

Research Article

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Effectiveness of Behavioural Intervention as Treatment for the Vasovagal Response in Blood Donation

Abstract

Background: The experience of a vasovagal reaction during blood donation, with symptoms such as dizziness, weakness, and fainting, contributes to a more negative donation experience and significantly decreases the likelihood of blood donor return. This study investigates the effects of two behavioural interventions on reducing the occurrence of such reactions, applied muscle tension and respiration control, and possible moderation of these effects by sex, BMI, and medical fear.

Methods: Six hundred and eleven participants were recruited from Héma-Québec blood drives across Montreal and randomly assigned one of four conditions: applied muscle tension, an anti-hyperventilation respiration control procedure, both techniques, or neither. Following their donation, participants completed the Blood Donations Reactions Inventory and Medical Fears Survey. Analysis focuses on the respiration control and applied tension groups.

Results: While donor sex and BMI did not predict the effectiveness of applied muscle tension intervention, results showed that the largest benefit was seen in donors who reported lower levels of medical fears in the respiration control condition group.

Limitations/Conclusions: The results are promising in that they suggest that intervention can decrease the risk for vasovagal symptoms in blood donation, though it may not be sufficient to reduce symptoms in donors with high levels of medical fear.

Introduction

The need for a large and consistent blood supply is critical for the medical system to function effectively. Health care relies heavily on transfusions of whole blood and its components to complete many types of necessary medical interventions.(1) Maintenance of an adequate blood supply at all times can only be achieved through sufficient numbers of voluntary donations from healthy individuals. Even though about 60% of the population of North America is eligible to donate blood, an analysis revealed that only five percent of the population donates frequently.(2) Increasingly rigid criteria for donation also limits the pool of potential donors. In 1988, a total of 13 exclusion criteria left 64% of the U.S. population eligible to donate blood.(3) This Fig. dropped to approximately 38% in 2007, when the total number of exclusion criteria reached 31.(4) Clearly, given the demands of our aging population, the limited pool of donors who meet criteria, and the limited number of potential donors who choose to donate, the pressure to increase blood donation is evident. A greater emphasis needs to be placed on recruiting new donors, as well as encouraging repeat donation, in order to maintain adequate blood reserves. One of the biggest obstacles to blood donor retention is the experience of vasovagal symptoms such as fainting, dizziness, weakness and nausea.

Mechanisms of vasovagal syncope

Research suggests that vasovagal symptoms may occur in response to an exaggerated stress reaction.(5) Following the experience of an anxiety-inducing stimulus such as blood donation, the sympathetic nervous system is activated, which increases heart rate and blood pressure. However, in periods of prolonged and intense anxiety, the body cannot maintain this level of arousal. As a result, the parasympathetic nervous system is triggered, leading to a rapid decrease in heart rate and blood pressure, which can be exaggerated at times. There are other possible mechanisms of the vasovagal response, but this a common explanation.(6) This sharp change in blood pressure and heart rate can result in loss of consciousness, weakness, and lightheadedness. Studies have shown that adverse reactions such as these make blood donors less willing to donate again in the future.(7,8)

Treatment

Methods of preventing these reactions may increase donor retention. The applied muscle tension (AT) technique has been shown to reduce vasovagal reactions in many studies.(9) This technique was originally developed as a behaviour therapy intervention to treat blood and injury phobias, but it quickly became apparent that muscle-tensing techniques could be useful for non-phobics as well, as in the case of blood donors.(9) The AT technique consists of repeated five second cycles of isometric muscle tension of the major muscle groups in the arms and legs.(10) It is presumed that this technique reduces vasovagal symptoms by increasing blood pressure and cerebral blood flow.(11)

It is hypothesized that the effects of the AT technique may be mediated in part by encouraging regular breathing. When people learn AT, they are usually told to maintain regular breathing patterns during muscle tension. Among other possible mechanisms, it has been suggested that vasovagal reactions may be exacerbated by hyperventilation that can be induced by stressful or anxiety-producing situations. Hyperventilation decreases the amount of carbon dioxide in the blood and if these levels become low enough, the body can enter a state of hypocapnia, which causes the blood vessels in the brain to constrict.(12) This vasoconstriction may cause a decrease in cerebral blood flow, reducing the amount of oxygen delivered to the brain. Thus, respiration control techniques have been developed to reduce the occurrence of hypocapnia episodes, and increase cerebral blood flow.(13) Although the effects of such techniques have not been studied in blood donors, they have been implemented in patients with blood-injection phobia. A recent study by Ritz suggested that a shallow breathing technique to prevent hyperventilation was as effective as an AT technique in reducing vasovagal symptoms in a sample of blood-injection phobics. (13) We intend to investigate the efficacy of both of these treatments in the context of blood donation.

