https://doi.org/10.22491/2357-9730.153782

Original article

Clinical evolution, transfusion reactions, and transfusion safety in recipients of blood components from donors with positive serology and/or positive PCR results for SARS-CoV-2

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ABSTRACT

Introduction: The COVID-19 pandemic has raised concerns about the possibility of virus transmission via blood transfusions. **Objective:** This study aimed to verify the safety of transfusing blood components from donors with positive SARS-CoV-2 serology and/or detectable PCR in serum. **Methods:** An analytical, longitudinal, and retrospective cohort study was conducted using 208 serum samples from blood donations collected from January to March 2021 at a Brazilian blood bank. After initial screening with a rapid test, samples were divided into a Test Group (TG), with 98 samples positive for SARS-CoV-2, and a Control Group (CG), with 110 negative samples. We collected donor demographic data, tracked blood components, and evaluated recipients regarding their demographic profile, hospitalization data, transfusion reactions, and SARS-CoV-2 test results up to 28 days after transfusion. **Results:** In the TG, 50% of samples were IgM positive and 97% were IgG positive. In total, 381 blood components were transfused in 217 transfusion procedures to 124 recipients. The recipients had a mean age of 43.4 years, with 49.2% in clinical beds and a median hospital stay of 28 days. The frequency of transfusion reactions was 2.3%, and 16.9% of cases presented with dyspnea/desaturation, with no significant difference between groups. **Conclusion:** In conclusion, we found no differences in transfusion outcomes between groups, as well as no evidence of transfusion-transmitted SARS-CoV-2 cases.

Keywords: *COVID-19; Hemotherapy; SARS-CoV-2; Transfusion safety.*

Clin Biomed Res. 2026;46:1-8

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INTRODUCTION

SARS-CoV-2 is a highly pathogenic virus that emerged in late 2019 and caused the COVID-19 pandemic, infecting more than 770 million people[1]. SARS-CoV-2 is primarily transmitted through the respiratory route via droplets and aerosols[2]. The pathogenesis of SARS-CoV-2 infection can vary greatly: most infected individuals are asymptomatic, while more severe cases are usually associated with older adult patients and/or those with underlying comorbidities. The most common symptoms are fever, cough, and dyspnea. Severe acute respiratory syndrome can be caused by the release of a cytokine storm that triggers the destruction of host cells by the immune system, which can result in multiple organ failure or death[2].

Blood transfusion is a highly complex therapy that must be performed with caution due to risks to both the donors and recipients. According to the World Health Organization (WHO)[3], the risk of COVID-19 transmission via blood transfusion has not been confirmed, as no cases have been identified. However, the risk cannot be ruled out since viral RNA can be detected in the

blood, plasma, and serum of infected individuals[4,5]. Therefore, there is uncertainty due to limited evidence about the transfusion transmission of SARS-CoV-2[6].

In Brazil, new criteria have been established for the screening of blood donors due to the pandemic. Post-donation information on contamination is a key measure to minimize the risk of transfusion transmission, including the recovery of blood components from stock and the monitoring of recipients in case of transfusion. However, serological tests for SARS-CoV-2 are not mandatory and are thus not routinely performed[7]. Therefore, our aim was to perform a predominantly descriptive and exploratory study aiming to investigate the risk of transfusion-transmitted SARS-CoV-2 and to assess the safety of transfusing blood components collected from donors with positive serology and/or detectable SARS-CoV-2 RNA in serum.

MATERIAL AND METHODS

Sample selection and analysis

An analytical, longitudinal, and retrospective cohort study was conducted using serum samples from blood donations collected from January to March 2021 at the Blood Bank of the Hospital de Clínicas de Porto Alegre (HCPA), Brazil. Serum was selected as the analytical specimen because it is the sample routinely used for serological screening of blood donors. Furthermore, evidence from the literature has shown that viral RNA can be detected in the serum of patients with COVID-19 for up to 20 days after symptom onset[6].

After receiving clarification and signing the informed consent form for blood donation, all donors participated in a clinical interview. At the time of donation, they were in good health, asymptomatic for SARS-CoV-2 infection, and reported no recent contact with infected individuals. The study (CAAE 65358722.8.0000.5327) was approved by the Research Ethics Committees of HCPA and UFRGS.

