Blood donation and donors: insights from a large German teaching hospital (2008–2017)

Torsten Chandler,1 Jens Hiller,2 Sven Peine2 & Tom Stargardt1

1Hamburg Center for Health Economics, Hamburg, Germany
2Institut für Transfusionsmedizin, Universitätsklinikum Hamburg-Eppendorf (UKE), Hamburg, Germany

Background and objectives The availability of blood and blood products is crucial for the provision of high-quality hospital services. We analyse changes in whole blood donations, donors and their behaviour over 9 years at a large German teaching hospital.

Materials and methods A descriptive analysis using data from over 34,000 donors and 265,000 donations from a large university hospital’s blood centre was conducted using data from July 2008 to December 2017. The analysis focussed on (a) whole blood donations and (b) donor characteristics and how they changed over time. We categorized donors into four categories according to their donation activity (First-Time, Highly Active, Active and Reactivated).

Results We observed falling donations over time and that donors donated less frequently. Consequently, we show a downward trend in the number of Highly Active donors, whilst First-Time donors remained stable. We also provide evidence that donors donated well below their capacity and that the blood type of donors appeared to be in line with the wider German donor population. Lastly, we show a sharp drop in the return rates of First-Time donors over time.

Conclusion We recommend that Highly Active donors and former Highly Active donors are more carefully considered when planning donor engagement strategies and effort made in (at the very least) maintaining their donation activity. Our results in the context of the literature highlight the need for further research into the changing attitudes towards blood donation and prosocial activities.

Key words: whole blood donations, blood donors, donor characteristics, donor management, donor behaviour, prosocial behaviour.

Introduction The availability of blood and blood products is crucial for the provision of high-quality hospital services. However, despite the introduction of restrictive transfusion policies and patient blood management strategies, blood collection services still face multiple challenges in meeting supply. An ageing population and an increase in the number of medical innovations available have increased the demand for care and thus for blood and blood products [1–4]. At the same time, increasingly more stringent donor selection criteria and an ageing population contribute to a shrinking donor base on the supply side [5]. Furthermore, the short shelf life of blood (3–5 weeks) makes the stockpiling of reserves challenging and the unpredictable nature of events such as natural disasters (e.g. floods, storms, etc.) and viral epidemics such as influenza may increase the short-term demand for blood, making meeting supply challenging [6]. Moreover, seasonal shortages around holiday periods and during the winter months are common [7,8].

Previous literature of interest has focussed on explaining donor behaviour and their characteristics [9–11]. Zou et al (2008) reported substantial changes in the age distribution of the volunteer donor population in the United States between 1996 and 2005, reporting a drop by over...
40% in donors aged 25 and 39 years, once adjusted for population trends [12]. Volk et al (2013) compare the individual characteristics using population-based surveys of donors in Germany and Switzerland in 1994 and 2010. They find donor rates increased in Germany by 8.6% and were maintained in Switzerland. They recommend intensifying efforts to recruit women and lower educated people to donate [13]. Muller-Steinhardt et al (2017) report in South-West Germany an increase in donors ≥60 years, no change in younger donors (<30 years) and declining donors aged 30–59 years [14]. Schreiber et al (2006) conclude that donors that donated more frequently in their first year were more likely to become regular donors [9]. Moreover, in a US setting most donors do not give near their donation limit and approximately half of first-time donors donate only once [11].

However, very few of the previous studies have looked in detail at changes in the donor base and donations over longer periods. We analyse changes in whole blood donations, donors and their behaviour over 9 years at a large German teaching hospital. We do so in order to help guide donor recruitment campaigns, to compare with national, European and global trends and to wider patterns in prosocial behaviour and volunteerism.

Methods

The objective of this study was to identify long-term patterns and changes in donations, donors and their behaviour. Our setting is a large German teaching hospital (1460 beds) in the country’s second largest city, Hamburg (population: 1.89 million). During the period (2008–2017), over 34 000 donors presented to donate on over 265 000 occasions. The blood donation centre operates on a fixed site to meet the needs of the hospital and collects around 30% of donations in the city. Donors are financially compensated €23 from their second donation on. Opening hours were constant throughout the observation period with longer opening hours on Tuesdays and Wednesdays (12.00–19:00) and earlier opening times on Mondays, Thursdays and Fridays (7:00–14:00). Donation frequency at the centre was limited according to German national guidelines restricting male donors to donating every 8 weeks and female donors to donating every twelve weeks [15–17]. Iron and haemoglobin levels of donors were monitored on a regular basis, and iron supplementation was offered to those that required it and was delivered by mail in some circumstances. There was no change in policy since the beginning of study period including haemoglobin cut-off levels which remained at ≥13.5 g/dl for males and ≥12.5 g/dl for females.

