypothetical hazard rather than an actual alarming case, and to evaluate the best blood

bank measures appropriate to their own locality to address safety, supply, and demand concerns in the pandemic setting.

CONCLUSION

In ensuring the safety in blood banks, the primary way is to be updated regarding the safety and security protocols set by the regulatory bodies and the local health institutions, as well as to adhere to them. The staff being central in the transmission among donors and patients, as well as being the workforce of the facility, must be equipped with PPEs, educated and trained with safety protocols, and also cared for.

In maintaining blood supply, adjusting the donor recruitment by setting programs and strategies reaching out and encouraging blood donation, and adjusting the utilization of blood products by canceling or postponing elective surgeries may both be measured.

In addressing the demand for CP treatment, blood banks were recommended to undergo accreditation and training of personnel by their local regulatory bodies to be able to perform and provide CP treatment according to the set guidelines and protocols. In order to prevent blood wastage due to decreased blood utilization, it was recommended to coordinate with other blood bank facilities in order to balance the supply to where it is much needed, and also to track efficiently the inventory and open orders of blood products.

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ABBREVIATIONS

PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; CP, Convalescent Plasma; EPO, Erythropoietin; FDA, Food and Drug Association; SOP, Standard Operating Procedure

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