





# Hospital transfusion service operations during the SARS-CoV-2 pandemic: Lessons learned from the AABB hospital survey in preparation for the next infectious disease outbreak

Srijana Rajbhandary<sup>1</sup> | Aaron Shmookler<sup>2</sup>  | Claudia S. Cohn<sup>3</sup>  |  
Eduardo Nunes<sup>1</sup> | Matthew S. Karafin<sup>4</sup> | James Stubbs<sup>5</sup>  | Monica B. Pagano<sup>6</sup> 

<sup>1</sup>AABB, Research, Bethesda, Maryland, USA

<sup>2</sup>WVU, Pathology, Anatomy and Laboratory Medicine, Morgantown, West Virginia, USA

<sup>3</sup>Lab Medicine and Pathology, University of Minnesota Medical Center, Minneapolis, Minnesota, USA

<sup>4</sup>University of North Carolina System, Chapel Hill, North Carolina, USA

<sup>5</sup>Mayo Clinic Rochester, Transfusion Medicine, Rochester, Minnesota, USA

<sup>6</sup>Department of Laboratory Medicine, The University of Washington, Seattle, Washington, USA

## Correspondence

Monica B. Pagano, Department of Laboratory Medicine, The University of Washington, 1959 Pacific Ave NE, Seattle, WA 98115, USA.  
Email: monibea@uw.edu

## Abstract

**Background:** The SARS-CoV-2 pandemic disrupted hospital operations, affected the blood supply, and challenged the health care system to develop new therapeutic options, including convalescent plasma (CCP). The aim of this study is to describe and analyze blood supply fluctuations and the use of convalescent plasma in 2020.

**Methods:** AABB distributed a weekly and biweekly questionnaire through email to hospital-based members (HBM).

**Results:** The survey was sent to 887 HBM with 479 unique respondents, most of the hospitals served pediatric and adult patients, and all states of the country participated, except Idaho and Vermont. Fifty four percent of HBM reported increased wastage in the early phase of the pandemic (May), which decreased to 4% by the end of June and throughout the rest of the year. The majority of HBM reported receiving alerts from their blood suppliers reporting blood shortages throughout the year. During March and April, only 12% of HBM were performing elective surgical procedures. The top reasons to delay procedures were: bed availability (28%); COVID-19 caseload (23%); and blood availability (19%). By mid-April, 42% HBM had transfused CCP and reported >24 h delay in getting the units; the vast majority obtained CCP using the Expanded Access Protocol, and later, the Emergency Use Authorization. HBM consistently prioritized the most severe patients to receive CCP, but the proportion of severely ill recipients fell from 52% to 37% between May and October, with an increase from 5% to 21% of HBM providing CCP transfusion early in the course of the disease.

**Discussion:** Blood utilization and availability fluctuated during the pandemic. The fluctuations appeared to be related to the number of COVID-19 in the community. The use and regulatory landscape of CCP rapidly evolved over the first 8 months of the pandemic.

## KEYWORDS

blood supply, blood transfusions, hospital operations, pandemic, transfusion services

