Fear of blood draws, vasovagal reactions, and retention among high school donors

Christopher R. France,1 Janis L. France,1 Bruce W. Carlson,1 Lina K. Himawan,1 Kirsten Yunuba Stephens,2 Terri A. Frame-Brown,2 Geri A. Venable,2 and Jay E. Menitove2

BACKGROUND: We previously demonstrated that fear of having blood drawn is one of the strongest known predictors of vasovagal reactions among high school blood donors. This report examines the combined effects of donor fear and experience of vasovagal reactions on repeat donation attempts among high school blood donors.

STUDY DESIGN AND METHODS: Immediately after completing the blood donor health screening, 1715 high school students were asked about their fear of having blood drawn. The donor record was then used to collect information regarding their experience of vasovagal reactions at the time of donation as well as their subsequent donation attempts within the following year.

RESULTS: Fear of having blood drawn and the experience of a vasovagal reaction each contributed to donor attrition, with only 33.2% of fearful donors who experienced a vasovagal reaction returning in the following year compared to 56.7% of nonfearful nonreactors. Path analyses demonstrated that fear has an indirect effect (through vasovagal reactions) on repeat donations among first-time donors and both direct and indirect effects on repeat donation attempts among experienced donors.

CONCLUSION: Among high school blood donors, fear of having blood drawn has both a direct negative effect on donor retention and an indirect negative effect by increasing the risk of vasovagal reactions. Accordingly, targeted efforts to reduce donor fear may be particularly efficient in promoting long-term donor loyalty among our youngest donors.

ABBREVIATIONS: CFI = comparative fit index; RMSEA = root mean square error of approximation; WRMR = root mean square residual.

From the 1Department of Psychology, Ohio University, Athens, Ohio; and the 2Community Blood Center of Greater Kansas City, Kansas City, Missouri.

Address reprint requests to: Christopher R. France, PhD, Department of Psychology, 251 Porter Hall, Ohio University, Athens, OH 45701; e-mail: France@ohio.edu.

Received for publication April 12, 2013; revision received June 24, 2013, and accepted June 29, 2013.

doi: 10.1111/trf.12368

TRANSFUSION 2014;54:918-924.
donors who did and donors who did not receive the predonation fear question.

One implication of the relationship between fear and vasovagal reactions is that it may be beneficial to routinely screen for fearful blood donors so that they can be observed more closely. Instruction in coping strategies may also be offered to help address fear (e.g., distraction) and prevent reactions (e.g., applied muscle tension). A second implication is that fearful donors may be at increased risk for attrition given the negative relationship between vasovagal reactions and retention among novice and experienced donors. Consistent with this notion, a recent reanalysis of college-aged donors revealed that fear of having blood drawn was related to increased risk of vasovagal reactions and decreased likelihood of donor retention in the subsequent year. Interestingly, subsequent donation behavior was observed to be lower only among fearful donors who also reported above-average vasovagal symptoms; the experience of vasovagal reactions did not affect return behavior among those who reported no fear, nor did fear relate to decreased return in the absence of vasovagal symptoms. These findings have potential limitations, however, as they were based on a small subsample of donors in a no-treatment control condition (n = 193) and relied on self-reported symptoms. To address these limitations, we conducted a 1-year follow-up of repeat donation attempts among high school donors who had previously participated in our study of the relationship between donor fear and phlebotomist ratings of vasovagal reactions. In the present report we examine the combined effects of donor fear and experience of vasovagal reactions on donor retention; hence, we restricted our focus to the 1715 participants in our original sample who responded to the fear question.

MATERIALS AND METHODS

Full procedural details are provided in our prior report, but to summarize, data for this study were obtained from 64 high school blood drives conducted between August and December of 2011. All participants were whole blood donors who met Community Blood Center of Greater Kansas City age restrictions and weighed at least 115 pounds. Donations were completed according to standard operating procedures, with the exception that during the health screening donors were asked to select a confidential response to the question “How afraid are you of having blood drawn from your arm?” Response options included 0 = “not at all afraid,” 1 = “somewhat afraid,” 2 = “moderately afraid,” 3 = “very afraid,” and 4 = “extremely afraid.” Donor information was obtained either from the health screen or from the donor record (e.g., vasovagal reaction codes). The final sample consisted of 1715 seventeen- and eighteen-year-old male (n = 760) and female (n = 955) whole blood donors. Consistent with our previous report, given the distribution of donor vasovagal reaction codes (i.e., none = 82.8%, mild = 14.8%, moderate = 0.8%, severe = 1.6%), this variable was recoded as either no vasovagal reaction (n = 1420, 82.8%) or vasovagal reaction (n = 295, 17.2%) for the primary analyses. The distribution of fear ratings was also positively skewed (i.e., not at all afraid = 56.0%, somewhat afraid = 31.7%, moderately afraid = 9.3%, very afraid = 2.2%, extremely afraid = 0.8%) and was recoded as a dichotomous variable of no fear (i.e., n = 960 or 56.0%) or fear (i.e., n = 755 or 44.0%) for the primary analyses. Table 1 provides descriptive characteristics of the sample as a function of first-time and experienced donor status.

