Original Article

Prevalence of transfusion-transmitted infections in donated blood at Thammasat University Hospital during 2017 to 2020

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Abstract:

Introduction: *In Thailand, all donated blood units are screened for syphilis, human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV). The prevalence of these infections varies among different donor populations and demographic characteristics. This study aimed to assess the prevalence of transfusion-transmitted infections (TTIs) in the donated blood at Thammasat University Hospital during 2017-2020.* ***Meterials and Methods:*** *Blood donation data (2017-2020) were retrospectively analyzed to determine the prevalence of TTIs obtained from serological tests and nucleic acid amplification technology results. The association between the explanatory variables including age, sex, ABO grouping, Rh(D) typing, frequency of donations, collection site and TTIs was also determined.* ***Results:*** *The overall prevalence of TTIs was 0.87% (132 donated blood units among 38,077 donations), for which a steady trend was observed during the analyzed period. Of these, HBV positive was the most common (0.38%), followed by HCV positive (0.22%), syphilis reactive (0.17%) and HIV positive (0.12%) while 0.01% were positive with more than one infection. The prevalence of TTIs was associated with male donors, mobile blood collection sites and first-time donation, while a significantly higher infection rate was found in the 31 - 40 year age group, particularly in the first-time donation ($p < 0.05$).* ***Conclusion:*** *The prevalence and trends of TTIs including syphilis, HBV, HCV, and HIV infections at Thammasat University Hospital were first assessed from 2017 to 2020. The positivity rates of TTIs trended to be constantly steady during the period. These results could support the development of donor recruitment strategies, promoting the quality and assurance of the safety of the blood transfusions involving in TTIs.*

Keywords : ● *Blood donation* ● *Prevalence* ● *Syphilis* ● *HBV* ● *HCV* ● *HIV*

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นิพนธ์ต้นฉบับ

ความชุกของการติดเชื้อที่สามารถติดต่อทางการให้เลือดของเลือดบริจาค ณ โรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติ ระหว่างปี พ.ศ. 2560 ถึง 2563

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บทคัดย่อ

บทนำ *ในประเทศไทยเลือดที่ได้รับบริจาคทุกยูนิต ต้องตรวจหาเชื้อซิฟิลิส ไวรัสตับอักเสบบี ไวรัสตับอักเสบซี และไวรัสเอชไอวี ความชุกของการติดเชื้อเหล่านี้แตกต่างกันในกลุ่มประชากรและลักษณะทางประชากร การศึกษานี้มีวัตถุประสงค์เพื่อประเมินแนวโน้มความชุกของการติดเชื้อที่สามารถติดต่อทางการให้เลือดของการบริจาคเลือดที่โรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติในช่วง พ.ศ.2560-2563* ***วิธีการวิจัย*** *วิเคราะห์ข้อมูลการบริจาคเลือดย้อนหลัง (พ.ศ. 2560-2563) เพื่อหาความชุกของการติดเชื้อต่าง ๆ ที่ได้จากผลการตรวจทางซีโรโลยีและการทดสอบกรดนิวคลีอิก และวิเคราะห์ความสัมพันธ์ระหว่างตัวแปร ได้แก่ อายุ เพศ หมู่เลือด ABO และ Rh(D) ความถี่ของการบริจาค และสถานที่รับบริจาค กับผลการติดเชื้อต่าง ๆ* ***ผลการศึกษา*** *ความชุกโดยรวมของการติดเชื้อต่าง ๆ เท่ากับ 0.87% (ผู้บริจาคติดเชื้อ 132 รายจากการบริจาค 38,077 ครั้ง) โดยมีแนวโน้มคงที่ในช่วงเวลาที่วิเคราะห์ ทั้งนี้พบผลบวกต่อ HBV มากที่สุด (0.38%) รองลงมาคือ HCV (0.22%), ซิฟิลิส (0.17%) และ HIV (0.12%) และอีก 0.01% เป็นการติดเชื้อร่วมกันมากกว่าหนึ่งชนิด ความชุกของการติดเชื้อต่าง ๆ มีความสัมพันธ์กับผู้บริจาคเพศชาย บริจาคที่หน่วยเคลื่อนที่ และการบริจาคครั้งแรก ขณะที่พบอัตราการติดเชื้อสูงขึ้นอย่างมีนัยสำคัญในกลุ่มอายุ 31-40 ปี โดยเฉพาะอย่างยิ่งการบริจาคครั้งแรก ($p < 0.05$)* ***สรุป*** *ความชุกและแนวโน้มของการติดเชื้อทั้ง ซิฟิลิส ไวรัสตับอักเสบบี ไวรัสตับอักเสบซี และไวรัสเอชไอวี ที่โรงพยาบาลธรรมศาสตร์เฉลิมพระเกียรติ ระหว่าง พ.ศ. 2560 ถึง พ.ศ. 2563 ที่ได้ศึกษาเป็นครั้งแรก พบแนวโน้มของอัตราการติดเชื้อต่าง ๆ คงที่อย่างต่อเนื่องในช่วงเวลาดังกล่าว ผลการศึกษานี้สามารถสนับสนุนกลยุทธ์การจัดหาผู้บริจาคเลือดเพื่อการพัฒนาปรับปรุงคุณภาพ และการประกันความปลอดภัยของการติดเชื้อต่าง ๆ จากการให้เลือด*

