

Appendix 1.

Recommendations to Minimize the Risk of Reactions and Injuries among Adolescent Blood Donors

Contributing authors: Anne Eder, Hany Kamel, Christopher France, Diane Killion, Patsy Shipley, Pat Demaris, Nina Salamon, and Dan Waxman for the AABB Younger Donors Adverse Reaction Working Group, Robert Jones, MD, Chair

Objectives

1. To review published data and reported efficacy of methods to enhance the donor experience and/or reduce donor complications.
2. To identify the different approaches that could be employed at blood centers to reduce donor complications at high school drives.

Executive Summary

Young (16- and 17-year-old) donors now represent a significant and increasing proportion of the whole blood donations to blood centers in the United States, accounting for about 8% of the whole blood donations or 450,000 whole blood collections to the American Red Cross (ARC) in 2006. However, young age, total blood volume, and first-time donation status are known to be independent risk factors and leading determinants of donation-related complications.¹⁻⁶ Even minor reactions or temporary deferrals decrease the probability of return donation,⁶⁻⁹ and efforts to improve the donation experience are crucial to sustain the blood supply. The increasing dependence on recruiting and retaining young blood donors requires a committed approach to donor safety, especially on high school blood drives.

A multidimensional view of the donation experience recognizes several aspects that influence the risk of complications after blood donation: inherent donor characteristics and predisposition toward reactions, blood center staff experience and skill, blood drive set-up and environmental features, and donor education before and after donation. Donor characteristics that correlate with higher syncopal complication rates after whole blood donation include young age, first-time donation status, low weight, low blood volume, female gender, and Caucasian race. While these may not all be independent predictors of reactions, an additive effect of risk factors has been observed in Caucasian high school students.⁵ Several interventions (eg, asking the donor to drink 16 oz of water shortly before donation, or using applied muscle tension or distraction techniques) have been used to improve the donation experience and/or reduce donor complication rates. However, no single measure has been shown to prevent a majority of systemic reactions or to prevent the rare but more serious complications, such as syncope-related injury after whole blood donation.

Consequently, blood centers should consider all factors that affect a donor's experience and influence the risk of complications before deciding which safety measures should be enhanced or introduced at the blood center. The effectiveness of safety initiatives should be monitored continuously, the resultant data should be peer reviewed, and the conclusions should be published to further our understanding of the efforts to improve the donation experience.

The working group recommends that blood centers consider one or more of the measures in the following areas and develop monitoring programs to continually assess safety:

- I. Predonation education
- II. Drive set-up and environment
- III. Staff supervision and phlebotomist skills
- IV. Interventions
 - A. Donor eligibility criteria
 1. Deferring young donors with blood volumes below 3500 mL
 2. Raising the minimum acceptable donor weight
 3. Collecting a smaller volume of blood from young donors
 - B. Distraction strategies
 - C. Water ingestion
 - D. Muscle tension
 - E. Automated red cell collection procedures with volume replacement
- V. Postreaction instructions to donor and parents

This report summarizes the available evidence on these different approaches to improve the donation experience, identifying expected benefits and limitations, providing directions for additional development and study, and estimating the impact on the donor base, to offer consensus-derived recommendations in each area.

I. Predonation Education

Efforts to address common donor concerns and provide useful coping suggestions were associated with improved scores on questionnaires that assessed donor attitude, anxiety, self-efficacy (the belief that one has the capability to manage a situation), and intention toward blood donation.¹⁰ There are no published studies that evaluate the effect of blood donation recruitment materials on complication or return donation rates.

Some unpublished data and anecdotal experience suggest that educational initiatives may be effective at reducing donor reactions and equipping the donor and staff to better handle reactions to reduce their severity.

Recommendations

Educational efforts may be reasonably expected to improve the donation experience and could result in greater participation and more effective preparation. Such efforts would not be expected to have an adverse impact on the donor base.

Educational initiatives should target the following groups:

- Chairpersons and sponsors of drives.
- High school students and their parents.
 - Educational material directed at donors should contain prevention strategies or anticipatory guidance and content that address coping strategies to reduce reactions.
 - Educational material should be delivered close to the day of donation.
- School nurses.