Demand for whole blood within the hospital has been rising substantially since 2006, and although the blood donation centre meets a large proportion of hospital requirements, at no point in time has it met the full extent of demand. The shortfall must be purchased from an external provider at an increased cost. The recruitment policies at the centre stayed quite continuous over time. Strategies included reminder letters with appointment details, infrequent phone calls and occasional promotional events aimed at encouraging blood donation. There were no specific policies regarding recruitment type O and Rhesus-negative donors.

A descriptive analysis using data from the university hospital’s blood centre, Universitätsklinikum Hamburg-Eppendorf (UKE), was conducted using data from July 2008 to December 2017. The analysis focused on (a) whole blood donations and (b) on donor characteristics and how they changed over time. Donations were broken down into first-time, repeat, successful and unsuccessful donations whilst donors were classified according to their donation activity. First-time donations were categorized as donations from new donors presenting for the first time at the centre.

The data set was accessed through the SwissLab GmbH laboratory information system for storing data in a clinical setting and comprised of multiple tables linked by a unique donation and donor number. The data set included data on donors (age, gender, donor number), donations (date of donation, donation outcome) and blood typing. Although multiple types of donation are recorded, we concentrate on whole blood donations for the analysis. We did not seek formal ethical approval for the study as the analysis was retrospective in nature and did not involve any additional exposure or risk to donors.

Included donors made at least one donation attempt between 13th July 2008 and 31st December 2017. Donations were categorized as either ‘successful’ or ‘unsuccessful’ depending on the recorded outcome of the donation. An unsuccessful donation could be due to donors not meeting the safety criteria for donating assessed through a physical examination and a questionnaire or the donation being interrupted for reasons including the donor fainting or walking away during the donation process (not completed). Donations were also broken down by day of the week (%) and time between donations (days). We also reported the percentage of donors returning within 1 year following first-time and repeat donations.

Classification of donors

The systems used to classify donors and terminology varied widely between studies [18,19]. The classification system we use to group donors was adapted from an existing system used for formal reporting to the Robert Koch Institute (RKI), a German federal government
agency and research institute responsible for disease control and prevention. The classification system aligned with those used by the DOMAINE project, a European wide project (Donor management in Europe) that classified donors into mutually exclusive groups based on their donation patterns [20]. As a very large number of the donors in our donor base were defined as ‘regular donors’ according to the DOMAINE definition, we further characterized regular donors into Highly Active and Active donors. In addition we refer to ‘Reactivated’ donors rather than ‘Returning’ donors with a comparable definition.

In our study, ‘First-Time’ donors were defined as having their first-time donation within the year; ‘Repeat’ donors had a first-time donation in a previous year and were sub-categorized into ‘Highly Active’, ‘Active’ and ‘Reactivated’ donors. The time between each repeat donation and the preceding donation was used in assigning donor categories. Reactivated donors had a previous donation over 24 months prior to their earliest donation in the year. Active donors had a previous donation within 6–24 months prior to their earliest donation in the year. Highly Active donors had a previous donation within 6 months of their earliest donation in the year. In the case of donors that fulfilled multiple criteria within 1 year, First-Time donors and Reactivated donors had precedence over Active and Highly Active donors. Furthermore, Highly Active donors took precedence over Active donors. For donors that had a first-time donation that occurred before the start of the data set, the date of their previous donation was imputed. The imputed donation date was calculated by deducting the average time between donations across all years (117 days) from the date donations could first be observed in the data set (13/07/2008). Table 1 provides a summary of the donor categories applied by the authors.

Furthermore, we report donor utilization to measure to what extent donation capacity of the donor was reached [Donor utilization = (total number of observed donations/the maximum number of donations possible)/100].

