

ORIGINAL PAPER

Research initiatives of blood services worldwide in response to the covid-19 pandemic

Sheila F. O'Brien,¹  Ryanne W. Lieshout-Krikke,² Antoine Lewin,³  Christian Erikstrup,⁴ Whitney R. Steele,⁵ 
Samra Uzicanin,¹ Brian Custer⁶ & On behalf of the Surveillance, Risk Assessment, Policy Sub-group of the ISBT
Transfusion Transmitted Infectious Diseases Working Party

¹Epidemiology & Surveillance, Canadian Blood Services, Ottawa, ON, Canada

²Department of Medical Affairs, Sanquin Blood Supply Foundation, Amsterdam, The Netherlands

³Medical Affairs & Innovation, Héma-Québec, Montreal, QC, Canada

⁴Department of Clinical Immunology, Aarhus University Hospital, Aarhus, Denmark

⁵Scientific Affairs, American Red Cross, Gaithersburg, MD, USA

⁶Research & Scientific Programs, Vitalant, San Francisco, CA, USA

Vox Sanguinis

Background and Objectives While coronavirus (COVID-19) is not transfusion-transmitted, the impact of the global pandemic on blood services worldwide is complex. Convalescent plasma may offer treatment, but efficacy and safety are not established. Measuring seroprevalence in donors would inform public health policy. Here, we survey blood services around the world to assess the different research programmes related to COVID-19 planned or in progress.

Materials and Methods Blood collection services were surveyed in June 2020 to determine whether they were participating in serosurveys or convalescent plasma collection and clinical trials.

Results A total of 48 countries (77% of those contacted) responded. Seroprevalence studies are planned or in progress in 73% of countries surveyed and in all continents, including low- and middle-income countries. Most aimed to inform public health policy. Convalescent plasma programmes have been initiated around the globe (79% of surveyed), about three quarters as clinical trials in high-, middle- and low-income countries.

Conclusion Blood services around the world have drawn upon their operational capacity to provide much-needed seroprevalence data to inform public health. They have rapidly implemented preparation of potential treatment when few treatments are available and mostly as clinical trials. At the same time, they must continue to provide blood products for recipients despite challenges of working in a state of emergency. It is important to track and coordinate research efforts across jurisdictions to gain a composite evidence-based view that will influence future practice and preparative strategies.

Key words: convalescent plasma, COVID-19, research, seroprevalence.

Received: 10 July 2020,
revised 10 August 2020,
accepted 10 August 2020,
published online 9 November 2020

Correspondence: Sheila F. O'Brien, Epidemiology & Surveillance,
Canadian Blood Services, 1800 Alta Vista Drive, Ottawa, ON, Canada
K1G 4J5
E-mail: sheila.obrien@blood.ca

Introduction

The emergence of coronavirus disease (COVID-19) in late 2019 has strained healthcare services, in some cases beyond their capacity. Worldwide, there have been more than 10 million diagnosed cases and over 500 000 deaths as of 30 June 2020 [1]. Public health policies to address risk have included cancellations of elective surgeries and

recommendations that people self-isolate. While COVID-19 has not been reported to be transfusion-transmissible, blood services around the world have been impacted in a variety of ways [2]. Surgery cancellations prompted rapid adjustment to blood collections, and aligning supply of components with demand for those components has been challenging. Some donors stopped donating to avoid social contact, but for others the sudden crisis motivated them to donate. Supply chains were threatened including availability of consumables for collections. Staff availability was reduced. Concomitant with these operational challenges has been a need to gear up for research specific to COVID-19.

Given the lack of proven effective treatment options, the potential for convalescent plasma to treat COVID-19 became a very high-priority research topic. The benefit was unclear from early reports with adverse events apparently rare [3–5]. However, neither the efficacy nor the safety has been conclusively shown. The dose criteria have not been established, and assays for qualifying plasma have been in various stages of rapid development [6]. As it is *sensu stricto* a new therapy, regulatory bodies in some countries have been unwilling to license blood establishments to collect and distribute convalescent plasma [7]. Rapid mobilization of clinical trials enabled this treatment to be available and studied.

