PREDICTING THE BLOOD DONOR POPULATION DURING A NATURAL DISASTER EVENT

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DEDICATION

For my husband, John N. Winn, PhD, who was the “wind below my wings” throughout this challenging and exciting journey. His never-ending patience, encouragement, and love provided the counter-balance to the hurdles and roadblocks in my path.

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ABSTRACT

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As natural disasters increase in frequency and intensity, maintaining a safe blood supply with acceptable volunteer donors has become a global health issue. Blood shortages are more dramatic during emergency events, directly affecting patient care since these blood units are needed to sustain life. Yet the donor statistics suggest a steady decrease in first-time and career donors. This study investigates whether donors responding to a natural disaster are more inclined to become career donors as compared to non-emergency first-time donors and if so what donor characteristics are predictive of returning donors. The questionnaire data of 4,388 participants were analyzed with cross-tabulation using Pearson's chi-square suggesting that first-time donors' (N = 2041) were less inclined to return as career donors when they first donated during an emergency event (15.4% returned) as compared to donors that donated during non-emergency timeframe (21.6% returned). An independent t-test analysis found that the returning donors were more inclined to have a lower mean age (M = 28.16) and a lower weight (M = 170.2) than donors less inclined to return (M = 33.77 and M =177.4, respectfully). In addition, 69.9% of all females returning to donate did not have a pregnancy history. Identifying the characteristics of potential donors during emergency events can be used

by blood centers (BCs) to recruit and design marketing strategies to improve the donors' response rate during natural disaster blood shortages. The logistic regression analysis was performed and established that the donors responding during the emergency tended to be younger and have a wider variation of blood pressure readings. Meanwhile, BCs should expect fewer of the first-time donors inspired to donate by social motivation, improved attitude and perceived behavioral control during the natural emergency to return to donate. After the emergency the first-time donors, their social inertia returns as the sense of urgency and priorities return to pre-emergency state.

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CHAPTER I

INTRODUCTION

As natural disasters increase in frequency and intensity, maintaining a safe blood supply with acceptable volunteer donors has become a global health issue (World Health Organization [WHO], 2018). The number of individuals who donate blood has decreased at a time when healthcare treatments requiring blood to sustain life have increased (Chung et al., 2016; Rajbhandary, Stubbs, Land, & Whitaker, 2016). There is an immediate public health need to identify additional volunteer blood donors to maintain a safe supply of blood units, especially for emergencies (Chung et al., 2016; Rajbhandary et al., 2016). Public alerts are released, advising the healthcare institutions to cancel elective procedures to reserve the blood units for trauma and emergency transfusions. Studies of how community engagement/external factors influence the intention to donate can help BCs develop targeted health education strategies to increase the donor response rate during ordinary times, as well as during emergency events. The blood supply is immediately impacted by severe weather events, as residents may be unable to travel to donate blood. When a weather or community emergency event occurs, the behavior of the blood donor populations is difficult to predict and results in blood shortages. Additionally, in compliance with the WHO recommendations to prevent the spread of infectious agents, an increasing number of potential donors are deferred based on recent travel to existing or emerging endemic areas (WHO, 2019; Wilson, 2010).

Supply

In the early 1990s, the United States purchased over 30 percent of the nation's blood from Europe, until beef from the United Kingdom farmlands was identified as the source of an outbreak of Creutzfeldt-Jakob disease (also known as Mad Cow disease or vCJD) (Centers for Disease Control and Prevention [CDC], 2018). Since this disease can be transmitted through beef or blood, the U.S. withdrew from the European blood markets, thus introducing a severe blood shortage (WHO, 2019). In response to this shortage, many states initiated new legislation in the 1990s allowing blood drives to be conducted at high schools (FDA, 2017; State of Texas, 2015). Recruitment of adolescent donors was adopted by all 50 states, as it proved to be an effective strategy for meeting the demand for a safe supply of blood.

As a consequence of the European vCJD outbreak, the local supply of blood was subjected to a higher level of infectious disease testing to mitigate the possibility of an infected donor transmitting a virulent pathogen to a recipient. As policy, the Food and Drug Administration (FDA), which provides oversight of blood donations, mandates deferring donors who have recently visited endemic or epidemic areas for certain infectious diseases (e.g., Zika, Ebola, and Malaria) (FDA, 2018a). Some of the deferrals are permanent as in the case of vCJD exposures, since there are no tests to confirm its transmission status. This increased regulation has diminished the blood donor pool, especially among travelers (FDA, 2018b).

Demand

In response to a decreasing supply of blood units, the healthcare facilities have developed blood management programs (BMP), to more effectively use the available blood supply (Ellingson et al., 2017; Kim et al., 2013). The BMPs educate healthcare providers on improved patient mortality and morbidity outcomes related to lower transfusion rates. Many programs require symptomatic indications for transfusions in addition to hemoglobin ranges (Darbandi et al., 2017). Healthcare facilities are asked to use new bloodless technologies and treatments to sustain life and improve health outcomes. Innovative strategies such as robots and laparoscopic surgeries are used to reduce the demand for blood in the hospitals, but the number of individuals diagnosed with cancer or blood dysplasia continues to increase as the population's mean age increases (Kim et al., 2013; Oliver et al., 2014). Since these diagnoses depend on volunteer blood units, the supply must increase to sustain their lives.

While some patients can defer their elective surgeries or treatments during blood shortages, hospitals will continue to need blood for emergencies such as trauma, burns, sickle cell patients, neonates, chemotherapy patients, and other diagnoses. In addition, unexpected events such as weather events or disasters challenge the healthcare organizations to maintain the safe level of units expeditiously for emergencies.

Interruption of Supply Chain

Severe weather events can compromise the nation's blood supply, putting patients at risk of not having the life-saving blood they need to survive. In January 2017, during a severe weather event, the American Red Cross (ARC) issued an emergency call for blood

donations to distribute blood to 2,600 hospitals nationwide for burn and accident victims, organ transplants, and treatments for sickle cell disease, cancer, and leukemia. During this emergency, surgeries and procedures were canceled due to the low blood units in inventory (ARC, 2017b). Identification and recruitment of donors during these emergencies can help provide the required blood supply since blood cannot be manufactured.

Need for Repeat (Career) Donors

Rajbhandary et al. (2016) report, in 2014, nearly 60% of all the nation's blood donations were made by donors over the age of 40 years; 84.3% of those donations were from repeat (career) donors, while only 15.7% were from first-time donors (FTDs). As these older career donors grow older and their incidence of health issues increase, there is an escalating public need to convert younger FTDs to career donors to maintain the needed blood supply. BCs aggressively recruit first-time blood donations at high schools to meet the blood supply necessary for medical treatments and traumatic events (Chung et al., 2016; Rajbhandary et al., 2016). Recruiters are challenged to identify motivations and barriers to recruit FTDs and encourage them to become career donors (Charbonneau, Cloutier, & Carrier, 2016). Since 50% of all FTDs will not return to donate, it is imperative to recruit a high number of donors, especially during community emergencies, and develop strategies to convert FTDs to career donors (Ringwald et al., 2010).

Statement of Purpose

The primary purpose of this study was to determine the descriptive variables/characteristics of blood donors who respond to a public health emergency

(severe weather). An additional purpose was to predict which FTDs during this emergency transitioned to career donors as compared to a non-emergency time period. The results of this study were used to make recommendations for health education efforts the BCs can use to improve the conversion rate of donors. The study results will also assist the BCs to better plan for blood inventory, to better manage blood supply, and to identify the donors most likely to respond in an emergency and focus educational materials on this population.

Theoretical Foundation

Blood donor's intention to donate blood is based on motivational factors and perceived barriers, which are the principal determinants of the theory of integrated behavioral model (IBM) (Montaño & Kasprzyk, 2015; see Appendix A). "Intention" is defined by Gibbons (2008, p.1) as "the amount of effort one is willing to exert to attain a goal" and is the best predictor of behavioral change. Both the theory of reasoned action (TRA) and the theory of planned behavior (TPB) constructs are used to focus on motivational factors and barriers impacting the individual's likelihood to perform a specific behavior, like donate blood (Conner, Godin, Sheeran & Germain, 2013; Masser et al., 2012; Wevers, Wigboldus, van Baaren, & Veldhuizen, 2014). The TRA/TPB models suggest the intention to perform the behavior is influenced by three dimensions of behavior: attitude, perceived norm, and personal agency (Montaño & Kasprzyk, 2015; see Appendix A). With the addition of self-efficacy from other models, the TRA/TPB expands into the IBM (Montaño & Kasprzyk, 2015).

The donor's willingness to engage in the desired behavior (i.e., donate blood) is based on intention, which is also a reflection of attitudes toward donating blood, cultural/community norms regarding donating blood, and perceived self-efficacy to donate blood (Chou & Murnighan, 2013). The donor's established attitudes about donating blood and expected outcome of donating directly affect their intentions to donate. The perceived norm or subjective norm refers to the donor's perception of whether people important to them expect them to donate, which may include friends, supervisors, and colleagues at work (Montaño & Kasprzyk, 2015). The descriptive norm refers to whether these friends, family, and colleagues are also willing to donate blood themselves, therefore influencing the donor's decision to donate. The construct of personal agency reflects the donor's confidence/self-efficacy and the perceived control of factors making it easy or difficult to donate blood. The donor is affected by both internal factors (e.g., eligibility) and external factors/resources needed to make it possible to donate blood (e.g., facilitating conditions such as transportation, time, location, etc.). Therefore, the intention of the individual may be mediated by factors outside his control (Montaño & Kasprzyk, 2015).

During severe hurricane winds and major flooding in a metropolitan area, thousands of individuals were subjected to higher risks and health hazards requiring community support to survive and re-build their homes. Thousands of altruistic volunteers assisted in multiple ways to alleviate the suffering and help achieve better outcomes for the survivors. Consistent with the subjective norm, news spread about the efforts of some to motivate fellow residents to reach out and volunteer (CBS News,

2017). Boat owners searched for the survivors and others fed the survivors in soup kitchens. Neighborhoods (social circles) formed networks of support, thus increasing the "intention" of more people to volunteer. Public broadcasts announced blood shortages were severe, and volunteers were influenced by both the subjective and descriptive norms of the community's response to willingly donate their time and resources to help others in need. Volunteers overcame their perceived barriers to donate blood and were inspired to commit the time and donate their blood to answer the public healthcare need of the community. The disaster recovery efforts may have increased the altruistic attitudes of individuals (potential donors), thus increasing their inclination/ self-efficacy to donate blood. According to Montaño and Kasprzyk (2015), effective constructs increasing the intention to donate can be used in communication tools to educate the public in both emergency events and non-emergency events to improve the response for first-time donations. Although these donors responded to the call for blood in an emergency, will they overcome their perceived barriers to become career donors?

Hypotheses

Primary Hypothesis

There is no significant difference in donor rate conversions to career donors among the donors who responded to an emergency call-for-blood as compared to non-emergency time frames.

Secondary Hypothesis

There is no significant difference in the descriptive variables between the career donors and emergency only donors.

Tertiary Hypothesis

Conversion of first-time donors to career donors: There are no significant predictive factors to determine if a donor will return to donate again.

Delimitations

The delimitations for this study were as follows:

1. This study analyzed secondary data on a sample of blood donors from three specific time periods (August 20 – September 23, 2016; August 20 – September 23, 2017; September 1, 2017 – August 23, 2018 [to include the follow-up time period]).
2. The sample was comprised of adults, aged 18 and over, who were eligible to donate.

Limitations

The limitations for this study were as follows:

1. The sample included adult eligible donors in the Houston, TX, metropolitan area. Individuals who did not donate were not captured in the data.
2. FTDs may have donated at another BC and were not captured in the data.
3. This study evaluated blood donor characteristics for a specific emergency weather event; thus, the results are not representative of donor characteristics for all emergency events.

Assumptions

The assumptions for this study were as follows:

1. Participants were honest in reporting demographics, health information, and contacts.
2. Participants understood and read English well enough to answer the questions.

3. Participants had good recall of their health history.

Importance of the Study

Essentially, the overarching questions were the following: During emergencies, which age groups are more inclined to donate blood when they have not donated before? Which of the first-time donors are more inclined to return to donate blood and which actually return? Do any health parameters correlate with donating or not donating again? Will some age groups or genders be more likely to respond during emergency events as compared to other groups?

If predictions can be made, targeted health education efforts can be directed at these groups routinely and especially during emergency events. Marketing strategies aimed at these groups would be more effective at recruiting donors for emergency situations. While multiple survey responses capture the failure of individuals to donate blood due to fear of needles and inconvenience, Livitz, Fox, Himawan, and France (2017) claimed, providing health education to individuals on the value of donating for the health of others enhances the donors' intention and intrinsic motivation among both career donors and non-donors alike. Conner et al. (2013) suggested, donors' fears and reservations are overcome when altruistic attitudes increase and they are subjected to social pressure to help others in need.

Studying who and why volunteers donate during emergencies allows the BCs to better predict the volunteer response during disaster events. As a result, the healthcare institutions can better plan and manage their blood needs, throughout the emergency event.

Although managing the blood supply during emergencies is critical, conversion of emergency responders to career donors is important to the future blood supply needed by the healthcare institutions. Blood is required to sustain life, only humans can produce it; yet, the number of repeat donors is decreasing as the healthcare need for blood units is increasing. Blood components are not only used in trauma (e.g. car accidents, gunshot injuries) and surgery cases, but also in transplants, chemotherapies, sickle-cell treatment, pediatrics (premature babies), and treatment for burn patients (Carson et al., 2012; Chou, 2013; Curinga et al., 2011). The loss of blood and the inability to produce blood during acute health situations prevent the patient from having the time required to self-generate sufficient blood using bone marrow stores/resources (Kim et al., 2013).