We also report the frequency and percentages of donors and donations by blood type according to the ABO and Rhesus blood grouping systems over time. We present these figures alongside representative figures for the wider German donor population for comparative purposes.

Results

Donations

The number of whole blood donations during the period is presented in Table 2 and in Figure 1. The results show a peak in donations in 2011 with over 31 000 donations and a steady decline in donations over time falling to 24 520 donations in 2017. Most donations were repeat donations rather than first-time donations made by First-Time donors. Whilst first-time donations stayed relatively constant during the period, repeat donations decreased. This was also reflected in the average time between donations, which steadily increased from 71 days in 2008 to 139 days in 2017.

During the study period, most donations were categorized as ‘successful’ indicating that donors met the eligibility criteria to successfully donate and no issues occurred during the donation procedure deeming it ‘not complete’. There was an overall decrease in unsuccessful donations falling to 2147 in 2017 which may partly be explained by a policy change in February 2010, which allowed a first-time donation to be used in contrast to an examination without donation due to safety concerns as in previous years. We expect that there was a delay in the implementation of the policy by physicians which could explain why unsuccessful donations actually increased in 2011.

Over 50% of donations occurred on the two days of the week that offered later opening hours. This remained relatively constant during the time period. In addition, Figure 2 shows that the most popular times for donating were lunchtimes (12:00–12:59), before regular working hours on early opening days (7:00–7:59) and after regular working hours on late opening days (17:00–17:59).

We found that the proportion of donors returning within 1 year of their donation were much higher following a repeat donation than following a first-time donation. The return rates following a first-time donation in particular fell quite substantially over the time period, falling from 72% in 2008 to 57% in 2016. Return rates in 2017 were not reported as a 1-year period was required to assess whether donors returned or not.

Table 1 Classification of donors by year

| Donor category | Donor sub category | Definition |
|----------------|-------------------|------------|
| First-Time (FT)|                   | First time donation within study year |
| Repeat (RD)    | Highly Active (RD < 6) | Donor presents in study year within 6 months of last donation and is neither First-Time nor Reactivated |
|                | Active (RD 6–24)   | Donor presents in study year within 6–24 months of last donation and is neither First-Time, Reactivated nor Highly Active |
|                | Reactivated (RD > 24) | Last time donor appeared to donate was over 24 months prior to donation in study year |

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Table 2 Whole blood donations by donation characteristics (2008–2017)

