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RESEARCH ARTICLE

Mobile blood collection sites and their roles in providing safe and adequate supply: A six-year experience

Mostafa Paridar[1], Abbas Khosravi (✉)[2], Mohammad-Ali Jalali-Far[2], Sima Zolfaghari[2], Omid Kiani Ghaleh Sardi[3], Mehdi Sajadi[4]

[1] *Deputy of Management and Resources Development, Ministry of Health and Medical Education,Tehran, Iran*
[2] *Transfusion Research Center, High Institute for Research and Education in Transfusion Medicine, Tehran, Iran*
[3] *Department of Hematolog, Iran University of Medical Sciences,Tehran,Iran*
[4] *Faculty of Allied Medicine, Birjand University of Medical Sciences, Birjand, Iran*

BACKGROUND: The determination of the role of mobile sites, as compared with fixed sites, in providing safe blood supply will help with the planning of future programs.
MATERIALS and METHODS: This retrospective study was carried out at the Khuzestan Blood Transfusion Organization from 2007 to 2012. Samples of the blood collected at mobile sites and fixed sites were compared. Comparisons took into consideration noticeable trends as well as the prevalence of major TTIs including HIV, HBV and HCV.
RESULTS: The total number of blood donations from 2007 to 2012 was 621117 out of which 89590 (14.43%) were collected from mobile sites. The overall blood donation index was estimated at 23.8 per 1000 population. The prevalence of HIV, HBV and HCV in mobile site donations was 5.31, 320.34 and 117.4, and in fixed sites was 5.31, 214.72 and 104.83 per 100000 donations respectively. HBV prevalence in mobile sites was significantly higher than in fixed sites ($p = 0.014$).
CONCLUSION: The blood donation index in Khuzestan province is much better when compared with areas of similar socio-economic status as well as neighboring countries. The allotment of blood units collected by mobile teams is lower than that of national reports. In addition, the prevalence of TTIs in mobile site blood donations was higher than at fixed sites.

Keywords fixed sites, mobile sites, blood donations, TTIs, Iran

Introduction

Blood transfusion is a vital treatment approach that saves millions of lives annually. So far, despite some efforts, no successful, alternative transfusion substance, such as a blood substitute, has been discovered (Van Veen and Hunt, 2015). Blood and blood components remain the only available treatment for trauma and surgery patients, as well as those with thalassemia, hemophilia, cancer and anemia. Due to the rising global rate of both advanced and elective surgeries, the need for blood and its components is increasing, while advancements in the donor selection process and serological tests now result in a higher rate of donor deferment (Belayneh et al., 2013). The number of deferred Iranian donors, for example, increased from 14 percent in 2001 to 22 percent in 2011(Cheraghalli, 2012; Razjou et al., 2012). To achieve a sufficient blood supply, the organization of mobile blood collection sessions may represent a useful strategy in overcoming current barriers to further donor recruitment and retention, such as a lack of convenient access to blood donation centers, seen especially in rural areas. Mobile sites are generally donor rooms located at a variety of relatively populous locations including military installations, schools, hospitals etc. (Rose et al., 2011; James et al., 2014). Such locations are chosen for their convenience and proximity to public, gathering areas in order to enhance donor recruitment (Abhishekh and Usha, 2013).

The Iranian Blood Transfusion Organization (IBTO), established in 1974, is a national organization of blood centers throughout Iran with the mission of providing a sufficient supply of safe blood products. As IBTO relies entirely on government funding it is worth mentioning that since 2007, blood donation has become entirely voluntary and non-remunerated all over the country (Gharehbaghian, 2012). The annual donation index in Iran is 26.2/1000,

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Correspondence: Abbas Khosravi
E-mail: Ali.khossravi70@yahoo.com

meaning that in 2011 about 2 million units of blood were collected by the IBTO. Currently 283 fixed blood donation sites are accessible in the country from which 80% of all donated blood is collected, while mobile teams collect the remaining 20% (Cheraghali, 2012).

The selection, however, of safe, healthy donors, the prevalence of transfusion transmissible infections (TTIs), including, most notably, hepatitis B, C and HIV and the need for "zero risk blood transfusion" remain major concerns for blood transfusion organizations throughout the world. Although the mobile teams provide a relatively high proportion of blood supplies, there are only a few studies concerned with the safety of collected blood from mobile sites as compared to fixed ones.

The aim of this study, therefore, was to investigate the mobile blood collection sites and their roles in providing safe and adequate supplies to the Khuzestan blood transfusion organization (KHBTO) from 2007 to 2012, in comparison with fixed centers. The results of this study are of great importance to the future establishment of both fixed and mobile collection sites; first with regards to their organizational management strategies and, additionally, in providing a framework from which to consider influential factors surrounding blood safety and donor numbers. It was found, to cite one example, that the creation of new collection centers in high-risk population areas should be avoided.

Materials and methods

Study population

This retrospective study was performed using collected data from donors referred to the Khuzestan Blood Transfusion Organization (KHBTO) between 2007 and 2012. The study included all healthy blood donors eligible to give blood but did not include the self-confidential exclusion donations. Khuzestan province is located in the south-west of Iran, neighboring Iraq and the countries bordering the Persian Gulf. The province has a population of about 4346000 (Census 2011), and is one of the largest economic hub provinces in Iran. Khuzestan province is located on the Thalassemia belt and has many transfusion-dependent patients. To estimate the index of blood donation in the province, the donation index was calculated by dividing the number of donations by the total population. The final index was reported per 1000 people.