The systematic review by Bednall, Bove, Cheethan, and Murray (2013) suggests blood donor behavior and intention to donate is influenced by multiple factors, some of which are more prominent during the emergency events. Some are internal factors, such as fear of needles and pain is individually determined, and others are external factors outside the donor's control, such as transportation. In order for BCs to recruit the volunteers to donate, they must use educational materials and other marketing strategies to address these multiple factors, especially during emergency events.

Schmidt (2002) claimed, during the World Trade Center emergency event over 500,000 volunteer donors were asking to donate. He claimed, Schmidt (2002) the donors were driven by a social need to be part of a community and found comfort in being with friends, neighbors, and others interested in helping. Based on a previous study, Schmidt conjectured 40% of the donors would return to donate again after an emergency.

Although BCs are challenged to recruit donors to provide sufficient blood products to meet daily patients' needs, it is especially during emergencies when blood shortages can become life threatening. If health education and marketing strategies can be used to improve the donor rates among specific groups of individuals, it would mitigate the shortages experienced during emergencies. The ability of healthcare institutions to predict the response of donors during emergencies allow them to better manage the existing blood supply through their BMPs and to reserve blood for life-threatening disasters.

Did the 2017 emergency event drive a stronger intention to respond to the need for blood donations among some community groups? Can the BCs capitalize by predicting these groups and targeting public health education efforts to increase awareness of the need for blood to more effectively recruit donors during blood shortages? This study is intended to shed light on the groups of individuals more inclined to respond initially and identify those more inclined to become career donors.

CHAPTER II

REVIEW OF LITERATURE

Most people assume blood components will be available should an emergency or health need arise, yet the number of blood donors providing these lifesaving products continues to decline (Chung et al., 2016; Rajbhandary, Stubbs, & Whitaker, 2016). Chung et al. (2016) state the buffer between the number of units collected (C) and the expected number of units needed (U) by patients for health treatments annually continues to narrow (C minus U = less available for emergencies). Therefore, the supply of blood is decreasing in relationship to the increasing demand for blood, thus reducing the number of blood units available for emergencies (Oliver, Griffin, Hannon, & Marques, 2014; Rajbhandary, Whitaker, & Perez, 2018; Sullivan, Cotton, Read, & Wallace, 2007) (see Appendix B for Graph for Collection and Utilization). According to the ARC (2018a), more than 21 million components are transfused each year, which is more than 40,000 units transfused daily (Rajbhandary et al., 2018). Someone in the United States requires blood every 2 seconds and one in seven people admitted to hospitals will need blood during their treatment. Although an accident victim requires up to 100 units of blood to survive (America's Blood Centers [ABC], 2018), patients undergoing chemotherapy treatments, surgical procedures, and transfusions for inherited blood disorders require the most blood to sustain life (Price et al., 2006). All blood units in the transfusion service must be screened and available when needed for the patients; therefore, these units must

be drawn previously from donors, tested, and made available on site for emergency and blood-dependent patients (ABC, 2018; FDA, 2018a; Schmidt, 2002).

In the US, all of the blood units must meet or exceed the safety standards established by the WHO (WHO, 2018) and the FDA (FDA, 2018a). These two agencies sanction only volunteer donors, not remunerated donors, be drawn for blood components to insure the highest level of safety to the recipients (Alfieri, 2017; Dhingra, 2013; FDA, 2018a; Kreuter & Gandhi, 2013; Spence & Iqbal, 2016; WHO, 2018). Both agencies state economic incentives for blood donations are "detrimental to the quantity and safety of the blood supply" (Lacetera, Macis, & Slonim, 2013, p. 928). As required by these agencies, each donor completes a donor health questionnaire and the blood is tested to identify viral infections and other relevant infections before the units are released for transfusion (Eder et al., 2009; FDA, 2018b; MDACC, 2017;Vahidnia et al., 2017; WHO, 2018) (see Appendix C for Donor Questionnaire). Travel to areas known to be endemic for notable infectious diseases, as well as to locations of emerging infectious diseases, threaten the donor pools by increasing the number of ineligible donors (Alter, Stramer, & Dodd, 2007). The current donor screening by multi-pathogen microarray technology reduces the transfusion risk to near-zero for known pathogens. Emerging and evolving pathogens such as Zika virus, Babesia, prions (e.g., Creutzfeld-Jacob disease), and other unknown infectious agents, threaten the safety of the blood supply (Alter, Stramer, & Dodd, 2007; Bloch, Ness, Tobian, & Sugarman, 2018; Lessler et al., 2016).

In support of the WHO safety recommendation of using only volunteer donors, Abdel Messih Ismail, Saad, and Azer (2014) reported family replacement donors have a

significantly higher prevalence of HBV, HCV, CMV IgG, and syphilis, as compared to volunteer donors. Allain and Sibinga (2016) revealed conflicting results, reporting family replacement donors' viral markers were not significantly different from volunteer donors' markers. Although the prevalence of transfusion-transmissible infections in blood donations continues to decline, especially in high-income countries such as the US, there is still a 0.003% (95% CI: 0.001%-0.04%) likelihood of a unit being positive for HIV and not being detected before transfusion (WHO, 2019) (see Appendix D for Prevalence of Transfusion-Transmissible Infections).

The ARC (2018a) reports less than 38% of the population are eligible to donate blood or platelets; yet, only 3% to 8% of the population will voluntarily donate blood components (Ringwald, Zimmerman, & Eckstein, 2010). Bagot, Murray, and Masser (2016) noted 50% of FTDs will never return to donate. Therefore, almost 50% of all blood units transfused in the US come from 1% of the population, the career donors, emphasizing how important it is to convert FTD donors to career donors (ARC, 2017a; Ringwald et al. 2010). In 2015, "1,844,000 (28.6%) FTDs and 4,604,000 (71.4%) repeat donors presented to the AABB member blood banks" to donate blood (Rajbhandary et al., 2018, p. 18). This represented a 5.8% decrease in total donors and a 17% decline in FTDs from 2013 (Ellingson et al., 2017). In addition, in 2015, there was a 0.5% decline in repeat donors, which equates to 1.7 donations per donor (Rajbhandary et al., 2018) (see Appendix E for Allogenic Donors by Donation History).

Donor Demographics

In 2014, males contributed 52.7% of the donations and 60% of donors were 40 years of age and older (Rajbhandary et al., 2016). The largest proportion of donations by age group were from those aged 50-59 (21.5%). In 2015, 1,464,000 blood units were collected from high school donors (16-18 years of age), which is 9.8% more than in 2013 (1,333,000 blood units) (Rajbhandary et al., 2016). This accounts for 11.4% of all allogenic collections in 2015, while adolescents aged 16 and 17 years comprised only 2.8% of the US population (Bloch, Mast, Josephson, Klein & Eder, 2017; Rose, 2014). In 2008, the BCs' response to declining FTDs was to increase high school blood drives. Although this solution creates a moral dilemma, the trend is increasing today (Parker-Pope, 2008; Rose 2014; Snelling, 2014). Unfortunately, adolescents are reported to have the highest number of adverse events during donations. The AABB reports FTDs between the ages of 16-22 years' experience 40.3% of the adverse reactions during donations, making them less likely to return to donate (Almutairi et al., 2017; Rajbhandary et al., 2016). There is also a health concern drawing blood from adolescents could deplete their iron stores, thus increasing the risk for anemia and other health issues (Gschwender, 2017). Despite the adverse events, high school blood drives continue to increase to meet the blood inventory needs (Rose, 2014).

Several studies reveal a discouraging decline in donor activity for FTDs (Bagot, Murray, & Masser, 2016; Ringwald et al., 2010; van den Hurk et al., 2017; Wevers, Wigboldus, de Kort, van Baaren, & Veldhuizen, 2014). Ringwald et al. (2010) reported the rate of "FTDs is declining and up to 50% or more of FTDs may never return for a

second donation" (p. 295). While donation frequency during the 18 months following an initial donation predicts the likelihood of becoming a career donor, only 23%-36% of FTDs will return within 12 months (Bagot, Murray, & Masser, 2016). The researchers recommend a concerted effort to increase the number of career donors by focusing on improving the rate of return for FTDs. This strategy may significantly increase the number of donated units and widen the buffer therefore increasing the supply of blood to meet the utilization needs of the healthcare industry and provide extra units for emergencies (Chung et al., 2016).

Also compounding the criticality of the narrowing buffer (the supply of blood units available for emergencies), the age distribution in the US is predicted to shift. The group of individuals 65 years of age and older will increase by nine percent during the years of 2014 to 2060 (Colby & Ortman, 2015). They will go from 15% of the population in 2014 to 24% in 2060 (Vespa, Armstrong, & Medina, 2018). On the other hand, the 18-64 year olds will decrease from 62% of the population in 2014 to 57% in 2060, a net decrease of 5.0%. By 2030, one in five Americans will be will be less than 18 years of age. The increased older population will need more blood products for elective and life-saving surgeries. Concurrently the voluntary FTD generations historically supply blood will be decreasing (Colby & Ortman, 2015; Ringwald et al., 2010; Rose, 2014; Vespa et al., 2018) (see Appendix F for a graph of Distribution of U.S. Population).

The population race/ethnicity distribution is also a concern, since as described by Bednall, Bove, Cheetham, and Murray (2013), most repeat donors are "educated middle-aged Caucasian males" (p. 87). According to Colby and Ortman (2015), the US census

projections, the non-Hispanic Caucasian sub-population will decrease by 8.2% while the African American sub-population will grow by 42% by the year 2060; the Hispanic sub-population is expected to grow by 114.8% and the Asian sub-population by 128%. By 2044, the country will become a "majority-minority" nation with non-Hispanic Caucasians comprising less than 50% of the population (Colby & Ortman, 2015). As the African American sub-populations continue to increase, the number of African American voluntary blood donors is not increasing at the same rate. According to James, Schreiber, Hillyer, and Shaz (2013) only 2.4% of the donor sub-population is African American donors as compared to 4.2% for Caucasians. In a study in Atlanta, the African American rate was 6/1000 population, as compared to 11/1000 population for Caucasians, and 3/1000 population for Hispanics (Colby & Ortman, 2015). This affects the number of units per population drawn nationally and also puts these minority groups at an additional risk of not having blood best meeting their phenotypic blood types to optimize their health outcomes. This is important in the transfusions of sickle cell patients, which are mainly of African American decent (Chou, 2013; Price et al., 2006; Vichinsky, 2001). Each individual has a genetic "fingerprint" of antigens identified on the red blood cells (RBCs) and the transfusion service prepares the most compatible unit for them. Donors from similar subpopulations are more inclined to resemble each other's "fingerprint" (James et al., 2013). An example is the distribution of surface antigens or lack of thereof, identified as "A" (presence of A antigen), "B" (presence of B antigen) and "O" (absence of A and B antigens) (see Appendix G for Blood Types Distribution).

Clinical concern example: Caucasian donors have a 45% chance of being type "O", the African American sub-population has a higher incidence (51%) of having "O" blood type, while Hispanics have the highest incidence (57%) of type "O" (ARC, 2018a). As a consequence, the requirement for "O" type blood is increasing while most repeat donors are currently non-Hispanic Caucasian males. If the African American and Hispanic sub-populations do not donate blood, the need for "O" type blood will not be met. All races are at risk of not having "O" type blood available resulting in blood shortages postponing elective surgeries and insufficient supply needed for emergencies. Health interventions to increase FTD and career donors must include subpopulations to mitigate the public health concern of insufficient blood supply.

2013-2015 Donation Trends

According to the American Association of Blood Banks (Rajbhandary et al., 2018), the number of donations in 2015 (12.8 million) was 5.8% lower than in 2013 (13.0 million), resulting in 12.1 million units available for transfusion as compared to 12.8 million in 2013 (Ellingson et al., 2017). In 2015, there were 2,642,000 platelets collected, which was 0.5% less than the 2,659,000 number drawn in 2013 (Ellingson et al., 2017). Consistent with this trend, plasma components declined by 14.4% from 2013 to 2015 (5,244,000 and 4,338,000, respectfully). Historically, the US peaked at 17.3 million donated units in 2008 and this number has continued to decline (Ellingson et al., 2017). The levels reported in 2015 are similar to the number of donated units drawn in 1997, a significant indicator of the decreasing supply of blood available while the population continues to increase and age.

The trends in decreasing donors and donated units continue to be a public health concern as the buffer continues to grow narrower between the collection amounts and the national utilization needs, reducing the number of blood units available for emergencies (Chung et al., 2016). In 2013, the whole blood and RBC collections were 69.0 units per 1000 population (aged 16-64 years) in comparison to 2011, when it was 76.2 units per 1000 population (aged 16-64 years) (Chung et al., 2016). In 2013, the rate of transfusions "per 1000 population also declined to 41.7 for all ages in comparison to 2011 which was 44.0 per 1000 population, all ages" (Chung et al., 2016, p. 2189). In 2011, there was an excess of 804,000 units collected but in 2013 the number fell to 215,000 units (decreasing the buffer), which raises concerns related to sustainability during an emergency event or for public health preparedness. Severe weather events can compromise the nation's blood supply, putting patients at risk of not having the life-saving blood they need to survive.

Chung et al. (2016) and Rose (2014) suggested, this risk may be compounded with the increasing population mean age as the anticipated number of transplants, orthopedic surgeries, cardiovascular surgeries, trauma events, and other blood-requiring medical surgeries, cardiovascular surgeries, trauma events, and other blood-requiring medical procedures or events also increase (see Appendix H for the Distribution of RBCs and Platelets per Specialty).

In addition, as the large number of career donors approach sixty, their incidence of health issues increase (Marik & Corwin, 2008; Oliver, Griffin, Hannon, & Marques, 2014; Rose, 2014). There is an escalating public need to convert FTDs to career donors to

maintain the needed and safe blood supply in addition to implementing more blood conservation programs.