## 1 | INTRODUCTION

On January 9, 2020 the World Health Organization (WHO) relayed that at least 59 people in Wuhan, China were infected by a novel and highly infectious coronavirus named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2).<sup>1</sup> Since that time, there have been over 125 million cases and nearly 3 million deaths worldwide due to COVID-19, the clinical manifestation of SARS-CoV-2.<sup>2</sup> Clearly, the COVID-19 pandemic has exerted a profound effect on healthcare delivery around the world, including the prospect of ever-increasing challenges to the adequacy and safety of the blood supply and to the availability of traditional and new transfusion medicine therapies. The field of Blood Banking/Transfusion Medicine (BB/TM) had an obligation to rapidly and successfully respond to these challenges in order to maintain effective support of healthcare delivery during the pandemic. An early signal of the effect of COVID-19 on the blood supply and transfusion services was provided in a report covering a two-week period in Washington state in early 2020.<sup>3</sup> The precipitous drop in blood collections and change in hospital operations created a state of uncertainty about the adequacy of the blood supply and prospective transfusion needs. What happened in Washington State foreshadowed the effects of COVID-19 on the blood supply and transfusion practices for the rest of the country shortly thereafter. By March 16, 2020, the American Red Cross reported that about 2700 blood drives had been canceled in the U.S., and this represented a decrease of approximately 86,000 blood donations (Pampee P. Young, M.D., Ph.D., e-mail communication, March 2020). On March 20, 2020, the WHO published an interim guidance on the management of the blood supply in response to the COVID-19 pandemic.<sup>4</sup> The WHO emphasized the potential for reduced blood donation and a significant harmful impact on the supply of blood and blood components. Therefore, the WHO recommended that blood services move quickly take steps to assess, plan, and implement mitigation strategies to address these potential threats. In addition, the WHO suggested that convalescent plasma might be useful as a COVID-19 treatment. On May 28, 2020, the AABB, America's Blood Centers and the American Red Cross issued a joint statement regarding the status of the nation's blood supply.<sup>5</sup> It was noted that during March, the blood supply decreased to a critically low level. Public statements encouraging blood donation resulted in a strong response with replenishment of the blood supply. At the time of the joint statement, however, blood inventory levels throughout the country were dropping to their lowest levels since the

early stages of the pandemic. Maintenance of the blood supply was challenging due to the cancelation of blood drives because many businesses, schools, and community organizations were closed. This joint statement urged individuals to schedule and donate blood at their local blood centers.

In order to understand the impact of the COVID-19 pandemic on BB/TM-related operations and practices, including but not limited to the collection and transfusion of CCP, AABB developed and distributed a multi-week survey about these issues to its hospital-based members (HBM). Herein we present the major findings from this survey.

## 2 | METHODS

A working group of AABB members was formed to develop the survey questionnaire, including three staff members from the Division of Science and Practice (SR, EN, and CSC) and the chair of the Clinical Transfusion Medicine Committee (MBP). The aim was to query AABB HBM for information regarding the impact of the COVID-19 pandemic on hospital transfusion service operations. The survey questionnaire was distributed by email and included relevant/current issues such as inventory management, transfusion practices, and the acquisition and utilization of CCP. Through June 1, 2020 only Medical Directors (MDs) were invited to participate, thereafter MDs and accreditation contacts from all AABB accredited hospitals were invited. Duplicate responses were identified and removed including only the response from the highest rank (medical director, laboratory director/manager, quality director, laboratory staff) using a facility identification number unique to each AABB hospital. The first survey was released on March 23, 2020. Thereafter, the survey was released Mondays weekly through the week of August 17, 2020. A summary of the results for the first 4 weeks is published.<sup>6</sup> Starting the week of August 31, 2020, the survey was released Mondays on a bi-weekly basis until December 14, 2020. Questions were reviewed and evaluated by the working group every survey week and modifications were made based on epidemiological changes, number of COVID-19 cases, introduction of new treatments, regulatory updates, as well as feedback received from survey respondents. The questions were predominantly objective and rank-order with less than 10% open-ended so that the survey could be completed in about 5 min (see Table S1 for questions included in the questionnaire).

Reports from the survey were released to AABB membership and published on the AABB website by Friday

afternoon of each survey week. Descriptive statistics including frequencies, percentages, and response ratios (for multi-select questions) were included in these survey reports. Survey reports also included US maps to describe the distribution, demand, and utilization of CCP units. Analyses were conducted using SAS 9.4, JMP 15, and Excel. Select survey reports are available for members on the AABB website (<https://www.aabb.org/news-resources/resources/hemovigilance/aabb-surveys-and-reports>).