Screening tests

All donated blood was screened for HIV, HBV and HCV infections with the approved kits and according to the manufacturer's instructions (Table 1). Donors who returned a positive screening test were considered as initially reactive individuals and the screening tests were performed again. Donors who were repeatedly reactive were considered to be seropositive for that infection and confirmatory tests were carried out (Table 1). The evaluation of TTI prevalence was conducted based on the results of the confirmatory tests.

According to the IBTO's standards, donated blood which initially tested positive was discarded and the positive donors were deferred permanently. For the donors whose screening tests were confirmed, consultation and further follow-up actions were organized. Moreover, it was suggested to the family members of the HBV positive donors that they be vaccinated.

Definitions

A first time blood donor was identified as a donor who donated for the first time. A regular donor was defined as a donor who had donated more than once during a 1 year period. A lapsed donor was defined as any donor who had a history of one or more previous donations but for whom the interval between two donations had been more than 1 year.

Statistical analysis

Statistical analyses were performed using SPSS version 16.0 and $P < 0.05$ was considered to be statistically significant. The prevalence of TTIs was reported per 100 000 donations. To evaluate the difference between the prevalence of TTIs' in the collected blood from the fixed sites and in that of the mobile sites, Chi-square analysis was performed.

Results

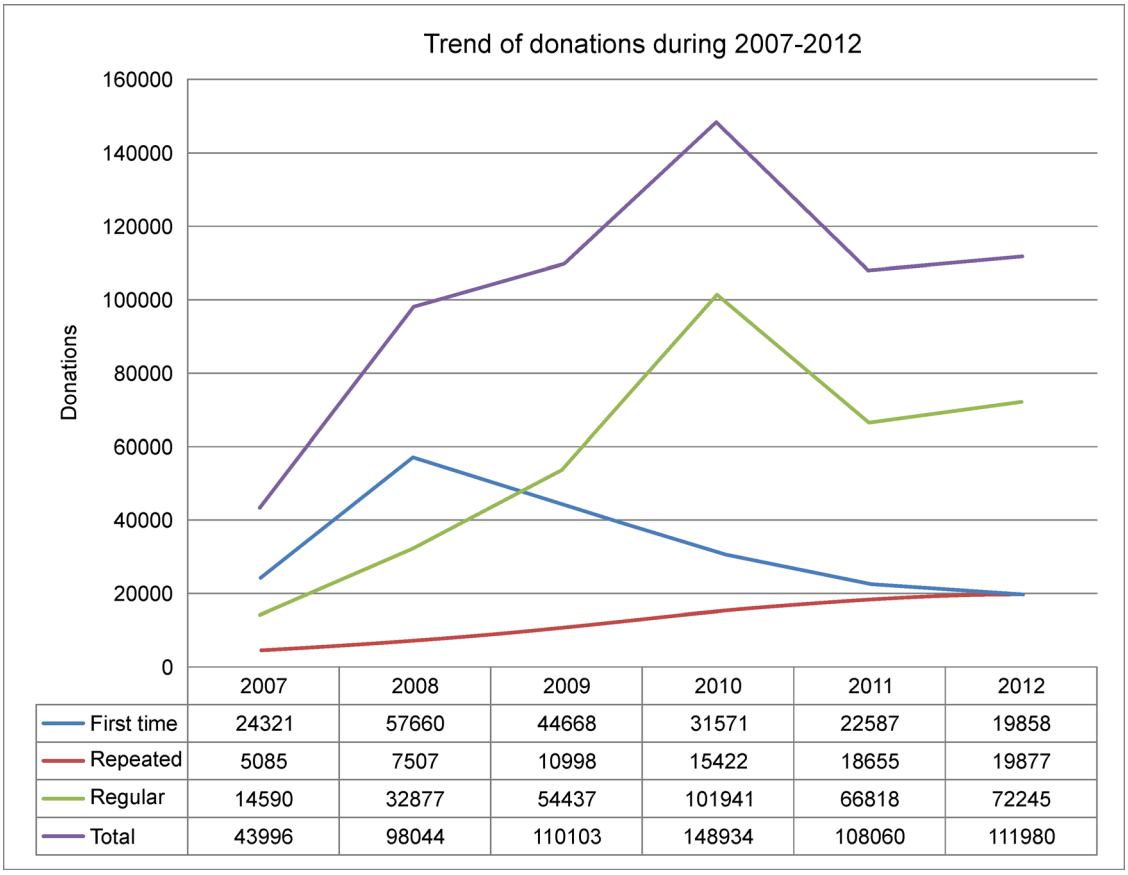
During the 2007-2012 period, 621117 blood units were assessed by the fixed (85.57%) and mobile centers (14.43%). The median index of blood donation in Khuzestan province was 23.8 per 1000 persons. Fig. 1 shows the trend of blood donation from 2007 to 2012 according to the status of donations. As shown in the figure, the highest and lowest blood numbers were received in 2010 and 2007, respectively. Most notably, in 2010 the mobile teams collected the lowest number of units (10.56%), whereas the highest (20.93%) was collected in 2009 (Fig. 2).