The study protocol was reviewed and approved by the Ohio University Institutional Review Board.

Statistical analysis

Three sets of analyses were conducted. Statistical analyses were performed using computer software (SPSS 19 for Windows, SPSS, Inc., Chicago, IL; and Mplus, Version 6.12, Muthen & Muthen, Los Angeles, CA) for the path analyses. All tests of significance used p values of less than 0.05 as the criterion.

First, bivariate analyses were conducted to investigate predictors of donor return (i.e., whether or not there was a donation attempt within the 1-year follow-up) and number of returns (i.e., the number of donation attempts during the follow-up period). The predictors were donor fear and donor vasovagal reaction. Chi-square tests, independent-samples t tests, and Poisson regression analyses were conducted.

Second, the aim of the primary set of analyses was to model donor return, which was defined as the number of days that elapsed between the date of eligibility to provide a new donation (i.e., 56 days postindex donation) and the first donation attempt within 1 year of the index donation. Because three individuals attempted to donate blood before they were eligible to do so, for the purposes of these analyses these individuals were coded as if they had returned on their first day of eligibility. It should be noted,

### Table 1. Descriptive characteristics of first-time and experienced high school donors

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>First-time donors (n = 855)</th>
<th>Experienced donors (n = 860)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (% female)</td>
<td>48.4</td>
<td>62.9</td>
</tr>
<tr>
<td>Age (years)</td>
<td>17.2 (0.4)</td>
<td>17.3 (0.5)</td>
</tr>
<tr>
<td>Number of prior donations</td>
<td>0.0 (0.0)</td>
<td>1.9 (1.2)</td>
</tr>
<tr>
<td>Any vasovagal reaction (%)</td>
<td>20.1</td>
<td>14.3</td>
</tr>
<tr>
<td>Any fear (%)</td>
<td>57.9</td>
<td>30.2</td>
</tr>
<tr>
<td>Repeat donation attempt (%)</td>
<td>42.8</td>
<td>58.3</td>
</tr>
</tbody>
</table>

* Data are reported as percentage or mean ± SD.
however, that the results were unchanged when these individuals were omitted from the analyses. Survival curves were empirically derived using the Kaplan-Meier method. Cox proportional hazards regression analyses were then conducted. Reported fear of having blood drawn (yes, no) and experience of a vasovagal reaction (yes, no) were the predictors of interest. Examination of the predicted plots from the Cox regression analysis and a goodness-of-fit test of the Shoenfeld residuals were used to confirm the appropriateness of the proportional-hazards assumption.

Finally, path analyses were conducted to 1) model the relationship among donor sex (male = 0 and female = 1), fear rating (not at all afraid = 0 to extremely afraid = 4), vasovagal reactions (none = 0 to severe = 3), and repeat donation attempts (no = 0 and yes = 1); and 2) examine if there was a previous donation effect (first-time donors vs. experienced donors) on the relationship among those variables. Nonsignificant paths were removed from the model and a chi-square difference test was conducted to examine if the fit of the model improved. Because the main variable of interest, repeat donation attempt, is a dichotomous variable, the model was estimated utilizing a weighted least-square method. In path analysis, the chi-square statistic provides a test of the null hypothesis that the covariance matrix conforms to the particular model being tested. A nonsignificant chi-square value is desirable since the goal is to develop a model that fits the data. However, the chi-square statistics is dependent on sample size and a trivial difference in large samples can result in a significant chi-square. Therefore, a number of goodness-of-fit indices are examined to assess how well the hypothesized model fits the data. As recommended in the literature, an index from each category of fit indices (comparative fit, parsimony correction, and absolute fit) was included: 1) comparative fit index (CFI), 2) root mean square error of approximation (RMSEA); and 3) weighted root mean square residual (WRMR). The range-of-fit indices for a good fit are as follows: CFI > 0.95, RMSEA < 0.06, and WRMR < 0.90.