First, 1,837 serum samples were screened with the One Step COVID-2019 rapid test kit (CELER®), based on a qualitative immunochromatographic method. Donors were then excluded if they reported a COVID-19 diagnosis within the past 30 days and/or SARS-CoV-2 vaccination, or if their donations were autologous, had positive serology for any mandatory serological marker, or were considered questionable. After exclusions, 98 samples with a positive rapid test (RT) for SARS-CoV-2 formed the Test Group (TG). An additional 110 samples with a negative RT result were selected by convenience to form the Control Group (CG). The blood donors (N = 208) were then evaluated for age, sex, schooling level, type of donation, and transfused blood components using the RealBlood system, based on the ISBT barcode of each donation.

Confirmatory testing

For confirmatory testing of the RT, the SARS-CoV-2 IgG II Quant chemiluminescent microparticle immunoassay (CMIA) (Abbott®) and the SARS-CoV-2 IgM CMIA (Abbott®) were performed for the qualitative and quantitative detection of IgG and IgM antibodies against SARS-CoV-2, following the manufacturer's instructions.

As a second confirmatory test, real-time polymerase chain reaction (RT-qPCR), considered the gold standard for the diagnosis of SARS-CoV-2 infection due to its high specificity and sensitivity, was performed. Serum aliquots were stored in a freezer at temperatures from −20°C to −30°C until testing. RNA was extracted using the nucleic acid adsorption method on silica particles, following the NewGene DNA/RNA extraction protocol (Simbios Biotecnologia, Brazil). RT-qPCR was performed according to the protocol developed by the Centers for Disease Control and Prevention[8], using one-step RT-qPCR (QuatroG, Brazil) and N1, N2, and RNase P primers and probes (Thermo Fisher Scientific, USA). The limit of detection of this protocol was estimated to be lower than 5 cópies *per* uL[9].

Evaluation of blood component recipients

The transfused blood components from the donations included in this study were tracked via the RealBlood system. Recipients' data were retrieved from both the RealBlood and AGHuse systems, and the following aspects were evaluated: age, sex, length of hospitalization, hospital discharge rate, mortality and causes of death, hospitalization unit, immediate transfusion reactions, and results of serological tests and nasopharyngeal PCR for SARS-CoV-2 after transfusion.

Recipients of blood components from donors who tested positive for SARS-CoV-2 by both confirmatory tests were monitored for up to 28 days post-transfusion. This evaluation included worsening of vital signs and symptoms potentially associated with SARS-CoV-2 transmission, such as fever, and respiratory, gastrointestinal, and thromboembolic manifestations. Recipients hospitalized due to a prior COVID-19 diagnosis were excluded from this analysis.

Statistical analysis

Data were analyzed in the SPSS® software (v.18.0) using the chi-square test with adjusted residual analysis for qualitative data. Parametric quantitative variables were analyzed using Student's t-test, whereas nonparametric variables were analyzed using the Mann-Whitney test. Statistical significance was set at $P<0.05$.

RESULTS

Sample characterization

Among the blood donors, 59.5% were male and 50.5% had completed higher education. The TG was more associated with replacement whole blood donations (43.9%), whereas the CG was more associated with spontaneous whole blood donations (63.6%) (chi-square test with adjusted residual analyses, p≤0.029). The mean age of the donors was around 39 years, and 50% of donations were transfused into two recipients. Table 1 presents all data.

Table 1: Characterization of blood donor samples

	Total (N= 208)	Test Group (N=98)	Control Group (N=110)	p-value
Sex – n (%)				
Male	123(59.1)	59(60.2)	64(58.2)	0.779
Female	85(40.9)	39(39.8)	46(41.8)	
Schooling level – n (%)				
Elementary Education	23(11.1)	14(14.3)	9(8.2)	0.211
High School	80(38.4)	40(40.8)	40(36.4)	
Higher Education	105(50.5)	44(44.9)	61(55.5)	
Type of donation – n (%)				
Spontaneous donations of whole blood	117(56.3)	47(48.0)	70(63.6)	0.029
Replacement whole blood donations	72(34.6)	43(43.9)	29(26.4)	
Spontaneous Plateletpheresis	19(9.1)	8(8.1)	11(10.0)	
Blood recipients per donor – n (%)				
1 recipient	70(33.7)	35(50.0)	35(50.0)	0.166
2 recipients	104(50.0)	52(50.0)	52(50.0)	
3 recipients	34(16.3)	11(11.2)	23(20.9)	
Age(years) – MEAN ± SD (min – max)	38.99 ± 11.71 (17 – 69)	38.34 ± 10.42 (18 – 62)	39.57 ± 12.78 (17 – 69)	0.443

Data presented as absolute (n) and relative (%) frequencies. Data were analyzed by Chi-Square test with adjusted residual analyses, with the exception of age (Student's t-test). Values highlighted in bold indicate statistical significance.