In the years analyzed, the mean value of HBV, HCV, HIV prevalence in fixed centers was 214(range from 97 to 372), 104.83(range from 53 to 150), and 5.32(range from 0 to 12), respectively. On the other hand, the mean value of HBV, HCV, HIV prevalence in mobile centers was 320.34 (range from 90 to 563), 117.4 (range from 36 to 178), and 5.31 (range 0 to 17), respectively.

The prevalence of HBV in the blood units collected at the fixed centers decreased from 372.42 per 100000 in 2007 to 97.19 in 2012. A similar trend was observed for the blood units collected by the mobile teams: 419.6 in 2007 and 90.28 in 2012.

Table 1 The screening/confirmatory test kits (2007-2012)

Year	Screening/confirmatory tests					
	HBs Ag		Anti-HCV		HIV	
	Screening kit (Manufacturer)	HBs Ag confirmatory	Screening kit (Manufacturer)	HCV RIBA	Screening kit (Manufacturer)	Confirmatory (Manufacturer)
2007	Enzygnost HBs Ag 5.0 (Dade-Behring)	HBs Ag confirmatory test (Dade Behring)	HCV 3.0 with enhanced SAVe (ORTHO) Hepanostika HCV Ultra (bioMérieux)	HCV BLOT 3.0 (Genelabs) HCV BLOT 3.0 (MP Diagnostics) Inno-LIA HCV Score (Innogenetics)	Genscreen ULTRA HIV Ag-Ab Vironostika HIV Uni-Form II Ag/AbINNO-LIA HIV I/II Score(Bio-rad/bioMérieux)	INNO-LIA HIV I/II Score HIV BLOT 2.2 (Innogenetics /Genelabs)
2008	Enzygnost HBs Ag 5.0 (Dade-Behring)	HBs Ag confirmatory test (Dade Behring)	HCV 3.0 with enhanced SAVe (ORTHO) Hepanostika HCV Ultra (bioMérieux)	Inno-LIA HCV Score (Innogenetics)	Genscreen ULTRA HIV Ag-Ab Vironostika HIV Uni-Form II Ag/AbINNO-LIA HIV I/II Score(Bio-rad/bioMérieux)	INNO-LIA HIV I/II Score HIV BLOT 2.2 (Innogenetics /Genelabs)
2009	Enzygnost HBs Ag 5.0 (Dade-Behring) Enzygnost HBs Ag 6.0 (Siemens)	HBs Ag confirmatory test (Dade Behring) HBs Ag confirmatory test (Siemens)	HCV 3.0 with enhanced SAVe (ORTHO)	Inno-LIA HCV Score (Innogenetics) HCV BLOT 3.0 (Genelabs)	Genscreen ULTRA HIV Ag-Ab Vironostika HIV Uni-Form II Ag/AbINNO-LIA HIV I/II Score(Bio-rad/bioMérieux)	INNO-LIA HIV I/II Score HIV BLOT 2.2 (Innogenetics /Genelabs)
2010	Enzygnost HBs Ag 6.0 (Siemens)	HBs Ag confirmatory test (Siemens)	HCV 3.0 with enhanced SAVe (ORTHO) Hepanostika HCV Ultra (bioMérieux)	Inno-LIA HCV Score (Innogenetics) HCV BLOT 3.0 (MP Diagnostics)	Genscreen ULTRA HIV Ag-Ab Vironostika HIV Uni-Form II Ag/AbINNO-LIA HIV I/II Score(Bio-rad/bioMérieux)	INNO-LIA HIV I/II Score HIV BLOT 2.2 (Innogenetics /MP Diagnostics)
2011	Enzygnost HBs Ag 6.0 (Siemens)	HBs Ag confirmatory test (Siemens) Anti-HBcAb (Siemens)	Hepanostika HCV Ultra (bioMérieux)	Inno-LIA HCV Score (Innogenetics) HCV BLOT 3.0 (MP Diagnostics)	Genscreen ULTRA HIV Ag-Ab Vironostika HIV Uni-Form II Ag/AbINNO-LIA HIV I/II Score(Bio-rad/bioMérieux)	INNO-LIA HIV I/II Score HIV BLOT 2.2 (Innogenetics /MP Diagnostics)
2012	Enzygnost HBs Ag 6.0 (Siemens)	Anti-HBcAb (Siemens)	Hepanostika HCV Ultra (bioMérieux)	HCV BLOT 3.0 (MP Diagnostics)	Genscreen ULTRA HIV Ag-Ab Vironostika HIV Uni-Form II Ag/AbINNO-LIA HIV I/II Score(Bio-rad/bioMérieux)	INNO-LIA HIV I/II Score HIV BLOT 2.2 (Innogenetics /MP Diagnostics)



	2007	2008	2009	2010	2011	2012
First time	24321	57660	44668	31571	22587	19858
Repeated	5085	7507	10998	15422	18655	19877
Regular	14590	32877	54437	101941	66818	72245
Total	43996	98044	110103	148934	108060	111980

Figure 1 Number of donations during 2007 to 2012 based on donation status.