While previous studies have shown that applied muscular tension and respiration control techniques can be effective at reducing symptoms of dizziness, weakness and fainting, various traits have been shown to affect the likelihood of experiencing an adverse reaction, as well as influence a patient's response to treatment.(9,13)

Donor Sex

In general, women are more likely than men to report symptoms during blood donation.(14) Additionally, in a study by Kamel, it was shown that delayed reactions are three times more likely to occur in females than males.(15) Thus, female sex seems to be a risk factor for vasovagal reactions during blood donation. This association might be explained in part by the fact that women tend to have a lower body mass than men, and a lower body mass is usually associated with a lower estimated blood volume (EBV). By calculating EBV using self-reported weight, height and sex, studies have shown that donors with lower EBV's have an increased risk of vasovagal reactions.(15) Because all donors are required to donate the same amount of blood, this might lead to increased vasovagal reactions in female participants. In line with this reasoning, Ditto found that AT significantly reduced symptoms in women but not men.(11)

Body Mass Index (BMI)

Newman found that low weight (<130 pounds) was associated with a vasovagal reaction rate of 13.6%, compared to 3.3% in higher weight donors.(16) Similar to EBV, BMI can be calculated using self-reported measures of weight, height and sex of blood donors. While national health recommendations indicate that BMI's of 18.5-24.9 are within the healthy range, blood donors with a BMI < 25 have been shown to be at greater risk for experiencing vasovagal reactions.(17) Low BMI is associated with low blood pressure, which in turn is related to susceptibility to vasovagal reactions. Blood donation causes blood pressure levels to drop; individuals who have low blood pressure at baseline might be more at risk to experience symptoms of dizziness, weakness, or fainting following donation. Given that applied muscle tension has the capacity to maintain blood pressure levels, this technique might be especially useful in donors with lower BMI's. Because of this, we will investigate whether BMI moderates the effects of applied muscle tension.

Medical Fears

In addition to biological risk factors for vasovagal reaction, donors' levels of fear may influence their likelihood of experiencing a vasovagal reaction. In fact, fear of injection and blood has been shown to be the strongest predictor of vasovagal symptoms in women, while the same was true for men who were first time donors.(18) As previously discussed, an anti-hyperventilation respiration control technique has been shown to be effective in reducing vasovagal symptoms in a sample of blood-injection phobics. Such a technique might be predicted to work better with high fear donors, if it successfully controlled respiration rates. Further, research concerning the efficacy of similar treatment in a sample of blood donors might be valuable in terms of targeting treatment interventions to higher risk groups, in order to reduce the probability of experiencing a reaction, thus increasing the likelihood of repeat donation.

The Current Study

This study was part of a randomized control trial investigating the effectiveness of three interventions in reducing the occurrence of vasovagal reactions during blood donation; applied muscular tension, respiration control, and a combined technique. Analyses will focus on results from the applied muscle tension and respiration control groups. It was hypothesized that applied muscle tension and respiration control would be effective at controlling vasovagal symptoms and reducing the need for treatment. Further, effects of applied muscle tension would be moderated by sex and BMI, whereas respiration control would be moderated by preexisting levels of medical fears.

Methods

Participants

Participants were recruited from mobile Héma-Québec blood drives at various universities and CEGEPs (collège d'enseignement général et professionnel; students aged 18 to 20 years) across Montreal, Québec. A total of 611 donors (321 female and 281 male) between the ages of 18 and 35 were recruited (Mean = 21.7, Standard Deviation = 3.3 years). Participants were assigned randomly to one of four treatment conditions; an applied tension only group (151 donors), a respiration control only group (153 donors), an applied tension and respiration control group (153 donors), and a control group (154 donors).

Procedure

After obtaining informed consent, participants completed a predonation questionnaire requesting demographic information and mood ratings. They were then randomly assigned one of four conditions. Based on the condition they were assigned, participants were given padded earphones to watch an instructional video. Each video demonstrated the technique that participants were asked to practice before and during blood donation. The videos were available in both English and French, narrated by the same bilingual narrator. The first video corresponded to the Applied Muscle Tension condition, during which participants were shown a muscle tensing technique. In the Respiration Control condition, participants were shown a shallow, anti-hyperventilation breathing technique. The third intervention was a combination of the Applied Muscle Tension technique and the Respiration Control technique. Participants in the Control condition did not watch an instructional video, but proceeded to the next set of measurements. After the video, a research assistant measured each participants' blood pressure and heart rate. Next, a portable capnometer (Micrograph Plus, Oridion Capnography, Minneapolis, MN) was attached to each participant to measure end-tidal CO₂, an index of hyperventilation, throughout the procedure. Participants then continued with the standard donation process.