Management of public safety during the pandemic relies on quality data. In the early phase of the pandemic, infection rates were monitored through nucleic acid testing of symptomatic individuals and counting the number of deaths attributable to COVID-19 infection [8]. These measurements are prone to certain biases. For example, the number of individuals testing positive depends on the criteria for being tested and the availability of tests. The apparent death rate will be higher or lower depending on the testing strategy and the characteristics of the population and the availability and extent of medical care. Population-based studies on the proportion of people with COVID-19-specific antibodies will provide a clearer estimate of the number of individuals who have been infected with COVID-19. These will allow evaluation of the efficacy of risk mitigation strategies and will aid in the mathematical modelling of the future course of the pandemic [9,10]. The World Health Organization has recommended that countries conduct seroprevalence studies and has indicated that blood donors are a suitable study population [11].

There have been early reports describing convalescent plasma research [4,12] and seroprevalence studies in blood donors [10,13,14]. The breadth of such research in blood centres has not yet been reported, but the scope of initiatives is important to describe in order to encourage collaboration and knowledge sharing. We aimed to

canvas blood services in as many countries as possible to understand the types of research different organizations are engaging in relative to COVID-19.

Methods

The survey instrument was distributed as an Excel spreadsheet and participants were asked about the region they were reporting for, whether donor seroprevalence studies were planned or in progress, and if so, the types of study design. The survey also collected information on whether the services had programmes to collect from donors who have recovered from COVID-19 infections including both convalescent plasma programmes and programmes to collect plasma for hyper-immune immunoglobulin.

A list of contacts was compiled from the membership of the International Society of Blood Transfusion (ISBT), Transfusion Transmitted Infectious Diseases Working Party and individuals who volunteered when contacted by a representative of the European Blood Alliance – Emerging Infectious Disease Monitoring Working Group. Additional participants were identified by the investigators. In June 2020, all potential participants were invited by email to complete the questionnaire on behalf of their country, or else for their region, or blood service. A data set of responses was compiled and sorted by geographic region to prepare summary tables.

Results

Overall, 79 contacts from 62 countries were invited, and 65 blood centres (82% of those contacted) from 48 countries (77% of countries with at least one contact) completed the questionnaire. These included responses from all continents (see Fig. 1). Many of the respondents reported on research being conducted in some or all areas of their country. For some countries, we received reports for one or more regions, or services within that country, which we have reported for the country although it is possible other research is being conducted in some other parts of the country. Many were from a large city or region such as Guatemala City, Mexico City, Ankara, in Turkey and Khartoum state in Sudan. Others provided diverse patches from their country. For example, from India there were blood centres in Udipi District, Manipal (south-west India), Raipur (central India), Saurashtra Region of Gujarat state (north-west India) and Chandigarh (North India). In China, questionnaires reporting activities in Hong Kong, Guangzhou, Macao, Wuhan, Chengdu, Shenzhen and Shanghai were received.

As shown in Table 1, 32 of 48 (73%) countries have a seroprevalence study planned or in progress. Most Western countries are carrying out seroprevalence studies,



Fig. 1 Participation in the survey: (■) – participation, (■) – invited but no participation, (□) – not contacted.

and most have serial cross-sectional designs to be able to track the infection rates in donors over time. Many centres in Asia, Africa, the Middle East and Latin America including some in low- and middle-income countries are also conducting seroprevalence studies, but more have single cross-sectional designs. Only a few countries have longitudinal cohort studies (tracking antibodies in the same donors over time). The majority of seroprevalence studies are intended to inform public health policy.

Table 2 shows the responses related to convalescent plasma programmes. Overall 38 of 48 countries (79%) have a convalescent plasma programme, 29 (76%) of these as a clinical trial. All European countries who responded to the survey, as well as respondents from the United States and Canada, have convalescent plasma programmes, and most are involved in clinical trials. Many centres in Africa, Asia and the Middle East also have convalescent plasma programmes, and about half are involved in clinical trials. The United States and some countries in Europe and Korea, Egypt and Turkey have programmes for hyper-immune immunoglobulin either planned or in progress.