- School nurses should be informed of the pathophysiology of donation-related adverse reactions and the care of donors who experience complications.
- In advance of the drive, donor centers should discuss with school nurses or administrators how to handle delayed or prolonged donor reactions and ensure continuity of care after release from the donation site.
- Training recruitment and collection staff.

The optimal delivery method for student education is unknown but may include the following formats:

- An educational DVD. A video format ≤10-minutes meets the students in their world and offers school administrators the ability to provide the education at their convenience.
- Podcast, downloadable eBook, or similar application.
- Blood center Web site.

II. Drive Set-Up and Environment

Blood centers should have systems in place to process donors efficiently and to provide good donor care regardless of age. Scant data exist on best practices for drive set-up, and sponsor groups are often challenged to find enough space to accommodate a blood drive. Most blood centers require site clearance before a blood drive. It is important to tour the location where the drive is held to ensure adequate ventilation, electrical outlets, and space for handling adverse reactions. In a recent Blood Centers of America (BCA) survey of 26 blood centers, nine centers responded that the drive set-up for high school drives differs from the set-up for regular drives (Nina Salamon, personal communication).

Recommendations

Supportive evidence does not exist to recommend more controlled or restrictive requirements for drive site set-up. However, blood centers are encouraged to share their experiences to identify and implement processes that may lessen the likelihood of adverse reactions.

A predonation hydration station or other mechanism to provide fluids to donors before donation should be part of the drive planning or set-up. Donors should be allowed to leave the area with bottles of water, which may require obtaining permission from the school administrators before the drive.

Blood centers should consider the following aspects of drive set-up that may mitigate adverse reactions at high school blood drives:

- Procedures for site selection to ensure acceptable conditions to support operations and guidance on discontinuing operations if the conditions become unsuitable.
- Controlled donor flow and adequate staff or volunteer availability. Arrival and departure patterns of students should be evenly spaced to minimize commotion. Access to the donation area should be limited to student donors, designated volunteers, and staff.
- Progressive recovery strategies (eg, dangling legs over the side of the bed with appropriate attention) before having the donor stand up after donation.
- Escorting donors through the process—in particular, from the chair/bed to the canteen. Consider asking the volunteers to escort the donors back to class.

- Predonation canteen table for fluid and food (see Water Ingestion, below).
- Postdonation canteen/refreshment area:
- Designated area and donor flow should allow for adequate time in the canteen after donation.
- Have donors lie on gym mats on the floor during the recovery and refreshment period after donation.
- Inform donors of the importance of staying in the canteen for an allotted time (eg, about 15 minutes) or until they feel well. Emphasize to staff the importance of instructing donors to stay in the recovery area for sufficient recovery time.
- Additional staff or volunteers who are trained in recognizing prereaction signs and symptoms can be assigned to the refreshment area.
- Area for recovery. Wheel chairs should be available. Mobile screens can be used to separate or partition areas for students who may feel anxious or sick.

III. Staff Supervision and Phlebotomist Skills

Employees in the collections department are crucial to the mission and success of the blood center and the safety of the blood donor, regardless of donor age. In one study, phlebotomists exhibiting high scores on a standardized social skills test were associated with reduced donor reaction rates.¹¹ Phlebotomy training was somewhat significant in this study.

Some donor centers try to mitigate adverse reactions at high school blood drives by including staff who are well trained to recognize signs of reactions and to take steps to prevent them, and by increasing the number of staff or other supervisory personnel at high school drives.

Recommendations

Although donor centers often report having “extra” or “more experienced” staff on high school blood drives, there is no industry benchmark for a staffing model or skill-set requirements. The importance of hiring practices and staff training in interpersonal skills as well as technical skills is recognized. Blood centers are encouraged to continually evaluate their training programs and staff performance.