| Number of donations (n) | 2008a | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|-------------------------|-------|------|------|------|------|------|------|------|------|------|
| Total donations         | 12 865| 30 382| 28 370| 31 232| 30 520| 28 783| 28 026| 25 700| 25 055| 24 520|
| First-time donations    | 983 (7.6%) | 2546 (8.4%) | 2490 (8.8%) | 3718 (11.9%) | 2856 (9.36%) | 2473 (8.6%) | 2896 (10.3%) | 2311 (9.0%) | 2382 (9.5%) | 2487 (10.1%) |
| Repeat donations        | 11 882 (92.4%) | 27 836 (91.6%) | 25 880 (91.2%) | 27 514 (88.1%) | 27 664 (90.6%) | 26 310 (91.4%) | 25 130 (89.7%) | 23 389 (91.0%) | 22 673 (90.5%) | 22 033 (89.9%) |
| Successful donations    | 10 945 (85.1%) | 25 503 (83.9%) | 24 473 (86.3%) | 26 428 (84.6%) | 26 114 (85.6%) | 25 288 (87.9%) | 24 853 (88.7%) | 23 449 (91.2%) | 22 725 (90.7%) | 22 373 (91.2%) |
| Unsuccessful donations  | 1920 (14.9%) | 4879 (16.1%) | 3897 (13.7%) | 4804 (15.4%) | 4406 (14.4%) | 3495 (12.1%) | 3173 (11.3%) | 2251 (8.8%) | 2330 (9.3%) | 2147 (8.8%) |
| Not completed (% of Unsuccessful) | 107 (5.57%) | 368 (7.54%) | 416 (10.67%) | 348 (7.24%) | 338 (7.67%) | 259 (8.16%) | 261 (8.7%) | 286 (10.57%) | 286 (12.27%) | 248 (11.55%) |
| Deferredb (% of Unsuccessful) | 1766 (92.0%) | 4400 (90.2%) | 3362 (86.3%) | 4312 (89.8%) | 3974 (90.2%) | 3133 (89.6%) | 2823 (93.0%) | 1952 (96.7%) | 1957 (84.0%) | 1838 (85.6%) |
| Donor walks away (% of Unsuccessful) | 30 (0.2%) | 73 (0.2%) | 44 (0.2%) | 61 (0.2%) | 57 (0.2%) | 31 (0.1%) | 39 (0.2%) | 30 (0.1%) | 39 (0.2%) | 25 (0.1%) |
| Other reasonsc (% of Unsuccessful) | 17 (0.9%) | 38 (0.8%) | 75 (1.9%) | 83 (1.7%) | 38 (0.9%) | 30 (1.0%) | 31 (1.4%) | 48 (2.1%) | 36 (1.7%) |
| Day of the week (%)     |       |      |      |      |      |      |      |      |      |      |
| Mon (7-2 pm)            | 17.6% | 15.7% | 15.6% | 15.1% | 14.6% | 15.6% | 16.4% | 15.9% | 14.8% | 13.9% | 13.8% |
| Tues (12-7 pm)          | 28.4% | 27.3% | 26.7% | 26.5% | 25.6% | 25.0% | 27.1% | 27.1% | 27.0% | 26.4% | 26.1% |
| Wed (12-7 pm)           | 21.9% | 24.4% | 25.5% | 25.3% | 25.7% | 24.7% | 24.6% | 25.6% | 25.9% | 26.1% | 26.1% |
| Thurs (7-2 pm)          | 15.5% | 15.7% | 15.5% | 16.5% | 15.8% | 15.5% | 15.5% | 15.5% | 15.5% | 15.5% | 15.5% |
| Fri (7-2 pm)            | 16.5% | 16.9% | 16.7% | 17.3% | 17.6% | 19.1% | 17.4% | 16.5% | 17.1% | 17.8% | 17.8% |
| Time between donations (days) | 71   | 93   | 105  | 109  | 113  | 120  | 123  | 129  | 136  | 139  |
| First-Time donor return within 1 year (%) | 72% | 71% | 68% | 66% | 61% | 60% | 55% | 60% | 57% | - |
| Repeat donor return within 1 year (%) | 92% | 91% | 90% | 89% | 89% | 88% | 89% | 89% | 88% | - |

aData available from July 2008 only.
bIncludes first-time visit sample only donations which accounted for all first-time donations before February 2010.
cCategory relates to a number of rare system codes that indicated an unsuccessful donation but did not fall within the more common 'deferred' and 'not completed' categories.
Donors

Figure 3 shows that the largest donor group (Highly Active) decreased over time dropping to just over 5500 donors in 2017 from 6851 donors in 2009. With the exception of spikes in 2011 and 2014, First-Time donors appeared to remain relatively stable. Active and Reactivated donor groups were much smaller and appeared to remain constant over the time period. In addition, the number of donations per donor within the study year fell for First-Time donors and dropped slightly for Highly Active and Active donors.

Table 3 presents donor groups for representative years 2009, 2013 and 2017 with results broken down by gender, age group and donor utilization. There were more male Highly Active donors (over 56%) than in other donor groups, which remained consistent over time. First-Time and Active donors comprised of more women than men (over 55%), and the proportion of male/female donors remained relatively constant throughout the time period.

First-Time donors were younger than the other donor groups with 39% of donors being 18–24 years and 38% being 24–34 years at the time of donating compared with 12% and 26% for Highly Active donors, respectively. Highly Active donors were more evenly spread over the older age categories with 18% and 26% in the 34–44 and 44–54 age categories, respectively. In addition, 42% of Active donors and 40% of Reactivated donors were between 24 and 34 at the time of donating. An increase was also observed in the number of donors in the 55–75 age categories across all donor categories, including an increase in older First-Time donors from 1.4% in 2009 to 5.0% in 2016 and 3.8% in 2017. In addition, a small decrease in donors in the 34–44 age categories was observed in both the Highly Active and Active donors.

The reported donor utilization figures give information about how close donors donated to their capacity. Even in the most active donor group, donors donated well below their capacity, which dropped slightly throughout the time period from 68% in 2009 to 64% in 2017.