Blood Conservation Programs

In response to the declining trends, the healthcare organizations have implemented BMPs decreased utilization by methods including health education, surgical robots, bloodless surgery techniques, and aggressive guidelines. Health educators emphasize the clinical symptoms of anemia should be used as the primary indicators instead of prescribing transfusions based on hemoglobin concentrations alone (Carson et al., 2012; Eder et al., 2008; Ellingson et al., 2017; Kim et al., 2013). This has resulted in fewer transfusions per person and fewer transfusions per medical specialty (Ellingson et al., (2017).

In 2015, the number of RBC transfusions per 1000 population was 15.3% lower (35.3 /1000 population) than in 2013 (41.7 per 1000 population) (Ellingson et al., 2017; Oliver et al., 2014). Joseph, Hendry, and Walsh (2009) and Tinegate et al. (2016) applauded the perioperative/surgical units' success at reducing the rate of blood transfusions but they suggested patient blood management (PBM) programs including health education strategies be focused on the medical units, since they have continued to increase the rate of transfusions.

Health outcomes studies claim patients receiving RBC transfusions incur higher mortality and morbidity risks (Marik & Corwin, 2008; Oliver et al., 2014; Tinegate et al., 2016). Hospitals should reevaluate the current transfusion practices to reduce the immune-modulating effects seen in almost all transfused patients (Oliver et al., 2014).

Utilizing blood appropriately would optimize patient outcomes and conserve blood for required health needs. Should the RBCs and platelets units fall below the minimum level; the elective surgeries will be cancelled or postponed. Insufficient blood inventory is life-threatening for accident victims and patients requiring blood to sustain life.

Blood Component Descriptions

Red Blood Cells (RBCs)

Day 1 in the life of a blood unit is the day of donation. The whole blood unit is separated into at least three components including RBCs, platelets, and plasma (Carson et al., 2012). In the body, the RBCs function as transporters of oxygen to the tissues in exchange for carbon dioxide is a waste product of the tissues. During the red cell unit's shelf life of 42 days, they are used to treat chronic anemia such as in sickle cell patients (blood disorders), kidney failures, gastrointestinal bleeds, blood dysplasias, and acute blood loss experienced during trauma (ARC, 2018a; Chou, 2014; Marik & Corwin, 2008).

Platelets

A second component is the platelets or thrombocytes, which are colorless, small cell fragments whose main function is to prevent or stop bleeding by adhering to the severed interlining of the blood vessels (ARC, 2018a). While they have a brief shelf life of 5 days, they are highly valued by chemotherapy patients to remedy thrombocytopenia; a condition of low platelets can result in spontaneous bodily bleeds especially in the brain. These bleeds are life threatening and require immediate resolution. Surgeons also use platelets to stop bleeding after a major procedure. Often accident victims are crushed

in some regard or have major trauma to the body organs will require platelets to mitigate or eliminate major blood loss. This product is on a constant need basis but can take two hours or more to collect a single donor product (Carson et al., 2012; Tendulkar, Shah, Patil, & Tambe, 2014).

Plasma

The third component derived from whole blood is the plasma, which is the liquid portion of the unit. Although this component is 92% water, it contains 7% of the vital proteins and 1% of mineral salts, sugars, hormones, vitamins, and fats of the body (ARC, 2018a). It functions as a transporter of not only these nutrients but also of the cellular components of the whole blood, while maintaining a satisfactory blood pressure and volume. It supports tissues by establishing a critical pH balance and provides blood clotting and immunity factors (Curinga et al., 2011). In order to preserve the blood clotting factors, the plasma is immediately frozen for a shelf life of one year. Once thawed, it is commonly used for burn victims, bleeding disorders and shock victims. The plasma derivative is fractionated to produce Albumin, Anti-Thrombin III, Anti- Inhibitor Coagulation Complex, and Immune Globulin in addition to the Factor VIII, Factor IX, and Factor XI concentrates to provide to hemophiliacs or other deficient individuals (ARC, 2018a).

White Blood Cells (WBCs)

As a safety measure to protect the recipients of the transfusions, WBCs (also known as granulocytes) are routinely removed from whole blood units to be transfused, since they can carry viruses causing immune suppression and release toxins to the

patients. The WBCs are left in the blood unit for patients having severe infections such as Clostridium difficile that do not respond to antibiotics since they are overly immune-suppressed by drug chemotherapy, or for patients having non-reactive bone marrows. These particular patients are successfully treated with granulocytes harvested from a donor within 24 hours and administered immediately (ARC, 2018a).

Artificial Blood

While all these components of whole blood can be extracted and processed for the patients, donors make it possible. Blood cannot be manufactured; it only comes from generous donors (ARC, 2018a). Researchers have designed successful genetic manipulation of stem cells to produce a few platelet cells under special conditions. Although the projects show promise, stem cells will not be replacing volunteer donors for many years to come. Since platelets lack a nucleus they will be the first blood product to be manufactured. Nucleated cells are more inclined to render carcinogenic cells when reprogrammed so platelets are the safer product to manufacture (Dolgin, 2017). There is no substitute for donors who are willing to share their blood with others in need.

There is a public health need to identify, educate, and motivate volunteer donors to provide the blood components required by the healthcare institutions to perform the healthy life-promoting surgeries or other life-sustaining procedures.

Intention to Donate

With this growing public health need, it is important to understand the characteristics of the donors and what motivates individuals to become a FTD and then translate those motivations to convert the FTDs to career donors. Multiple studies have

identified factors influencing the donation behavior of FTDs and career donors and intentions to donate blood (Alfieri, Marta, & Saturni, 2016; Alfieri, Pozzi, Marta, Saturni, & Aresi, 2017; Balegh et al., 2016; Bednall et al., 2013; Bloch et al., 2017; Bognar, Ribic, & Kriznjak, 2016; Burgdorf et al., 2017; France & France, 2018; Poon, Lee, & Lee, 2013; Rose, 2014). Gibbons (2008) defined *intention* as "the amount of effort one is willing to exert to attain a goal" and suggested it is highly predictive of behavioral change (p. 1). Bednall et al. (2013) suggested the strongest predictive antecedents of blood donation behavior can be grouped into six categories: the TPB and its expansions including TRA, affective expectations, prosocial motivation, past donation behavior, experience at donor site, and demographics of the donors (Alfieri, 2017; Alfieri et al., 2016; Bednall et al., 2013; Bednall & Bove, 2011; Burgdorf et al., 2017; Charbonneau, Cloutier, & Carrier, 2015a; Charbonneau, Cloutier, & Carrier, 2016; Ferguson, 2015; Chell, Davison, Masser, & Jensen, 2018; Godin et al., 2012; Karacan et al., 2013; Piersma et al., 2017; Ringwald et al., 2010).

Theory of Planned Behavior/Theory of Reasoned Action

The TPB/TRA constructs are used to focus on positive motivational factors and beliefs impacting the individual's probability to perform a specific behavior, like donate blood (Bednall et al., 2013; Conner, Godin, Sheeran & Germain, 2013; Masser et al., 2012; Wevers, Wigboldus, van Baaren, & Veldhuizen, 2014). The TPB/TRA models suggest the intention to perform the behavior is influenced by three dimensions: attitude, perceived norm, and personal agency (Montaño & Kasprzyk, 2015). Since the construct of self-efficacy was added from other models, the TPB/TRA expands into the IBM

(Montaño & Kasprzyk, 2015) (see Appendix A for IBM). The donor's willingness to participate in the desired behavior (i.e. donate blood) is based on intention, which is also a reflection of attitudes toward donating blood, community /cultural norms regarding donating blood, and perceived self-efficacy to donate blood (Chou & Murnighan, 2013).

The donor's recognized attitudes about blood donation and expected consequences of donating directly affect intentions to donate blood (Ditto, Gilchrist, & Holly, 2012). The subjective norm refers to the donor's sensitivity to whether significant others such as colleagues, friends, and supervisors at work assume they will donate (i.e., social pressure) (Montaño & Kasprzyk, 2015). The descriptive norm refers to people such as friends, family, and colleagues who are also willing to donate blood themselves, thereby influencing the donor's decision (Queniart, 2013). The construct of personal agency reflects the donor's self-efficacy (donor role identity) and the perceived control of factors may make it easy or difficult to donate blood. The donor is affected by both personal/internal factors (e.g., eligibility) and external factors/resources are required to enable the blood donation (e.g., facilitating conditions such as transportation, time, location, etc.). Therefore, the intention of the individual may be mediated by factors outside his control (Montaño & Kasprzyk, 2015).

Affective Expectations

The influence of anticipated affective reactions to donation has been suggested as a strong motivator when the donor believes they are playing an important role. The concept of positive feelings of pride and satisfaction is termed anticipated affective reactions to donation has been suggested as a strong motivator when the donor believes

they are playing as *benevolence* or impure altruism since the donor is anticipating a "warm glow" about oneself (Bagot et al., 2016; Evans & Ferguson, 2014). Anticipated affective reactions may be a barrier if the donor generates pre-donation anxiety about the pain and possible side-effects of donating, reducing the intention to donate (Bednall et al., 2013; France et al., 2013). Fu and Levine (2016) suggest effective and timely interventions (education) can reduce the anxiety and adverse events among this population.

Pro-Social Motivation

Guiddi, Alfieri, Marta, and Saturni (2015) suggested donating blood also can be a gesture of "pure altruism" (p. 339). They defined altruism as the "motivation to help another person with no prospect of personal compensation for those who offer assistance" (p. 339). Some contributing factors are known as the motivational antecedents, which prime the individuals to achieve an "objective such as donating blood [while] taking into consideration the conditions of the environment in which s/he is situated" (Guiddi et al., 2015, p. 339). Donors base their decision on multiple motivational functions conjointly (Guiddi et al., 2015). All the contributing functions impact the donors' commitment to donating blood. Guiddi et al. (2015) suggested five motivational functions are associated with volunteerism: social motivation, value motivation, self-enhancement motivation, ego-protection motivation, and knowledge motivation. The functions can weigh differently, competing but not eliminating the individual motivations. Evidence has revealed these five functions change over time and are gender dependent. The data suggests women are more motivated by altruism, social enhancement and ego-protection,

while men are influenced by individualistic motivations such as social enhancement, ego-protection, and knowledge (Ferguson, 2015; Guiddi et al., 2015).

Long and Krause (2017) found individuals were more inclined to be less altruistic when the recipient individual was more socially distant, such as strangers as compared to family. The genetic relatedness is not a predetermination of "an individual's willingness to endure some personal sacrifice for group survival beyond their gene pool" (p. 21). In a study of the mind, Volz, Welborn, Gobel, Gazzaniga, and Grafton (2017) found, although individuals were willing to forgo monetary rewards to prevent others' harm, they were not willing to inflict harm on themselves to secure rewards for the other. The Volz et al. (2017) study suggests the avoidance of adverse events and fear reduction is particularly effective at promoting long-term donor loyalty and retention. Additional studies confirm the negative impact of adverse events and the failure to return to donate (France et al., 2013; France et al., 2014).

A prosocial behavior enhancement to increase donations among university students was the "watching-eyes" intervention (Senemeaud et al., 2017). Students receiving flyers with the "watching-eyes" were three times more inclined to present to donate blood. The picture of the human eyes created a form of embedded social pressure and stimulated a moral obligation to donate blood (Bednall et al., 2013; Senemeaud et al., 2017). Bednall et al. (2013) defined obligation as a "moral belief that one ought to help others" based on their "internal standards of how they should behave which is activated by particular situations" (p.87). Senemeaud et al. (2017) suggested the "watching-eyes" picture may activate a desire to help others by donating blood without any regard for

social rewards. France, France, Carlson, Himawan, Kessler, Rebosa, … Fox (2017) added when a potential donor already has a high pro-social motivation to donate, a brief motivational interview may be sufficient to self-commit to donate.

In a donor motivation survey including prosocial motivations, Charbonneau, Cloutier, and Carrier (2015b) found the largest number of donors chose the altruistic motivation of "my blood can save lives" and "giving blood is a positive thing to do and requires little effort" (p. 325). Both of these primary motivators confirm the importance of prosocial motivations in blood donations.

Past Donation Behavior Influence

According to Ringwald et al. (2010), FTDs are driven by external stimuli, while committed career donors are inclined to self-identify as a donor consistent with the identity theory. When donors self-identify they have a high level of intrinsic motivation driven by their sense of altruism and responsibility (Bednall et al., 2013; Ringwald et al., 2010). These donors have a favorable image of donors and must be encouraged by the BC from the beginning of the donation journey with recruitment/educational materials including the most effective motivations (Masser, 2016). These donors value having sensitive, motivated and well-trained staff focusing on reducing the anxiety levels, and the number of adverse events (Ditto et al., 2012; Fisher, Allen, Naylor, Angelantonio, & Roberts, 2016; France & France, 2018; France et al., 2014; McMurtry et al., 2015). In a survey, participants report they were recruited by interpersonal contacts who had donated and had a positive donor experience (Kilic et al., 2013). France, France, Carlson, Frye, et al. (2017) suggested BCs enhance or provide the positive socio-environmental conditions

reinforcing the behaviors that are internally motivated (self-determination). According to the self-determination theory, the donor becomes more self-determined to donate if "fundamental human needs such as competence (a sense of self-efficacy to achieve specific goals), autonomy (a sense of volitional control over one's behavior), and relatedness (a sense of connection to a larger group)" is satisfied (France, France, Carlson, Frye, et al., 2017, p. 44). France, France, Carlson, Himawan, et al. (2017) and Livitz, Fox, Himawan, and France (2017) recommended promoting these potential mediators will enhance donor retention. Based on an intervention by Livitz et al. (2017), a simple motivational interview may serve as an effective means to encourage recruitment of new donors and retain career donors (see Appendix I for Self-Determination Theory).