คำสำคัญ : ● *การบริจาคเลือด* ● *ความชุก* ● *เชื้อซิฟิลิส* ● *ไวรัสตับอักเสบบี* ● *ไวรัสตับอักเสบซี* ● *ไวรัสเอชไอวี*

วารสารโลหิตวิทยาและเวชศาสตร์บริการโลหิต. 2564;31:137-44.

Introduction

A major problem associated with blood transfusion is transfusion-transmitted infections (TTIs), including those caused by viruses, bacteria, parasites, and prions. Owing to the high prevalence rates, human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV) are the most eminent infectious agents. Other infectious agents causing TTIs include cytomegalovirus (CMV), dengue virus, human T-cell lymphotropic virus (HTLV-I/II), parvovirus B19, and West Nile virus (WNV), malaria parasites, trypanosome, *Treponema* (TP) and transmissible spongiform encephalopathy (TSE) agent.[1] Those infections can be transmitted from the donors to the patients through parenteral administration of blood or any blood products resulting in unsafe transfusions. Acute clinical sickness can occur among certain recipients, while either asymptomatic or carrier infection can persist in other cases.[2] Donor exclusion and screening for infectious markers by serological tests and viral genes by nucleic acid amplification technology (NAT) can reduce the risks of TTIs.[1]

According to the National Blood Centre, Thai Red Cross Society (NBC-TRCS) guidelines, all donated blood units must be screened for syphilis, infections by HIV, HBV, and HCV. Detections of treponemal antibodies, HIV antigen-antibody combination, HBsAg,and anti-HCV are performed by enzyme immunoassay (EIA) or chemiluminescent immunoassay (CMIA). In addition, the NBC-TRCS has implemented mandatory NAT screening for HIV, HBV, and HCV in every blood unit. Only blood and blood components from the donors, that are nonreactive by all screening tests for all markers, can be released for clinical use.[3]

The prevalence of TTIs among the blood donors had been reported and may vary in different regions of Thailand including Prajuabkirikhan, Khon Kaen, Kamphaengphet, and Chonburi Provinces.[4-7] HBV infection has the highest prevalence among the donors with TTIs; 1.41, 2.15, 2.36, and 3.30%, respectively. Next, the prevalence of HCV and HIV infections, and syphilis ranged from 0.58 to 1.07%, 0.13 to 1.30%, and 0.40 to 0.57%, respectively among the above-mentioned donors.[4-7] The influencing factors associated with the prevalence of TTIs depend on sex, age, occupation, country, and donation frequency.[4-10]

Thammasat University Hospital is a blood transfusion service branch of NBC-TRCS. Blood collection is performed mainly on-site or at mobile collection sites. All donated blood samples were sent to NBC-TRCS for infectious marker testing, blood grouping, and antibody screening test. Consequently, the results are directly reported to the Hospital Blood Bank. The donated blood units with either positive infectious disease markers or antibody screening tests were discarded. Moreover, those infected individuals are referred for appropriate counseling, treatment and further management as they may infect other individuals if they are unaware of their status. Hence, clear policies and systems to communicate with these donors are implemented to minimize any risk of further transmission.[11] To provide a better understanding of the epidemiology of TTIs, additional studies among the Thai blood donors can support in evaluating the safe blood supply measures and preventing and managing the burden of these infections in the community. Therefore, this study aimed to assess the trends in the prevalence of TTIs among donated blood at Thammasat University Hospital during 2017 to 2020.