### 3 | RESULTS

#### 3.1 | Demographics

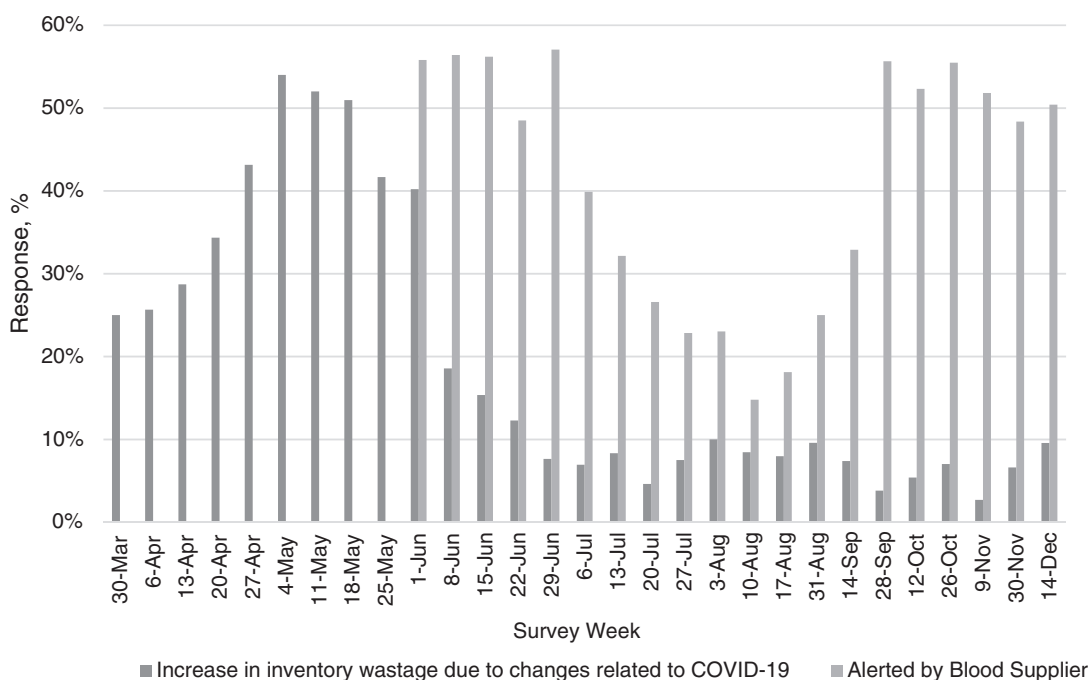
The survey was sent to 887 HBM with 479 unique respondents participating at least once during the survey period. The respondents represented Adult, Pediatric, and Pediatric and Adult institution types, and all states of the country except Idaho and Vermont. Hospitals serving both the Pediatric and Adult populations represented the most common reporting institution type (52.5%, 223/425), and California was the most well-represented state of the country (313 unique respondents in over 30 surveys). Survey responses generally correlated with population density, as does blood transfusion generally.<sup>7</sup> On average, each respondent participated in the ongoing survey an average of 8.6 times (SD 8.4).

Lastly, participation in this survey was greatest during week of June 8, 2020 (236 unique respondents) and lowest during Week of June 1, 2020 (95 unique respondents).

#### 3.2 | COVID-19s impact on blood inventory

The number of COVID-19 cases in the country increased throughout 2020, with at least two prominent surges, the first in the beginning of summer (June–July) and the second beginning at the end of autumn (November–December). Fifty four percent (54/100) of HBM reported increased wastage during the first week of May, which decreased to 4.5% (7/157) by the end of June and throughout the rest of the year (Figure 1). More than half of HBM (54.8%, 472/861) also reported receiving alerts from their blood suppliers regarding challenges in filling blood orders in particular during June and throughout the first week of July, and then from September to December.

Throughout the pandemic red blood cells units (RBC), especially O Rh positive and O Rh negative, were in shortest supply, followed by platelets, plasma, and cryoprecipitate (Figure 2). Beginning in late September, at least 45% (33/74) of HBM reported an abrupt increase in the shortage of cryoprecipitate and a concomitant increase in blood supplier notification of this shortage.