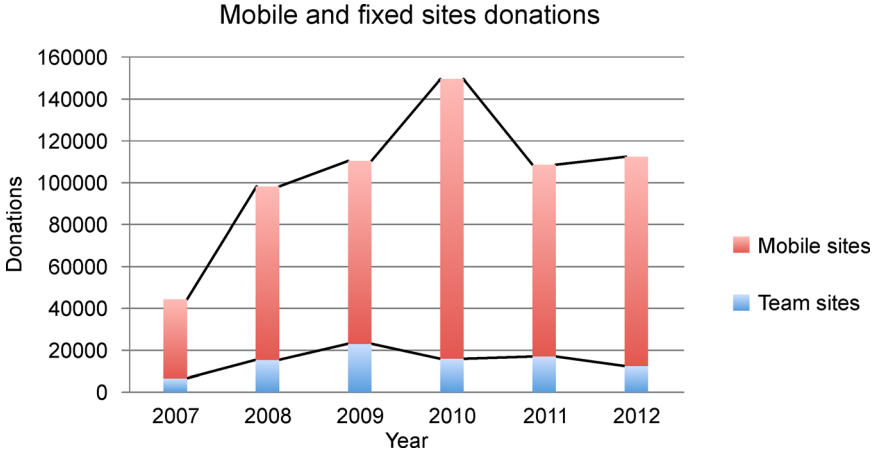
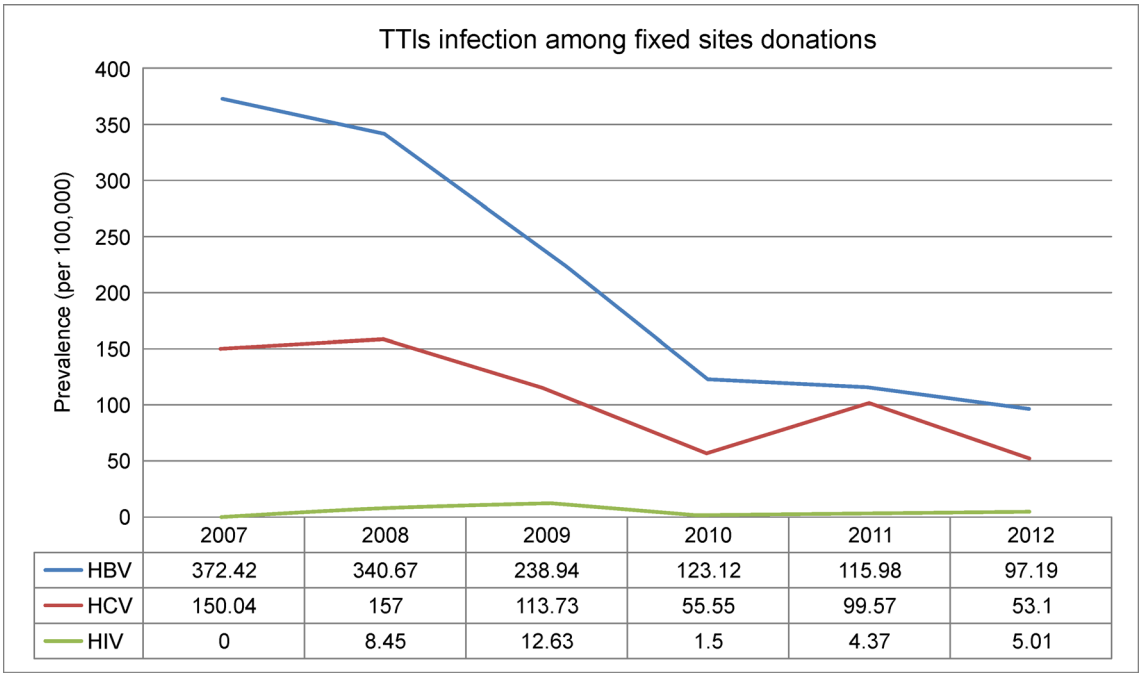


Figure 2 Number of donations in fixed and mobile sites during 2007 to 2012.