Influence of Donor Site

According to Poon et al. (2013), the accessibility of the donor centers to the donors' workplace, and daily commuting patterns of the donors motivate new donors, resulting in more donations and returning donors. If the donors are highly motivated, the distance is less impactful as compared to the less motivated individuals. Proximity is important when recruiting blood donors, especially FTDs, since half of the donors reported 30 minutes or 5 km as the maximum distance, they were willing to travel to donate (Poon et al., 2013). Understanding where people spend their time on weekdays or weekends can be helpful in planning blood drives (Poon et al., 2013).

Social Factors and Social Capital Influence

Although society views blood donors as altruistic, the donation may be in their own self-interest or involve reciprocal altruism since some donors may expect donors to provide blood for them should they need it. To others it may appear they are helping strangers for no apparent reason but in reality, they are conducting reciprocal altruism (Lantos, 2006). Other donors may be testseeking to insure their health status, also considered reciprocal altruism (de Vos et al., 2016; Hyde, Knowles, & White, 2013). Social factors such as the ability to pay for infectious disease testing may drive individuals to donate. Consistent with this motive, Burgdorf et al. (2017) suggested the socio-demographic characteristics of blood donors such as their income levels and social status directly affect their intentions to donate in the middle to high income groups (but not the highest income groups). Middle and high-income groups have four times the number of donations as compared to the low-income groups. Individuals having less leisure time due to work requirements tend to donate less than individuals in higher paying jobs (Burgdorf et al., 2017; Carver, Chell, Davison, & Masser, 2018). In general, donors are said to have a higher level of social consciousness and sensitivity to fairness than non-donors, which may affect their intention to donate (Ferguson & Lawrence, 2018).

The marital status of the individuals also has a bearing on their inclination to donate blood. Burgdorf et al. (2017) data suggests a social marginalization with men living alone or without a woman donating less than men who live with a woman. Men living with parents are more inclined to donate less frequently or were non-donors.

As individuals age, their social paths change. According to the donor data, female donations peaked at age 25 and declined once they have children. Meanwhile men peaked at 30 years of age and continued for longer periods of time (Carver et al., 2018). Both genders were more educated and employed when compared to non-donors and have more leisure time (Burgdorf et al., 2017; Ringwald et al., 2010). When designing recruitment efforts for new donors the intervention must consider the donors' socio-economic status and sense of social capital, especially in disasters and emergencies (Burgdorf et al., 2017).

As the social makeup of the US continues to change as the ratios of majority versus minority races shift in the US, it is important to identify motivations and incentives to increase the number of donors from multi-cultural communities. Shaz et al. (2009) suggested African American level of fear to donate blood, lack of knowledge about the blood donation process, donor deferrals due to low hemoglobin, and mistrust in healthcare system prevent the individuals from donating routinely. Price et al. (2006) suggested although current recruitment methods endeavor to increase general blood donation education levels, the education designed lacks the cultural sensitivity needed to appeal to the African American population.

As the sub-population ratios shift, the donor pools must also. In 2010, U.S. Census data reveals there were 50.5 million Hispanics in the US, making up 16 % of the population. The population grew by 43% from the year 2000 to 2010, accounting for over half of the 27.3 million increase in total population, yet the blood donor rate is only 3/1000 population in contrast to the Caucasian rate of 11/1000 population (Colby &

Ortman, 2015). In the interest of maintaining safe blood inventories, there is a critical need to identify interventions and motivations effective with the Hispanic population (see Appendix F for Distribution of U.S. Population).

Career Donor Motivations

According to Bednall et al. (2013), Burgdorf et al. (2017), and Rose (2014), the career donors' characteristics have been quite stable over time suggesting most are non-Hispanic Caucasian males, between the ages of 35-45 years, educated, financially secure, and participate in multi-affiliations of different types, such as sports, donations, and recreational activities (Alfieri, 2017). These donors donate through a civic organization or at work-related blood drives; their priorities are to donate blood routinely; and, they feel a public responsibility to do so (Burgdorf et al., 2017). Donors 50 years and older are motivated by the public need for blood, since they have lived long enough to witness a health situation needing blood, while the younger donors have not had similar history (Charbonneau et al., 2015b). Donors in the child bearing age also have a sociological life-course perspective, since they are more likely to have had a "family member or friend in need of blood" (Charbonneau et al., 2015b). Charbonneau et al. (2015b) continue the "life course paradigm stresses the young people construct their own autonomous identities through the practice and frequency of activities during early adulthood" (Charbonneau et al., 2015b; p. 326). The youngest career donors state donating blood "gives me a sense of pride" or "I like to have goals" (Charbonneau et al., 2015b; p. 324 - 326). These younger career donors are also more inclined to be influenced by their families to donate blood regularly (Charbonneau et al., 2015b; Gazibara et al., 2015;

Hyde, Knowles, and White, 2013; Pedersen et al., 2015). When marketing and promoting blood drives, BCs need to design intervention strategies accounting for generational differences in motivating donors (Charbonneau et al., 2015a; Gazibara et al., 2015; Masser, Bednall, White, & Terry, 2012; Misje, Bosnes, & Heier, 2010; Yuan, Chang, Uyeno, Almquist & Wang, 2016). Motivating FTDs of all ages to become career donors must be addressed to meet the growing needs for blood products for treatments and emergencies in the healthcare industry (Piersma et al., 2017).

Volunteers' Response to Emergencies

Alfieri et al. (2016) claimed during a crisis volunteers "feel more vulnerable and less affluent"; further, the crisis often intensifies their mistrust in institutions and their feeling of isolation (p.396). Alfieri et al. (2016) suggested in emergencies and crisis scenarios individuals are driven by six motivations to volunteer:

- Values: they can share and express their humanitarian and altruistic values;
- Knowledge: exercise their skills, knowledge, and abilities;
- Career: discovering new skills can be used in new employment opportunities;
- Protective: reduce their feelings of guilt resulting from one's sense of being more fortunate than others and shifting the attention to those who benefit from one's service;
- Self-enhancement: increases one's self-efficacy and self-esteem, improving one's mood;
- Social: possibility of meeting new people or volunteering with a friend.

These six motivations can vary over time depending on one's phase of life and their social and personal contextual factors (Alfieri et al., 2016). According to data captured on the influence of the six motivations in a crisis, self-enhancement and values were most strongly felt by the donors, although specific motivations may be inherent to the donors' fundamental motivations (Alfieri et al., 2016; Guiddi et al., 2015). The increase of self-enhancement during the crisis may be construed as "donating blood helps them become better people" (Alfieri et al., 2016, p. 399). Civil engagement during crisis situations can benefit the individuals on a social and psychological level by increasing their self-efficacy and self-esteem and giving them a sense of community (Alfieri et al., 2016).

The second strongest motivator felt by the donors was *values motivations,* which attest to the inclination of people to use voluntary action as a means to share and express their values. While the volunteers felt a lack of trust towards many organizations, their trust did not erode in regards to donor centers. Donors found donor centers/institutions deserving of their loyalty, trust, and commitment (Alfieri et al., 2016). Women were anticipated to have a high regard for the values motivation since it is consistent with the conjecture women are primarily driven by altruism, but there was no statistically significant difference between the genders (Alfieri et al., 2016).

Although women are said to be driven by *ego-protection motivations*, Alfieri et al.'s (2016) results demonstrated it was the least meaningful factor among both genders, implying donors did not feel more fortunate than others, since so many people were impacted. Identifying motivations during crisis situations can be valuable in recruitment

and managing inventories. Recognizing the value motivation instead of the ego-protection motivation for advertising and marketing strategies during the crisis can result in more volunteer donors presenting to donate and becoming career donors.

Emergency Events

During 2017, there was an immediate public health need to identify additional volunteer blood donors to continue to maintain a safe supply of blood units, especially during emergencies (Chung et al., 2016; Rajbhandary et al., 2018). Although Ohto (2016) argued the history of disasters has prepared the healthcare industry for future disasters, the hospitals cannot provide blood to their critical patients during emergencies may disagree. Severe weather events can compromise the nation's blood supply, putting patients at risk of not having the life-saving blood they need to survive. In January 2017 during a severe weather event, the ARC issued an emergency call for blood donations to distribute blood to 2,600 hospitals nationwide for burn and accident victims, organ transplants, and sickle cell disease, cancer and leukemia treatments. During this emergency, surgeries and procedures were canceled due to the low blood units in inventory (ARC, 2018b).

Another emergency event requires blood to be available was the World Trade Center and the Pentagon attacks in 2001. Schmidt (2002) stated although there was a healthy supply of 50,000 units of blood available, the country responded with more than 475,000 units drawn within the week. Only 258 units were actually used by the victims and all these units were already tested and in stock before 9-11 (Schmidt, 2002). More than a million would-be donors contacted the blood-collection sites trying to donate.

Schmidt (2002) claimed although altruism was driving the donation numbers, donating blood met a "need of the individuals to be with each other, friends, neighbors, and strangers" (p. 618). Shrivastava, Shrivastava, and Ramasamy (2017) referred to this as "establishing connection among all through blood donation" (Shrivastava, Shrivastava, and Ramasamy, 2017, p. 1357). "The response was disproportionate to the medical need; the social value of blood donation at once became far more important to the community than its medical value" (Schmidt, 2002, p. 618). As a positive outcome of such a major disaster, it was anticipated 40% of all the FTDs would make a second donation within six months consistent with a disaster event in 1991 (Schmidt, 2002). While disasters can occur without any notice, it is important to note the blood used on September 11, 2001, was already tested and in inventory at the time of need. The available emergency supply of 258 units saved lives on September 11, 2001.

Many healthcare institutions have implemented disaster preparedness plans to include a safe number of blood units available without an expectation of waste (Glasgow, Allard, Rackham, & Doughty, 2014; Gschwender & Gillard, 2017). Sonmezoglu et al. (2005) recommended, a pool of potential donors be instituted as a disaster resource should blood inventory levels drop to unacceptable levels or should a disaster consume the blood inventory. A safe inventory of blood must be available when needed during critical events, disasters, and routine healthcare protocols; therefore, the donor pool must increase as the population increases (Gillard, 2017). According to Schmidt (2002), a high percentage of emergency responders in 1991 converted to career donors but this event was more than 25 years ago and may be different today. As seen by Bednall et al. (2011),

donors' motivations change depending on multiple factors. The question remains: If donors responding to emergency events such as severe storms or bombings, are they inclined to donate again? Is there an opportunity to identify new FTDs responding to disasters and transition them to career donors to improve the blood inventory? Whether donors are driven by multiple or single motivations, there is an opportunity to promote health education strategies about the "gift of life" and eliminate the anxieties and barriers related to donating (Solomon, 2013). The decline of FTDs is a public health concern that needs mitigation as soon as possible.

Education on Public Health Issues

In order to maintain a healthy pool of volunteer donors, several government and private agencies work with communities to provide education on different public health issues. They teach students as early as grade school; there is a need for blood products and only volunteers can provide it for others (Community Tool Box [CTB], 2018; WHO, 2017). These agencies collaborate with community partners and other agencies such as the health departments to provide education on safe transfusions, follow-up to positive donor deferrals, and help to communities to maximize the donation events to increase blood donations (CTB, 2018). These agencies support the blood system by standardizing the universal access to blood (WHO, 2017).

Private agencies such as the Community Blood Center (CBC, 2018) are active in educating Pre-K through high school classes about the function of blood, the need for blood, and volunteer donors. The teaching staff of CBC reaches out to the different school districts providing health education, laboratory visits, donor center visits, and high

school awards for schools participating in blood drives. Many community BC advocates actively search for community events to educate individuals about the public health need for blood in their community and promote the local BC (Community Blood Center [CBC], 2018). The community learns about emergency events resulting in the unavailability of blood leading to deaths and patients experiencing ill-health (WHO, 2017). A sufficient inventory of blood must be maintained at all times since emergencies cannot always be predicted (CBC, 2018). BCs collecting from high school students collaborate with the high school health education teachers on both the education and the recruitment of the students to donate blood (CBC, 2018).

BCs also recruit university students by posting flyers with key information concerning the need for blood, including a patient in immediate need, if appropriate (see Appendices J1 – J4 for Disaster Education Posters). The BCs hand out pamphlets that give the students basic eligibility information and if there is a directed need of one type of blood (ARC, 2018c; CBC, 2018). Even though the population of sickle cell children in the African American population continues to grow, distrust of healthcare institutions and the fear of needles keep African Americans from donating blood (James et al., 2012; Muthivhi et al., 2015).

In an additional university study, the students were more inclined to donate blood if the school was more involved in the blood drive and they were given the chance to meet with an expert donor and learn from them (Zito et al., 2012). Informal donor education from family or friends can have a significant impact on the donor's intent to

donate but altruism and convenience show to have the highest impact on their decision (Yuan et al, 2016).

Although a growing percentage of the blood is being drawn from high schools and universities, there is a need to increase the public health education opportunities for these individuals to insure a safe blood inventory level for emergencies (CBC, 2018). The CBC public education materials include multiple disaster scenarios to make everyone aware should an emergency occur, blood on the shelves saves lives (see Appendix J for Disaster Education Poster) (CBC, 2018).

CHAPTER III

METHODOLOGY

When volunteer blood donors are screened for eligibility, the answers to the required questions are entered into iDonor, a software product designed for BCs. The secondary data used in this study was provided by a blood collection center located in Houston, Texas. This center collaborates with other BCs to provide blood units to cancer centers and local healthcare facilities. This particular BC collects over 35,000 units per year with a volunteer base of over 55,000 individuals. All volunteers must pass eligibility criteria and be in the age range of 17-70 years. In the state of Texas (State of Texas, 2015), 17 year olds do not need parental consent to donate blood. The BCs draws its donors at multiple locations including the BCs, mobile drives, high school drives, community churches, and businesses. The donor data is managed electronically with iDonor software and is available at each drawing site at the time of the donors' assessment.