\* Starting 8/17/2020 the survey was conducted on a bi-weekly basis

FIGURE 1 Inventory challenges for transfusion services

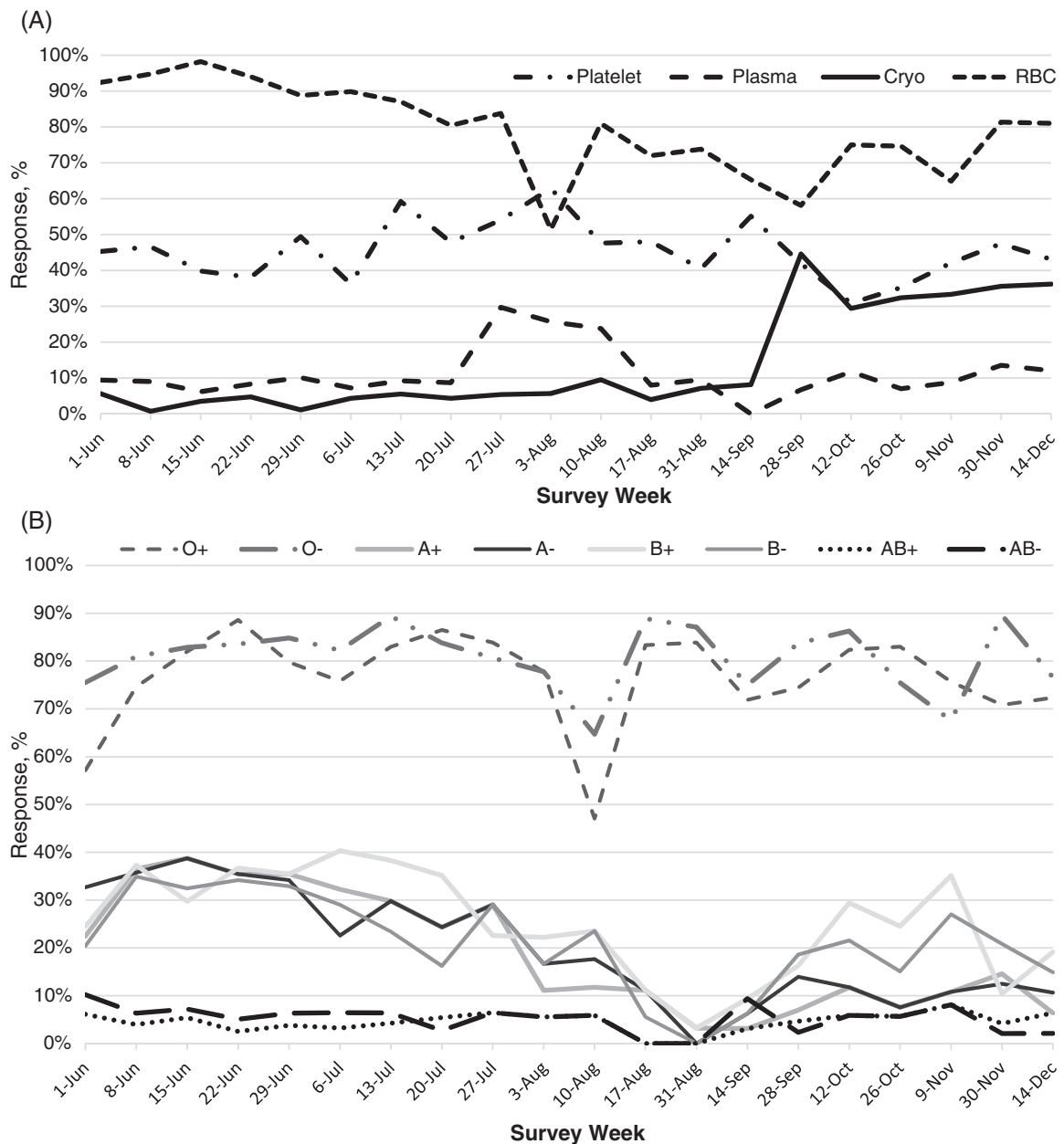


FIGURE 2 (A) Component type reported by the blood supplier to be in short supply. (B) ABO/Rh types of red blood cells in short supply

HBM adapted their practice habits in response to blood shortages. On average, 45% (215/478) of HBM lowered their RBC transfusion hemoglobin threshold to 7 g/dL and implemented prospective auditing of orders for RBC and for platelets, and 12.7% (59/474) of HBM lowered their RBC transfusion thresholds below 7 g/dL.