We also asked respondents whether they were engaged in any other research activities; in response, some provided additional information. For example, blood services have a role in vaccine-related research (the Netherlands, Kenya) and studies in patient groups (the Netherlands, Spain, Brazil), as well as research on

donor health, behaviour and awareness (the Netherlands, India, Cameroon).

Discussion

This survey provides a snapshot of COVID-19 research in progress in blood services around the globe as of June 2020, approximately 6 months since the first case reports from Wuhan [15] and three months since the World Health Organization declared COVID-19 a pandemic [16]. The pandemic has progressed through its first wave in Europe, Canada, Australia and New Zealand, whereas cases continue to increase in other areas [1]. The two most salient observations are that blood services worldwide have engaged in seroprevalence studies primarily to inform public health policy, and they have initiated convalescent plasma programmes, many within the framework of clinical trials.

Due to the rapid pace of activity during the pandemic, much of this research has been developed within country rather than as large internationally coordinated studies. There has been interaction and sharing of information. For example, the European Blood Alliance facilitated knowledge exchange on convalescent plasma via online meetings and an online site where protocols could be uploaded to share. Starting a little later in the course of the pandemic, six francophone African countries are carrying out seroprevalence under the umbrella of AfraCoV-

Table 1 Seroprevalence studies, International COVID-19-Related Research

Region	Country	Seroprevalence	Single cross-sectional	Serial cross-sectional	Longitudinal cohort	Informing public health policy	Informing convalescent plasma programme
United States/Canada	Canada	Seroprevalence studies	✓			✓	✓
	United States		✓	✓		✓	✓
Latin America	Argentina	Seroprevalence studies	✓			✓	✓
	Brazil			✓		✓	✓
Europe	Mexico		✓				
	Guatemala	No Seroprevalence studies					
	Belgium	Seroprevalence studies		✓		✓	✓
	Denmark		✓			✓	
	France		✓			✓	✓
	Germany		✓			✓	✓
	Ireland		✓			✓	✓
	Italy		✓			✓	✓
	Malta		✓			✓	✓
	the Netherlands			✓		✓	✓
	Norway					✓	✓
	Slovenia			✓		✓	✓
Spain			✓		✓	✓	
	Sweden				✓	✓	
Switzerland			✓		✓	✓	
United Kingdom			✓		✓	✓	
	Portugal	No seroprevalence studies	✓			✓	✓
Romania							
Poland							
Asia	China	Seroprevalence studies	✓		✓	✓	✓
	India		✓			✓	✓
	Japan						
	Kazakhstan		✓				✓
	Russia		✓				✓
	Korea	No seroprevalence studies					
Malaysia							
Africa	Singapore						
	Burkina Faso	Seroprevalence studies	✓			✓	
	Cameroon		✓			✓	
	Ghana		✓			✓	
	Kenya		✓			✓	✓
	Mali		✓			✓	
	South Africa			✓		✓	✓

Table 1 (Continued)

Region	Country	Seroprevalence	Single cross-sectional	Serial cross-sectional	Longitudinal cohort	Informing public health policy	Informing convalescent plasma programme
Middle East	Algeria	No seroprevalence studies					
	Ethiopia						
	Malawi						
	Sudan						
	Uganda						
	Iran	Seroprevalence studies	↘				↘
	Oman						↘
	Turkey						↘
	Egypt	No seroprevalence studies					
	Pakistan						
Oceania	Australia	Seroprevalence studies				↘	
	New Zealand						↘