This study used the data captured in the blood donors' history files to analyze and interpret donor trends during emergency conditions as compared to non-emergency conditions. All donors at registration are required to answer a series of questions including demographics, personal history, and health status. The interviewer asks each donor the questions and they record it electronically into iDonor database. The required questions include those mandated by the FDA, with any additional questions required by the BCs' medical director. The FDA donor card was validated in a study by Kreuter and

Gandhi (2013) when they were studying remuneration and incentives for donors. The MD Anderson Cancer Center 2016 Donor Questionnaire of approved questions was used for this study (see Appendix A for Donor Questionnaire). Once a donor is found eligible to donate according to the established criteria, additional health parameters, testing results, information related to the donor's medical outcomes, sexual history, donation history, and recruitment responses are added to the donor's file. The secondary data used in this study was gathered on only those participants who passed the criteria and donated a blood component. The data was stored in iDonor (a product of Haemonetics, Inc.) and extracted with IRB approval. All qualifying donors sign a permission statement allowing the blood and donor file to be used for research purposes after the information has been de-identified. In addition, emails, letters, and phone calls are used to contact donors to encourage them to donate again and donor comments (e.g., barriers to donating) are documented in their files.

Any donor not meeting the FDA required criteria is deferred either temporarily or permanently based on the result. All temporary deferrals are encouraged to return at a later date but all permanent deferrals are stored in a national dataset by a unique number assigned to the volunteer. Although the deferrals, both permanent and temporary, are included in the donor center's datasets, they were not used in the analyses of donor ratios in this study.

Population and Sample

Two cross-sectional groups comprised of at least 500 volunteer blood donors who donated during a natural weather emergency event (August 20 – September 23, 2017) and

at least 500 volunteer donors who donated during a non-emergency time period (August 20- September 23, 2016). At least 200 first-time volunteer donors during the emergency were followed for 44 weeks (11 months) to capture which donors returned to donate after the emergency event (September 1, 2017 – August 23, 2018). Donors that donated for the first-time during the non-emergency timeframe (August 20 – September 23, 2016) were also followed for 44 weeks (11months) to capture which donors returned to donate again (September 1, 2016 – August 23, 2017). When donors declined to return and did not offer an excuse, they are often emailed for a deferral reason.

Protection of Human Participants

This study received exempt approval from MD Anderson Cancer Center Institutional Review Board (IRB) for Human Participant Protection and Texas Woman's University's IRB. The researcher and advisor completed the Human Participation education as required by the MD Anderson Cancer Center IRB and the Texas Woman's University IRB. All donors were requested to sign research consent before donating blood and are provided with health educational information about how their blood will be used for patients and research. Should a donor refuse to sign research consent form, their file was tagged and their data set was unavailable for extraction. All individuals responsible for extracting the data files were identified to the MD Anderson Cancer Center IRB and completed the Human Participation education as required. All donor data files have been extracted from iDonor database and de-identified to protect the donors' identity. The de-identified files have been released in Excel format to the researcher.

Data Collection Procedures

Instrumentation

Since all donors are volunteers they are a self-selected group of individuals more inclined to donate blood than others (internal validity threat). The eligibility interviews included the required questions capturing the donors' demographics (e.g., gender, date of birth, weight, height, ethnicity/race [optional], and health information (e.g., pulse, temperature, blood pressure, hemoglobin, pregnancy history, receipt of any bone marrow or transfusions, adverse medications, other invasive medical procedures, and self-accessed health status), personal sexual history (for exclusion only), travel, exposures to infectious diseases, and contact with any individuals diagnosed with specific infectious medical conditions.

As required by the FDA, the donors' blood is tested for infectious diseases (a criterion validity measure), while the history is confirmed by the phlebotomist at the time of draw (concurrent validity). This increases internal validity of data by triangulation. Questions regarding race and ethnicity are optional and, as such, may be missing.

At least 500 data files of volunteer blood donors who donated during an emergency event and at least 500 data files of donors who donated during a non-emergency time period (the same time period the previous year) were compared for trends and interpretations. This large number of donors in the study increases the power of the analysis, thereby improving the reliability of the data. The analysis includes demographics, health related issues, and data related to donating and repeat donations.

Depending on the type of product donated during the emergency event, donors are told when they can donate again. The longest interval between donations is 12 weeks. At least 200 first-time emergency event donors are followed for 44 weeks (11 months) to document donors who return to donate after the emergency event. The expectation is in the absence of the emergency event, some donors' intention to donate will decrease (historical validity threat). Some donors may return at a later date to donate but would not be captured in this time-limiting data search. There may be donors who donate at a different location and would not be captured in the data set; this is known as mortality internal validity (Leedy & Ormrod, 2015). The non-emergency donors were also followed for 44 weeks (11 months) to capture returning FTDs.

When the donor is contacted to donate again, some agree to donate (thereafter classified as career donors) and other FTDs reject the invitation to donate again. Those donors may be asked to respond with reasons (perceived barriers) for deferring to donate again (internal consistency reliability).

Prior to the analysis, the data was stripped of all personal identifiable variables. The data was analyzed with statistics software (SPSS) for trends and descriptive variables and compared to predict the populations of donors who will respond to an emergency. The data was used to estimate the number of career donors resulting from emergency donor responders.

Although the study had a large number of participants, the emergency event study results may not be generalizable to other non-weather related events (external validity

threat). The study would need to be validated in another emergency event at a different site or of a different emergency type to determine if the same results are obtained.

Data Analysis

Emergency weather event (time) and certain descriptive variables (age, gender) were reviewed in IBM SPSS to establish any patterns or trends on donors' intention to donate and their willingness to return (first-time blood donors versus repeat donors). Several statistical tests were used to analyze the variables produced in the study, such as the comparison of demographic variables, donor conversion rates, differences in descriptive variables between the career donors and emergency donors, and donor conversion rates to career donors among the emergency group and control group. The statistical tests included:

- Chi-square analyses were used to compare donor status by individual demographic (categorical) variables.
- *T*-tests were used to evaluate group differences (emergency donors versus non-emergency donors) on donor conversion rates.
- Logistic regressions were used to evaluate the predictive effect of timing and descriptive variables on donor status. The level of statistical significance (alpha) was set at $p < 0.05$; power at = 0.80 and effect size = 0.50 (see Appendix K for Comparison of Variables).

Timeline of Study

This study utilized secondary data on a sample of blood donors from several specific time periods:

- August 20 – September 23, 2016; (Non-emergency – control group)
- August 20 – September 23, 2017; (Emergency group)
- September 1, 2017 – August 23, 2018 [to include the follow-up time period for emergency group].
- September 1, 2016 through August 23, 2017 [to include the follow-up time period for the non-emergency group]

CHAPTER IV

RESULTS

The data used in the analysis was taken from blood donor FDA questionnaires at the time a participant presents to donate blood at a BC or blood mobile. The participants (*N* = 4388) were asked demographic information (age, gender, and ethnicity) and evaluated for health using weight, pulse rate, diastolic blood pressure rate, systolic blood pressure rate, hemoglobin level, and pregnancy history. Additional criteria, clinical tests, and sexual history are captured on all participants to insure safe blood is administered to the patients but are not included in this study. The criterion for each metric has an acceptable range that must be met by the participants to be eligible to donate blood. Any participant not meeting the required metric is deferred either temporarily or permanently based on the result. All temporary deferrals are encouraged to return at a later date but all permanent deferrals are stored in a national dataset by donor number, a unique number assigned to the participant. The secondary data used in this study was gathered on only those participants who passed the criteria and donated a blood component. The data from participants who were deferred were not included in the dataset (*N* = 1506).

Descriptive Statistics

The proportions of female and male participants were similar, with 51.5% (*N* = 2260) female and 48.5% (*N* = 2127) male (see Table 1). The participants' ages ranged from 17 to 86 years of age with a mean of 36.6 years. Twenty-five percent of all participants were 22 years of age or younger, possibly a result of high school senior blood

drives. Since ethnicity was an optional data field, only 40.5% of participants reported their ethnicity, which is categorized in Table 1. For the 1,778 participants who completed the data field, ethnicity was categorized into two groups to account for the uneven sample size proportion (see Table 2): non-Hispanic Caucasians (57.4%, *N* = 1021) and non-Caucasian (42.6%, *N* = 757). The health assessment data of the participants from the emergency period and the non-emergent period are listed in Table 3.

Table 1

Summary of Genders and Ethnicity with Percentages

All Participants	*n*	%
Gender		
Male	2127	48.5
Female	2260	51.5
Ethnicities*		
African American	162	3.7
Asian	131	3.0
Caucasian	1021	23.3
Hispanic	436	9.9
Native American	3	0.1
Other	25	0.6
Missing	2610	59.5
Total	4388	100.0

Note. *Self-reported.

Table 2

Ethnicity Classified into 2 Categories*

Ethnicities	*n*	%
Non-Caucasian	757	42.6
Caucasian	1021	57.4

*Uneven sample size population

Table 3

Health Variables of Emergent and Non-emergent participants

	Weight	Pulse	Diastolic blood pressure	Systolic blood pressure	Hemoglobin level
N	4352	4347	4347	4347	4343
Median	175.0	76.0	74.0	125.0	14.1
Range	305	96	76	107	10
Minimum	105	40	49	80	10
Maximum	410	136	125	187	20

The secondary data was comprised of donors (participants) during two specific timeframes: August 20 through September 22, 2017, and August 20 through September 22, 2016. During the 2017 timeframe, Houston, Texas experienced a severe flooding emergency event resulting in shortages of blood products in local healthcare institutions placing the patients at risk; therefore 2017 is the emergency year and 2016 is considered as the non-emergency year for comparison. The descriptive variables include the number of participants measured, the number of missing variables, and the median/mean when appropriate. The summary of health variables includes the number of participants, the mean (as appropriate), and the minimum and maximum values per category. The descriptive and health variables data used for analysis are available in Table 4, 5, 6, 7, and 8 for both the emergency year and non-emergency year. Both timeframes provide frequency data for all blood donors donating during each year.

Descriptive findings reveal that during the emergency (2017), 5.6% more female donors had no history of pregnancy when compared with female donors during the non-emergency event (53.0% versus 47.4%, respectfully). During the emergency year (2017),

there were 9.9% more females donating as compared to the non-emergency year (2016) (56.5% versus 46.6%, respectfully).

The ethnicity field on the questionnaire was significantly different for the two time periods. During the emergency year (2017), 71.4% of the participants did not report their ethnicity as compared with 47.8% who did not report race/ethnicity during the non-emergency year (2016). Participants donating during the emergency event (2017) were less likely to self-report their race/ethnicity than the non-emergency period (2016).

Table 4

Descriptive Variables: Number and Percent Reported

Emergency (2017)	Age at donation	Pregnancy history	%	Gender	%
N	2177	1187	54.5	2176	99.9
Missing	0	990	45.5	1	<1.0
Mean	35.9				
Non-emergency (2016)					
N					
	2211	992	44.9	2211	100
Missing	0	1219	55.1	0	0
Mean	37.3				

Table 5

Participants Self-reported Pregnancy History

Categorical Variable		*n*	%
Emergency (2017)			
	No	628	53.0
	Yes	559	47.0
	Total	1187	100.0
Non-emergency (2016)		*n*	%
	No	470	47.4
	Yes	522	52.6
	Total	992	100.0

Note. Only females reporting were included in percentages.

Table 6

Gender Number and Percentages

Categorical Variable	*n*	%
Emergency (2017)		
Male	947	43.5
Female	1229	56.5
Unknown	1	<.1
Total	2177	100
Non-emergency (2016)	*n*	%
Male	1180	53.4
Female	1031	46.6
Total	2211	100.0

Note. Only participants who responded were included.

Table 7

*Ethnicity Groups with Percentages**

Ethnicity Groups (2017)	*n*	%
African American	53	2.4
Asian	31	1.4
Caucasian	398	18.3
Hispanic	132	6.1
Native American	2	0.1
Other	7	0.3
Missing	1554	71.4
Total	2177	100.0

Ethnicity Groups (2016)	*n*	%
African American	109	4.9
Asian	100	4.5
Caucasian	623	28.2
Hispanic	304	13.7
Native American	1	0.0
Other	18	0.8
Missing	1056	47.8
Total	2211	100.0

Note. *Self-reported.

Table 8

Summary of Health Variables

Emergency (2017)	Weight	Pulse	Diastolic	Systolic	Hgb level
N	2161	2164	2164	2164	2159
Mean	181.63	77.1	75.0	125.6	14.3
Minimum	105	48	49	80	10
Maximum	410	126	109	180	20
Non-emergency (2016)					
N	2155	2183	2183	2183	2184
Mean	177.25	76.4	74.6	127.0	14.3
Minimum	110	40	50	82	10
Maximum	393	136	125	187	18

Hypothesis 1

Cross-tabulations using Pearson's chi-square and Cramer's V tests were conducted to examine the counts and percentages between FTDs returning to donate again and those who did not return. As shown in Table 9, the relationship was significant, χ^2 (1) = 13.038, $p < .001$, Cramer's V = .08. A greater proportion of participants who donated during the non-emergency time period (21.6%) returned as compared to the participants who donated during an emergency event (15.4%). This result indicates FTD participants were more likely to return when they first donate during a non-emergency situation. Donors donating for the first-time during an emergency were less inclined to return.

Table 9

Frequencies and Percentages for Donors who returned and did not return to donate by year.

	2016		2017				Cramer's
	n	*%*	*n*	*%*	χ^2	*p*	V
					13.04	<.001	0.08
Did not return	862	78.4_a	796	84.6_b			
Returned	238	21.6_a	145	15.4_b			

Note. Each subscript letter denotes a subset of Year of visitation categories whose column proportions differ significantly from each other at the $p < .05$ level.