Materials and Methods

Data from volunteer donors donating to the Blood Bank, Thammasat University Hospital, and recruited by mobile units from January 2017 to December 2020 were included in the analysis. Demographic data regarding age, sex, ABO grouping, Rh(D) typing, frequency of donations and collection site were obtained from the computer system of the blood bank. The results of infectious marker testing including HBV, HCV, HIV and syphilis were obtained from the NBC-TRCS. Tests in this study included HBsAg, HCV Ab, HIV Ag/Ab combined, HBV NAT, HCV NAT, HIV NAT and syphilis Ab. All

donated blood samples were assessed for HBsAg to confirm the presence of HBV, antibodies to HCV, HIV p24 antigen, and antibodies to HIV-1 groups M and O and/or antibodies to HIV-2 and anti-TP by chemiluminescence microparticle immunoassays (CMIA) on the ARCHITECT i6000 (Abbott Diagnostics, Wiesbaden, Germany). Quantitation of HBV, HCV, and HIV-1 was determined in all donor samples by using the COBAS 6800 & 8000 (Roche Diagnostics, Basel, Switzerland). To assess the positivity rate of TTIs, the results of either serology and/or NAT were found to be positive.

Statistical analysis

Descriptive analysis of TTI results obtained from all donations was performed according to age groups, sex, ABO grouping, Rh(D) typing, frequency of donations and collection site. The positive and negative TTI results of each factor from these screening were compared and expressed in percentage, 95% confidence intervals (CI) and the odds ratios (OR). Moreover, categorical variables of age groups, sex, frequency of donations and collection site were compared using the Chi-square (χ^2) test. The results were analyzed using SPSS 16.0 Software (SPSS Inc., Chicago, IL, USA). A *p*-value of less than 0.05 was considered statistically significant.

Results

From January 2017 to December 2020, a total of 38,077 donations were collected at Thammasat University Hospital. Of these, 19,215 (50.46%) were donated from males and 18,862 (49.54%) from females (Table 1). The donors' ages ranged from 17 to 63 years. For ABO types, group O was the most common 14,497 (38.07%), followed by group B 12,712 (33.38%), group A 7,629 (20.04%) and group AB 3,239 (8.51%), in rank. For Rh(D) types, Rh positive donors totaled 37,897 (99.53%) and Rh negative donors totaled 180 (0.47%). Regarding donation frequency, repeat donors totaled 31,610 (83.02%) and first-time donors totaled 6,467 (16.98%). The majority of blood donations were obtained from mobile sites 21,691 (56.97%), while, 16,386 (43.03%) were obtained onsite. The details of demographic characteristics of blood donors divided from 2017 to 2020 are shown in Table 1.

Overall, 333 (0.87%) donors had a reactive result for one or more TTIs. The positivity rates for all the tests combined (screening and confirmatory) were 1.18, 0.81, 0.79, and 0.78% for the years 2017, 2018, 2019 and 2020, respectively (Table 2). Of these, 132 donors (0.35%) were HBV positive, 85 donors (0.22%) were HCV positive, 64 donors (0.17%) were positive for syphilis, 47 donors (0.12%) were HIV positive and 5 donors were positive with multiple infections (3 syphilis + HIV, 1 syphilis + HBV and 1 syphilis + HIV + HCV). No significant difference was found in each TTI after bivariate analysis.

Demographic characteristics of the overall TTI population including age, sex, ABO grouping, Rh(D) typing, frequency of donations and collection site associated with TTIs status, were identified using the bivariate analyzes in OR, 95%CI, and *p*-value. No significant differences were found in ABO and Rh(D) types ($p > 0.05$). Interestingly, the positivity rates for TTI combined tests were compared between male and female donors. The rates were higher among male donors in 2017, 2019 and 2020, which was significant only for 2017 (OR: 1.990, 95%CI: 1.219 - 3.049, $p = 0.002$) and 2020 (OR: 2.150, 95%CI: 1.317 - 3.509, $p = 0.002$), as shown in Figure 1. Regarding the donation frequency, the overall positive rate of TTIs among the first-time donors was significantly higher than repeat blood donors ($p < 0.0001$) from 2017 to 2020, as shown in Table 3. The prevalence of TTIs in blood donations collected onsite were 0.25, 0.24, 0.24 and 0.58% and donations at mobile sites were 0.93, 0.56, 0.54 and 0.20% in 2017 through 2020, respectively. Only in 2019 was the prevalence of TTIs collected in mobile sites significant higher than that of those collected onsite (OR: 1.924, 95%CI: 1.174-3.154, $p = 0.009$).