Confirmatory tests

Among the TG samples, 50% were positive for IgM and 97% were positive for IgG. Of the samples positive for IgM, three were negative for IgG. The RT-qPCR test presented undetectable results in 99% of the samples. One sample showed invalid results, with no amplification of either viral targets or control genes (Table 2).

Table 2: Frequency distribution of Chemiluminescence (CMIA) and RT-qPCR tests of the Test Group

	Total (N = 98)
IgM – n (%)	
Negative	49 (50.0)
Positive	49 (50.0)
IgG – n (%)	
Negative	3 (3.0)
Positive	95 (97.0)
RT-qPCR – n (%)	
Undetectable	97 (99.0)
Invalid*	1 (1.0)

Data presented as absolute (n) and relative (%) frequencies. *Amplification of only one viral target.

Transfused blood components

A total of 381 blood components were transfused in 217 transfusion procedures involving 124 different recipients. Of these, 93 transfusions involved blood components from the TG into 47 recipients, and 115 involved components from the CG into 77 recipients. In addition, nine transfusions consisted of pools of blood components from both groups. Moreover, 27 recipients received components from both groups in separate transfusions.

The most frequently transfused components were packed red blood cells (pRBCs), followed by platelet concentrates and fresh frozen plasma (FFP). Moreover, 142 (37.3%) transfused components were in pools, including 98 platelet concentrate and 44 cryoprecipitate pools, with no significant difference between groups. Most of the blood components underwent leukoreduction and irradiation (47.5%), with no difference between the groups (Table 3).

Table 3: Frequency distribution of types of blood components from donations by group

	Total (N=381)	Test Group (n=172)	Control Group (n=209)	*p-value
Type of blood component – n (%)				
Packed Red Blood Cells	172(45.1)	78(45.3)	94(45.0)	
Platelet concentrates	128(33.6)	65(37.8)	63(30.1)	0.113
Fresh frozen plasma	81(21.3)	29(16.9)	52(24.9)	
Blood Component in Pool – n (%)	142(37.3)	61(35.5)	81(38.8)	0.525
Special procedure on the blood component – n (%)				
Leukoreduction	9(2.4)	4(2.3)	5(2.4)	
Irradiation	16(4.2)	7(4.1)	9(4.3)	0.841
Leukoreduction and irradiation	181(47.5)	86(50.0)	95(45.5)	

Data presented as absolute (n) and relative frequencies (%). *Chi-Square test with adjusted residual analyses.

In total, four components associated with three TG samples that presented positive IgM only (three pRBCs and one FFP) were transfused into four different recipients. Of these, two recipients were excluded from the analysis due to a prior diagnosis of COVID-19. The remaining transfused blood components derived from a single donation, one pRBC and one FFP. The FFP recipient was a 50-year-old woman with infectious gastroenteritis who did not present any clinical changes in her clinical condition, neither signs/symptoms, related to COVID-19 or any transfusion reactions. The pRBC was transfused into a 66-year-old woman with a severe case of colon cancer. She had undergone multiple transfusions and did not present any transfusion reactions or COVID-related signs/symptoms; however, she experienced several complications associated with her underlying condition and passed away 11 days after the transfusion. No data regarding serological tests and/or PCR for SARS-CoV-2 were available for either patient.

Evaluation of blood component recipients

A total of 124 patients were analyzed, including 47 recipients of blood components from the TG and 77 from the CG. The mean age was 43.44 years (range: 0-93 years), most patients were male (53.2%) and admitted at the Clinical Unit (49.2%). No significant differences were found between recipient profiles in the TG and CG. The median hospital stay was 28 days. Most patients (78%) underwent multiple transfusions, with no significant group differences (Table 4). The most common diagnoses were hematological (30.6%) and gastrointestinal diseases (19.4%) (Table 5).