Hypothesis 2

An independent samples *t*-test was conducted to compare the means of descriptive continuous variables of participants who donated for the first-time (N = 2041), using the combined emergency (2017) and non-emergency data (2016). The first-time participants were grouped according to if they returned to donate again or not. The *t*-test compared the means of the participants' ages, weights, pulse rates, diastolic and systolic blood pressure readings, and hemoglobin levels between the two groups of donors. Of the 2041 donors, 1,658 did not return to donate (81.2%) and 383 participants (18.8%) did return to donate during the combined emergent and non-emergent years. The *t*-test analysis revealed the mean age of the first-time participants who did not return (M = 33.77, SD = 15.38) was significantly different from the participants who returned (M = 28.16, SD = 14.94), $t(2039) = 6.47$, $p < .001$ (see Table 10), suggesting those who returned were younger than those who did not return. The *t*-test also compared the means of the weights of the two groups with the non-returning first-time participants having a significantly higher mean weight (M = 177.4, SD = 43.42 lbs.) than the participants who

returned (M = 170.16, SD = 40.94 lbs.), $t(2036) = 2.97$, $p = .003$. The pulse, diastolic blood pressure, systolic blood pressure, and hemoglobin levels means were found to be not significantly different between the two groups; all p's > .05 (see Table 10).

The categorical variables such as pregnancy history, gender, and ethnicity were analyzed using crosstabulation via Chi-square test to compare the frequencies and percentages of the variables associated with the FTDs' decision to return (see Tables 11, 12, and 13). According to the Pearson's chi-square and Cramer's V test analysis, there was a significant association of the pregnancy history of the first-time female donor to their return to donate again: $\chi^2(1) = 19.3$, $p < .001$, Cramer's V = .134. A higher proportion of donors who returned did not have pregnancy history (69.9%) than those who did not return (52.9%).

Additional categorical variables such as gender and ethnicity were found to have no significant relationship with the return to donate for a FTD. A Pearson's chi-square and Cramer's V test were performed to determine the relationship of gender to the donor's return: $\chi^2(1) = .003$, $p = .960$, Cramer's = .001. Since 1,554 (71.4%) of all participants did not report their ethnicity, the remaining 623 (28.6%) participants were grouped into non- Caucasian and non-Hispanic Caucasian: 46% were non-Caucasian and 54% were non-Hispanic Caucasian. The Chi-square and Cramer's V test analysis found the dichotomous variable of ethnicity participants not significantly associated with the return of the FTD: $\chi^2(1) = .130$, $p = .719$, Cramer's V = 0.012.

Table 10

Means and Standard Deviations for Donors by Age, Weight, Pulse, Diastolic and Systolic Blood Pressure and Hemoglobin

Variables		*n*	*M*	*SD*	*t*	*p*
Age at donation					6.47	<.001
	Did not return	1658	33.77	15.38		
	Returned	383	28.16	14.94		
Weight					2.97	0.003
	Did not return	1655	177.40	43.42		
	Returned	383	170.16	40.94		
Pulse					-0.45	0.655
	Did not return	1655	77.84	12.42		
	Returned	383	78.15	12.34		
Diastolic blood pressure Ψ					1.49	0.136
	Did not return	1655	74.77	10.39		
	Returned	383	73.88	10.94		
Systolic blood pressure Ψ					-1.19	0.233
	Did not return	1655	125.91	14.91		
	Returned	383	126.93	15.28		
Hemoglobin level Ψ					0.37	0.710
	Did not return	1655	14.39	1.24		
	Returned	383	14.36	1.18		

Ψ indicates equal variance not assumed

Table 11

Frequencies and Percentages for Female Donors by Pregnancy History

	No pregnancy		Pregnancy History				Cramer's
	n	*%*	*n*	*%*	χ	*p*	*V*
					19.3	<.001	0.134
Did not return	451	52.9	402	47.1a			
Returned	137	69.9	59	30.1b			

Note. Each subscript letter denotes a subset of Career donors category whose column proportions do not differ significantly from each other at the .05 level.

Table 12

Frequencies and Percentages for Donors by Gender

	F		M				Cramer's
	n	*%*	*n*	*%*	χ	*p*	*V*
					.003	0.960	.001
Did not return	859	51.8a	798	48.2b			
Returned	198	51.7a	185	48.3b			

Note. For each row category, pairs of columns proportions with the same subscript did not differ significantly from each other at the .05 level.

Table 13

Frequencies and Percentages for Donors by Ethnicity (Two categories)

	Non-Caucasian		Caucasian				Cramer's
	n	*%*	*n*	*%*	χ	*p*	*V*
					.130	.719	0.012
Did not return	337	45.7	400	54.3			
Returned	71	47.3	79	52.7			

Hypothesis 3 (All donors Emergent and Non-emergent combined.)

A logistic regression was performed on the combined donor datasets of all donors during non-emergency (2016) and emergency (2017) timeframes to determine what factors may predict if donors would return to donate again. The potential predictors were the demographic and health variables obtained at donation. Overall, the model was significant, (χ^2 (8) = 34.1, $p < .001$, Nagelkerke R^2 = .087). The analysis found younger participants were more likely to return than older participants (odds ratio = .955, p = 0.001). The participants' weight, pulse rate, blood pressures, and hemoglobin levels were all determined to be insignificant predictors of participants' likelihood to return to donate. In addition, the participants' pregnancy history and ethnicity were not predictive variables of the likelihood of their return to donate. Only the continuous variable of "Age at donation" was analyzed to be a significantly predictive variable among the eight variables (see Table 14).

Table 14

Summary of Logistic Regression Predicting Donor's Decision to Return or Not Return

Emergent and Non-emergent	Beta	Odds Ratio	95% C.I.for EXP(B) Lower	Upper	*p*
Age at donation	-.046	.955	.931	.981	.001
Weight	-.004	.996	.989	1.004	.322
Pulse	-.010	.990	.971	1.010	.323
Diastolic blood pressure	-.021	.979	.950	1.010	.178
Systolic blood pressure	.020	1.021	.998	1.044	.077
Hemoglobin	.043	1.044	.767	1.421	.784
Pregnancy history	.211	1.234	.650	2.345	.520
Ethnicity	.026	1.027	.617	1.708	.919

Note. Variable(s) entered on step 1: Age at donation, Weight, Pulse, Diastolic blood pressure, Systolic blood pressure, Hemoglobin, Pregnancy history, Ethnicity.

(χ^2 (8) = 34.1, *p* <*.001*, Nagelkerke R^2 = .087).

Logistic regressions were performed on each year independently to assess if donors during the emergency event had different descriptive or health variables influencing their decision to return as compared to the year with no emergency event (see Table 11). Overall, the model for emergency year (2017) was significant, χ^2 (8) = 18.9, *p* < .05, Nagelkerke R^2 = .193. Of the nine variables studied, the results suggest younger aged participants (odds ratio = .901, *p* = 0.008), participants with lower diastolic blood pressure readings (odds ratio = .925, *p* = 0.039) and participants with higher systolic blood pressure (odds ratio = 1.066, *p* = 0.029) were statistically significant predictors of

participants inclined to return to donate following an emergency event. Although these health criteria have acceptable ranges for participants to qualify as donors, the emergency donors had lower diastolic blood pressures and those who have higher systolic blood pressures were more inclined to return to donate at a later date. The remaining variables of participants' weight, pulse rate, history of pregnancy and participants' ethnicity were found to not be significant predictors of career donors (see Table 15).

Table 15

Summary of Logistic Regression Predicting Emergency Donor's Decision to Return or Not Return (2017)

Emergency	Beta	Odds Ratio	95% C.I.for EXP(B) Lower	Upper	*p*
Age at donation	-.104	.901	.835	.973	.008
Weight	.003	1.003	.988	1.019	.670
Pulse	.011	1.011	.962	1.063	.658
Diastolic blood pressure	-.078	.925	.860	.996	.039
Systolic blood pressure	.064	1.066	1.007	1.128	.029
Hemoglobin	.440	1.552	.795	3.030	.198
Pregnancy history	-.918	.399	.079	2.017	.267
Ethnicity	-.376	.687	.201	2.345	.549

Note. Variable(s) entered on step 1: Age at donation, Weight, Pulse, Diastolic blood pressure, Systolic blood pressure, Hemoglobin, Pregnancy history, Ethnicity.

χ^2 (8) = 18.9, p <.05, Nagelkerke R^2 = .193.

A logistic regression was performed on the non-emergency (2016) participants' dataset to assess if any variables predicted the donors' likelihood to return to donate. The

model was found to be significant, $\chi 2$ (8) = 24.3, $p < .05$, Nagelkerke $R^2 = .087$ (see Table 16). Of the predictive variables, only the age of the donor was a significant predictor (odds ratio = 0.965; $p = 0.013$) indicating younger participants were more inclined to return to donate. The remaining variables, including lower weight (odds ratio = .995, $p = .274$), lower pulse (odds ratio = .987, $p = .219$), lower diastolic blood pressure reading (odds ratio .989, $p = 0.539$), higher systolic blood pressure reading (odds ratio 1.011, $p = .383$), lower hemoglobin (odds ratio = .990, $p = .957$), pregnancy history (odds ratio = 1.517, $p = 0.255$), and ethnicity (odds ratio = .687, $p = 0.549$) were found to not be significant predictors of a donor's return.

Table 16

Summary of Logistic Regression Predicting Non-emergency Donor's Decision to Return or Not Return (2016)

Non-emergency	Beta	Odds Ratio	95% C.I.for EXP(B) Lower	Upper	*p*
Age at donation	-.036	.965	.938	.992	.013
Weight	-.005	.995	.986	1.004	.274
Pulse	-.014	.987	.965	1.008	.219
Diastolic blood pressure	-.011	.989	.956	1.024	.539
Systolic blood pressure	.011	1.011	.986	1.037	.383
Hemoglobin	-.010	.990	.680	1.441	.957
Pregnancy history	.417	1.517	.740	3.110	.255
Ethnicity	-.069	.934	.520	1.675	.818

Note. Variable(s) entered on step 1: Age at donation, Weight, Pulse, Diastolic blood pressure, Systolic blood pressure, Hemoglobin level, Pregnancy history, Ethnicity.

χ^2 (8) = 24.3, $p < .05$, Nagelkerke R^2 = .087

The logistic regression analyses in the non-emergency (2016) and emergency (2017) datasets, respectively, suggest younger donors are more likely to return to donate both during an emergency event and during a non-emergency timeframe. Additionally, during an emergency event, donors with lower mean diastolic blood pressure (odds ratio = .925, p = 0.039) and higher mean systolic blood pressure (odds ratio = 1.066, p = 0.029) were more likely to donate.

Summary

Discovering the metrics that can best describe or predict donors who are more inclined to return to donate can be used by donor centers to increase donor pools and establish a more stable blood supply. According to the data, donors inspired to volunteer to donate during emergencies are less inclined to become career donors (15.4%) as compared to donors donating for the first-time during other timeframes (21.6%). Among the variables studied, the donors who returned were younger and had a lower mean weight. The females who chose to return were more inclined to have no pregnancy history as compared to those who did not return. The gender of the participants did not increase their likelihood to return to donate. In addition, during the emergency, 71.4% of all donors did not self-report their race/ethnicity as compared to the 47.8% of the donors during the non-emergency period. The comparative analysis was affected by the missing data for this ethnicity variable during the emergency period. The age of the participants was the only statistically significant predictor of a donor returning to donate during both emergency and non-emergency timeframes.

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

In the past decade, the demand for blood products has steadily increased while the number of volunteer donors has steadily declined. The shifting demographic composition of the national population is a factor to be assessed in maintaining a healthy blood inventory (Ellingson et al., 2017). The blood shortages are more dramatic during emergency events, directly affecting patient care since these blood units are needed to sustain life (ARC, 2017b). This study sought to determine the descriptive variables/characteristics of blood donors who respond to a public health emergency (severe weather) and predict conversion from FTD to career donor. The BCs can use the results of this study to design health education strategies to improve the conversion rate of donors and more effectively use resources for recruitment. The results will also assist the BCs and hospitals' BMPs to better plan and manage blood inventory and to establish a donor pool most likely to respond in an emergency.

Summary

In order to avoid critical shortages, the blood donor centers must identify characteristics of volunteers willing to donate during emergency timeframes and improve the return rate of those donors. The study included secondary data of demographics and health factors of participants who donate blood during an emergency event and compared it with similar data of participants who donated during a non-emergency time period. When a potential donor volunteers, the FDA requires a health questionnaire (source of secondary data) be completed which includes demographics, health history, travel

history, and a health assessment and which, more specifically includes the volunteer's gender, age, weight, pulse rate, diastolic and systolic blood pressure, hemoglobin level, and pregnancy history, if appropriate. Vossoughi et al. (2019) reported plasma taken from females having a positive pregnancy history increases the risk of inducing a transfusion reaction (in the recipient) known as TRALI (transfusion-related acute lung injury) as compared to males (33.85 vs. 1.59; $p < 0.001$) (p. 1). The demographics and health assessment data were used in this study to define the individuals who would be more inclined to donate and return to become career donors. The study results will help BCs and BMPs maintain resiliency in the blood inventory and meet surge demands.

The study included 4,388 participants, of which 51.5% were female and 48.5% were male, with an age range of 17 to 86 years ($M = 22$). Twenty-five percent of all the donors were 22 years of age or younger as a result of multiple high school blood drives during both time periods. Donors were measured for their weight, pulse rate, blood pressure, hemoglobin levels, and were asked for their pregnancy history (if appropriate) and race/ethnicity. All the variables had less than one percent of the data missing except race/ethnicity, which was an optional field. During the emergency event, 71.4% of all participants did not self-report their race/ethnicity as compared to 47.8% of the participants during the non-emergency timeframe. This was a 23.6% increase in the number of participants who did not self-report during the emergency event.

During the weather emergency event, 2,177 participants donated blood, of which 941 (43.2%) were FTDs. Among these FTDs, only 145 (15.4%) returned to donate after the emergency. During the non-emergency timeframe, 2,211 participants donated blood

products, of which 1,100 (49.8%) were FTDs. Among these FTDs, 238 (21.6%) returned to donate, which was a 6.2% higher return rate than during the emergency time period. Donors donating during an emergency event were less inclined to return to donate. This behavior, according to Wevers, Wigboldus, de Kort, van Baaren, and Veldhuizen (2014) suggests participants experience a reduction of social inertia when they respond to media requests for blood donations during emergencies.