Table 4 presents the number of donors that donated during the study year by blood type according to the ABO and Rhesus blood groups. The blood group mix was relatively constant over time and did not appear to vary substantially from the wider German donor population which is displayed for comparative purposes [21]. We also found the figures for donations broken down by blood type over time (not presented) to be very similar and also in line with the wider German donor population. Unassigned donors were missing either a Rhesus factor or an ABO blood type. In addition, donors are presented in combined ABO and Rhesus factor blood groups in the appendix which is available as a Table S1 to this manuscript.
Discussion

We observed falling donations over time and an increase in the average time between donations, suggesting that donors donated less frequently. We showed a large drop in donor return rates for donors donating for the first time. Furthermore, we show a downward trend in the number of Highly Active donors and a more stable trend...
in First-Time donors. We also provide evidence that donors donated well below their donation capacity and that the blood type of donors appeared to be in line with the wider German donor population.

We consider that factors affecting blood donation may be both endogenous to the study setting (e.g. organizational reputation of the hospital, effectiveness of donor engagement strategies and donor experience) or exogenous (e.g. population changes, natural disasters, epidemics, changing attitudes towards blood donation). We assume that the peak in donations observed in 2011 could be partly explained by increased public awareness during the *enterohemorrhagic Escherichia coli* outbreak in Northern Germany. Increased donations during this period were also observed by other blood collection agencies operating in the region [22].

In line with other regions in Germany, the Netherlands and Switzerland, we observe falling donations and donors [2,4,14,23]. The trends observed in the blood donation context appear to contradict a wider trend observed in prosocial activities across Germany reported in a government survey [24]. For example, the German Red Cross Blood Donation Service, which accounted for two thirds of donations in Germany in 2009, lost 5% market share to private organizations between 2000 and 2009 [25,26].

The population of Hamburg increased during the study period from 1.74 to 1.89 million (8.37%), and the age distribution remained relatively constant except for an increase in those aged 45–60 who were still eligible to donate [27]. In addition, the upper age limit for donation was increased from 71 to 75 from January 2011 allowing older donors the opportunity to donate. We therefore assume that an ageing population may not be driving the fall in donations observed in our setting. Additional reasons that could explain falling donations include greater pressures on leisure time and during working hours, message saturation and a vast increase in communication mediums resulting in fragmentation and reduced possibilities to communicate through traditional platforms [5].

In the case of donors, we observe that even the most active donor group in the study population, despite a high donation rate, did not donate at their capacity. A similar finding has been observed in US blood donations centres [11]. The results suggest that efforts to increase donations from all donors will not be inhibited by restrictions on donation frequency set by national guidelines. More stringent donation criteria for female donors limiting donation frequency could explain why there were more Highly Active donors who were male. In addition, the higher number of First-Time donors in the younger age categories could be explained by this group simply having less time to develop consistent donation behaviour or possible generational differences being reflected in their donation behaviour and by definition a first-time donation occurs earlier in life than subsequent repeat donations. We assume that the peak in First-Time donors observed in 2014 could be explained by a successful free football shirt campaign during that year.

Donors and donations in our data set appeared to be aligned with the distribution of blood types in the wider German donor population. The results could suggest donors with more desirable blood types (O and Rhesus (−)) were not choosing to donate more than the wider donor population based on altruistic motivations. However, we do not offer a formal analysis of this aspect of blood donation. The high proportion of unassigned donors reached up to 3.4% in 2011 and can most likely be attributed to unsuccessful donation attempts from First-Time donors that did not reach the stage where their blood type was assigned.

The reported patterns in blood donations and donors over time offer useful information that could advise the management of hospital blood supply and help in designing effective donor engagement strategies. We recommend that the blood donation centre should consider strategies that ensure to capture Highly Active donors and focus on (a) maintaining (or increasing) the frequency of their donations and (b) encouraging them to not stop donating entirely. In addition, former Highly Active donors could be identified and encouraged to resume their previous donation behaviour. Although a differentiated marketing approach targeting Highly Active donors only may not be an effective strategy [28], the results suggest ensuring that this group is engaged when planning donor engagement strategies is important. Tools that have been shown to be effective in the literature at temporarily increasing donations without compromising the safety of blood include small gifts, newspaper recognition and active decision-making for those that present to donate [29–35]. Campaigns aimed at increasing awareness around the importance of blood donation could also be an important tool for encouraging donation. Moreover, given that we observed a higher preference for donations at lunchtime, before and after work, adjusting opening hours accordingly could also be an option to impact the willingness to donate.