Table 4: Characterization of blood recipients

	Total (N= 124)	Test Group (N=47)	Control Group (N=77)	p-value
Sex – n (%)				
Male	66(53.2)	29(61.7)	37(48.1)	0.194[a]
Female	58(46.8)	18(38.3)	40(51.9)	
Inpatient unit – n (%)				
Clinical Unit	61(49.2)	23(48.9)	38(49.4)	
Intensive Care Unit (ICU)	23(18.5)	8(17.0)	15(19.5)	0.621[a]
Surgical Unit	20(16.1)	10(21.3)	10(13.0)	
Pediatric Unit	20(16.1)	6(12.8)	14(18.2)	
Multiple transfusions - n (%)	97(78.2)	34(72.3)	63(81.8)	0.264[a]
Respiratory complications - n (%)	31(25.0)	12(25.5)	19(24.7)	1.000[a]
Gastrointestinal complications - n (%)	8(6.5)	4(8.5)	4(5.2)	0.476[a]
Thromboembolic complications - n (%)	1(0.8)	1(2.1)	0(0.0)	0.379[a]
Need for oxygen therapy - n (%)				0.743[a]
Non-invasive ventilation	9(7.3)	4(8.5)	5(6.5)	

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Table 4: Continuation

	Total (N= 124)	Test Group (N=47)	Control Group (N=77)	p-value
Mechanical ventilation	16(12.9)	7(14.9)	9(11.7)	
Hospital discharge - n (%)	100(80.6%)	39(83.0)	61(79.2)	0.648[a]
Death - n (%)	50(40.3)	15(31.9)	35(45.5)	0.186[a]
Age (years) – MEAN ± SD (min – max)	43.44 ± 24.25 (0 – 93)	48.62 ± 23.48 (4 – 80)	40.27 ± 24.31 (0 – 93)	0.063[b]
Days of hospitalization – MEDIAN [IQR] (min – max)	28.0 [12.0 – 46.0] (0.0 – 262.0)	26.0 [14.0 – 44.0] (3.0 – 151.0)	28.0 [10.0– 46.0] (0.0 – 262.0)	0.930[c]
Days of readmission after discharge – MEDIAN [IQR] (min – max)	11.5 [4.0 – 32.5] (1.0 – 439.0)	17.0 [10.0 – 43.0] (2.0 – 332.0)	7.0 [4.0– 18.0] (1.0 – 439.0)	0.063[c]

Data presented as absolute (n) and relative (%) frequencies. IQR - Interquartile range; Data were evaluated by [a]Chi-square test with adjusted residual analyses, [b]Student's t-test or [c]Mann-Whitney test.

Table 5: Frequency distribution of underlying diseases and clinical outcomes of blood component recipients

	Total (N=124)	Test Group (N=47)	Control Group (N=77)
Underlying disease – n (%)			
Hematological diseases	38(30.6)	9(19.1)	29(37.7)
Diseases of the gastrointestinal system	24(19.4)	12(25.5)	12(15.6)
Cardiovascular diseases	14(11.3)	6(12.8)	8(10.4)
Diseases of the urinary system	7(5.6)	3 (6.4)	4(5.2)
Gynecological diseases	6(4.8)	0(0.0)	6(7.8)
Orthopedic diseases	3(2.4)	2(4.3)	1(1.3)
Respiratory diseases - Non-Covid-19	8(6.5)	3(6.4)	5(6.5)
Infectious diseases	6(4.8)	2(4.3)	4(5.2)
Neurological diseases	5(4.0)	4(8.5)	1(1.3)
Other unspecified diseases	13(10.5)	6(12.8)	7(9.1)
Clinical evolution – n (%)			
No change	72(58.1)	27(57.4)	45(58.4)
Dyspnea and/or desaturation	21(16.9)	8(17.0)	13(16.9)
Hypotension and/or tachypnea	3(2.4)	2(4.3)	1(1.3)
Septic shock	9(7.3)	4(8.5)	5(6.5)
Diarrhea, nausea, and/or vomiting	4(3.2)	2(4.3)	2(2.6)
Fever	6(4.8)	1(2.1)	5(6.5)
Runny nose, cough, and/or sore throat	3(2.4)	1(2.1)	2(2.6)
Sensory dysfunction	3(2.4)	1(2.1)	2(2.6)
Pulmonary congestion	3(2.4)	1(2.1)	2(2.6)

Data presented as absolute (n) and relative (%) frequencies.