19 coordinated by the French Institute for Public Health (INVS). In the United States, as a result of the widespread distribution of SARS-CoV-2 infection, donor and recipient studies are being conducted both locally and as part of large national initiatives. Individual blood centres have implemented programmes to monitor infection in donors, including offering SARS-CoV-2 antibody testing as part of health screening to all donors. In parallel, blood centres have implemented recruitment efforts to encourage recovered COVID-19 patients to donate convalescent plasma. Eligibility for convalescent plasma donation has evolved along with testing of the units to determine neutralizing antibody levels that are appropriate for transfusion to patients to increase the odds of efficacious clinical impact. Data from these local initiatives are pooled together to understand the pandemic in the country. These efforts draw on and expand initiatives such as the Transfusion-Transmissible Infections Monitoring System (TTIMS) in ways in which donor testing is considered fundamental to understanding broader infection trends in the general population.

Estimating the seroprevalence of COVID-19 has clear relevance to public health policy and could have some relevance to convalescent plasma programmes as well. The true progression of the pandemic is not fully understood by testing for active infections or by related death rates; both of these statistics are likely underestimates [8]. Actual morbidity and mortality attributable to COVID-19 may be under-reported because of incomplete ascertainment and will also vary depending on the age distribution of the populations and availability of medical care, which has been reduced in some areas due to overwhelming numbers of symptomatic cases. The identification of active infections depends on test availability, the recognition of suspected cases and accessibility, which varies by jurisdiction. About 80% of infections are mild or asymptomatic and thus are less likely to be identified [17]. Seroprevalence studies can therefore provide a better estimate of the proportion of people that have been infected since COVID-19 outbreaks have occurred in a given population. Although the availability of sensitive and specific assays was initially a limitation, they have improved since then. There are now several commercially available assays that appear to have excellent sensitivity and specificity. However, access to the better performing tests is not universal meaning data reported by jurisdiction may be of variable quality. Perhaps a greater concern is the availability of samples from a representative population. Community population-based studies such as random household surveys are not practical because they cannot be conducted quickly to immediately inform public health decision-making. Samples leftover from unrelated patient testing are a possibility, but the extent to which such samples

Table 2 Convalescent plasma programme, International COVID-19-Related Research

Region	Country	Convalescent plasma	Part of a clinical trial	Hyper-immune immunoglobulin
United States/Canada	Canada	Convalescent plasma programme	✓	
	United States		✓	✓
Latin America	Argentina	Convalescent plasma programme	✓	✓
	Brazil		✓	✓
	Guatemala		✓	
	Mexico			No Convalescent plasma programme
Europe	Belgium	Convalescent plasma programme	✓	
	Denmark		✓	
	France		✓	✓
	Germany		✓	
	Ireland		✓	
	Italy		✓	✓
	Malta			
	the Netherlands		✓	✓
	Norway		✓	
	Poland		✓	✓
	Portugal			
	Romania			
	Slovenia		✓	
	Spain		✓	✓
	Sweden		✓	
	Switzerland		✓	✓
United Kingdom	✓			
Asia	China	Convalescent plasma programme	✓	✓
	India		✓	
	Kazakhstan			
	Malaysia			
	Russia		✓	
	Singapore			
	Japan			No convalescent plasma programme
	Korea			
Africa	Burkina Faso	Convalescent plasma programme	✓	
	Ethiopia			
	South Africa		✓	
	Sudan			
	Uganda		✓	
	Algeria			No convalescent plasma programme
	Cameroon			
	Ghana			
	Kenya			
	Malawi			
Middle East	Egypt	Convalescent plasma programme	✓	✓
	Iran		✓	
	Oman		✓	
	Turkey			✓
	Pakistan			No convalescent plasma programme
Oceania	Australia	Convalescent plasma programme	✓	
	New Zealand			

are representative of the general population is questionable, and the numbers of samples at particular time periods may be insufficient. Blood donors can provide convenient samples and are reasonably representative of the healthy adult population, although older people and those living in rural areas may be under-represented. Importantly, many donations provide leftover samples that could be used for COVID-19 antibody testing and large numbers of donations are collected on a daily basis, allowing monitoring of seroprevalence over time. Several seroprevalence studies currently underway capitalize on these strengths and leverage to maximum benefit the serial cross-sectional study design.