A research assistant was present in the donation area to observe the behaviour of the participants, and to verify that they practiced the assigned technique(s) during the donation process. The research assistant completed an assessment form, indicating whether a vasovagal reaction occurred, whether the reaction required treatment, and any other irregularities witnessed throughout the procedure. When the donation was complete, participants were asked to wait in a rest area for five minutes. Following this rest period, the capnometer was removed, and participants proceeded towards a post donation snack area, where they were asked to complete a post donation questionnaire. This questionnaire included the Blood Donations Reactions Inventory (BDRI) to evaluate participants' experience of vasovagal symptoms, assessed the participants' likelihood of donating again, asked the degree to which the participant practiced their assigned technique (all the time or occasionally before, during or after donation), and included the Medical Fears Survey.(18,19) Finally, a research assistant obtained post donation measures of blood pressure and heart rate.

Experimental Conditions

Applied Muscle Tension

The Applied Muscle Tension video demonstrated a whole body, isometric muscle tension technique. Participants were asked to engage in repeated cycles of tension for five seconds, followed by five seconds of rest. They were told to emphasize leg muscle tension by pointing their toes downwards and flexing their thigh muscles. Participants were reminded to breathe normally throughout their donation.

Respiration Control

Individuals in this condition were shown an anti-hyperventilation breathing technique, modeled by the narrator of the video. Participants were asked to engage in slow, shallow breathing with their mouths closed. They were also instructed to use abdominal breathing, rather than chest breathing. This technique was emphasized by asking the participants to place one hand over their chest, and the other over their abdomen, allowing them to

observe the movement of their diaphragm while breathing.

Combined Technique

In this video, the Applied Muscle Tension technique was explained first, followed by the Respiration Control technique. Participants were asked to practice both techniques during their donation.

Measures

Blood Pressure and Heart Rate

Pre and post donation measures of blood pressure and heart rate were obtained using manual blood pressure monitors (Model A10, Becton Dickinson, Franklin Lakes, NJ).

Capnometer

Participants were asked to wear a portable capnometer (Micrograph Plus, Oridion Capnography, Minneapolis, MN) throughout the study in order to obtain end-tidal CO_2 measurements. Capnometer data was not analyzed for the purposes of the current study.

BDRI

The Blood Donation Reactions Inventory (BDRI) is a well-validated, 11-item scale that allows participants to self-report the experience of vasovagal symptoms during donation on a 6-point scale. A shortened four-item version of the BDRI has shown to be useful in assessing the subjective perception of pre-faint symptoms; therefore, this version was used for statistical analysis.⁽¹⁹⁾ This version relies on the results from items 1, 2, 3, and 7, looking at participant self-report of faintness, dizziness, weakness, and lightheadedness, respectively.

Medical Fears Survey

This self-reported survey contains 25 items. In various ways, participants were asked to indicate the level of fear or tension they would likely experience when exposed to different medical situations, such as having blood drawn from the arm.⁽²⁰⁾

Results

A total of 521/611 individuals completed their blood donations and had data entered in the analyses. Participants who did not meet the eligibility requirements issued by Héma-Québec were not able to complete their blood donation, and therefore had to be excluded from the study.

Donor Sex

An analysis of variance revealed that women were significantly more likely to report symptoms on the BDRI than men, $F(1,585)=13.928$, $p=0.000$, however, women were not more likely to require treatment during donation than men. Results indicated that the effects of AT were not moderated by sex. A Pearson correlation matrix indicated that donor sex and scores on the Medical Fears Survey were moderately negatively correlated, such that men were slightly less likely to report medical fears, $r(581)=-0.354$, $p=0.000$.

BMI

Donors' BMI was calculated using self-reported weight, height, gender and published formulas. An analysis of variance revealed that donors with low BMI were significantly more likely to report symptoms on the BDRI, $F(1,591)=10.229$, $p=0.001$, although they were not more likely to require treatment by a nurse. Further, the effects of AT were not moderated by BMI.