Social inertia is driven by their perception of urgency, barriers, and motivations in their life. When an emergency occurs, they re-evaluate their resistance and donate but when the emergency is over, these donors do not return. They often state their most common reason for not returning as having time constraints (Wevers, Wigboldus, de Kort, van Baaren, & Veldhuizen, 2014). This suggests the level of social inertia reemerges and the possibility of donating again does not have the urgency and priority in life it once had during the emergency, therefore resulting in only 15.4% of the participants returning after the emergency versus 21.6% of participants returning after the non-emergency donation. In contrast, the non-emergency donors were initially motivated by personal values, such as obligation to help others, their perceived need for donations, and/or collectivism of community or family and friends. These personal, prosocial values and social norms increased their intention to return to donate and self-identify as blood donors reinforcing their intrinsic motivation to donate blood again for others.

Consistent with the Wevers, Wigboldus, de Kort, van Baaren, and Veldhuizen (2014) study, the emergent FTDs were less likely to return than FTDs donating during the non-emergency period. The statistically significant predictive characteristics of the

emergent career donors were that they tended to be younger with a mean age of 28 years old, with a tendency to have a higher diastolic blood pressure, and/or a lower systolic blood pressure. The wider blood pressure variation could be a result of anxiety or other factors related to the emergency event but information was not captured in this study. The study suggests young adults in their twenties should be sought after by BCs to increase the donor pool. These young adults are prime marketing and health education targets to help BCs and hospitals provide the blood required for patient safety.

Conclusion

Hypothesis 1: There is no significant difference in the percentage of first-time donor rate conversion to career donors during the emergency event as compared to the non-emergency timeframe.

Hypothesis 1 was rejected by this data: A statistically significant lower percentage of first-time emergent donors (15.4%) returned to donate again as compared to the non-emergency FTDs (21.6%). Of the 947 FTDs donating during the emergent time period (2017), 145 donors returned to donate again compared to 238 returning donors out of 1,100 total FTDs in the non-emergent timeframe (2016).

Hypothesis 2: There is no significant difference in the descriptive variables between the first-time participants who returned to donate as compared to first-time donors who did not return to donate.

Hypothesis 2 was partially rejected by this data because some of the variables differences were statistically significant while other variables were not statistically significant. An independent sample *t* test was conducted on the 2,041 first-time

participants revealing the mean age of the returning donors (M = 28.16) was statistically significantly younger as compared to those who did not return (M = 33.77). In addition, the returning participants' mean weight (M = 170.16 lbs.) was significantly lower than the mean weight of the participants who did not return (M = 177.4 lbs.). There was no significant difference in the pulse rate, blood pressure readings, and hemoglobin levels among the returning donors compared to those who did not return. Among the categorical variables, only the pregnancy history had a statistically significant result in characterizing the 1049 female FTDs. Of the 196 females returning to donate, 69.9% (N = 137) did not have a pregnancy history. Other variables such as gender and race/ethnicity were found to have no significant relationship to whether a donor returned or not.

Hypothesis 3: There are no significant predictive factors to determine if a donor will return to donate again.

Hypothesis 3 was rejected by this data. A logistic regression model was used to evaluate the health wellness and demographic variables of the 4,388 participants who donated during the two periods of August 20 through September 23 in 2016 and 2017 to determine if any variables predict if donors would return to donate. The model was found to be statistically significant (χ^2 (8) = 34.1, $p < .001$, Nagelkerke R^2 = .087), finding younger participants were more inclined to return than older participants (odds ratio = .955, $p < .05$). Of the many variables, weight, pulse, diastolic and systolic blood pressures, pregnancy history, hemoglobin levels, and race/ethnicity, none were statistically significant predictive variables to determine if the participants would return to donate again.

The logistic regression model was then applied to each year independently to assess if participants during the emergency event had variables that would statistically predict if they would return. The model for the emergency year was found to be significant, χ^2 (8) = 18.9, $p < .05$, Nagelkerke $R^2 = .193$. The study suggests younger participants (odds ratio = .901, $p < .05$), participants with lower diastolic blood pressure (odds ratio = .925, $p < .05$) and participants with higher systolic blood pressure (odds ratio = 1.066, $p < .05$) were statistically significant predictors of participants inclined to return to donate. This would imply participants responding during emergencies, although young would also have a wider variation in the range of these health variables. More information is needed to assess the clinical indications of this finding. All other demographic and health wellness variables were found to not be statistically significant as predictive factors of whether a participant would return.

Lastly the logistic regression model was applied to the data from the non-emergent year, finding the model to be statistically significant, χ^2 (8) = 24.3, $p < .05$, Nagelkerke $R^2 = .087$. The only significant predictive variable was the age of the participant (odds ratio = .965, $p < .05$), indicating younger participants were more inclined to return to donate. All other health and demographic variables were found to be insignificant in predicting the participants return during the non-emergent timeframe.

Table 17

Hypotheses Summary

Hypotheses	Nature Question	Statistical Test	Rejected Hypothesis?
1	Association between groups	Pearson's Chi square & Cramér's V̊ test	Yes
2	A comparison of group means in terms of outcomes	*T* test	Partially rejected.
3	Discover relationship between predictive variables and outcome variables	Logistic Regression	Yes

Discussion and Implications

Every year millions of lives are saved with blood products through the generosity of volunteers willing to donate their time and blood for people they may not know. The public perception is that blood products will be available should there be an emergent need, yet, BCs are challenged to meet the growing demand with a decreasing donor pool. Chung et al. (2016) stated that as blood collection decreases, the buffer between utilization and collection is narrowing, despite decreasing transfusions by hospitals. This narrowing buffer reduces the supply of inventory for emergency events, which is a public concern for disaster preparedness and unexpected utilization.

The FDA regulates the donor eligibility criteria to insure the safest blood inventory to healthcare organizations. The criteria continue to increase the number of individuals deferred either temporarily or permanently, resulting in less than 38% of the population being eligible to donate (ARC, 2018a). Yet, only 3% to 8% of this population will voluntarily donate blood or platelets (Ringwald, Zimmerman, & Eckstein, 2010). Only 50% of these donor volunteers will return to donate again, suggesting almost 50% of all blood units transfused to patients come from only 1% of the population (ARC, 2017b; Bagot et al., 2016; Chung et al., 2016; Ringwald et al., 2010). Ellingson et al. (2017) reported 1,844,000 (28.6%) FTDs and 4,604,000 (71.4%) career donors donated blood in 2015; but this is a 5.8% decrease in total donors and a 17% decrease in FTDs from 2013. The number of career donors also decreased by 0.5%, which equates to 1.7 donations per donor. A significant loss is occurring with "the Greatest Generation" donors who were highly committed to community engagement but are now aging out (Ellingson et al., 2017; Rose, 2014, p. 7). The declining number of volunteers willing to donate their blood is a public health concern (see Appendix A for graph on Donation History).

Should the current donor trends continue, BCs can expect additional challenges in donor recruitment with the redistribution of the age groups and race/ethnicities in the growing U.S. population over the next 45 years (Colby & Ortman, 2015; Rajbhandary et al., 2016; Rose, 2014). In 2014, the largest percentage of blood was donated by those aged 50-59 years (21.5%), with nearly 60% of all blood donations made by donors over the age of 40 years (Rajbhandary et al., 2016). Rajbhandary et al. (2016) reported 84.3%

of all blood donations are being drawn from career/repeat donors. In 2015, 1,464,000 blood units were collected from high school donors (16-18 years of age), which is 11.4% of all allogenic collections, while adolescents aged 16 and 17 years comprised only 2.8% of the U.S. population that year (Bloch, Mast, Josephson, Klein & Eder, 2017; Rose, 2014). According to the 2014 data from the U.S. Census Bureau, it is estimated by 2030, one in five Americans will be 65 years or over, an increase of 9 percentage points. Meanwhile, the population under 18 is projected to decline from 23% to 21% during this same period (Colby & Ortman, 2015). Although the increase is not distributed equally across all age groups, the youth population (under 18) is expected to record the lowest change (see Appendix L for Projected Population Growth). As the aged incur chronic and acute health conditions, the need for blood products will also increase. Simultaneously, the percent of young healthy donors will be decreasing in the population, resulting in the reduction of emergency blood supply.

According to the U.S. Census Bureau, the U.S. racial and ethnic sub-population percentages are expected to shift, creating a "plurality of racial and ethnic groups" by 2060 (Colby & Ortman, 2015, p. 9). The U.S. Census projects the non-Hispanic Caucasian (having the highest percent of donors) sub-population will decrease by 8.2%, while the African American sub-population will grow by 42% by the year 2060, the Hispanic sub-population by 114.8%, and the Asian sub-population by 128%. By 2044, the US will become a "majority-minority" nation with non-Hispanic Caucasians comprising less than 50% of the population (Colby & Ortman, 2015, p. 9). According to ARC (2018a), non-Hispanic Caucasians have 45% of O-positive blood while 51% of

African Americans are type O-positive and 57% of Hispanics have the type O-positive blood type (see Appendix G). Since O-positive and O-negative blood types are considered universal donors, meaning anyone regardless of blood type can receive these, it is important that O-units be available for emergencies. Unfortunately, O-positive and O-negative patients can only receive O-units and cannot receive any other type (ARC, 2018a).

As the sub-populations shift, so do the average needs of the total population, increasing the need for O-blood types. The non-Hispanic Caucasian group represents the highest percentage of donors (11/1000 population) but have the lowest percentage of O-positive blood. James et al. (2013) reported the blood donor rate for African Americans was 6/1000 population while Hispanics donor rate was 3/1000 population. These donor rates produce blood units/donation rates of "77 donations per 1000 population for non-Hispanic Caucasians, 22/1000 population for African Americans and 10/1000 population for Hispanics" (James et al., 2013, p. 87). In order to insure all subpopulations have the blood type required for emergencies, individuals from other races/ethnicities must donate to diversify and increase the inventory of blood. The percentage of O-positive and negative blood needed for emergencies will increase as the racial and ethnicity diversity increases in the population.

There were 4,388 participants in the study but only 1778 (40.5%) of them self-reported their race/ethnicity. There was significant discrepancy between the numbers of participants who divulged their race/ethnicity during the emergency event compared to non-emergency event. Although 2,177 emergency donors responded to news releases

requesting blood donors willing to donate, 1,554 (71.4%) of them did not self-report their race/ethnicity which is 1.49 times the number of non-emergency participants who did not self-declare their race/ethnicity. Shaz and Hillyer (2010) suggested that African Americans harbor a fear and distrust of the health system. The race/ethnicity field may heighten those barriers and need education as to the need of having them answered. James et al. (2013) reported that African American donors preferred race-specific marketing, and donor center community involvement to help them understand the need for blood. A study reported that African American women's primary donation motivator was an emphasis on the need for blood, especially in the treatment of sickle cell disease (James et al., 2013). A third study of African American church attendees suggested motivations centered on the need for blood and saving lives were the strongest (James et al., 2013). Culture-sensitive education in collaboration with the community may help them overcome the barriers associated with donation blood.

The race/ethnicity data field could be perceived as a barrier in recruiting donors since even during non-emergency timeframes, 1,056 (47.8%) donors out of 2,211 did not self-report their race/ethnicity. The self-declaration of race/ethnicity may also be a barrier to Hispanics since there is currently a heightened sensitivity to immigration reporting. There is a public health need to identify the donors, design culturally-sensitive education for the different groups, and diversify the donor pool to insure a larger number of blood units are collected from other than non-Hispanic Caucasians.

As healthcare institutions design disaster response plans and develop how they will function during emergencies, whether related to weather events or mass casualties,

they predict the level of blood inventory to sufficiently meet the immediate needs of the anticipated victims. Schweitzer (2018), in the aftermath of the Florida mass casualty event suggests healthcare organization plan for disasters whenever there are large crowds or events in the area to insure blood-on-the-shelf for victims. The healthcare organizations collaborate with BCs to have the blood available and expect them to maintain an established donor pool (career donors) to meet surge demands for blood. As shown in this study: the number of weather (i.e., tornadoes, hurricanes, flooding) and mass-casualty events (Boston marathon, Florida shootings) continue to increase, so do the BCs challenges to maintain an adequate donor pool to address the public health emergencies, especially when, as seen in this study, 84.6% all FTDs responding to catastrophic events do not return to become career donors. Recent mass-casualty events have demonstrated disasters have required hundreds of units already screened and ready to use (ARC, 2018b). Therefore, the blood units physically available at the immediate time of the emergency event will be the ones used to save the patients' lives. This emphasizes the public need to improve donor rates and have a safe number of units available even in non-emergency times. The BCs depend on career donors and use marketing techniques to target potential donors. The analysis predicted marketing to young donors would be the most productive use of resources.

Predicting the donors responding to the disaster would help in the marketing techniques and determining the venues used to run mobile blood drives. Although most of the variables used in the study did not predict the donors who would return as career donors, the analysis did find younger donors with a mean age of 28 years old and having

an average weight of 170.16 lbs. were more inclined to return to donate after donating during emergencies and non-emergency timeframes. The emergency donors were also predicted to have a wider range of blood pressure metrics but there was insufficient clinical evidence to capture the importance of this finding in this study. The BCs can use this analysis and design incentives to attract the young healthy adults and use motivational tools to target this group of individuals. .