There is a clear rationale for so many countries to turn to blood services for seroprevalence estimates. Of particular note, this observation represents a marked departure from the traditional role of blood services. Instances of blood donors participating in non-transfusion-related research are limited. For example, the Danish Blood Donor Study has examined questions not related to transfusion medicine [18]. In Sweden and Denmark, a large database of blood donor and recipient records (SCANDAT) has been used to analyse aspects of donor health, but has largely focused on research to support blood donor/transfusion policy [19]. A few countries have biobanks of blood donor samples [20,21], but these are mainly intended for blood service-related work such as in the investigation of potential transfusion-transmitted infections. Of note, most emerging infectious disease research has focused on infections that may have posed a risk to blood recipients. For example, in the United States and Canada studies of *Babesia Microti* infection and in the Netherlands studies of Q fever and Usutu virus have measured the frequency of infections in large samples [22–24]. Calls from the World Health Organization to consider blood donors for COVID-19 seroprevalence studies no doubt influenced decisions to do so [11]. The concept of conducting blood donor studies to inform public health policy is not exactly new. It has been discussed in various forums over many years. It did not gain traction at the time, but it might have laid the foundation by which the urgency for seroprevalence data saw quick uptake by blood services in response to COVID-19.

Convalescent plasma programmes also have been quickly implemented in most centres worldwide. Convalescent plasma is not a new therapy *per se*. Examples of past applications include treatment of SARS, MERS, H1N1 influenza and Ebola virus, although evidence was largely observational. It is generally considered a stopgap ahead of more targeted therapies such as antivirals or hyper-immune immunoglobulins, but in low- and middle-income countries it could be a longer-term therapy due to resource limitations [7] or as a therapy requiring

limited manufacturing capacity and short time span to be available to treat patients. In spite of the great urgency to treat patients, the transfusion community and its regulators have acknowledged that the efficacy of this therapy is unknown: Is it effective at all, if so which patients will benefit, when in the course of infection should it be given, and importantly will some patients be harmed by the treatment? It is encouraging that most have opted to test the procedure in a clinical trial, even though it adds an extra layer of complexity to strained healthcare systems and carries the burden of some patients not receiving the treatment. Such studies may be particularly challenging in low- and middle-income countries due to funding limitations, limited testing to confirm cases and reliance on replacement donors which may compound the difficulty of recruiting volunteers with resolved infections. In addition, concerns have been raised regarding the safety of plasma transfusion in low- and middle-income countries where product safety standards may not be as high as in high-income countries [25].

Much will be learned from blood donor studies as the pandemic progresses. As results are generated, it will be important to bring together the learnings from different countries to gain an evidence-based composite view. The World Health Organization has plans to bring together data in general, including blood donor studies. The ISBT Transfusion Infectious Diseases Working Party plans to facilitate collaboration between different blood services to compare data and to examine related topics. The data will in turn influence future practice and preparative strategies. Our survey already shows that the impact of the COVID-19 pandemic on blood donor research is evident. The necessity of clinical trials for novel therapies even in a state of emergency is established. The previously untapped resource of blood donors to quickly mobilize large numbers of samples from the healthy adult population has been recognized. This may prove to be a turning point in the relationship between blood establishments and public health entities.

Acknowledgements

All authors contributed to questionnaire design and recruiting participants. Sheila O'Brien and Samra Uzi-canin analysed the data. Sheila O'Brien drafted the manuscript, and all authors revised it critically. All authors approved the submitted version. We thank Henrik Ullum for suggesting the project. We are indebted to the following individuals who provided us with completed questionnaires: Paula Saa, Louis Katz, Michael Busch, Oscar Walter Torres, Pedro Sebastian Ruiz, Paula Loureiro, Cesar de Almeida Neto, Luiz Amorim, Paula Castellanos Fernandez, Karla Maldonado Silva, Amalia G. Bravo Lindoro,