Medical Fears

For this measure, the primary analyses were 2 Respiration Control (yes/no) x 2 Applied Tension (yes/no) x Total Medical Fears Score (treated as

a continuous variable) general linear models (GLMs). The primary dependent variables were BDRI score and whether or not the donor was treated by the nurse for a vasovagal reaction as indicated by the research assistant. Both analyses produced strong main effects of Medical Fears, $F(1,490)=39.90$, $p<0.001$ and $F(1,484)=14.50$, $p<0.001$, respectively. In general, donors who reported greater fears in medical environments were much more likely to indicate symptoms of dizziness, weakness, lightheadedness and faintness on the BDRI (Fig. 1) and more likely to receive treatment for a vasovagal reaction (Fig. 2).

Figure 1: BDRI Score Outcomes by Medical Fear

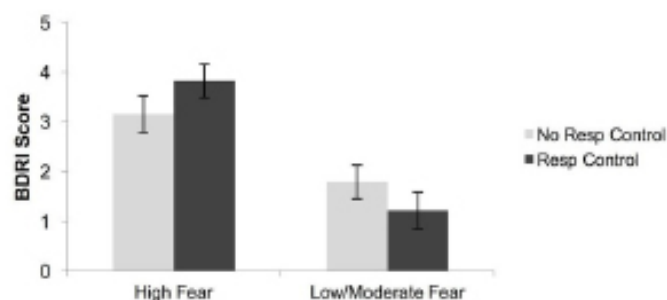


Fig. 1. Donors reporting greater fears in medical environments were more likely to indicate symptoms of dizziness, weakness, lightheadedness and faintness on the BDRI than donors reporting lesser fears.

Figure 2: Treatment for Vasovagal Reactions by Medical Fear

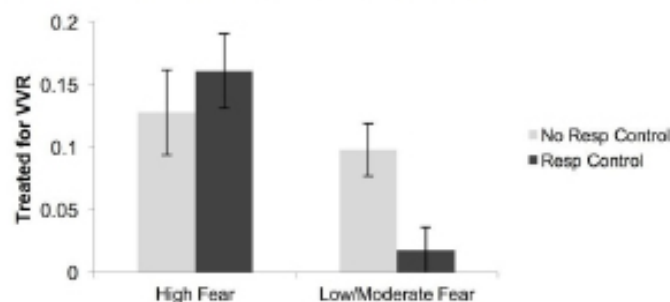


Fig. 2. Donors reporting greater fears in medical environment were more likely to receive treatment for vasovagal reactions than donors reporting lesser fears.

The effects of medical fears were influenced to some degree by the respiration control intervention as indicated by significant 2-way Medical Fears x Respiration Control interactions in both analyses, $F(1,490)=9.36$, $p=0.002$ and $F(1,484)=11.30$, $p=0.001$, respectively. There were no significant effects involving applied tension in the analyses, and this intervention will not be discussed further.

As can be seen in Fig. 1, the BDRI interaction was due to a combination of somewhat fewer (but not significantly fewer) symptoms in lower fear participants who practiced respiration control and somewhat more (but not significantly more) symptoms in higher fear participants who practiced respiration control.

As can be seen in Fig. 2, while the same non-significant trend was observed among high fear donors in regards to whether or not they required treatment for a vasovagal reaction, the benefit of practicing respiration control was much stronger among donors who were somewhat less fearful. In fact, after dividing participants based on the median medical fear score, less fearful donors who practiced respiration control were significantly less likely to require treatment for a vasovagal reaction compared to those who did not practice the technique, $F(1,244)=7.15$, $p=0.008$.

Discussion

The primary goal of this study was to investigate the effectiveness of the two chosen behavioural interventions as possible treatments for vasovagal reactions during blood donation. It was hypothesized that findings from previous studies would be replicated, indicating that females would be more likely to experience vasovagal symptoms than males. Expectations were that donor sex and BMI would moderate the effectiveness of applied muscle tension, while medical fears would moderate the effectiveness of respiration control.

Results were consistent with findings from previous studies, indicating that being female would present as a risk factor for the occurrence of a vasovagal reaction.⁽¹⁴⁾ While female donors reported higher scores on the BDRI, they were not significantly more likely to be treated than men. This might be because while women were more likely to experience symptoms in the clinic than men, this difference was not pronounced enough for women to require more treatment. Alternatively, women may simply be more likely to report symptoms retrospectively, whereas men may be less likely to report them. Thus, a bias in self-report of symptoms could influence results on the BDRI. These factors may also explain why the effects of AT were not moderated by sex. If, in absence of treatment conditions, men and women do not differ in likelihood to require treatment during blood donation, then applied tension is unlikely to benefit one sex more than the other in terms of reducing the occurrence of symptoms.