Assessing the positivity rate of TTIs among age groups demonstrated that the overall rates were high in the 21 to 30 and 31 to 40 years groups and negativity rates were shown in the > 60-year group in 2017 through

Table 1 Demographic characteristics of blood donors at Thammasat University Hospital, 2017-2020

Year	2017	2018	2019	2020	Total
Number	8,138 (100.00%)	11,158 (100.00%)	9,404 (100.00%)	9,377 (100.00%)	38,077 (100.00%)
Sex					
Male	4,095 (50.32%)	5,775 (51.76%)	4,764 (50.66%)	4,581 (48.85%)	19,215 (50.46%)
Female	4,043 (49.68%)	5,383 (48.24%)	4,640 (49.34%)	4,796 (51.15%)	18,862 (49.54%)
Age group (years)					
≤ 20	893 (10.97%)	1,073 (9.62%)	913 (9.71%)	1,085 (11.57%)	3,964 (10.41%)
21 - 30	2,632 (32.34%)	3,432 (30.76%)	2,983 (31.72%)	3,010 (32.10%)	12,057 (31.66%)
31 - 40	2,703 (33.21%)	3,293 (20.51%)	2,291 (24.36%)	2,142 (22.84%)	10,429 (27.39%)
41 - 50	1,483 (18.22%)	2,410 (21.60%)	2,147 (22.83%)	2,066 (22.03%)	8,106 (21.29%)
51 - 60	427 (5.25%)	947 (8.49%)	1,058 (11.25%)	1,048 (11.18%)	3,480 (9.14%)
> 60	0 (0.00%)	3 (0.03%)	12 (0.13%)	26 (0.28%)	41 (0.11%)
Blood group					
A	1,597 (19.62%)	2,238 (20.06%)	1,894 (20.14%)	1,900 (20.26%)	7,629 (20.04%)
B	2,789 (34.27%)	3,691 (33.08%)	3,196 (33.99%)	3,036 (32.38%)	12,712 (33.38%)
O	3,075 (37.79%)	4,269 (38.26%)	3,498 (37.20%)	3,655 (38.98%)	14,497 (38.07%)
AB	677 (8.32%)	960 (8.60%)	816 (8.68%)	786 (8.38%)	3,239 (8.51%)
Rh(D) typing					
Positive	8,089 (99.40%)	11,108 (99.55%)	9,358 (99.51%)	9,342 (99.63%)	37,897 (99.53%)
Negative	49 (0.60%)	50 (0.45%)	46 (0.49%)	35 (0.37%)	180 (0.47%)
Donation frequency					
First-time	1,541 (18.94%)	1,781 (15.96%)	1,460 (15.53%)	1,685 (17.97%)	6,467 (16.98%)
Repeat	6,597 (81.06%)	9,377 (84.04%)	7,944 (84.46%)	7,692 (82.03%)	31,610 (83.02%)
Collection site					
Onsite	1,620 (19.91%)	3,974 (35.62%)	4,358 (46.34%)	6,434 (68.61%)	16,386 (43.03%)
Mobile sites	6,518 (80.09%)	7,184 (64.38%)	5,046 (53.66%)	2,943 (31.39%)	21,691 (56.97%)

Table 2 TTIs positivity rate (%) among the donated blood, 2017-2020

Test/Year	2017	2018	2019	2020	Total
Number	8,138	11,158	9,404	9,377	38,077
HBV infection	45 (0.55%)	38 (0.34%)	23 (0.25%)	26 (0.28%)	132 (0.35%)
HCV infection	21 (0.26%)	28 (0.25%)	17 (0.18%)	19 (0.20%)	85 (0.22%)
Syphilis	16 (0.20%)	9 (0.08%)	21 (0.22%)	18 (0.19%)	64 (0.17%)
HIV infection	12 (0.15%)	15 (0.14%)	11 (0.12%)	9 (0.10%)	47 (0.12%)
Multiple infections	2 (0.02%)[a,b]	0 (0.00%)	2 (0.02%)[a,c]	1 (0.01%)[a]	5 (0.01%)
Total	**96 (1.18%)**	**90 (0.81%)**	**74 (0.79%)**	**73 (0.78%)**	**333 (0.87%)**

Abbreviation: HBV, Hepatitis B virus; HCV, Hepatitis C virus; HIV, human immunodeficiency virus

Note: [a]Syphilis + HIV infection; [b]Syphilis + HBV infection; [c]Syphilis + HIV + HCV infections

