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Seropositivity for syphilis among Brazilian blood donors. A retrospective study 2015–2020

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ABSTRACT

Introduction: Syphilis is a transfusion-transmitted infection and the disease re-emerged in many countries, including Brazil, as a public health risk.
Objective: Evaluate the prevalence of positive serology in blood donations rejected by Hemobanco (Curitiba- PR) from January 2015 to December 2020, with special focus in syphilis.
Methodology: In the studied period, we analyzed the number of blood donations discarded annually for each serological test performed on blood donors' samples, according to gender and donors age.
Results: Within the studied period, 134,741 blood donation were analyzed. 54.5 % of sample were male. Otherwise, it was observed a significant increase in the number of donations by females ($P < 0.0001$). There was an increase of 437 % in the prevalence of syphilis positive serology made by donors with $\geq$ 60 years. Besides that, it was noticed a significant increase in donations by aged people throughout these six years ($P < 0.0001$). The percentage of total blood donation deferred had a significant reduction, although it was observed an increase in the rate of discarded blood bags due to positive serology in the first 4 studied years. It was observed an increase of 20 % in positive syphilis serology.
Conclusion: The greatest cause of discard of blood donations changed during the analyzed 5-years; there was an increase in seropositivity donations from donors with $\geq$ 60 years old. In 2015, Hepatitis B (0.8 %) was the most prevalent and in 2020, syphilis became more prevalent (0.82 %). The medical community should be aware of the rising number of cases of syphilis infection. There is an urgent need to implement actions against the dissemination of this disease.

1. Introduction

According to the Hemotherapy Production Bulletin, the Brazilian donor's profile remained constant between 2015 and 2019 with a predominance of young men [1,2]. Among Brazilian donors in 2019, there were 18.87 % ineligible candidates by clinical screening and 2.18 % by serological screening [2]. Syphilis was the second most detected disease (1.07 % of all cases) in serological screening [2], indicating a significant increase when compared with previous data from 2003 and 2012, in Curitiba-Paraná, which indicated a 0.5 % rate of positive serology for syphilis in this last period [3].

The detection rate of acquired syhilis in the general population from Brazil has progressively increased since 2010, when compulsory notification was introduced. Between 2015 and 2019, an increase of 113 % was observed (34.1–72.8 cases per 1,000 population), with a peak in 2018 (76.2 cases per 1.000 inhabitants). In the state of Paraná, the detection peak of acquired syphilis also occurred in 2018, with 125.1 cases per 100,000 inhabitants, denoting higher rates than in the others Brazilian states [4].

Screening for syphilis is performed with non-treponemal and treponemal tests. Non-treponemal tests (such as VDRL) are sensitive, but may yield false-negative results in 0.2−0.8 % of cases. Moreover, they are performed manually and have decreased sensitivity for primary syphilis and in the late latent syphilis [5]. Treponemal tests are sensitive, specific and automated. Nevertheless, they may persist positive after previous treated infection, as a serological scar [6]. In Brazil, there is no

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specification of which test should be used [7], but treponemal tests such as ELISA and chemiluminescence have been prefered for blood bank serological screening because of their capacity to be automated [6].

Development of technologies to reduce transfusion risks of infectious diseases is a major characteristic of hemotherapy [3]. However, the adoption of serological tests alone is not sufficient as no serological test is 100 % sensitive or specific. Hence, the retention and management of healthy regular donors is crucial for blood banks [8]. Thus, this study not only updates the literature about the donor's profile and discard of blood bag at a reference blood bank in Curitiba, but also highlights the importance of an effective serological screening for recipients, as well as health promotion for donors. Furthermore, the results of this study will support the implementation of public health strategies to control this infectious disease.

So, this study aimed to evaluate the prevalence of positive serology tests for syphilis in donations rejected by blood bank in Curitiba from 2015–2020. In addition, it determined the frequency of positive cases for HIV, Hepatitis B, Hepatitis C, HTLV and Chagas disease in the same period.