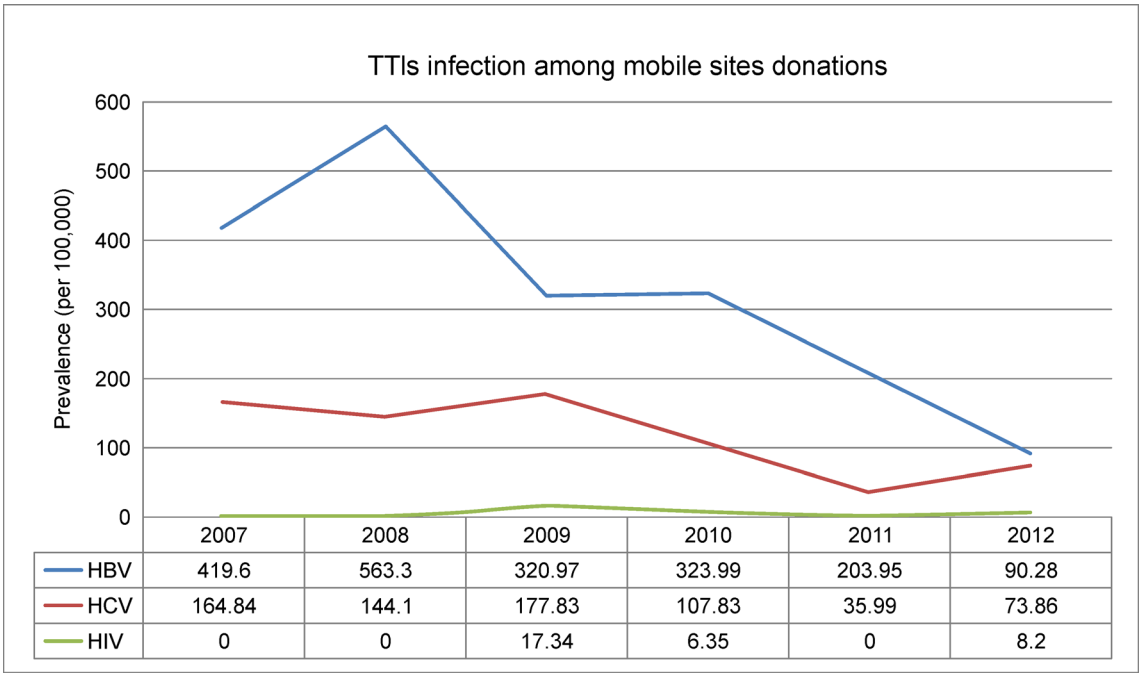
The HCV prevalence in the units collected by the mobile centers decreased from 150.04 in 2007 to 53.1 in 2012, whereas it was 164.84 and 73.86 in units collected by the fixed centers in 2007 and 2012, respectively. Fluctuation was observed in the trend of HCV prevalence in both groups; the prevalence slope of HCV declined at a gradually slower rate than that of HBV. A similar fluctuation was seen in HIV prevalence which in blood units collected by the fixed centers increased from 0 in 2007 to 12.63 in 2009 and then dropped to 5.01 in 2012. Meanwhile, in the units collected by the mobile teams the fluctuations in HIV prevalence were notably high (Figs. 3, 4).

In Table 2, the annual prevalence of TTIs in the units collected at the fixed or mobile centers is compared. As shown in the table, a higher prevalence of HBV is observed in blood collected by the mobile teams and this difference is



	2007	2008	2009	2010	2011	2012
HBV	372.42	340.67	238.94	123.12	115.98	97.19
HCV	150.04	157	113.73	55.55	99.57	53.1
HIV	0	8.45	12.63	1.5	4.37	5.01

Figure 3 Trend of TTIs in Fixed sites blood donations.



	2007	2008	2009	2010	2011	2012
HBV	419.6	563.3	320.97	323.99	203.95	90.28
HCV	164.84	144.1	177.83	107.83	35.99	73.86
HIV	0	0	17.34	6.35	0	8.2

Figure 4 Trend of TTIs in Mobile sites blood donations.

statistically significant ($p = 0.014$). Although the prevalence of HCV and HIV was higher in units collected by the mobile teams than in those collected at the fixed centers, statistically no significant differences were observed. The differences between HBV and HCV prevalence in the beginning and at the end of the study, however, were significant in both fixed and mobile blood collections.

Discussion

The results of our study showed that the blood donation index in Khuzestan province was 23.8 per 1000 people. Maghsudlu et al. reported that the blood donation index in Iran ranges from 13 in the North-west region to 39 in the Central region, with a mean rate of 24.2 per 1000 persons (Maghsudlu et al.,

Table 2 TTIs prevalence(per 100000) in Mobile sites in compared with Fixed sites

Infections	Years	Mobile team	Fixed team	*P* value
HBV	2007	419.6	372.42	***0.014***
	2008	563.3	340.67	
	2009	320.97	238.94	
	2010	323.99	123.12	
	2011	203.95	115.98	
	2012	90.28	97.19	
	Total	320.34	214.72	
HCV	2007	164.84	150.04	***0.68***
	2008	144.1	157	
	2009	177.83	113.73	
	2010	107.83	55.55	
	2011	35.99	99.57	
	2012	73.86	53.1	
	Total	117.4	104.83	
HIV	2007	0	0	***0.20***
	2008	0	8.45	
	2009	17.34	12.63	
	2010	6.35	1.5	
	2011	0	4.37	
	2012	8.2	5.01	
	Total	5.31	5.32	

2009). A WHO report stated that the blood donation rate in middle income countries is 11.7 per 1000 population (http://www.who.int/mediacentre/factsheets/fs279/en/). Hence the results of this study revealed that the index of blood donation in Khuzestan province is close to the national average but nearly two times higher than that of countries of a similar economic level and also higher than that of neighboring countries (http://www.searo.who.int/thailand/factsheets/fs0029/en/). The blood donation index is lower due to severe climate conditions and other factors which act as blood donation barriers, causing difficulties in accessing collection centers, such as a low number of mobile sites for blood collection.