### 3.3 | COVID-19s impact on elective surgical procedures

Between March 23rd and April 13th, an average of 12% (44/348) of HBM reported that their respective

institution continued to perform elective surgical procedures (ESP), with 26% (91/346) reporting increased wastage secondary to canceled procedures (data previously published).<sup>6</sup> At least 75% (79/105) of HBM consistently reported the resumption of some ESP beginning in mid-May, which increased to 95% (130/137) by mid-August. Despite the continuation or resumption of ESP, 3.2% (40/1264) of HBM consistently reported that ESP were being postponed due to concerns for a second wave of COVID-19 cases beginning in late June. In order of descending frequency, the limitations to resuming ESP included availability of intensive care unit beds (28%, 1344/4781), hospital

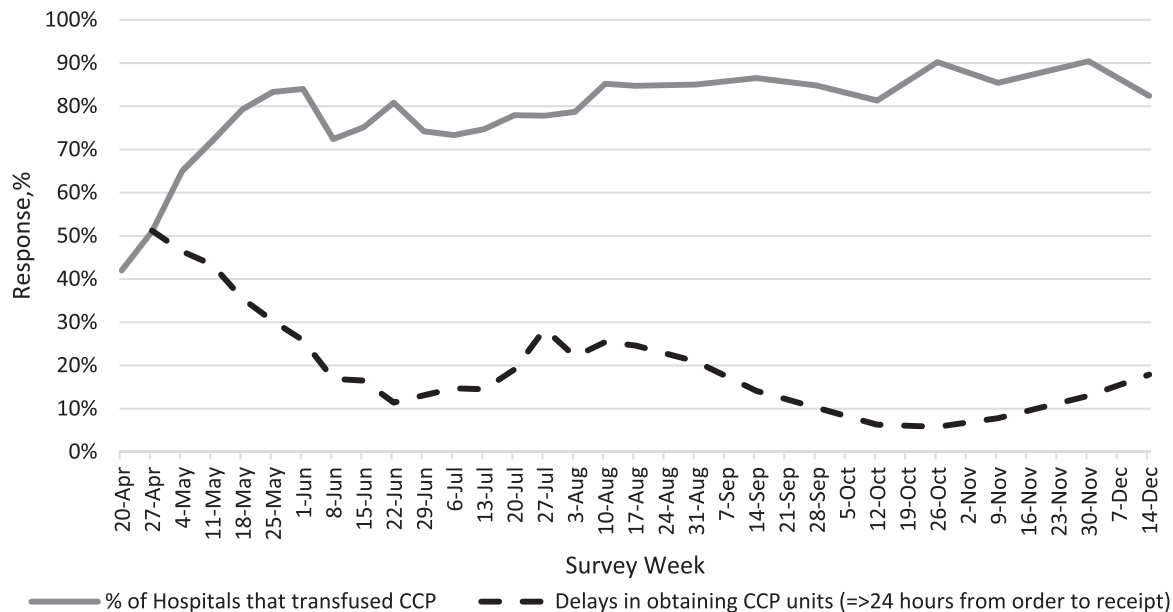


FIGURE 3 Percentage of HBM reporting the transfusion of CCP and delays in obtaining convalescent plasma

TABLE 1 Mechanisms to obtain COVID-19 convalescent plasma

	Average	n	Total hospitals that transfused CCP
<b>Responses from April 20 through June 22</b>			
Hospital protocol (including clinical trials)	10.0%	93	932
Mayo Clinic Expanded Access Protocol	86.2%	803	932
Emergency Investigational New Drug (eIND)	23.9%	223	932
<b>Responses from June 29 through July 13</b>			
Clinical trials	35.3%	129	365
Mayo Clinic Expanded Access Protocol	83.8%	306	365
Emergency Investigational New Drug (eIND)	39.7%	145	365
<b>Responses from August 31<sup>a</sup></b>			
Clinical trials	16.9%	24	142
Emergency Use Authorization (EUA)	66.9%	95	142
Modified investigational use	13.4%	19	142
<b>Responses from September 14 through October 12</b>			
Clinical trials	9.3%	32	344
Emergency Use Authorization (EUA)	59.6%	205	344
Investigational use (units not labeled)	38.1%	131	344
<b>Responses from October 26 through December 14</b>			
Clinical trials	13.0%	51	391
Other including Emergency Use Authorization (EUA)	93.6%	366	391

<sup>a</sup>Single selection question in the week of August 31.