Of the 217 transfusions, only five resulted in transfusion reactions, including two nonhemolytic febrile reactions, two allergic reactions, and one due to volume overload. These reactions occurred in both groups. Most transfusions were performed individually (66.4%), also with similar values between groups (Table 6).

Most patients (58.1%) did not show changes in their underlying clinical conditions within 28 days post-transfusions. Among the 52 patients who did, the most common change was dyspnea and/or desaturation (16.9%, Table 5), with a median of 3.5 days between transfusion and symptom onset.

RT-qPCR and/or serology test results for SARS-CoV-2 were found for only 36 recipients (Table 7). Of these, 86.1% had undetectable results. Among the five recipients who presented detectable RT-qPCR

results, two had received blood components from the TG and three from the CG. None of the patients presented COVID-19-related signs and/or symptoms that could suggest transmission by transfusion, despite the detectable viral load by PCR. Only two of the 36 recipients had chemiluminescence serology results for COVID-19, both receiving components from the TG: one tested negative for both IgM and IgG, whereas the other tested positive for IgM and IgG, had an undetectable viral load by RT-qPCR, and showed no signs of COVID-19 post-transfusion.

Table 6: Frequency distribution of blood transfusions according to transfusion reaction and pooled transfusion

	Total (N=217)	Test Group (N=102)	Control Group (N=115)
Transfusion Reaction - n (%)			
Nonhemolytic Febrile Reaction	2(0.9)	1(1.0)	1(0.9)
Allergic Reaction	2(0.9)	0(0.0	2(1.7)
Volume overload	1(0.5)	1(1.0)	0(0.0)
Pool Transfusion - n (%)	73(33.6)	39(38.2)	34(29.6)

Data presented as absolute (n) and relative (%) frequencies.

Table 7: Frequency distribution of RT-qPCR testing of blood recipients after transfusion

	Total (N=36)	Test Group (N=11)	Control Group (N=25)	p-value
RT-qPCR – n (%)				0.631
Undetectable	31(86.1)	9(81.8)	22(88.0)	
Detectable	5(13.9)	2(18.2)	3(12.0)	

Data presented as absolute (n) and relative (%) frequencies.

The hospital discharge rate of recipients was 80.6%, with some individuals being readmitted on average 11.5 days after discharge. The mortality rate was 40.3%, with no difference between groups (Table 4). Notably, some deaths occurred during readmission. The most common cause of death was septicemia, followed by unspecified shock.

DISCUSSION

Most of the donations were voluntary and involved men with higher education, similar to the profile of the donors in other Brazilian studies[10,11]. Considering that blood donors are typically healthy individuals, antibody detection is an effective surveillance indicator and a reliable predictor of viral circulation. In the TG, confirmatory tests showed that 50% of the donors presented positive IgM, whereas 97% had positive IgG for SARS-CoV-2. A meta-analysis of 18 studies found that the positivity rate for SARS-CoV-2 antibodies among asymptomatic patients ranged from 21% to 85%[12]. This wide variation in prevalence rates can be attributed to the different periods in which these tests were performed, as well as by the different individual profiles and vaccination coverage worldwide.

The RT-qPCR data showed no RNAemia in the samples. A Chinese study that tested over 98.000 blood donations also found no RNAemia[13]. However, different results have been reported in other studies. In Japan, a study involving 496 samples from SARS-CoV-2-infected blood donors found an RNAemia rate of 4.6%[14]. Cappy et al.[15] tested 311 blood donations and found three positive results with high cycle threshold values (Ct > 37). Another study in the United States analyzing over 200.000 blood donations found an estimated RNAemia prevalence of 1.16/100.000[16]. Other studies have suggested that RNAemia is associated with disease severity and that patients with mild or asymptomatic infections typically do not present SARS-CoV-2 RNA in serum[17,18]. Considering that blood donors in this study were asymptomatic and viral load in the bloodstream is much lower than in the respiratory tract, the absence of RNA in the samples is expected.

The most frequently transfused blood component was pRBCs, followed by platelet concentrate, in line with data from the Brazilian Ministry of Health[19]. Almost 40% of transfusions involved pools of platelet concentrates and cryoprecipitate. In addition, almost 50% of the transfused components were leukoreduced and/or irradiated. Leukoreduction reduces non-hemolytic febrile reactions, cytomegalovirus transmission, and

HLA alloimmunization, while irradiation prevents transfusion-associated graft-versus-host disease. Although less than 5% of all transfused blood undergoes irradiation in Brazil[19], the high rate of modified components in this study is justified by the setting of a high-complexity hospital.