IV. Interventions

A. Donor Eligibility Criteria

1. Deferring young donors with blood volumes below 3500 mL.
 - Postdonation syncope may be a manifestation of the typical “vasovagal” attack, but can be a manifestation of hypovolemia.
 - One study of whole blood donations showed that a donor blood volume below 4775 mL is an independent risk factor for faint and prefaint reactions.²
 - The risk of reaction decreases substantially with increasing blood volume in the ranges assessed.² Five percent of donors in this study had blood volumes of less than 3500 mL, which guarantees that their 525-mL donations would be more than 15% of their blood volumes.
 - Implementing an additional requirement for minimum total blood volume (>3500 mL) may reduce the risk of faint and prefaint reactions. A bivariate analysis indicates that the difference in reaction rates based on donor blood volume is larger at a younger age than the

- difference for donors older than 30 years of age. An intervention applied to young donors (<23 years of age) with low blood volumes (<3500 mL) might reduce reactions.
- Preliminary unpublished data (Hany Kamel, personal communication) have indicated that donors younger than 23 years of age whose blood volume is <3500 mL represent 9% of donors younger than 23 and 1.6% of all donors. The rate of moderate and severe reactions in this group is 1.7% (compared to a 0.33% overall rate of moderate and severe reactions). A policy of excluding donors <23 years of age with blood volumes <3500 mL is estimated to eliminate 20% of moderate and severe reactions in this age group (9% of all reactions).
2. Raising the minimum acceptable donor weight.
 - Trouern-Trend et al reported a reaction rate of 0.46% in donors weighing <120 lb compared to a rate of 0.14% in the reference group of donors weighing 150 to 179 lb.¹
 - In high school students, Newman et al reported a reaction rate of 16.9% in donors weighing <130 lb compared to a rate of 8.2% in donors weighing 130 lb or more.¹² Donors weighing <130 lb represented 4.1% of all donors (118/2894).
 - In one study, 22 of 32 (69%) injured 16- and 17-year-old donors who received outside medical care for donation-related injuries weighed >130 lb; only 4 of 32 (12.5%) weighed less than 120 lb.⁶ Selection criteria based on donor-reported weight, therefore, would be expected to prevent only a small fraction of the injuries sustained by adolescent donors.
 3. Collection of smaller volume of blood from young donors.
 - Two abstracts demonstrated equivalent overall safety profiles for 450-mL and 500-mL whole blood collections.^{13,14} In these studies, donors were not stratified by factors known to predispose to systemic reactions (eg, age, weight, experience, etc). It is possible that any beneficial effect of collecting smaller volumes from young and/or low-weight donors may have been masked.
 - Tomasulo et al measured the weight of whole blood units collected in a 450-mL bag, calculated the percentage of blood volume removed, and reported donor reaction rates in different donor groups.¹⁵ Female donors who had 14% to 16% of their blood volume removed were more likely to experience a reaction than those who had only 10% removed. The authors concluded that donors weighing 110 to 119 lb had an increased reaction rate, which was attributed to collection volume.

Recommendations (Donor Eligibility Criteria)

Studies have identified subgroups at higher risk that may benefit from having different selection criteria. The current eligibility requirement for minimum weight of 110 lb and to limit collection to 10.5 mL/kg is sufficient to protect most, but not all, donors. This requirement was based on the assumption that it would prohibit drawing more than 15% of a donor's blood volume. Recent data suggest that this assumption is not accurate² and a new standard approach may be needed to limit whole blood collection to no more than 15% of the total blood volume for adolescent donors. Although the reduction in reaction rates for a given change in selection criteria can be estimated by multivariate analysis, it is not known if implementation of a given policy will achieve the predicted results. Blood centers are encouraged to evaluate the potential effectiveness of different donor selection criteria in preventing reactions and injury.

B. Distraction of the Donor During Collection

It is widely recognized that distraction techniques are effective at putting donors at ease during collection. In a small study the use of audiovisual distractions reduced the self-reporting of vasovagal reactions.¹⁶ Some examples of easy-to-implement audiovisual distractions for donor drives include allowing the use of MP3 players or providing headsets with music, encouraging applied muscle tension activities, and placing donor chairs back to back.