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A limitation of the study is that it only considers one research setting: a public hospital offering financial compensation in a large city in Northern Germany. However, many of the challenges such as donor base shrinkage and increased competition from private blood donation centres are also relevant to other centres [5,14].

Furthermore, the imputation method described for donors with a first-time donation prior to the start of the data set may overestimate Highly Active donors in 2008, although not affecting any of the results presented in this paper. In addition, in the beginning of the data set (before 2011), Active donors were slightly overestimated and Reactivated donors slightly underestimated. We therefore do not expect this approach to have a sizable effect on the overall trends observed as well as their interpretation.

Conclusion

We observe falling donations and donation frequency over 9 years and that the number of Highly Active donors was shrinking. The return rates following a first-time donation in particular fell quite substantially over the time period. Our findings provide context to the changing pattern of prosocial activities in Germany and show that despite increased rates in prosocial behaviour in the case of volunteerism overall, blood donations have decreased in our setting as has been reported across other regions in Germany [2,14,24]. Our results in the context of the literature highlight the need for further research into the changing patterns in blood donation in Germany and more generally into the changes in attitudes towards prosocial behaviour more generally.

These findings are important in that they provide our centre with essential information for guiding future recruitment campaigns and can be considered in the context of wider blood donation trends and attitudes towards charitable behaviour. We recommend that Highly Active and former Highly Active donors are more carefully considered when planning donor engagement strategies and effort made in (at the very least) maintaining their donation activity. Lastly, we suggest further work is required to understand the reasons for the large drops in reported First-Time donor return rates and interventions considered to facilitate the improved return of these donors.

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Conflict of interests

The authors declare no conflict of interests.