Of all the blood resources provided by the KHBTO, 14.43% were provided by the mobile teams, whereas the median range of blood units collected by mobile teams in the whole country was reported to be 20%. (Pourfathollah et al.,2015). Studies on the allotment of blood units collected by mobile centers were sporadic. Carey et al. showed that in the United States, two-thirds of whole blood donations (67.9%) were given at mobile centers (Carey et al., 2012). Shi et al. also stated that most whole blood units were collected by mobile centers but they did not report the exact number (Shi et al., 2014). Based on this limited data it could be suggested that the number of donations at the mobile sites of KHBTO was lower than the national average and much lower than that of developed countries. Therefore, better design and planning could provide a safe and adequate blood supply to mobile teams and needs to be considered before their establishment.

It has been reported that altruistic and religious reasons are the main motives for blood donation among Iranian donors (Maghsudlu and Nasizadeh, 2011). For example, a positive deviation in blood donations is observed during the religious month of Muharram (Prophet's grandson, Imam Hussein) (Gharehbaghian,2012). Furthermore, the eight-year war between Iran and Iraq also had a profound impact on voluntary, non-remunerated blood donation in Iran. Khuzestan province is known as one of the most religious provinces in Iran and was also the main front of the war, two factors which, seemingly, provide it with the greatest potential for the recruitment and retention of blood donors. In addition, about one-third of the Khuzestani population lives in rural areas and, as such, utilizing mobile blood centers could be the best way of collecting blood ; the mobile teams can play a crucial role in providing blood supplies to the province.

During this five-year period, the number of donations underwent many fluctuations, and a sudden increase was observed in 2008 (Fig. 1) which, most likely, was due to the fact that satellite organizations joined the central KHBTO at that time. Blood donation continued its upward trend until 2010, when a sudden declining trend was observed due to the relocation of some of the blood transfusion services to adjoining neighboring provinces as well as the closure of others which failed to meet IBTO standards in 2011 (Table 2).

Additionally, a declining trend was observed in the number of first-time donors in contrast to an increasing trend in regular and repeat donors. Based on this finding it could be concluded that the return rate of first-time donors to the KHBTO is high; this reflects the success of the IBTO recruitment strategy and satisfaction of blood donors. In addition, several studies have reported that blood units collected from regular and repeat donors have a lower prevalence of TTIs (Al Shaer et al., 2012; Song et al., 2014). Thus, the safety of the Khuzestan blood supplies may be enhanced by this change in the pattern of blood donation.

The mean value of HBV prevalence in the blood units collected by the mobile teams and fixed centers was 320.34 and 214.72 per 100000 donations, respectively; for both groups, we observed a significant decrease of HBV prevalence during the study period.

This finding was in accordance with other studies in the country. Pourfathollah et al. reported a decreased HBV prevalence from 610 per 100000 donations in 2005 to 136 in 2013 (Pourfathollah et al., 2015). Keshvari et al. found a pattern of decrease in the HBV prevalence in the Tehran blood transfusion service from 423 to 153 per 100000 donors during the five-year period from 2008 to 2013(Keshvari et al., 2015). A similar decline has also been found in most other regions of the world, according to Adouani et al. in Morocco, Singh et al. in India and Chiamchanya et al. in Thailand (Singh et al., 2009; Adouani et al., 2013; Chiamchanya,

2014). In light of the fact that the 21 to 25 year old age group represents the largest number of blood donors in Iran, and given that a national vaccination program has been in place for all infants since 1993, HBV vaccination is likely the main reason for the declining pattern of HBV prevalence (Maghsudlu et al., 2009; Mirrezaie et al., 2014).

The mean value of HCV prevalence in the blood units collected by the mobile teams and fixed centers was 117.4 and 104.83 per 100000 donations, respectively; for both groups, we observed a slow decrease of HCV prevalence during the study period in agreement with another wide Iranian study carried out by Khodabandehloo et al. (2013). Similar data has been reported in studies carried out in other countries, namely in China (Gao et al., 2011), Argentina (Lucky et al., 2013), and Australia (Flichman et al., 2014). By contrast, increasing trends have been reported in India (Meena et al., 2011) and Turkey (Uzun et al., 2013). This decreasing trend of HCV infection in Iran reveals that sites have been successful in following IBTO standards: systematic screening of all donated blood, permanent exclusion of donors with a positive HCV result, training programs in relation to TTI transmission throughout the country, implementing confidential unit exclusion, and increasing the number of repeat and regular donations.

The mean value of HIV prevalence in the blood units collected by the mobile teams and fixed centers was 5.31 and 5.32 per 100000 donations, for the mobile teams and fixed centers, respectively. Although the prevalence trend showed some fluctuations, it generally increased in accordance with the findings of Mohammadali et al. in Tehran province, Iran (Mohammadali and Pourfathollah, 2014) contrary to the previous findings of Kasraian of (Shiraz, Iran), Pourfathollah (Iran) and Al Shaer (UAE). (Kasrian, 2010; Al Shaer et al., 2012; Pourfathollah et al., 2015). Hong et al. (China), Rudowska (Poland) and Suligoli (Italy) all reported an incremental increase in HIV prevalence among blood donors(Suligoi et al., 2010; Rudowska et al., 2011; Hong et al., 2012). Likatavicius reported a different pattern of HIV prevalence in Europe, which includes an incremental increase in Eastern Europe, stability in Central Europe and a decrease in the West (Likatavicius et al., 2007). The current prevalence of HIV in the general Iranian population is 34.91 per 100000 (based on the registered records of the Iranian Ministry of Health) which is more significant compared with that which was found in the donations analyzed by this study. Moreover, the trend of HIV transmission by blood donation decreased from 0.9% in 1986 to 0 in 2012(Iran Ministry of Health, 2011). Because the trend of HIV prevalence in the national studies is decreasing (whereas it is increasing in the regional studies), we assumed that HIV has a different prevalence in different parts of the country. Therefore, regional studies and locally-oriented training would be helpful to identify the high-risk areas in Iran. Media propaganda, especially surrounding World AIDS Day and training programs concerned with HIV, is one of the motivators driving high risk blood donors to refer to blood transfusion organizations to check their HIV status. Establishing dedicated centers to carry out HIV tests for free of charge could decrease the high risk individuals visiting donation sites.