COVID-19 case load (23%, 1080/4781), blood availability (19%, 911/4781), personal protective equipment (17%, 815/4781), testing capacity (11%,

508/4781), and others (3% 123/4781). The response distribution of these different options did not change over the time this question was offered.

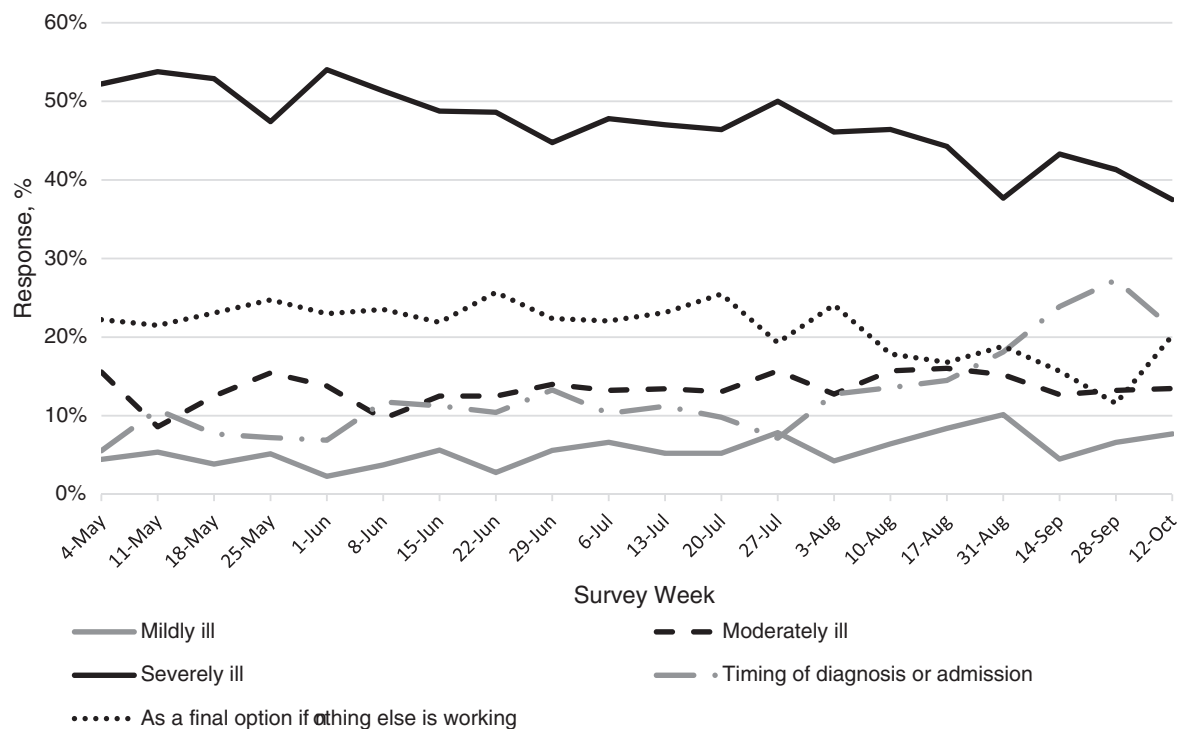


FIGURE 4 Criteria to prioritize use of COVID-19 convalescent plasma

### 3.4 | COVID-19 convalescent plasma

As COVID-19 cases were rising, HBM reported increased CCP transfusions and also initial delays in obtaining CCP. By late April, 51% (52/102) of HBM reported transfusing at least one unit CCP, but 42% (43/102) also experienced a delay of at least 24 h in obtaining CCP (Figure 3). Greater than 75% (84/106) HBM were consistently transfusing CCP as early as mid-May, plateauing at over 90% (110/122) as early as late October, and with as little as 5% (7/112) reporting delays by mid-October. The vast majority of HBM reported obtaining CCP using the Expanded Access Protocol, and later, the Emergency Use Authorization pathway (Table 1).