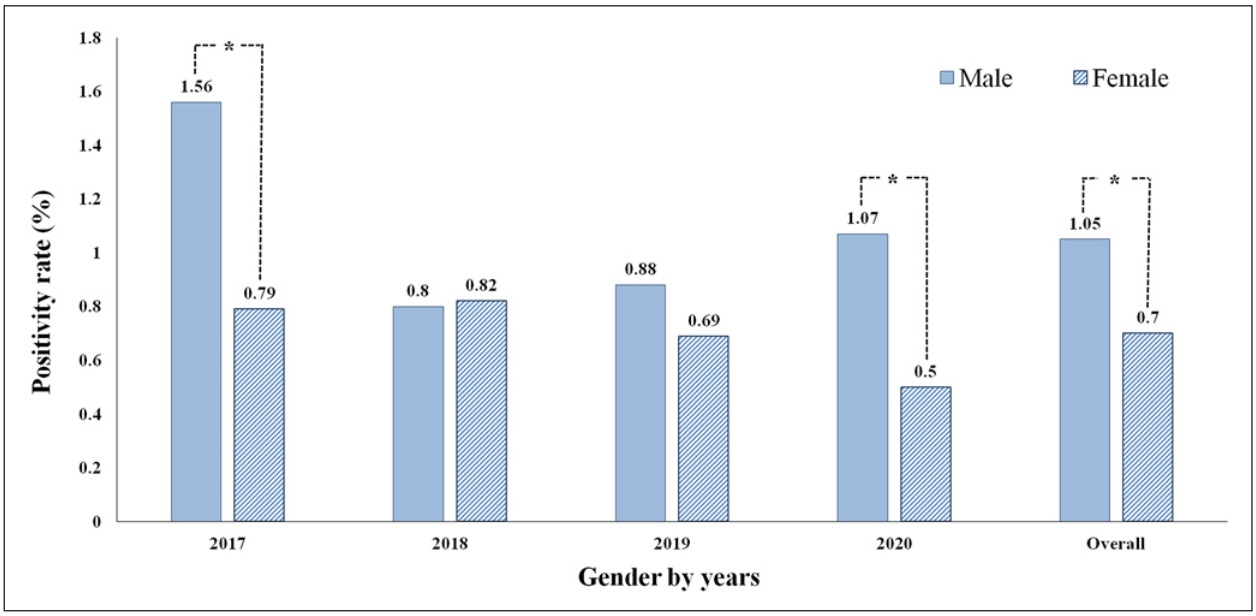

Figure 1 Sex distribution and positivity rates for TTIs among blood donors at Thammasat University Hospital, 2017-2020. *p-value < 0.05

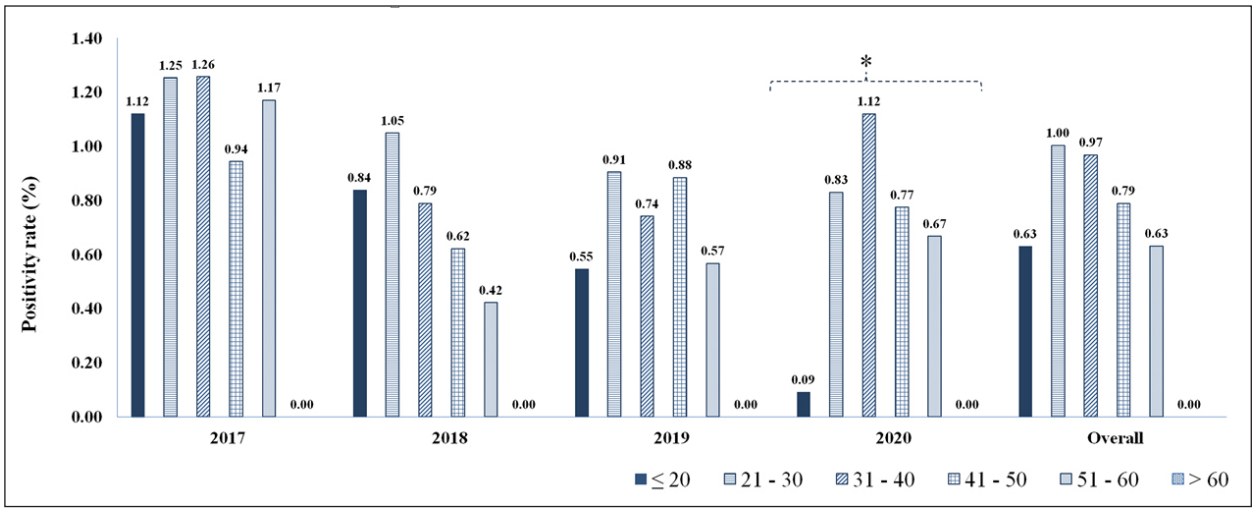

Figure 2 Age distribution and positivity rate of TTIs among blood donors at Thammasat University Hospital, 2017 - 2020. *p-value < 0.05