Briefly, TTI prevalence in the blood units collected by the mobile teams was higher than that of the blood units collected in the fixed centers. Although HBV prevalence was significantly different in both groups, insignificant differences were seen in the prevalence of HCV and HIV (Table 2). In contrast to our findings, Abhikhesh et al. reported a higher incidence of TTIs among donors at the fixed centers than among those at the mobile centers (Abhishekh and Usha, 2013). Nearly 50% of the blood units at the mobile centers were obtained from first-time donors, whereas this figure was 29% at the fixed centers (Table 2). As the prevalence of TTIs is higher for first-time donors, the difference between the prevalence in the two groups is logical (Mohammadali and Pourfathollah, 2014). The increased TTI prevalence in donations collected by mobile centers can be due to a lack of an appropriate strategy of recruitment of regular and lapsed donors.

Conclusions and recommendations

Although Khuzestan province has a high potential for the recruitment of more donors through mobile teams, the number of blood units collected by the mobile teams was lower than the national average. However, the findings of this study showed that the number of blood donations in Khuzestan province is comparable with the number of blood donations in the rest of the country. In addition, TTI prevalence in the blood units collected through drives at the mobile centers was higher than that of blood collected at the fixed centers. This may be due to inadequate programs pertaining to the use of mobile centers and insufficient privacy between donors and physicians during donor interviews in some situations. The vast survey on blood donation in Khuzestan province and the comparison of the TTI prevalence in mobile and fixed collection centers were the main advantages of this study. On the other hand, the demographic information of the donors was not evaluated and the circumstances of blood donation in different areas of the province were not examined; these are acknowledged limitations of the study.

Throughout the country, donor recruitment and the safety of blood resources can be improved through the implementation of the following recommendations:

- Increasing the number of mobile teams and their establishment in rural areas, religious places and educational centers
- Implementing educational programs on blood donation, blood safety and TTI transmission pathways in order to increase awareness in the general population
- Conducting regional studies to assess blood donation and

the prevalence of TTIs across the country in order to implement strategic programs and provide adequate supplies of safe blood.

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Compliance with ethical standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

References

Abhishekh B, Usha K (2013). Donor profile and blood safety: comparison between fixed (institute) and mobile site (CAMP) blood collections. International Journal of Current Research and Review, 5(1): 32–35

Adouani B, Alami R, Laouina A, Benahadi A, Boulahdid S, Mokhtari A, Soulaymani A, Abouyoub A, Benajiba M (2013). Hepatitis B in Moroccan blood donors: a decade trend of the HBsAg prevalence in a resources limited country. Transfus Med, 23(6): 432–437

Al Shaer L, AbdulRahman M, John T J, AlHashimi A (2012). AbdulRahman M, John TJ, AlHashimi A. Trends in prevalence, incidence, and residual risk of major transfusion‐transmissible viral infections in United Arab Emirates blood donors: impact of individual‐donation nucleic acid testing, 2004 through 2009. Transfusion, 52(11): 2300–2309

Belayneh T, Messele G, Abdissa Z, Tegene B (2013). Blood requisition and utilization practice in surgical patients at University of Gondar Hospital, Northwest Ethiopia. Journal of blood transfusion. 2013: 758910

Carey P M, High P M, Schlumpf K S, Johnson B R, Mast A E, Rios J A, Simon T L, Wilkinson S L (2012). Donation return time at fixed and mobile donation sites. Transfusion, 52(1): 127–133

Cheraghali A (2012). Overview of blood transfusion system of Iran: 2002–2011. Iran J Public Health, 41(8): 89

Chiamchanya N (2014). The prevalence of transfusion-transmissible infection in blood donors in Thammasat University Hospital between 2007–2012. Journal of the Medical Association of Thailand = Chotmaihet thangphaet. 97(10): 1055–63

Flichman D M, Blejer J L, Livellara B I, Re V E, Bartoli S, Bustos J A, Ansola C P, Hidalgo S, Cerda M E, Levin A E, Huenul A, Riboldi V, Treviño E M C, Salamone H J, Nuñez F A, Fernández R J, Reybaud J F, Campos R H (2014). Prevalence and trends of markers of hepatitis B virus, hepatitis C virus and human Immunodeficiency virus in Argentine blood donors. BMC Infect Dis, 14(1): 218