The evaluation of platelet concentrate recipients is particularly relevant in transfusion safety studies involving SARS-CoV-2. In addition to being stored at room temperature, a condition that could theoretically favor the maintenance of viral infectivity, platelets can interact with the virus, internalize viral RNA, and express molecules such as ACE2 and TMPRSS2. Although their anucleate nature limits viral replication, these characteristics justify their inclusion in transfusion-transmission risk assessments. Furthermore, this approach is consistent with international haemovigilance recommendations, which advocate monitoring recipients of all blood components collected from donors subsequently diagnosed with COVID-19. Therefore, the evaluation of platelet recipients contributes to a comprehensive and conservative assessment of transfusion safety in the context of emerging infectious agents[20-22].

Most of the recipients of blood components were male, with a mean age of 43.44 years, and over 70% underwent multiple transfusions, similar to what was reported by other Brazilian studies[23-25]. The most frequent underlying condition was hematologic disease (30.6%).

Only five (2.3%) patients developed transfusion reactions, all of which were immediate, including two non-hemolytic febrile reactions, two allergic reactions, and one due to volume overload. Another Brazilian study reported 5.5 reactions per 1.000 units of transfused blood components, with non-hemolytic febrile and allergic reactions also being most common[23]. A Canadian study reported a 0.24% prevalence of non-hemolytic febrile reactions[26]. Our data demonstrated a slightly higher prevalence rate, but considering that transfusion reactions are still underreported, we can infer that our data are consistent with the literature. Certain patient profiles, such as onco-hematological patients may present more transfusion reactions due to case severity and/or low immunity.

The clinical behavior of patients was monitored for 28 days post-transfusion, covering the incubation period for SARS-CoV-2 (14 days), in addition to another 14 days for disease progression in case of infection. Most patients (58.1%) presented no change in clinical condition. Respiratory complications developed in 31 patients (25%), and 16 required mechanical ventilation (MV), with no significant differences between those who received blood from the TG or CG. The most common symptoms were dyspnea and desaturation. Since there was a median of 3.5 days between transfusion and dyspnea and/or desaturation onset, these alterations are more likely associated with patients' pre-existing conditions. In a study involving transfused ICU patients, 22.5% developed post-transfusion respiratory complications and 89% required MV[27]. Similarly, Lobo et al.[24] found that approximately 79% of transfused patients required MV.

No differences were found in the clinical outcomes of patients who received blood components from different groups, and recipients of components that tested positive for SARS-CoV-2 in both tests did not develop complications that could be associated with infection via transfusion. These results are similar to those from other studies involving a small number of recipients of blood components from donors who tested positive for SARS-CoV-2[14,28,29].

Among the 124 patients analyzed, the hospital discharge rate was 80.6% and the mortality rate was 40.3%, with septicemia being the most common cause of death, followed by unspecified shock. Other studies reported similar results, with the mortality rate of transfused patients ranging from 38.9% to 46%[24,27].

Our study presents some limitations. The small number of donors with serological evidence of recent infection (IgM-positive only) may decrease the possibility of SARS-CoV 2 transmission by transfusion. Moreover, the small number of recipients with post-transfusion PCR and/or serological testing limits its sensitivity to detect asymptomatic or mildly symptomatic transfusion-transmitted infections. Furthermore, the lack of detectable RNA does not absolutely exclude the presence of infectious virions below the assay detection limit. The lack of systematically recorded data on immunosuppression and comorbidities, inherent to the retrospective design and variability in clinical documentation, also represents a limitation of this study.

In conclusion, no differences were observed in transfusion reactions between recipients of SARS-CoV-2-positive and SARS-CoV-2-negative blood components. These findings are consistent with previous studies suggesting that transfusion-transmitted SARS-CoV-2 either does not occur or is exceedingly rare. However, the absence of documented cases in our cohort should be interpreted as an absence of evidence rather than definitive evidence of absence. Therefore, although our results further support the very low likelihood of transfusion transmission, the possibility of rare events cannot be completely excluded, underscoring the importance of continued haemovigilance and ongoing monitoring in transfusion medicine.

FUNDING

This work was supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).

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Received: Feb 25, 2026
Accepted: May 25, 2026