2. Material and methods

The Ethics Committee in Research from Evangelical Beneficent Society of Curitiba (PR) approved this study, with protocol number 4.192.566.

This is retrospective research performed in Paranaense Institute of Hematology – Hemobanco in Curitiba (State of Paraná, Brazil). Data analyzed compose Hemobanco's database and were assessed after authorization. The analysis took into account the number of donations per year, the number of annual donations by gender and the total number of blood donations discarded annually due to seropositivity in exams of serologic screening. In addition, it was investigated the age groups profile in discard of blood donations from 2015–2020, according to the established stratification (≤17 years old, 18 and 19 years old, between 20 and 39 years old, between 40 and 59 years old, and ≥60 years old). The analysis took into account the total number of blood donations discarded annually by gender and annual data for each serological test performed on blood samples.

Tests for serological screening followed the norms of the National Health Surveillance Agency (ANVISA). Syphilis testing changed over the years in the studied service. Flocculation test (VDRL, Laborclin, Brazil) was used in 2015 and 2016; VDRL and immunoenzymatic test (ELISA) in 2017; ELISA (Abbot, USA) in 2018; ELISA and chemiluminescence (Alinity, Abbot, Lake Forest, USA) tests in 2019 and 2020.

Validated commercial kits that detect antibodies or antigens by immunoenzymatic methods (Chemiluminescence) using automated procedures (Alinity, Abbot, Lake Forest, USA) were used to detect hepatitis B (anti-HBc and HBsAg), hepatitis C (anti-HCV), Chagas disease, HIV (anti-HIV-I, anti-HIV-II and HIV antigen testing p24), and HTLV (anti-HTLV-I and anti-HTLV-II).

Blood bags of patients with positive serology were rejected when positive at the first sample collected, regardless of subsequent confirmatory testing. However, only after confirmatory test the patient was considered as having the infection.

Data was expressed in absolute number and frequency was expressed in percentage. Comparison analysis was performed using the χ^2 test using the software Graph Pad Prism version 6·0 (GraphPad Software Inc., La Jolla, CA, USA). P values lower than 0.01 were considered significant.

3. Results

In the period between January 2015 to December 2020, 134,741 blood donations were done in Hemobanco. The donor's profile is on Table 1 that shows a slight predominance of male donors. Comparing the results from these six years, it was observed a significant increase in the number of donations by females ($P < 0.0001$) (Table 2). In Table 3, it was observed the higher positive serology in donors aged between 20−39 years, followed by people with 40−59 years old. Regardless of that, the percentage from 20−39 years of age's group has progressively decreased and donations made by donors with ≥ 60 years old had a significant increase throughout these six years ($P < 0.0001$).

Table 1
Blood donors' profile during 2017–2020 of the Hemobanco in Curitiba (State of Paraná, Brazil).

Total (n)		134.741
Females/males -		61.787 (45.8 %)/73.054 (54.2 %)
Distribution of donations for studied year		
2015		20,937 (15.5 %)
2016		20,127 (14.9 %)
2017		20,682 (15.3 %)
2018		20,595 (15.2 %)
2019		23,910 (17.7 %)
2020		28,490 (21.1 %)
Deferrals (serology)		5789
Females /Males		2837 (49.0 %)/2952 (50.9 %)
Distribution of deferrals (serology) by age (years)		
≤17	6 (0.2 %)	
18−19	49 (2.3 %)	
20−39	1134 (55.5 %)	
40−59	777 (38.0 %)	
≥60	76 (3.7 %)	
Distribution of deferrals (serology) for studied year		
2015		1020 (17.6 %)
2016		1031 (17.8 %)
2017		938 (16.2 %)
2018		779 (13.4 %)
2019		873 (15.0 %)
2020		1144 (19.7 %)

The percentage of total blood donation deferred during these six years was 3.9 %, with a significant reduction in discards comparing the number of blood bags discarded in the first three years with those of the last three years: 4.8 % and 3.8 %, respectively ($P < 0.0001$) (Table 2). It can be viewed, in Table 4, an increase in the rate of discarded blood bags due to positive serology from 2015 to 2019 followed by a decrease in 2020. This table also reveals the proportion of rejected bags because of positive serology, which was similar between genders. In addition, it is noticeable that 35.3 % of all blood bags discards were by positive serology.