Recommendations

Blood centers should provide education to donors on permissible activities for distraction that may increase their sense of control during the donation. Blood centers should instruct staff on the importance of distraction as a possible way to reduce reactions.

C. Water Ingestion

To date, two studies have been published on the effects of predonation hydration on blood donor reactions. In a randomized controlled trial, 83 male and female first-time donors (median age = 19) consumed 500 mL of water 30 minutes before allogeneic whole blood donation.¹⁷ Results indicated that the donors who received water reported significantly fewer presyncopal reactions (eg, faintness, dizziness, weakness) as compared to those who did not hydrate. This finding was later confirmed in a study of nearly 9000 high school donors (17-19 years of age) who consumed 473 mL of water 0 to 30+ minutes before phlebotomy.¹² Based on donor reactions recorded on the health history form, reaction rates were reduced 21% by predonation hydration (water = 9.9% reaction rate; no water = 12.5% reaction rate). Additional analyses indicated that reaction rates were lowest for those who consumed water within 10 minutes of the phlebotomy, with reaction rates increasing with longer lag times.

Although there are only two published studies on the effects of predonation hydration on donor reactions, additional laboratory research has demonstrated that acute water loading increases blood pressure, peripheral vascular resistance, and cerebral blood flow, and can serve as an effective prophylaxis against vasovagal reactions in healthy individuals undergoing orthostatic challenge.¹⁸⁻²⁰

Table 1. Summary of Reductions in Donor Reactions Observed as a Function of Predonation Water Loading vs Standard Donation Control

| Study | Water | Control | Change |
|---|----------------------------|----------------------------|--------|
| Hanson and France ¹⁷ (2004) | 0.48 (BDRI, log units) | 0.91 (BDRI, log units) | ↓47% |
| Newman et al ¹² (2007) | 9.9 % (donor reactions) | 12.5% (donor reactions) | ↓21% |

Note: The BDRI, or Blood Donation Reactions Inventory, is a self-report measure of donor reactions such as faintness, dizziness, weakness, etc. Elevations on this scale predict donor non-return over and above the effect associated with reactions recorded on the donor record.

Recommendations

Based on existing evidence that predonation hydration can help prevent presyncopal reactions in both male and female donors, does not interfere with the donation process, and is perceived by collection staff as easy to implement, donors should be provided with 500 mL of water or fluid and encouraged to consume the water approximately 10 minutes before phlebotomy.

D. Muscle Tension

To date, four studies have been published on the effects of applied muscle tension (AMT) on blood donor reactions.²¹⁻²⁴ Although AMT exists in many forms, it typically involves repeated, rhythmic contraction of the large muscles of the arms and legs. In the first study to apply this technique in the context of blood donation, a brief video was used to teach AMT to a small group (n = 37) of relatively inexperienced donors (ie, 0 to 2 prior donations).²¹ Compared to controls who did not view the video, donors who learned AMT reported significantly fewer presyncopal reactions (eg, faintness, dizziness, weakness) following donation. Furthermore, those who said they used AMT throughout the donation had the fewest reactions.

The beneficial effects of AMT were confirmed and extended in a larger study of 605 young donors (mean age = 22; mean prior donations = 3.5).²² In this study, donors were randomly assigned to 1) standard donation, 2) AMT predonation (placebo control), or 3) AMT during donation (intervention). In both AMT conditions the donors learned the muscle tensing technique from a brief video presentation. To control for positive expectancy effects, participants in the AMT predonation (placebo control) condition were instructed to practice AMT from the time they sat down in the donation chair until just before needle insertion. Overall, the results indicated that AMT had a beneficial effect for female, but not male, donors. Specifically, female donors assigned to the intervention condition reported significantly fewer presyncopal reactions, required fewer donation chair reclines, and were more likely to produce a full unit of blood than females in the placebo or standard donation conditions (the placebo and standard donation conditions did not differ).