Over the course of 20 surveys (from the week of May 4th through October 12th), HBM consistently prioritized the following patients for CCP transfusion: 46.9% (1209/2577) used CCP for severely ill patients; 21.2% (546/2577) used CCP as the last resort if all other treatment options failed to demonstrate clinical improvement; and 13.4% (345/2577) used CCP for moderately ill patients (Figure 4). Timing of diagnosis or admission was considered by 12.9% (332/2577) of HBM. Only 6% (145/2577) of HBM reported using CCP for mildly ill patients. However, these priorities changed over time. Figure 4 shows a modest but steady decline in CCP prioritized for severely ill patients [from 52% (47/90) to 37% (39/104)] and a converse increase in the proportion of

patients who were given CCP early, either relative to the date of SARS-CoV-2 infection or hospital admission [from 5% (5/90) to 21% (22/104)].

## 4 | DISCUSSION

The early stages of the pandemic were marked by a paradoxical combination of blood wastage and blood shortages.<sup>8-10</sup> The majority of HBM responded by lowering their RBC transfusion hemoglobin threshold to 7 g/dL for most patient populations. This is a surprising observation as current AABB and other society guidelines recommend a restrictive transfusion threshold of 7 g/dL for most patients.<sup>11</sup> It is encouraging, though, that many respondents implemented other methods, such as prospectively auditing RBC and platelet orders. Prospective auditing, which can be performed by laboratory personnel such as pathology residents and medical laboratory technologists, reduces unnecessary transfusions, and can be a component of a successful patient blood management program.<sup>12-14</sup>

On the other hand, there was an increase in blood wastage due to the cancelation of elective surgeries. The American College of Surgeons developed the Elective Surgery Acuity Scale to assist hospitals and surgery centers in triaging non-emergent surgical procedures during the COVID-19 pandemic.<sup>15</sup> Based on this scale, arguably most,

if not all, surgical procedures associated with the highest risk of RBC transfusion—and which account for over 50% of surgical patients exposed to RBC transfusion<sup>16</sup>—should not have been postponed. This suggests a significant portion of blood utilization is attributed to elective surgeries,<sup>17</sup> which is somewhat unexpected given that transfusion requirements are higher in non-ESP compared to ESP.<sup>18,19</sup> Despite the implementation of a maximal surgical blood order schedule to improve the efficiency of blood ordering practices for ESP,<sup>20</sup> crossmatch-to-transfusion ratios remain high and/or blood is underutilized.<sup>21,22</sup> Respondents were not asked to identify surgeries that were impacted explicitly. Yet, this finding could provide insight into the evaluation and treatment of preoperative anemia (another patient blood management program component<sup>23</sup>), the benefits of which might include decreased blood transfusions, not to mention improved outcomes and shorter length of hospital stay.<sup>24–28</sup> Notably, a recent randomized controlled trial showed that patients receiving iron supplementation were not transfused less blood compared to patients who did not receive iron up to 42 days before major abdominal surgery.<sup>29</sup>

The counterbalance between blood shortage and blood wastage was likely overshadowed by external factors affecting overall hospital utilization. ICU bed availability and COVID-19 caseload, not blood availability, were the most relevant considerations for canceling surgeries; PPE availability was a close fourth. Remarkably, blood supplier notification was closely associated with reduced wastage throughout the course of the pandemic despite the resumption of ESP<sup>30–32</sup> and despite the increasing number of COVID-19 cases. Wastage remained at or below 10% even as notifications reached their lowest levels in mid-August, by which time blood suppliers were able to increase their donor pools in response to blood donor eligibility criteria modifications made by the Food and Drug Administration.<sup>33</sup>