Table 3 Donation frequency and positivity rate (%) of TTIs among blood donors at Thammasat University Hospital, 2017-2020

Year	TTIs positivity rate (%)		OR	95%CI	*p*-value
	First-time	Repeat			
2017	3.18	0.71	4.577	3.055 - 6.856	< 0.0001
2018	2.36	0.51	4.694	3.093 - 7.125	< 0.0001
2019	2.40	0.49	4.978	3.143 - 7.885	< 0.0001
2020	1.96	0.52	3.821	2.403 - 6.078	< 0.0001
Overall	**2.46**	**0.55**	**4.554**	**3.667 - 5.656**	**< 0.0001**

Abbreviation: OR, Odds ratio; CI, Confidence interval

2020. In 2020, the positivity rate in the 31 to 40 years group was significantly higher than that of other groups (OR: 1.673, 95%CI: 1.024 - 2.733, p = 0.039). Among them, bivariate analysis was performed to determine the independent association between TTI status and demographic factors including sex, donation sites and frequencies, revealing that TTI status was associated only with first-time donation (χ^2 = 10.398 and p = 0.001).

Discussion

Although transfusion of donated blood can be life-saving, its procedure is associated with considerable potential risk to the recipients. TTIs among blood donors remain a major threat to blood safety, so blood donation centers must be concerned over the relevant information on the risk of TTIs, TTI screening and confirmatory algorithms.[1] Notably, the demographic factors of voluntary blood donors are related to these TTIs.[12] To ensure the safety of the blood supply, comprehensive surveillance and control of TTIs among blood donors are necessary. Hence, knowing the prevalence of infection in different communities will be important for managing positive or reactive blood donors.

In this study, the positivity rate of the combined tests, consisting of serological and NAT tests, were assessed among blood donations from 2017 to 2020. Of these infections, the prevalence rates of all infections remained stable during the past four years, for which the most common was HBV, followed by HCV, syphilis and HIV, in rank, similar to a related study.[4] Multiple infections were found among five donors with syphilis combined with other infections, which might have been related to diseases usually transmitted by sexual contact.

An equal ratio of male and female donors was identified but males were found to exhibit an increasing trend of these TTIs in 2017, 2020 and total population. The results supported the increasing trends for those infections found in different regions of Thailand[4-7] and Chinese populations.[12,13] Moreover, the association between ABO groups and infection has already been reported such as *Escherichia coli*, *Vibrio cholera*, *Helicobacter pylori*, norovirus, and rotavirus.[14] In this study, ABO groups and Rh(D) types showed no association with HBV, HCV, HIV and syphilis infections among blood donors. To achieve a sufficient blood supply, organizations using mobile blood collection sessions may represent a useful strategy in overcoming current barriers of higher rates of blood use to further donor recruitment and retention.[15] Our results showed that the majority of blood donations were obtained from mobile sites surrounding Thammasat University Hospital and TTI prevalence in the blood units collected at mobile sites was higher than that of blood units collected onsite.

Notably, regarding donation frequency, repeated donors usually exhibited altruistic behavior and felt responsible for recipient safety. Thereby, the prevalence of TTIs in this donor category was reduced compared with first-time donors.[4,9,16] The high probability for positive tests of TTIs in first-time donors was found in our results from 2017 to 2020.

Generally, younger donors, mostly less than 30 years in age, seemed to contribute more blood donations.[17] Even though major blood donations in our study received from donors with age ranging from 21 to 30 years, the positivity rate was assessed throughout the study periods and only 2020 indicated a significantly higher rate in the 31 to 40 years group, particularly in first-time donations. This finding was similar to related studies in other populations,[8,9] whereas, the high rates were found in the 17 to 20 years group from different Thai regions.[4-7] Further investigations are needed to assess the distribution and determine these infections in various communities to reinforce the development of effective prevention and control strategies, and to diminish potential risks of TTIs.

Conclusion

The prevalence and trends of TTIs including HBV, HCV, HIV, and syphilis among Thai blood donors at Thammasat University Hospital were first assessed throughout 2017 to 2020. The positivity rates of TTIs trended to be constantly steady during these periods. These results could support the development of donor recruitment strategies, promoting the quality and assurance safety of blood transfusions involving TTIs.

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