**RESULTS**

Follow-up donation behavior as a function of fear and vasovagal reactions

Table 2 describes donor return behavior during a 1-year follow-up period as a function of fear of having blood drawn and the experience of vasovagal reactions at the time of the index donation. With respect to donor fear, a higher percentage of nonfearful donors (54.9%) than fearful donors (45.0%) returned to make a donation attempt within 365 days of their index donation ($\chi^2(1, n = 1715) = 16.4; p < 0.05; OR, 1.5; 95\% CI, 1.2-1.8$). Nonfearful donors also made more donation attempts (mean, 0.8; SD, 1.0) than fearful donors (mean, 0.7; SD, 0.9) during the 1-year follow-up period ($\chi^2(1, n = 1715) = 22.3; p < 0.05; risk ratio, 1.2; 95\% CI, 1.1-1.4$).

With respect to donor vasovagal reactions, a higher percentage of nonreactors (53.6%) than reactors (35.9%) returned to make a donation attempt within 365 days of their index donation ($\chi^2(1, n = 1715) = 30.5; p < 0.05; OR, 2.1; 95\% CI, 1.6-2.7$). Nonreactors also made more donation attempts (mean, 0.8; SD, 1.0) than reactors (mean, 0.5; SD, 0.7) during the 1-year follow-up period ($\chi^2(1, n = 1715) = 33.6; p < 0.05; risk ratio, 1.7; 95\% CI, 1.4-2.0$).

**Cox proportional hazards regression model of donor return**

Cox proportional hazards regression analyses were conducted to model the number of days that elapsed between the date of eligibility to provide a new donation and the first donation attempt within 1 year of the index donation as a function of both donor fear and vasovagal reaction experience. Preliminary Cox proportional hazards regression analyses confirmed the appropriateness of the

<table>
<thead>
<tr>
<th>Donor fear</th>
<th>Vasovagal reaction</th>
<th>% of sample</th>
<th>Returned (%)</th>
<th>Number of returns, mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>49.7</td>
<td>56.7</td>
<td>0.9 (1.0)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>6.3</td>
<td>40.7</td>
<td>0.6 (0.8)</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>33.1</td>
<td>48.9</td>
<td>0.7 (1.0)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>10.9</td>
<td>33.2</td>
<td>0.4 (0.7)</td>
</tr>
<tr>
<td>No</td>
<td>Combined</td>
<td>56.0</td>
<td>54.9</td>
<td>0.8 (1.0)</td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td>44.0</td>
<td>45.0</td>
<td>0.7 (0.9)</td>
</tr>
<tr>
<td>Combined</td>
<td>No</td>
<td>82.8</td>
<td>53.6</td>
<td>0.8 (1.0)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>17.2</td>
<td>35.9</td>
<td>0.5 (0.7)</td>
</tr>
<tr>
<td>All donors</td>
<td></td>
<td>100.0</td>
<td>50.6</td>
<td>0.8 (1.0)</td>
</tr>
</tbody>
</table>

* Denotes significant differences as a function of donor fear (collapsed across vasovagal reaction) and vasovagal reaction (collapsed across donor fear).
proportional-hazards assumption for these data. For ease of interpretation, one minus the Kaplan-Meier survival curves are depicted in Figure 1.

A Cox proportional hazards regression analysis was conducted by simultaneously entering both predictors into the model. Tests of the Schoenfeld residuals were nonsignificant, indicating that the proportional hazards assumption was satisfied \( (p > 0.40) \). After controlling for the experience of a vasovagal reaction at the index donation, the hazard rate \( (1.23; 95\% \text{ CI}, 1.08-1.42) \) for nonfearful donors was greater than that for fearful donors \( (\chi^2(1, n = 1715) = 8.9; \ p = 0.003) \). That is, those who reported no fear of having blood drawn returned at a higher rate than those who reported fear, even after controlling for vasovagal reactions. Similarly, after controlling for fear, the hazard rate \( (1.63; 95\% \text{ CI}, 1.33-2.00) \) for those without a vasovagal reaction at the index donation was greater than that for those who did not experience a vasovagal reaction \( (\chi^2(1, n = 1715) = 21.5; \ p < 0.001) \). Hence, experiencing a vasovagal reaction was associated with a decreased rate of returning to donate blood throughout the 1-year follow up, even after controlling for fear.

Although the Community Blood Center of Greater Kansas City uses a minimum donor weight of 115 pounds to address the issue of proportion of total blood volume withdrawn, some blood collection services calculate estimated total blood volume and do not allow individuals to donate if a standard collection would represent more than 15% of the donor’s estimated total blood volume. To generalize the present results to these other settings, the Cox proportional hazards regression analysis was repeated for the present sample after eliminating donors whose blood draw exceeded 15% of their estimated total blood volume. For the purpose of this analysis, estimated blood volume was computed according to sex-specific equations using height and weight values, and this was used to compute individual percent blood volumes assuming a standard 528-mL blood draw (i.e., 500 mL and, on average, 28 mL for blood test samples). The results were unchanged in this subsample.