Véronique Van Gaever, Katy Davison, Pierre Gallian, Michael Schmidt, Niamh O'Flaherty, Stephen Field, Giancarlo Maria Liumbruno, Monique Debattista, Kristin Gjerde Hagen, Piotr Grabarczyk, Magdalena Łętowska, Mario Chin Muon, Oliviaz Ligia Burta, Lisa Jarvis, Polonca Mali, Emma Castro Izaguirre, Luisa Maria Barea Garcia, Salvador Oyonarte, Jonas Nordberg, Christoph Niederhauser, Yongshui Fu, Crystal Hui Ping, Wai-Chiu TSOI, Yongming Zhu, Xun Wang, Xue Chen, Jinfeng Zeng, Lei Zhao, Hua Shan, Dhivya Kandasamy, Rounak Dubey, Nishith A. Vachhani, Ratti Ram Sharma; Suchet Sachdev; Divjot Singh Lamba, Minoko Takashi, Saniya Abdrakhmanova, So-Yong Kwon, Ailin Mazuita Mazlan, Eugene Zhiburt, Ramil Khamitov, Sergey Madzaev, Diana Teo, Ai Leen Ang, Souaad Bouali, Salam Sawadogo, Claude Tayou Tagny, Abiy Belay, Yaregal Bante Demem,

Justina K Ansah, Valerie Magutu, Bridon M'baya, Stephen Njolomole, Amadou B. Diarra, Marion Vermeulen, Areej Abdalla, Mona Omer Ahmed Awad Elkarim, Khalfalla Fadlalla, Wambi Wilson, Magdy El Ekiaby, Mahtab Maghsudlu, Arwa Z. Al-Riyami, Wasifa Mutassim, Irfan Shabbir, Soner Yılmaz, Clive Seed, Veronica Hoad, Christine Van Tilburg and Sarah Morley.

Financial support

None.

Conflict of Interests

The authors have no conflicts of interest to declare.