This survey confirmed that the availability of specific blood components did fluctuate, which mirror the findings reported by Barriteau et al.<sup>34</sup> Respondents clearly and consistently specify group O RBCs as the most affected blood component. This is likely explained by hospitals focusing care on traumas and other surgical emergencies during the pandemic<sup>35</sup>; many of these patients often present initially with no known blood type, thereby requiring the emergency release of group O RBCs. At one large academic medical center, Pagano et al.<sup>36</sup> reported lower admission rates and overall blood use due to the postponement of ESP, and an increased proportion of massive transfusion protocol activations compared to the previous 2 years (2019 and 2018). Moreover, patients with severe COVID-19 infections did not appear to have increased transfusion needs,<sup>34,37,38</sup> other

than convalescent plasma.<sup>39–41</sup> Although many of these patients received extracorporeal membrane oxygenation,<sup>42</sup> the latest guidelines from the Extracorporeal Life Support Organization do not recommend deviating from usual institutional practices for blood transfusion thresholds,<sup>43</sup> which otherwise may be kept low (hemoglobin 7 g/dL) as is the practice in experienced centers.<sup>44</sup> Reserve shortages of plasma and its derivative, cryoprecipitate, were observed a few months into the pandemic as blood suppliers concentrated their efforts in manufacturing convalescent plasma.

Initially, respondents reported transfusing convalescent plasma primarily based on disease severity and later based on timing of the disease and based on the safety update regarding the COVID-19 Convalescent Plasma Expanded-Access Program.<sup>45</sup> The Program was a collaboration between the American Red Cross and an academic institution, Mayo Clinic, and the results of retrospective analysis led to the Emergency Use Authorization of convalescent plasma.<sup>46</sup>

The major limitation of this study is that questions were continuously revised and fine-tuned over time. This introduced the risk of bias and precluded accurate and meaningful statistical analyses. The survey was not formally validated for clarity or content, and so errors in question interpretation were possible. Also, most HBM did not respond to the survey every single week, leading to an inability to assess practice changes by individual respondent or institution. The first surveys were submitted to only medical directors, and due to low response rate, starting on week of June 8, two contacts (medical directors and accredited contacts) were invited for each institution that resulted in increased response rate.

The survey concluded in December, but the pandemic has continued beyond our survey, potentially limiting what could be learned regarding transfusion practice and the pandemic. While this may be true, we observed that survey responses did not change over the last weeks of the survey period, limiting the value of continuing the survey. Further, additional practice surveys have been completed in 2021 by other groups, and we look forward to seeing how the results of those surveys add to the findings of our own work.

These limitations aside, the strength of this cross-sectional survey study included the relatively high number of participating respondents, representing both pediatric and adult hospitals from every state in the United States except for Idaho and Vermont. There is clear evidence that HBM made significant practice adjustments in keeping up with the latest research developments. For example, an increasing number of HBM were transfusing CCP early in the disease course in accordance with new findings.<sup>47,48</sup>

Transfusion medicine and blood banking does not stop during a pandemic, although many aspects of the pandemic directly and indirectly affected the blood industry. The principal lesson learned from this study, which can be applied to the next infectious disease outbreak, is to plan ahead, stay organized, and carry on in maintaining close communication between hospitals and blood suppliers. For every action there is an equal and opposite reaction, none perhaps as great as fallout from a pandemic: social distancing and business closures, not to mention actively ill donors, will lead to blood supply shortages; an anticipated decrease in the volume of ESP will lead to a decrease in blood utilization and subsequent wastage of blood products. By identifying these counterforces early, the supply and demand of blood may be adjusted accordingly to mitigate product wastage without compromising patient care. Furthermore, close communication provides the inspiration for future collaborative studies that can inform the next pandemic, such as prospective studies toward the appropriate marketing and use of convalescent plasma. However, this does not absolve blood banks from revising transfusion practices now in accordance with current evidence-based guidelines and recommendations. Blood banks and their affiliated hospitals always have the opportunity to implement elements of a patient blood management program such as transfusion auditing and preoperative anemia management. This would not only crystalize institutional blood needs but also make vacillations in manufactured blood components potentially more predictable and more manageable.

## CONFLICT OF INTEREST


Nothing to disclose.

## ORCID

Aaron Shmookler  <https://orcid.org/0000-0001-7789-7184>

Claudia S. Cohn  <https://orcid.org/0000-0001-9847-0470>

James Stubbs  <https://orcid.org/0000-0002-3270-4913>

Monica B. Pagano  <https://orcid.org/0000-0001-5183-6471>

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## SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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