Table 5 demonstrates that between 2015–2020 the highest positive serology was due to hepatitis B, which caused 0.67 % discards, followed by syphilis with 0.58 % discards, then the positivity for hepatitis C, HIV, Chagas disease and HTLV. The rate of syphilis rejection has increased significantly. There was an increase in the losses because of serology by syphilis until 2018 that tends to reverse in 2019−2020. Comparing the number of discarded bags because of syphilis from 2015 to 2017 (349/2993 or 11.6 % of total discards) with those from 2018 to 2020 (427/2796 or 15.2 % of total discards), there was a significant difference ($P < 0.0001$; OR = 1.3; 95 % CI = 1.17–1.59).

It is relevant to notice that syphilis test has changed over the years in the Hemobanco's service (Fig. 1).

4. Discussion

This study presents data from a large sample of 134,741 blood donations over a longitudinal period, identifying the evolution of detection rates of infectious diseases in a donor population. An increase in syphilis rates, stability of HTLV seropositivity, and a decrease in detection rates of the other infectious diseases screened in blood banks over the period studied were characterized. The main focus of the study was given to syphilis, since Brazil is experiencing an epidemic of the disease in the general population, with a 113 % increase in the detection of acquired syphilis between 2015 and 2019 according to the national database [1].

Between 2015 and 2020, there was a reversal of the prevalence of

Table 2
Total number of blood donations and discards according to gender from 2015 to 2020 in Hemobanco in Curitiba (State of Paraná, Brazil).

	Males				Females				Total			
	Donations		Discards		Donations		Discards		Donations		Discards	
	n	%	n	%	n	%	n	%	N	%	n	%
2015	11,593	55.4 %	499	4.3 %	9,344	44.6 %	525	5.6 %	20,937	19.7 %	1,024	4.9 %
2016	11,426	56.8 %	527	4.6 %	8,701	43.2%	504	5.8%	20,127	18.9%	1,031	5.1 %
2017	11,506	55.6 %	499	4.3 %	9,176	44.4%	439	4.8 %	20,682	19.5%	938	4.5 %
2018	11,361	55.2 %	344	3.0 %	9,234	44.8 %	435	4.7%	20,595	19.4%	779	3.9 %
2019	12,896	53.9 %	394	3.1%	11,014	46.1 %	479	4.3 %	23,910	22.5 %	873	3.7 %
2020	14,272	50.1 %	574	4.0%	14,318	49.9 %	570	4.0 %	28,490	21.1 %	1,144	4.0 %

Males vs females: $P < 0.0001$.

Table 3
Proportion of blood deferrals for positive serology and absolute number of blood deferrals for positive syphilis serology according to donor's age from 2015 to 2020 at Hemobanco in Curitiba (State of Paraná, Brazil).

Age (years)	2015			2016			2017			2018			2019			2020		
	N	%	S	N	%	S	N	%	S	N	%	S	N	%	S	N	%	S
≤17	0	0.0%	0	1	0.3%	1	0	0.0%	0	2	0.6%	1	2	0.5 %	0	1	0.4%	0
18–19	12	4.0%	5	11	3.2%	6	11	2.9%	5	6	1.7%	3	6	1.4%	1	3	1.3%	2
20–39	189	62.4%	60	218	63.2%	80	203	52.3 %	70	188	52.4%	78	235	56.8 %	83	101	43.3%	76
40–59	97	32.0%	15	104	30.1%	19	158	40.7%	74	152	42.3 %	65	158	38.2%	49	108	46.4%	51
≥60	5	1.6 %	1	11	3.2%	0	16	4.1%	13	11	3.0%	6	13	3.1%	6	20	8.6 %	6
Total	303	100 %	81	345	100 %	106	388	100 %	162	359	100 %	153	414	100 %	139	233	100 %	135

N = total number of blood deferrals for positive serology; S = absolute number of blood deferrals for positive syphilis serology.
Comparison of 2015–2017 versus 2017–2020, with $P = 0.0001$.