In a separate sample of donors (n = 467), presyncopal reactions were attenuated for both male and female donors assigned to the AMT intervention instead of either placebo control or standard donation (which did not differ).²³ Most recently, 1209 donors (50% female, mean age = 22, mean prior donations = 2.2) were randomly assigned to either standard donation or one of five forms of muscle tensing.²⁴ Donors assigned to AMT viewed a brief video depicting repeated muscle tensing of the 1) full body (arms, legs, and abdomen), 2) lower body only (legs and abdomen), 3) upper body only (both arms), 4) upper body only with distraction (both arms, but instructed to attend to nondonation arm), or 5) donation arm only. When compared to standard donation, full body AMT replicated prior effects of significantly lower reports of presyncopal reactions and fewer donor chair reclines. Similar benefits were observed for lower body AMT, but not upper body AMT, suggesting that tension in the legs and lower abdomen are important components of the beneficial effects of AMT. Upper body AMT with distraction was also associated with a significant reduction in presyncopal reactions, suggesting that AMT benefits may also derive, at least in part, from distraction.

In addition to research in the blood donation context, AMT has been used for decades to successfully treat patients with syncope related to blood and injury phobia²⁵⁻²⁹ as well as other

causes of vasovagal syncope.³⁰⁻³⁴ Laboratory studies suggest that AMT may help prevent syncopal and presyncopal reactions by increasing blood pressure and cerebral blood flow and oxygenation.^{31,35-39}

Table 2. Summary of Reductions in Donor Reactions Observed as a Function of Applied Muscle Tension vs Standard Donation Control

| Study | Muscle Tension | Control | Change |
|---------------------------------------|------------------------------------|---------------------|--------|
| Ditto et al ²¹ (2003) | 4.9 (BDRI units) | 6.3 (BDRI units) | ↓22% |
| Ditto et al ²² (2003) | All donors = 0.43 (log BDRI) | 0.47 (log BDRI) | ↓8% |
| | Female donors = 0.44 (log BDRI) | 0.55 (log BDRI) | ↓20% |
| Ditto and France ²³ (2006) | 0.35 (log BDRI) | 0.45 (log BDRI) | ↓22% |
| Ditto et al ²⁴ (2007) | 0.42 (log BDRI) | 0.52 (log BDRI) | ↓19% |

Note: The BDRI, or Blood Donation Reactions Inventory, is a self-report measure of donor reactions such as faintness, dizziness, weakness, etc. Elevations on this scale predict donor non-return over and above the effect associated with reactions recorded on the donor record.

Recommendations

Based on existing evidence that AMT is easy to learn, safe to use, and effective at reducing or averting presyncopal reactions in young donors, donor and staff instruction in this technique is recommended. Different approaches are possible but should be focused on tensing the large muscles of the legs and abdomen during donation. Further study is encouraged to evaluate the effectiveness of the intervention in reducing reactions and injuries after donation.

V. Automated Red Cell Collection

The safety of automated collection of Red Blood Cells (RBCs) has been compared to whole blood donation.^{40,41} In the American Red Cross experience, the vast majority of adverse reactions to Whole Blood (WB) and 2-unit RBC donation were minor, systemic complications (eg, pre-faint, citrate reactions).⁴⁰ The overall rate of complications was marginally greater for 2-unit RBCs than for WB collections (320.3 vs 274.5 per 10,000 collections; odds ratio, 1.17 (95% CI, 1.15 to 1.20).

Table 3. Risk Factors for Donation-Related Complications*

| Demographic Characteristic | Reaction Rate (/1,000 donations) | Unadjusted Odds Ratio (95% CI) | Adjusted Odds Ratio [†] (95% CI) |
|--|----------------------------------|--------------------------------|---|
| Blood volume < 3500 mL [‡] | 34.9 | 4.47 (4.10-4.88) | 2.88 (2.57-3.23) |
| Age = 17-18 years [‡] | 39.6 | 4.19 (3.94-4.45) | 2.78 (2.59-2.98) |
| Age = 19-24 years [‡] | 27.4 | 2.87 (2.68-3.06) | 2.39 (2.23-2.56) |
| First-time donor [‡] | 27.5 | 2.80 (2.66-2.94) | 2.20 (2.07-2.33) |
| Race = Caucasian ethnicity [‡] | 14.3 | 3.42 (2.63-4.46) | 2.15 (1.64-2.82) |
| Blood volume = 3500-4000 mL [‡] | 23.5 | 2.97 (2.77-3.17) | 2.09 (1.90-2.31) |

*Donor reaction rates and odds ratios of combined mild, moderate, and severe reactions by donor characteristics compared to donors without reactions.²

[†]Includes age group, gender, donation history, race/ethnicity, estimated blood volume, pulse, systolic blood pressure, and blood center as covariates.