### Path analysis of donor return

Path analyses were conducted to examine the simultaneous relationships among donor sex, fear, vasovagal reactions, and repeat donation attempts. This analysis, which was conducted separately for first-time and experienced donors, used continuous measures of fear (0-4) and vasovagal reaction (0-3).

As can be seen in Figure 2, among experienced blood donors, both fear \( (\beta = -0.096; \ p < 0.05) \) and vasovagal reactions \( (\beta = -0.158; \ p < 0.001) \) had direct, negative effects on repeat donation attempts. In addition, fear also exerted an indirect, negative effect on repeat donation attempts through its positive association with vasovagal reactions \( (\beta = 0.129; \ p < 0.001) \). Donor sex was also associated with fear and vasovagal reactions, with female donors having higher fear and vasovagal reaction values than male donors. This model showed a good fit to the data, surpassing standards on all fit indices \( (\text{CFI}, 1.00; \ RMSEA, 0.00; \ WRMR, 0.128; \chi^2(1) = 0.187; \ p = 0.67) \).

The same model fitted to experienced donors was fitted to first-time donors. For first-time donors, the direct pathway from fear to repeat donation attempts was not significant \( (\beta = -0.03; \ p = 0.57) \). Thus this path was removed from the model and the chi-square difference test indicated that the model without the direct path from fear to repeat donation attempts had a better fit. Among first-time blood donors, vasovagal reactions had a direct, negative effect on repeat donation attempts \( (\beta = -0.204; \ p < 0.001) \). Even though fear did not have a direct effect on repeat donation attempts, it did have an indirect, negative effect on repeat donation attempts through its positive association with vasovagal reactions \( (\beta = 0.118, \ p < 0.001) \). Donor sex was also associated with fear and vasovagal reactions, with female donors having higher fear and vasovagal reaction values than male donors. This model showed a good fit to the data, surpassing standards on all fit indices \( (\text{CFI}, 1.00; \ RMSEA, 0.00; \ WRMR, 0.181; \chi^2(2) = 0.382; \ p = 0.83) \).
DISCUSSION

We have previously demonstrated that donors who report a fear of having blood drawn are at increased risk of experiencing a vasovagal reaction, with this risk more than doubling among high school donors.\(^5\) We and others have also previously demonstrated that vasovagal reactions are a significant deterrent to donor retention.\(^{18-25}\) The present findings confirm and extend this work, demonstrating that both donor fear and donor vasovagal reactions independently affect whether or not high school donors return to provide a repeat donation. Specifically, in the present study the experience of a vasovagal reaction reduced 1-year repeat donation attempts by approximately 16 percentage points among both fearful donors (from 48.9% to 33.2%) and nonfearful donors (from 56.7% to 40.7%). Further, fear of having blood drawn reduced repeat donation attempts by more than seven percentage points for donors who experienced a vasovagal reaction during their most recent donation (from 40.7% to 33.2%) as well as those who did not (from 56.7% to 48.9%). Overall, fearful donors who experienced a vasovagal reaction returned 23.5 percentage points less often when compared to nonfearful nonreactors (i.e., 33.2% vs. 56.7%).

Although it is tempting to conclude from the observed data that vasovagal reactions are a more potent impediment to donor retention than donor fear, this conclusion may not be accurate for at least several reasons. First, the total impact on donor retention is determined by the change in the rate of return and the frequency of the characteristic in the donor population. Whereas the experience of vasovagal reactions was associated with a larger reduction in the percentage of donors who returned compared to fear (i.e., 17.7% vs. 9.9%, respectively), in the present sample fear was more common than vasovagal reactions (44.0% vs. 17.2%, respectively). When the observed change in the rate of return is considered in combination with the frequency of the characteristic in the sample, then fear accounted for 4.4% (0.099 \times 0.440) fewer donors and vasovagal reactions accounted for 3.0% (0.177 \times 0.172) fewer donors in the subsequent year.