Gao X, Cui Q, Shi X, Su J, Peng Z, Chen X, Lei N, Ding K, Wang L, Yu R, Wang N (2011). Prevalence and trend of hepatitis C virus infection among blood donors in Chinese mainland: a systematic review and meta-analysis. BMC Infect Dis, 11(1): 88

Gharehbaghian A (2012). Introduction of a program for voluntary blood donations in Iran (blood transfusion status in Iran). ISBT Sci Ser, 7 (1): 183–187

Hong Y, Huang X, Ling H, Liao H (2012). Prevalence and trend of HIV infection among voluntary blood donors in China since implementation of the Blood Donation Law: a systematic review and meta‐analysis. Trop Med Int Health, 17(8): 978–988

Iran Ministry of health (2011). Center for disease control. Annual report of HIV in Iran. December of 2011

James A B, Josephson C D, Shaz B H, Schreiber G B, Hillyer C D, Roback J D (2014). The value of area‐based analyses of donation patterns for recruitment strategies. Transfusion, 54(12): 3051–3060

Kasraian L (2010). Trends in the frequency of blood donors donating blood to be tested for HIV in Shiraz from 2004 to 2006. Transfus Med, 20(2): 127

Keshvari M, Sharafi H, Alavian S M, Mehrabadi H, Zolfaghari S (2015). Prevalence and trends of transfusion-transmitted infections among blood donors in Tehran, Iran from 2008 to 2013. Transfus Apheresis Sci, 53(1): 38–47

Khodabandehloo M, Roshani D, Sayehmiri K. Prevalence and trend of hepatitis C virus infection among blood donors in Iran: A systematic review and meta-analysis. Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences. 2013;18(8): 674

Likatavicius G, Hamers F F, Downs A M, Alix J, Nardone A (2007). Trends in HIV prevalence in blood donations in Europe, 1990–2004. AIDS, 21(8): 1011–1018

Lucky T T, Seed C R, Keller A, Lee J, McDonald A, Ismay S, Wand H, Wilson D P (2013). Trends in transfusion‐transmissible infections among Australian blood donors from 2005 to 2010. Transfusion, 53 (11): 2751–2762

Maghsudlu M, Nasizadeh S (2011). Iranian blood donors' motivations and their influencing factors. Transfus Med, 21(4): 247–252

Maghsudlu M, Nasizadeh S, Abolghasemi H, Ahmadyar S (2009). Blood donation and donor recruitment in Iran from 1998 through 2007: ten years' experience. Transfusion, 49(11): 2346–2351

Meena M, Jindal T, Hazarika A (2011). Prevalence of hepatitis B virus and hepatitis C virus among blood donors at a tertiary care hospital in India: a five‐year study. Transfusion, 51(1): 198–202

Mirrezaie S M, Saber H R, Hajibeigi B, Salekmoghaddam E, Abbasian A, Alavian S M (2014). Impact of HBV vaccination on prevalence of hepatitis B virus infection among volunteer blood donors in Tehran-Iran. Shiraz E Med J, 15(2): e18066

Mohammadali F, Pourfathollah A A (2014). Changes in Frequency of HBV, HCV, HIV and Syphilis Infections among Blood Donors in Tehran Province 2005–2011. Arch Iran Med, 17(9): 613

Pourfathollah A, Hosseini Divkolaye N, Seighali F (2015). Four decades of National Blood Service in Iran: outreach, prospect and challenges. Transfus Med, 25(3): 138–143

Razjou F, Maghsudlu M, Nasizadeh S, Zadsar M (2012). The impact of donor selection on blood safety in Iran. Transfus Apheresis Sci, 47 (1): 13–16

Rose W N, Dayton P J, Raife T J (2011). An analysis of mobile whole blood collection labor efficiency. Transfusion, 51(7pt2): 1609–1612

Rudowska E, Basta L, Piwowarska G, Drybańska B, Dylag S (2011). [The epidemiological trends connected with detection of HIV, HCV, HBV and syphilis markers in blood donors in the years 2006–2009]. Polski merkuriusz lekarski: organ Polskiego Towarzystwa Lekarskiego. 30(177): 181–6

Shi L, Wang J, Liu Z, Stevens L, Sadler A, Ness P, Shan H (2014). Blood donor management in China. Transfus Med Hemother, 41(4): 273–282

Singh K, Bhat S, Shastry S (2009). Trend in seroprevalence of Hepatitis B virus infection among blood donors of coastal Karnataka, India. J Infect Dev Ctries, 3(05): 376–379

Song Y, Bian Y, Petzold M, Ung C O L (2014). Prevalence and trend of major transfusion-transmissible infections among blood donors in Western China, 2005 through 2010. PLoS One, 9(4): e94528

Suligoi B, Raimondo M, Regine V, Salfa M C, Camoni L (2010). Epidemiology of human immunodeficiency virus infection in blood donations in Europe and Italy. Blood Transfus, 8(3): 178

Uzun B, Güngör S, Demirci M (2013). Seroprevalence of transfusion transmissible infections among blood donors in western part of Turkey: A six-year study. Transfus Apheresis Sci, 49(3): 511–515

Van Veen T, Hunt J A (2015). Tissue engineering red blood cells: a therapeutic. J Tissue Eng Regen Med, 9(7): 760–770