Table 4
Total number of discards due to any reasons versus seropositivity according to gender from 2015 to 2020 at Hemobanco in Curitiba (State of Paraná, Brazil).

	Males			Females			Total		
	Total Discards	SP Discards		Total Discards	SP Discards		Total Discards	SP Discards	
	N	n	%	n	n	%	n	n	%
2015	499	151	30.2 %	521	152	29.1%	1020	303	29.7 %
2016	527	178	33.8 %	504	167	33.1%	1031	345	33.5 %
2017	499	228	45.7 %	439	160	36.4%	938	388	41.4 %
2018	344	180	52.3 %	435	179	41.1%	779	359	46.1 %
2019	394	195	49.5 %	479	219	45.7%	873	414	47.4 %
2020	574	126	21.9 %	570	107	18.8%	1144	233	20.4 %
Total	2837	1058	37.3 %	2948	984	33.4%	5785	2.042	35.3 %

SP: seropositivity; n = number.

Table 5
Blood deferrals according to positive serology during the years of 2015 to 2020 at Hemobanco in Curitiba (State of Paraná, Brazil).

	2015		2016		2017		2018		2019		2020	
	N	%	N	%	N	%	N	%	N	%	N	%
Chagas Disease	6	0.03 %	3	0.01 %	9	0.04 %	12	0.06 %	23	0.10 %	2	0.01 %
Hepatitis B	168	0.80 %	161	0.80 %	126	0.61 %	138	0.67 %	199	0.83 %	93	0.33 %
Hepatitis C	25	0.12 %	51	0.25 %	65	0.31 %	24	0.12 %	37	0.15 %	1	0.00 %
HIV	26	0.12 %	29	0.14 %	34	0.16%	35	0.17%	26	0.11 %	8	0.03 %
HTLV	2	0.01 %	1	0.00 %	3	0.01%	2	0.01%	1	0.00 %	2	0.01 %
Syphilis	81	0.39 %	106	0.52%	162	0.78%	153	0.74%	139	0.58 %	135	0.47 %
Seropositivity Discards	303	1.45 %	345	1.71%	388	1.88%	359	1.74%	414	1.73%	233	0.82 %
Donations total	20,937	100 %	20,127	100 %	20,682	100 %	20,595	100 %	23,910	100 %	28,490	100 %

N = number. Comparison of blood bags discard because of positive syphilis serology from 2015 to 2017 versus 2017–2020, $P < 0.0001$, OR = 1.3; 95 % CI= =. 1.17–1.59.

diseases screened at the Hemobanco. While at the beginning of the studied period, Hepatitis B was the disease with the highest discard rate, in 2020, the highest refusal rate occurred due to syphilis. On the other hand, the Bulletin of Hemotherapy Production in Brazil published in 2021 still shows Hepatitis B with higher prevalence (1.36 %) compared to syphilis (1.07 %). In 2020, the disease found with the lowest seropositivity rate in the Hemobanco was Hepatitis C (0.00 %), while in the Hemotherapy Production Bulletin in Brazil it was Chagas disease (0.15 %) in national territory, and HIV in the state of Paraná (0.11 %) [2].