[‡]Compared to the reference group: blood volume >4775 mL; age 25-65; repeat donor, and Black, non-Hispanic ethnicity.

However, the rate of major systemic complications (loss of consciousness, loss of consciousness with injury, prolonged recovery, major citrate) in 2-unit RBC donations was lower compared to the rate in WB donations; in particular, for donors <20 years [odds ratio, 0.41 (95% CI, 0.32 to 0.53)].⁴⁰ Blood Systems demonstrated that manual WB collections have a low incidence of moderate and severe reactions (47.1 per 10,000 collections, 0.47%).⁴¹ Single-unit RBCs collected by apheresis have the same safety profile (37.44 per 10,000 collections, $p > 0.20$). Two-unit RBC collections by apheresis and plateletpheresis collections have a significantly lower reaction rate (15.65 per 10,000 collections, $p < 0.00005$; and 14.84 per 10,000 collections, $p < 0.00005$, respectively).⁴¹

Automated 2-unit RBC collections have a favorable safety profile compared to whole blood collections, with a lower risk of major systemic complications compared to whole blood donation. This benefit is most pronounced among young and first-time donors, providing a rationale for further study and for possibly expanding apheresis red cell donation programs in colleges and high schools.

The apparent safety advantage of 2-unit RBC collections may be attributed to the saline replacement during such procedures or to the more stringent criteria for such donations (the hematocrit, height, and weight criteria used to select donors for 2-unit RBC donations are designed to select donors with larger red cell or total volumes than whole blood donors of smaller stature). Further analysis is needed to tease out the true impact of volume replacement.

Recommendations

The available evidence supports further study of expanding apheresis red cell donation programs in high schools and colleges.

VI. Postreaction Instructions to Donors and Parents

Donor centers must have procedures for postreaction care of donors (Standard 5.3.2.1).⁴²

Measures to improve communication with parents/guardians or school nurses may decrease the likelihood of delayed reactions after leaving the site, and donor centers should consider the following aspects:

- Communication with parents/guardians that the donor experienced a loss of consciousness or other reaction or injury, in accordance with state laws.
- Blood centers should ensure that donors who have had a reaction receive continued care while they are still at the collection site and after they reach home.

Conclusions and Future Directions

Blood centers should recognize all the dimensions of the donation experience that affect the risk of complications and consider one or more of the measures discussed in this report to enhance safety on high school drives. Blood centers should also monitor the effectiveness of their efforts to gauge progress and further refine their policies and procedures to protect donors and ensure a good donation experience. Although most donations are uneventful, even a minor complication reduces the likelihood of return donation. Serious injury following blood donation occurs infrequently among all donor age groups, but adolescent donors are disproportionately affected compared to older adults. In one study, the risk of syncope-related injury among 16- and 17-year-donors was 5.9 per 10,000 donations compared to 0.4 per 10,000 donations by individuals 20 years or older (odds ratio, 14.46; 95% CI, 10.43-20.04).⁶ Although the initiatives that have been defined in this report to reduce donor reactions are predicted to also prevent some injuries, the actual benefit of any specific action may be difficult to measure given the rarity of the occurrence of donor injuries. Currently, it is also impossible to compare reaction rates across donor centers because of inconsistent definitions of what constitutes a reaction, different reporting criteria, and variability in how individual phlebotomists recognize and report adverse reactions. AABB's effort to establish a national hemovigilance program in the United States will provide not only a uniform reporting structure for adverse events after blood donation but also the mechanism to monitor the effectiveness of efforts to prevent the rare, but more medically serious, donation-related complications. Although zero risk may not be attainable even in adults, the rate of complications in minors calls for ongoing attention to a sustained operational effort that is continually focused on donation safety.