References

- World Health Organization: Coronavirus disease (COVID-19) Situation Report-162. [Last Accessed July 7, 2020] Available from : https://www.who.int/docs/default-source/coronaviruse/20200630-covid-19-sitrep-162.pdf?sfvrsn=e00a5466_2
- Kumar S, Azim D, Nasim S, *et al.*: Dwindling blood supplies: an ominous downside of COVID-19 pandemic. *Transfus Apher Sci* 2020:102818. <https://doi.org/10.1016/j.transci.2020.102818>. Online ahead of print.
- Chen B, Xia R: Early experience with convalescent plasma as immunotherapy for COVID-19 in China: Knowns and unknowns. *Vox Sang* 2020. <https://doi.org/10.1111/vox.12968>
- Li L, Zhang W, Hu Y, *et al.*: Effects of convalescent plasma therapy on time to clinical improvement in patients with severe and life-threatening COVID-19 – A randomized controlled trial. *JAMA* 2020; 324:1–11
- Joyner MJ, Wright RS, Fairweather D, *et al.*: Early safety indicators of COVID-19 convalescent plasma in 5000 patients. *MedRxiv* 2020;95(9):1888–1897. <https://doi.org/10.1016/j.mayocp.2020.06.028>
- Tiberghien P, Lamballerie X, Morel P, *et al.*: Collecting and evaluating convalescent plasma for COVID-19 treatment: Why and how? *Vox Sang* 2020. <https://doi.org/10.1111/vox12926>. Online ahead of print.
- Bloch E, Bournouf T, Al-Riyami A, *et al.*: Guidance for the procurement of COVID-19 convalescent plasma: Differences between high and low-middle income countries. *Vox Sang* 2020. <https://doi.org/10.1111/vox.12970>. Online ahead of print.
- Weinberger DM, Chen J, Cohen T, *et al.*: Estimation of excess deaths associated with the COVID-19 pandemic in the United States: March to May. *JAMA Intern Med* 2020:e203391. <https://doi.org/10.1001/jamainternmed.2020.3391>. Online ahead of print.
- Perez-Saez J, Lauer SA, Kaiser L, *et al.*: Serology informed estimates of SARS-CoV-1 infection fatality risk in Geneva, Switzerland. *MedRxiv* 2020. <https://doi.org/10.1101/2020.06.10.20127423>
- Erikstrup C, Hother CE, Pedersen OBV, *et al.*: Estimation of SARS-CoV-2 infection fatality rate by real-time antibody screening of blood donors. *Clin Infect Dis* 2020. <https://doi.org/10.1093/cid/ciaa849/5862661>. Online ahead of print.
- World Health Organization: Population-based age-stratified seroepidemiological investigation protocol for COVID-19 virus infection. [Last Accessed July 4, 2020] Available from: https://www.who.int/docs/default-source/inaugural-who-partners-forum/covid-19-seroepidemiological-investigation-protocol-v3.pdf?sfvrsn=ef4acd9_1&download=true
- Duan K, Liu B, Li C, *et al.*: Effectiveness of convalescent plasma therapy in severe COVID-19 patients. *Proc Natl Acad Sci USA* 2020; 112:9490–9496
- Slot E, Hogema BM, Reusken CBEM, *et al.*: Herd immunity is not a realistic exit strategy during a COVID-19 outbreak. *Nature Res.* <https://doi.org/10.21203/rs.3.rs-25862/v1>
- Ng DL, Goldgof GM, Shy BR, *et al.*: SARS-CoV-2 seroprevalence and neutralizing activity in donor and patient blood from the San Francisco bay area. *MedRxiv* 2020. <https://doi.org/10.1101/2020.05.19.20107482v2>
- World Health Organization: Timeline – COVID-19. [Last Accessed July 8, 2020]. Available from <https://www.who.int/news-room/detail/27-04-2020-who-timeline-covid-19>
- World Health Organization: WHO announces COVID-19 outbreak a pandemic. [Last Accessed July 8, 2020]. Available from <https://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/news/news/2020/3/who-announces-covid-19-outbreak-a-pandemic>
- WHO: Coronavirus disease 2019 (COVID-19) Situation Report-46 [Last Accessed July 8, 2020]. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200306-sitrep-46-covid-19.pdf?sfvrsn=96b04adf_4#:~:text=For%20COVID%2D19%2C,infections%2C%20requiring%20ventilation

- 18 Kaspersen KA, Pedersen OB, Petersen MS, *et al.*: Obesity and risk of infection: results from the Danish Blood Donor Study. *Epidemiology* 2015; **26**:580–589
- 19 Edgren G, Hjalgrim H: Epidemiology of donors and recipients: lessons from the SCANDAT database. *Transfus Med* 2019; **29**(Suppl 1):6–12
- 20 Franklin IM, Dow BC, Jordan AD: Benefits of a blood donation archive repository: international survey of donor repository procedures and Scottish experiences. *Transfusion* 2007; **47**:1172–1179
- 21 Zoglmeier C, Martin S, Weinauer F: The Bavarian Red Cross Blood Donor BioBank: the first successful combination of blood donation and biobanking for medical research. *Transfusion* 2011; **51**:1121–1122
- 22 Tonnetti L, O'Brien SF, Gregoire Y, *et al.*: Prevalence of babesia in Canadian blood donors: June - October 2018. *Transfusion* 2019; **59**:3171–3176
- 23 Slot E, Hogema BM, Molier M, *et al.*: Screening of blood donors for chronic *Coxiella burnetti* infection after large Q fever outbreaks. *Transfusion* 2014; **54**:2867–2870
- 24 Zaaier HL, Slot E, Molier M, *et al.*: Usutu virus infection in Dutch blood donors. *Transfusion* 2019; **59**:2931–2937
- 25 Epstein J, Smid M, Wendel S, *et al.*: Use of COVID-19 convalescent plasma in low and middle income countries: A call for ethical principles and assurance of quality and safety. *Vox Sang* 2020. <https://doi.org/10.1111/vox.12964>