In this study, there was an increase of 59 % in the number of discards due to seropositivity for syphilis between 2015 and 2019. In contrast, in Paraná, in the same period, there was an increase of 98.5 % in the detection rate of acquired syphilis, being higher than the national average throughout the studied period. The detection rate in the state

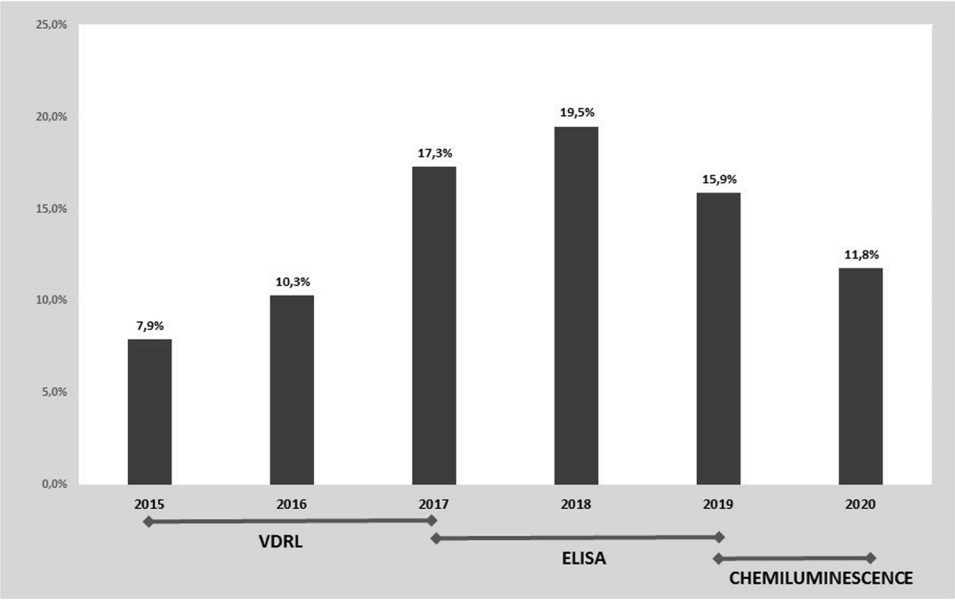

Fig. 1. Blood deferral (%) because of positive serology for syphilis from 2015 to 2020 at Hemobanco froim Curitiba (State of Paraná, Brazil).
Bellow the graphic tests used in the blood bank to detect syphilis during this period of time: VDRL, (from 2015 to 2017, June) ELISA (from 2017, July to 2019, June) and chemiluminescence (from 2019, July to 2020).

went from 59.7 in 2015 to 118.6 per 100,000 inhabitants in 2019. On the other hand, in the national territory, the increase was 113.5 %: 34.1–72.8 per 100,000 individuals [1]. The peak detection of acquired syphilis in the national territory with 72.8 positive patients per 100,000 inhabitants was in 2019 when the highest percentage of discards due to seropositivity also occurred in the Hemobanc comprizing 47.4 % of the discards due to positivity in serological screening [1]. Moreover, it was observed that there was a significant drop in discards due to syphilis in 2020 at the Hemobanco compared to 2019.

The women's seropositivity rate was higher compared to men's rate between 2015 and 2019, with the exception in 2020, when 4% of all blood donations of both genders were discarded. Nevertheless, between 2015 and 2019, the national male average prevalence was 60.03 %, while the female prevalence was 39.90 %, in addition to 0.07 % of ignored gender [1].

Regarding age, it was found in the period studied an increase of 437 % in positive serology tests in patients older than 60 years. These number were higher than the data found in a North American study, which reported an increase of 109 % in the rate of syphilis in those older than 55 years in the period between 2015 and 2019 [9]. Another data, from the population of the state of Santa Catarina in Brazil, showed an increase of 1470 % between 2010 and 2017 in this same age group [10, 11]. In 2015, in the sample collected at the Hemobanco, seniors made up 1.6 % of the totals discarded for syphilis seropositivity in relation to other ages, increasing to 8.6 % in 2020. Even with this significant increase, the 2020 Syphilis Epidemiological Bulletin shows that in 2019, the age group with the highest detection rate for acquired syphilis is 20–29 years old (38.8 %), followed by the 30–39 years old group (22.3 %). The sum of the prevalence of these 2 groups is similar to the 56.8 % rate found in the Hemobank with patients aged 20−39 years in this same year [1].