References

1 Ali A, Auvinen MK, Rautonen J: The aging population poses a global challenge for blood services. Transfusion 2010; 50:584–588
2 Greinacher A, Fendrich K, Alpen U, et al.: Impact of demographic changes on the blood supply: mecklenburg-West Pomerania as a model region for Europe. Transfusion 2007; 47:395–401
3 Tinegate H, Chattree S, Iqbal A, et al.: Ten-year pattern of red blood cell use in the North of England. Transfusion 2013; 53:483–489
4 Volken T, Buser A, Castelli D, et al.: Red blood cell use in Switzerland: trends and demographic challenges. Blood Transfusion = Trasfusione del sangue 2018; 16:73–82
5 Carter MC, Wilson J, Redpath GS, et al.: Donor recruitment in the 21st century: challenges and lessons learned in the first decade. Transfusion Apheres Sci 2011; 45:31–43
6 The American National Red Cross: How can one donation help multiple people? 2019. https://www.redcrossblood.org/donate-blood/how-to-donate/types-of-blood-donations/blood-components.html [Last accessed 14/06/2019].
7 Oliveira CDL, Almeida-Neto C, Liu EJ, et al.: Temporal distribution of blood donations in three Brazilian blood centers and its repercussion on the blood supply. Revista Brasileira de Hematologia e Hemoterapia 2013; 35:246–251
8 The American National Red Cross: Red Cross Issues Emergency Need for Blood and Platelet Donors 2019. https://www.redcross.org/about-us/news-and-events/news/Emergency-Need-for-Blood-Donors-following-Historic-Snowstorm.html [Last accessed 14/06/2019].
9 Schreiber GB, Sharma UK, Wright DJ, et al.: First year donation patterns predict long-term commitment for first-time donors. Vox Sang 2005; 88:114–121
10 Ferguson E, Bibby PA: Predicting future blood donor returns: past behavior, intentions, and observer effects. Health Psychol 2002; 21:513–518
11 Schreiber GB, Sanchez AM, Glynn SA, et al.: Increasing blood availability by
changing donation patterns. Transfusion 2003; 43:591–597
12 Zou S, Musavi F, Notari EP, et al.: Changing age distribution of the blood donor population in the United States. Transfusion 2008; 48:251–257
13 Volken T, Weidmann C, Bart T, et al.: Individual characteristics associated with blood donation: a cross-national comparison of the German and Swiss population between 1994 and 2010. Transfusion Medicine and Hemoth-apy 2013; 40:133–138
14 Müller-Steinhardt M, Weidmann C, Klüter H: Changes in the whole blood donor population in south-west Germany: 2010 versus 2016. Transfusion Medicine and Hemoth-apy 2017; 44:217–223
15 Goldman M, Magnus K, Gorfín J, et al.: International Forum regarding practices related to donor haemoglobin and iron. Vox Sang 2016; 111:449–455
16 Karp JK, King KE: International variation in volunteer whole blood donor eligibility criteria. Transfusion 2010; 50:507–513
17 Bundesärztekammer: Richtlinie zur Gewinnung von Blut und Blutbe-standteilen und zur Anwendung von Blutprodukten (Richtlinie Hämosther-a pie). 2017.
18 Veldhuizen IJT: Blood donor profiling using donation patterns. ISBT Science Series 2013; 8:233–237
19 Suennig A, Konerdung U, Hron G, et al.: Motivational factors for blood donation in first-time donors and repeat donors: a cross-sectional study in West Pomerania. Transfusion Medicine 2017; 27:413–420
20 De Kort W, Veldhuizen I: Donor man-agement manual. Nijmegen, the Netherlands: DOMAINE project 2010.
21 Wagner FF, Kasulke D, Kerowgan M, et al.: Frequencies of the blood groups ABO, Rhesus, D category VI, Kell, and of clinically relevant high-frequency antigens in south-western Germany. Infusionsther Transfusionsmed 1995; 22:285–290
22 Shehu E, Langmaack AC, Clement M: The dark side of using emergencies in direct marketing campaigns for blood donation services. Serv Sci 2013; 5:163–178
23 Borkent-Raven BA, Janssen MP, Van Der Poel CL: Demographic changes and predicting blood supply and demand in the Netherlands. Transfu-sion 2010; 50:2455–2460
24 Federal Ministry for Family Affairs, Senior Citizens, Women and Youth: Volunteering in Germany: Key Findings of the Fourth German Survey on Volunteering. 2017.
25 Mews M, Boenigk S: Does organiza-tional reputation influence the willingness to donate blood? International Review on Public and Nonprofit Mar ket-ing 2013; 10:49–64
26 Henseler O, Heiden M, Haschberger B, et al.: Bericht zur Meldung nach § 21 TFG für die Jahre 2010 und 2011. Bundesgesundheitsblatt - Gesundheitsfor-schung - Gesundheitsschutz 2013; 56:1352–1367
27 Bevölkerung in Hamburg: Auszählung aus dem Melderegister Statistisches Amt für Hamburg und Schleswig-Holstein, 2008–2017.
28 Sundermann LM, Boenigk S, Willems: J: Under blood pressure – differentiated versus undifferentiated marketing to increase blood donations. Interna-tional Review on Public and Nonprofit Marketing 2017; 14:321–340
29 Slonim R, Wang C, Garbarino E: The market for blood. Journal of Economic Perspectives 2014; 28:177–196
30 Garbarino E, Slonim R, Wang C: The multidimensional effects of a small gift: evidence from a natural field experiment. Economics Letters 2013; 120:83–86
31 Lacetera N, Macis M: Social image concerns and prosocial behavior: field evidence from a nonlinear incentive scheme. J Econ Behav Organ 2010; 76:225–237
32 Lacetera N, Macis M, Slonim R: Will there be blood? Incentives and dis-placement effects in pro-social behav-iour. American Economic Journal: Economic Policy 2012; 4:186–223
33 Lacetera N, Macis M, Slonim R: Eco-nomic rewards to motivate blood donations. Science 2013; 340:927–928
34 Lacetera N, Macis M, Slonim R: Rewarding volunteers: a field experi-ment. Manage Sci 2014; 60:1107–1129
35 Stutzer A, Goette L, Zehnder M: Active decisions and prosocial behaviour: a field experiment on blood donation. Econ J 2011; 121:F476–F493

Supporting Information

Additional Supporting Information may be found in the online version of this article:
Table S1 Donating donors by blood type 2008–2017 (%).