Further, donors with low BMI reported experiencing more symptoms on the BDRI questionnaire than high BMI donors. BMI did not influence the likelihood to require treatment, nor did it moderate the effects of AT.

Another aim of this study was to investigate the benefits of implementing an anti-hyperventilation respiration control technique to reduce vasovagal reactions in blood donation. As demonstrated by results on the BDRI as well as observational measures made by a research assistant during donation, it was expected that vasovagal reactions would be more likely to be experienced by donors with higher levels of medical fears. The effects of the respiration control technique were hypothesized to be particularly helpful for this group of donors because they would be the most likely to hyperventilate.

Results support the hypothesis that levels of medical fears influenced the occurrence of vasovagal reactions. Donors who reported high levels of fear in medical situations were significantly more likely to report experiencing vasovagal symptoms during blood donation. These donors were also significantly more likely to be treated for a reaction during their donation.

Results failed to support the hypothesis that the benefits of respiration control would be highest amongst donors with high levels of medical fear. Instead, outcomes of the BDRI indicate that amongst donors in the respiration control treatment group, lower fear participants reported slightly fewer vasovagal symptoms, whereas higher fear participants reported slightly more symptoms. It is possible that presenting this intervention to high fear donors heightened their fears by drawing attention to the possibility of an adverse reaction. Alternatively, perhaps they found the task too complicated, which reduced the positive effects of the treatment. Similarly, participants with lower fear levels were less likely to require treatment for a vasovagal reaction if they were in the respiration control group. These results suggest that recommendations to practice the anti-hyperventilation breathing technique should be aimed at donors who initially report low levels of fear or tension with regards to medical situations.

The correlation between donor sex and Medical Fears Survey scores was calculated to investigate whether medical fears in the respiration control group were influenced by donor sex. Males were slightly less likely to report medical fears. While this was a subjective measure, given that analysis revealed only moderate correlations, future studies should look into this further.

A few limitations exist with regards to the research and analysis of this study. Firstly, while the sample size was large, it was mostly comprised of students due to convenience sampling. Participants were recruited from

mobile Héma-Québec blood drives at CEGEPs and universities across Montreal, making student participation predominant. This limits the capacity to generalize our findings to older donor populations.

The strict eligibility criteria of Héma-Québec resulted in 90 participants being deferred from blood donation, making them unable to complete the study and be included in analysis. This reduction in sample size may have prevented strong correlations from being seen in the data.

A further limitation of this study was that both the Medical Fears Survey and the BDRI questionnaire were completed post-donation. As such, donors' self-report of medical fears might have been influenced by their experience during blood donation. Being exposed to some of the aspects discussed in the survey during the course of the donation, such as needles and blood, may have temporarily heightened individuals' levels of fear. Filling out the surveys after the experience of a vasovagal reaction may have also made participants more likely to report higher levels of medical fears. Subsequent research should investigate whether the administration of the Medical Fear Survey prior to donation influences results, although exposing donors to the information on this survey might end up priming fear or anxiety by suggestion. An interesting alternative would be to administer the survey both prior to and following donation, to compare scores and see whether they remain consistent.

Similarly, the BDRI requires participants to report symptoms such as dizziness, weakness, and faintness on a 6-point scale. The completion of this survey after the donation process may have caused participants to be less accurate in reporting the extent to which they experienced symptoms. While results might be more accurate if the BDRI could be completed in real time, this is highly unrealistic given the complexity of the donation process in the clinic. Participants would most likely not be able to complete the survey on their own, and if a research assistant asked the donor direct questions for an extended period of time, it may interfere with the work of the nurses and other clinic personnel.

Conclusion

This study was part of a randomized control trial investigating the effectiveness of three interventions – applied muscular tension, respiration control, and a combined technique – as treatment for the vasovagal response in blood donation. The goals were to assess the effectiveness of applied muscular tension and respiration control on reducing vasovagal reactions and treatment likelihood, as well as to investigate the moderating effects of donor sex and BMI on applied muscle tension and the effect of medical fears on respiration control. While donor sex and BMI did not moderate the effects of AT, there was a significant interaction between medical fears and respiration control. It seems as though respiration control might be most useful in reducing vasovagal symptoms of donors with low medical fears. Given these findings, blood collection agencies might suggest that donors self-reporting low medical fears practice the respiration control technique during the donation process in order to reduce the likelihood of experiencing a reaction. In doing so, this intervention has the potential to increase the occurrence of repeat donation, and contribute to the maintenance of adequate blood reserves for our health care system.

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