References

1. Trouern-Trend JJ, Cable RG, Badon SJ, et al. A case-controlled multicenter study of vasovagal reactions in blood donors: Influence of sex, age, donation status, weight, blood pressure, and pulse. *Transfusion* 1999;39:316-20.

2. Wiltbank T, Giordano G, Kamel H, et al. Faint and pre-faint reactions in whole-blood donors: An analysis of pre-donation measurements and their predictive value. *Transfusion* 2008 (in press).
3. Eder AF, Dy BA, Kennedy JA, et al. The American Red Cross Donor Hemovigilance Program, complications of donation reported in 2006. *Transfusion* 2008 (in press).
4. Newman BH. Blood donor complications after whole-blood donation. *Current Opin Hematol* 2004;11:321-2.
5. Newman BH, Satz SL, Janowicz NM, Siegfried BA. Donor reactions in high-school donors: The effects of sex, weight, and collection volume. *Transfusion* 2006;46:284-8.
6. Eder AF, Hillyer CD, Dy BA, et al. Adverse reactions to allogeneic whole blood donation by 16- and 17-year-olds. *JAMA* 2008;299:2279-86.
7. France CR, Rader A, Carlson B. Donors who react may not come back: Analysis of repeat donation as a function of phlebotomist ratings of vasovagal reactions. *Transfus Apher Sci* 2005;33:99-106.
8. Rader AW, France CR, Carlson B. Donor retention as a function of donor reactions to whole-blood and automated double red cell collections. *Transfusion* 2007;47:995-1001.
9. Custer B, Chinn A, Hirschler NV, et al. The consequences of temporary deferral on future whole blood donation. *Transfusion* 2007;47:1514-23.
10. France CR, Montalva R, France JL, Trost Z. Enhancing attitudes and intentions in prospective blood donors: Evaluation of a new donor recruitment brochure. *Transfusion* 2007;48:526-30.
11. Stewart KR, France CR, Rader AW, Stewart JC. Phlebotomist interpersonal skill predicts a reduction in reactions among volunteer blood donors. *Transfusion* 2006;46:1394-401.
12. Newman B, Tommolino E, Andreozzi C, et al. The effect of a 473-mL (16-oz) water drink on vasovagal donor reaction rates in high-school students. *Transfusion* 2007;47: 1524-33.
13. Kakaiya R, Burns S, Dausch D. Comparison of systemic reactions among blood donors with 450 mL and 500 mL whole blood donation (abstract). *Transfusion* 2005;45(Suppl):88A.
14. Bianco C, Robins JL. Whole blood collection volumes and donor safety: Equivalence between 450 mL and 500 mL collection sets (abstract). *Transfusion* 1994;34(Suppl):15S.
15. Tomasulo PA, Anderson AJ, Paluso MB, et al. A study of criteria for blood donor deferral. *Transfusion* 1980;20:511-18.
16. Bonk VA, France CR, Taylor BK. Distraction reduces self-reported physiological reactions to blood donation in novice donors with a blunting coping style. *Psychosom Med* 2001;63:447-52.
17. Hanson SA, France CR. Predonation water ingestion attenuates negative reactions to blood donation. *Transfusion* 2004;44:924-8.
18. Schroeder C, Bush VE, Norcliffe LJ, et al. Water drinking acutely improves orthostatic tolerance in healthy subjects. *Circulation* 2002;106:2806-11.
19. Lu CC, Diedrich A, Tung CS, et al. Water ingestion as prophylaxis against syncope. *Circulation* 2003;108:2660-5.
20. Claydon VE, Schroeder C, Norcliffe LJ, et al. Water drinking improves orthostatic tolerance in patients with posturally related syncope. *Clin Sci (Lond)* 2006;110:343-52.
21. Ditto B, Wilkins JA, France C R, et al. On-site training in applied muscle tension to reduce vasovagal reactions to blood donation. *J Behav Med* 2003;26:53-65.