A second reason that it is difficult to determine the relative importance of fear and vasovagal reactions is that they may exert both indirect and direct effects on return behavior. For example, our prior report\(^5\) demonstrated that fear more than doubled the risk of vasovagal reactions among the current sample of high school donors; hence, as shown in the path analyses reported in this study, reduced retention rates observed among vasovagal reactors reflect, at least in part, the indirect effect of greater fear. In addition, the current findings demonstrate that, in the overall sample, fear was associated with a similar reduction in retention among donors who did and did not experience a vasovagal reaction. Consistent with the results of the path analyses, this indicates that fear also exerts a direct inhibitory effect on donation behavior beyond its effect on vasovagal reactions. Interestingly, the results of the path analyses indicate that this direct effect was present among experienced but not first-time blood donors, which is consistent with recent findings that anxiety did not predict return among first-time donors who experienced an adverse reaction.\(^{24}\) One possible explanation for this moderating effect of donation experience is that predonation fear ratings in first-time donors may reflect a variety of incorrect assumptions about donation (e.g., based on exaggerated media depictions of fainting, negative anecdotes told by friends), which are likely to be corrected with donation experience. Thus, given that most donors have a positive experience and do not have a

---

Fig. 2. Path analyses of the relationships among donor sex (male = 0, female = 1), fear (0 = not at all afraid to 4 = extremely afraid), vasovagal reactions (0 = none to 3 = severe), and repeat donation attempt (yes/no) conducted on first-time donors and experienced donors. All illustrated paths are significant. Standardized path coefficients are provided, although residual variances for the dependent variables are omitted for figure simplicity.
vasovagal reaction, predonation fear ratings obtained from first-time donors may not be a good indicator of their postdonation fear or attitudes toward future donation. In contrast, predonation fear reports of experienced donors may reflect genuine concerns based on prior experience (e.g., concerns about needle pain, bruising). Thus, among experienced donors, fear that is reported at predonation may be more likely to be retained at postdonation and to deter future donation attempts. Further studies are needed to establish how a history of vasovagal symptoms and changes in donor fear combine over time to influence donation behavior among diverse donor populations.

Finally, while we only examined the direct effect of vasovagal reactions to blood donation on donor return in this study, it is also possible that prior experience of vasovagal reactions to other medical procedures (e.g., blood tests, vaccination) may contribute to reduced retention if such experiences promote subsequent blood donor fear.

An important question that remains to be addressed is how blood donor fear contributes to an increased risk for vasovagal reactions. For many years, efforts to explain the physiologic basis of vasovagal reactions to blood, injection, and injury stimuli have focused on a diphasic response pattern, wherein an initial fear-related hyperdynamic arousal phase was posited to give way to sharp decreases in heart rate and blood pressure once the threat was removed. Although this is an appealing description of the blood donation context, given that risk for vasovagal reactions peak shortly after donors leave the donation chair, empirical support for a diphasic response pattern is surprisingly inconsistent. An intriguing new psychophysiologic model suggests that vasovagal symptoms experienced by individuals with blood injection injury phobia may result from hyperventilation, hypocapnia, and a resultant decrease in cerebral blood flow that is triggered by exposure to fear-related stimuli. This model has yet to be assessed in the blood donation context, however; hence it is unclear whether, or to what extent, hyperventilation may account for vasovagal reactions among volunteer blood donors who report significantly less fear than those with blood injection injury phobia. Vasovagal reactions to blood or injury stimuli have also been argued to reflect a central nervous system response to anticipated blood loss, wherein brainstem nuclei are engaged in response to threat cues to induce bradycardia, hypotension, and ultimately a supine posture to encourage hemostasis. Although this reflex may be evolutionarily adaptive in the case of large-blood-volume losses that can accompany life-threatening injury, it is clearly maladaptive in the context of blood donation where the risks of injury from falling in response to vasovagal symptoms far outweigh the risks of uncontrolled hemorrhage. Nonetheless, the potential evolutionary advantage may account for the persistence of this predisposition among some, and recent support for the theory among blood donors includes evidence that fear of blood loss is a stronger predictor of vasovagal reactions than fear of needles and that subjective perception of amount of blood loss is positively related to vasovagal symptoms.

In sum, there is growing evidence that fear of having blood drawn is relatively common among high school donors, is associated with increased likelihood of donation-related vasovagal reactions, and can contribute to donor attrition. Although fear and vasovagal reactions are less common among more experienced donors, addressing donation-related fear may be a particularly efficient means of promoting long-term donor loyalty among high school blood donors. A few studies provide evidence that predonation education in coping strategies, including distraction, may be effective in reducing donation-related anxiety and risk of vasovagal reactions. To date, however, no studies have specifically targeted fearful donors to see what impact such interventions may have when administered on an as-needed basis on the day of donation. We believe that the results of this study support the need for such research given the potential to improve donor comfort, reduce adverse reactions, and increase retention.

ACKNOWLEDGMENTS

The authors certify that they have no conflicts of interest or financial involvement with this manuscript.

REFERENCES

Copyright of Transfusion is the property of Wiley-Blackwell and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder’s express written permission. However, users may print, download, or email articles for individual use.