In 2019, at the Hemobanco, the most frequently positive serology was for syphilis, responsible for 0.47 % of total discards. It can be gauged that, in the period from 2015–2020, there was a 60 % decrease in the detection rate of hepatitis B in this same institution. An increase of 20.5 % was observed in the disposal due to syphilis seropositivity (0.39 % in 2015 to 0.47 % in 2020). The 2019 National Hemotherapy Production Bulletin pointed out that in that same year, 0.44 % of serological samples were reagent, considering all serologies. Among them, 1.36 % of samples tested for hepatitis B (anti-Hbc) were reagent, followed by 1.07 % seropositivity for syphilis, 0.26 % due to hepatitis C, 0.24 % for HTLV I and II, 0.20 % for HIV, and 0.15 % for Chagas disease [2].

In the studied period, syphilis was the second most common disease found in the screening, only less important than hepatitis B. In contrast, Monich et al. [3] conducted a study in the same institution between 2003 and 2012 evaluating the serological causes of discard. The authors found that among 399,280 donations there was a significant drop in discards, from 10.2 %–5.0 % over the period. However, they pointed out an increase in seropositivity for syphilis, which accounted for 0.5 % of discards, the 5th most prevalent disease [3]. Another article, published by Jaques et al., [8] described the characteristics of blood donors and the serological profile of blood donations from a Hospital in Santa Catarina (Brazil) between 2011 and 2016. Among the 14,368 donations made, 0.8 % had positive serology, with syphilis being the second most prevalent. However, the syphilis detection rate of 0.13 % in the study was lower than that detected in the present sample [8].

Pessoni et al. performed a retrospective analysis of data from 137,209 blood donors between 2010 and 2016 at the Hemocentro de Goiás, Brazil. In relation to the total donations of this institution, 0.87 % presented positive serology for syphilis with an increase in the period, being the second most frequent [8,12].

Where the study took place between 2015 and 2020, testing method changes in syphilis screening were necessary, which followed the trends of developed countries and greater automation. The technical regulation proposed by ANVISA (resolution number 153) defines that donor screening for syphilis should necessarily be performed with a treponemal or non-treponemal test; however, there is no specification of which test should be used. Some hemotherapy services still use non-treponemal testing, because it is inexpensive [7,13]. However, ELISA and chemiluminescence tests have been licensed for use as initial screening tests because they can be automated and the results can be read objectively. Thus, in high demand settings, screening is performed by ELISA or chemiluminescence and, if reagent, a non-treponemal test is performed [6].

Some authors have suggested that the risk of transfusion-transmitted syphilis is very low and the screening costs did not justify universal testing of the blood donors [14,15]. According to them, these tests should be reserved to high-risk populations. The results presently found

suggests that, in the Brazilian population, this screening still is necessary.

On the other hand, it is relevant to emphasize that these tests have been developed for diagnostic use and not as screening tests and that the use of diagnostic tests for screening low-risk populations results in a relative increase in false-positive test results [16].

In view of raising cases of syphilis detected at Hemobanco, health public measures to avoid the dissemination of this disease are needed.

5. Conclusion

Within the studied period the greatest cause of discard of blood donations changed during the analyzed 5-years. In 2015, Hepatitis B (0.8 %) was the most prevalent, however, in 2020 syphilis became more prevalent (0.82 %). There was an increase in the number of donations. Male donors are still majority; however, the number of female donors has increased significantly. The proportion of blood deferrals according to donor's age has also changed, with an increase in seropositivity donations from donors with $\geq$ 60 years old.

Authors' contributions

GPZK, JBFO, KBF, TLS and RN conceived and carried out the study; KBF, PTRA, TLS and RN organized and analyzed data. All authors were involved in writing the paper and had final approval of the submitted and published versions.

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Declaration of Competing Interest

The authors have no competing interests.

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