22. Ditto B, France CR, Lavoie P, et al. Reducing reactions to blood donation with applied muscle tension: A randomized controlled trial. *Transfusion* 2003;43:1269-75.
23. Ditto B, France CR. The effects of applied tension on symptoms in French-speaking blood donors: A randomized trial. *Health Psychol* 2006;25:433-7.
24. Ditto B, France CR, Albert M, Byrne N. Dismantling applied tension: mechanisms of a treatment to reduce blood donation-related symptoms. *Transfusion* 2007;47:2217-22.
25. Kozak MJ, Montgomery GK. Multimodal behavioral treatment of recurrent injury-scene-elicited fainting (vasodepressor syncope). *Behav Psychother* 1981;9:316-21.
26. Ost LG, Fellenius J, Sterner U. Applied tension, exposure in vivo, and tension-only in the treatment of blood phobia. *Behav Res Ther* 1991;29:561-74.
27. Ost LG, Sterner U. Applied tension. A specific behavioral method for treatment of blood phobia. *Behav Res Ther* 1987;25:25-9.
28. Ost LG, Sterner U, Fellenius J. Applied tension, applied relaxation, and the combination in the treatment of blood phobia. *Behav Res Ther* 1989;27:109-21.
29. Peterson AL, Isler WC 3rd. Applied tension treatment of vasovagal syncope during pregnancy. *Mil Med* 2004;169:751-3.
30. Croci F, Brignole M, Menozzi C, et al. Efficacy and feasibility of isometric arm counter-pressure manoeuvres to abort impending vasovagal syncope during real life. *Europace* 2004;6:287-91.
31. Krediet CT, van Dijk N, Linzer M, et al. Management of vasovagal syncope: controlling or aborting faints by leg crossing and muscle tensing. *Circulation* 2002;106:1684-9.
32. Ten Harkel AD, van Lieshout JJ, Wieling W. Effects of leg muscle pumping and tensing on orthostatic arterial pressure: A study in normal subjects and patients with autonomic failure. *Clin Sci (Lond)* 1994;87:553-8.
33. van Dijk N, Quartieri F, Blanc JJ, et al. Effectiveness of physical counterpressure maneuvers in preventing vasovagal syncope: The Physical Counterpressure Manoeuvres Trial (PC-Trial). *J Am Coll Cardiol* 2006;48:1652-7.
34. van Lieshout JJ, ten Harkel AD, Wieling W. Physical manoeuvres for combating orthostatic dizziness in autonomic failure. *Lancet* 1992;339:897-8.
35. Brignole M, Croci F, Menozzi C, et al. Isometric arm counter-pressure maneuvers to abort impending vasovagal syncope. *J Am Coll Cardiol* 2002;40:2053-9.
36. Foulds J, Wiedmann K, Patterson J, Brooks N. The effects of muscle tension on cerebral circulation in blood-phobic and non-phobic subjects. *Behav Res Ther* 1990;28:481-6.
37. France CR, France JL, Patterson SM. Blood pressure and cerebral oxygenation responses to skeletal muscle tension: A comparison of two physical maneuvers to prevent vasovagal reactions. *Clin Physiol Funct Imaging* 2006;26:21-5.
38. Kim KH, Cho JG, Lee KO, et al. Usefulness of physical maneuvers for prevention of vasovagal syncope. *Circ J* 2005;69:1084-8.
39. van Dijk N, de Bruin IG, Gisolf J, et al. Hemodynamic effects of leg crossing and skeletal muscle tensing during free standing in patients with vasovagal syncope. *J Appl Physiol* 2005;98:584-90.
40. Eder AF, Dy BA, Kennedy J, Benjamin RJ. The relative safety of automated red cell procedures and allogeneic whole blood collection in young donors. *J Clin Apher* 2007;22:53.

41. Wiltbank TB, Giordano GF. The safety profile of automated collections: An analysis of more than 1 million collections. *Transfusion* 2007;47:1002-5.
42. Price TH, ed. Standards for blood banks and transfusion services. 25th ed. Bethesda, MD: AABB, 2008:20.