Since race/ethnicity had an uneven sample size distribution, it was dichotomized into two groups, 1021 non-Hispanic Caucasian individuals (57.4%) and 757 non-Caucasian individuals (42.6%). The study had a majority of non-Hispanic Caucasians but recruitment strategies must be designed to motivate other races/ethnicities to donate blood, as well. According to James et al. (2013), African Americans said they would be most motivated by the following: being asked to donate, donation taking less than one hour, knowing it was safe to donate, and having a free blood sugar test. The barriers most affecting their failure to donate were convenience of collection site, insuring the process was safe, and fear of needles (James et al., 2013). Identifying the motivations and barriers of different groups among the young adult donors would help to increase the donor pool required to sustain a safe blood inventory and develop a more diversified donor pool.

Who are the individuals more inclined to donate during an emergency to replenish blood stocks? Are there characteristics that can be used by the BCs to more effectively provide education in anticipation of blood emergencies to increase the number of individuals who respond? Do the individuals have any characteristics that can be

targeted by marketing strategies to improve response rates? Are individuals who respond during an emergency more or less inclined to return to donate again becoming a career donor?

This study was designed to answer these questions and establish any predictive characteristics for BCs to use in education, recruitment, and retention strategies. The researcher captured and analyzed the demographic and health wellness variables of the participants (N = 2177) who responded to public announcements asking for donors during an emergency weather event. As suggested by the IBM, an individual's intention to donate blood is a reflection of their community/cultural norms regarding donating blood, their own attitude about donating, and perceived self-efficacy to donate blood (Chou & Murnighan, 2013). Guiddi et al. (2015) propose donations can be a gesture of "pure altruism" and suggests multiple motivational functions are associated with volunteerism and they weigh differently depending on the situation (p. 339). An answer to the call for blood donors during emergency events will require volunteers to weigh these motivational functions differently, resulting in some reporting to donate while others will not.

This study focused on the new volunteers who presented to donate blood for the first time during the emergency. These FTDs were monitored for one year after their first donation to capture if they became career donors. These data were compared to FTDs who donated during the same timeframe (non-emergency) the previous year in an attempt to identify characteristics particular to donors who respond during emergencies and to investigate which ones return to become career donors. Are there predictive

characteristics to help BCs with marketing strategies, maximize resources, and design public health education?

Donors and Return Donors

This study found 941 FTDs were motivated to donate during this 2017-emergency weather event and only 145 (15.4%) of these donors returned to donate again. In comparison, during the non-emergency period, 1,100 FTDs were motivated to donate while 238 (21.6%) of them retuned to donate. The findings suggest FTDs donating during emergency events are less inclined to return to donate as compared to FTDs who donate during non-emergency events. The findings from this study are consistent with the Bednall et al. (2013) study; personal motivators weigh more heavily on the individual's decision to donate rather than external forces or social pressures. Bednall et al. (2013) suggest altruism, community engagement, and collectivism (friends and family) are some of the strongest motivators for FTDs and continue to be once they become career donors. Therefore, once non-emergent FTDs decide to donate overcoming any perceived barriers, they are more inclined to continue to donate as career donors as demonstrated by this study. Consistent with the Livitz et al. (2017) evidence (and confirmed in this study), young adults are internally motivated to donate blood. In the Livitz et al. (2017) study, a brief motivational interview enhanced the donor's intention and motivation to donate again and may be effective on FTDs. The Livitz et al. (2017) study also suggests the "internal motivation to donate blood is thought to develop as a product of repeat donations" and may be used in retention of career donors (p. 1533). The donors donating during the non-emergency timeframe were more inclined to return to donate, which is

consistent with the concept of internal motivation that enhances donors' intention to donate (Livitz, et al., 2017).

Although multiple types of intervention strategies have been used to promote blood donations, Godin, Vézina-Im, Bélanger-Gravel and Amireault (2012) suggested the three most successful interventions are psychosocial cognition related, those emphasizing altruism, and donor reminders. The psychosocial cognition is based on increasing motivation through improving attitudes, decreasing perceived barriers, and emphasizing adherence to the social norm. This is consistent with the TPB a well-recognized model (Godin et al., 2012). Bednall et al. (2013) and Godin et al. (2012) declare most donors cite altruism as their primary reason to donate. Therefore, interventions stressing the benevolence of volunteering for those in need can be an effective approach to donor recruitment. These interventions based on altruism are found to be highly effective among women and young adults, especially if the messaging is framed as helping behavior and avoiding the loss of a life (Chou & Murnighan, 2013: Godin et al., 2012).

During the emergency, the donor center asked the news stations to stress the need for blood for the patients in the hospital and how blood can save lives. Consistent with the framing of the message around altruism, which is highly effective among women and children, this study found 9.9% more females donated during the emergency event as compared to the non-emergency event timeframe (56.5% and 46.6%, respectfully).

Consistent with this study's findings, Charbonneau et al. (2015b) submits that women tend to donate for humanitarian and altruistic reasons as well as to meet the need of blood units. The 9.9% increase of women during the 2017 emergency event confirms

the altruistic messaging did improve the response rates of women and young adults. In addition, the study concurred that the women returning to donate were more inclined to not have a pregnancy history (69.9%) as compared to those who did not return (52.9%) consistent with the Ringwald et al. (2010) findings. Ringwald et al. (2010) also found that the major reason for the low return rate of younger women was pregnancy.

Strategies and interventions. Strategies and interventions to improve donor rates among diverse groups of volunteers must address not only generational differences but also racial and ethnicity sensitive concerns to donating blood. Successful strategies may include Community Tool Box frameworks, which have been shown to be highly effective (CTB, 2018). The frameworks suggest working with communities through churches and diverse groups to develop neighborhood action plans to first identify the local needs and resources and collect information related to the problem. The groups help define and determine the root cause of the lack of donors and develop an action plan to increase participation. Their plan includes building community leadership to help with promoting and advocating the locally designed intervention. In order to sustain the initiative, community presentation are planned and presented and educational programs are enhanced for students and adults (CTB, 2018). Additional immediate strategies include reminders by using mobile APPs, emails, face-to-face, and a mix of modes of delivery found to be highly successful (Godin et al., 2012). Electronic and internet communications can be used to increase awareness and increase the number of young adult donors (Ouhbi et al., 2015).

According to this study, the target population to recruit would be the young adult population throughout the year; yet, Alfieri (2017) claimed young donors lack information and have false beliefs. An intervention based on improved public health education as provided by CTB volunteers can be started in the early years at schools to improve the future pool of donors (CTB, 2018). In addition, Alfieri (2017) suggested informing young adult donors through meetings at school, pamphlets in doctors' waiting rooms, media advertising, and other widespread communications targeted at incentivizing these young adult donors.

This study data suggested the BCs should continue to recruit FTDs during emergency events, but BCs should expect only a small percentage of those donors will return as career donors. Although 15.4% returning FTDs is lower than the non-emergency timeframe, which had 21.6% returning donors, it is still an opportunity to convert the donors to career donors and expand the emergency donor pool. Highly successful interventions such as brief motivational interviews to promote internal motivation to donate blood and face-to-face promotions have been found to be the best strategies to increase donations (Godin et al., 2012; Livitz et al., 2017). Although telephone recruitment was not as effective, it was more cost-efficient. It informs the donors of the location and times of the mobile sites providing a cue-to-action to encourage a given desired behavior and the call also eliminates one of the top barriers of knowing when and where for young donors, including African American individuals (James et al., 2013; Ringwald et al., 2010). Emails and public health education are also used effectively to recruit and retain donors, especially for younger donors.

This study identified the responding donors as young adult donors externally motivated by social norms and altruism. The majority of the donors never internalized the motivation and never returned to donate again. This allows BCs to conserve resources devoted to retaining donors responding during emergency events and reallocating those resources to promote donor recruitment during non-emergency timeframes to increase donor rates and provide health education among the young to recruit new adult donors year around.

First-Time Donors: Comparing Who Returned

The FTDs returning to donate were younger (M = 28) and had a lower mean weight (M = 170) than those FTDs who did not return to donate again (M = 34; M = 177, respectfully). In addition, this study provided data to support that females having no pregnancy history (69.9%) were more inclined to return to donate as compared to the females with a pregnancy history (30.1%), consistent with the Burgdorf et al. (2017) data. Burgdorf et al. (2017) found that female donor rates peaked at 25 years old. The decline of the female donor rates were attributed to having children of any age (Burgdorf et al., 2017). All other measured variables such as pulse rates, blood pressure metrics, hemoglobin levels, gender and race/ethnicity were not determinates of whether the FTDs returned or not, suggesting younger and lower weight individuals were more inclined to return to visit once they donated. This information can be used for marketing by the BCs to increase their FTD rates and return rates by targeting institutions with younger adults for blood drives. In addition, using healthy motivators in mobile drives near gyms and

fairs that are frequented by young adults may be used in BCs marketing strategies to inspire them to donate

Predictive Factors

The study found younger adults were statistically more inclined to donate during both an emergency and a non-emergency timeframe. The returning donors were inclined to be younger than the donor who did not return: emergency odds ratio = .901, p = .008; non-emergency odds ratio = .965, p = .013. This result is consistent with Charbonneau et al. (2015b) suggesting external influences "appearing to be more important to young donors" (p. 321). Using the IBM as a template of intention, the disaster acted as an external motivator to decrease the donor's social inertia and increase the intention to donate (Montaño & Kasprzyk, 2015). Young adults have a high degree of altruism; therefore, it is natural for them to respond to the call for blood (Bloch et al. 2017).

In addition, the diastolic and systolic variables were significantly predictive of returning donors (diastolic BP OR = .925, p = .039; systolic BP OR = 1.066, p = .029). These data suggest returning donors had lowered diastolic and higher systolic blood pressure readings compared to non-returning donors. The fact that returning donors have a wider range of health variables during an emergency event may be associated with the stress related to the emergency and not native to the individual. Additional clinical studies would be required to define the reasons. Consistent with calmer times, the blood pressure readings of the non-emergent donors were not predictive of donors' return to donate. The remaining variables of donors' gender, weight, pulse rates, hemoglobin levels, pregnancy history, and race/ethnicity were all found to not be statistically

significant in predicting returning donors in both the emergency and non-emergency logistic regression models.

In summary, the study provides statistical evidence that FTDs responding to emergency public announcements requesting blood donors are less inclined to return to become career donors once the emergency is over. The donors' attitude, perceived norm, and personal agency return to pre-storm levels and their intention to return never manifests itself. Data from this study concludes when recruiting for FTDs it is best to establish marketing strategies targeting the young adults and provide personal interviews or face-to-face interactions to increase the likelihood of their return. Public health education in schools and motivational strategies should be focused on this young adult group of individuals.

During 2009 to 2011, the supply of blood collected decreased 32.2 units from 76.2 blood units per 1,000 population to 44.0 blood units per 1,000 population. During 2011 to 2013, another decrease of 27.3 blood units per 1,000 population was experienced, dropping from 69.0 blood units per 1,000 population to 41.7 blood units per 1,000 population. During the third timeframe ending in 2015, there was a 25.1 blood unit decrease per 1,000 populations with the units falling from 60.4 blood units per 1000 population to 35.3 blood units per population. Chung et al. (2016) are concerned about this pattern of dramatic drops in collections of negative 23 (2011), negative 27.3 (2013) and negative 25.1 (2015). They state that the gap between the collected and utilized blood is becoming more narrow, making it more apparent that emergency surge demands for blood can become life threatening, since blood on the shelf is what saves lives (Ellingson,

2017) (see Appendix B for Blood Collection and Transfusion). In the Florida mass shooting, Boston marathon bombing, and the Paris bombing and shooting attacks it was units of blood available to victims during the first 24 hours that saved their lives (Schweitzer, 2018). It was the career donors who were notified to replace the empty coffers of blood. Although new donors lined up to donate, the units are useless until testing was completed two days later. This study indicates once the emergency is over, the majority of emergency-motivated donors lose their motivation to return as career donors. It is imperative that BCs recruit donors and retain them to stabilize the donor pools.

Whether the emergency is weather related or mass casualty related, all emergency preparedness plans include the assessment of blood inventories to mitigate the loss of lives during the emergencies. It is a public health need to maintain a safe, resilient, and sufficient stock of blood continuously for patients and emergencies and to maintain the pool of career donors needed to replace the reserves as quickly as possible. BCs are challenged to use different strategies to increase the donor diversity, address the barriers held by different race/ethnicity groups, and establish generational and culturally appropriate motivations. Since the FDA continues to expand the exclusion criteria for donors, there is a need to retain donors as career donors, yet the number of FTDs willing to become career donors is diminishing. Unless this cycle is broken by improving the attitude and intention of potential donors through education and improved perceived norms of blood donation, blood shortages will become more common. Chronic anemia patients (i.e., sickle cell), burn victims, chemotherapy patients, neonates, and surgery

patients will incur risks associated with insufficient blood stocks. The population is shifting in regards to age and growing minorities, therefore increasing the need for blood and certain types of blood.

Education must address the personal agency of donating blood by decreasing the fears and myths associated with donating blood per the IBM (Montano & Kasprzyk (2015). It was the intention of this study to qualify whether a weather disaster was an opportunity to introduce new FTDs to donating and to study if these FTDs would return as career donors. Although 15.4% of the FTDs did return after the emergency, it was the internalized motivated donors first donating during the non-emergency timeframe that returned at a higher percentage (21.6%). Recruitment of donors that internally motivated to donate should be an ongoing process. This study has supplied valuable information to identify donors that respond to disasters and those that will return. Also, marketing and educational materials should address diversified young donors groups to increase the donor pool and become career donors.

Limitations

The study was conducted on 4,388 participants who donated at one BC or one of its multiple mobile sites during a weather emergency (Harvey floods) and during the same timeframe the previous year. The results may not be generalizable to other types of disasters such as in tornados, fires, and other mass casualty scenarios. Also, other BCs may have different response rates even to a weather emergency depending on its victims. Since the Harvey emergency involved flooding, it is possible volunteers could not get to the mobile sites even if they were inclined to donate blood. Although since mass media

messaging and public alerts requesting volunteers to donate were frequently heard or seen on television, altruistic individuals had many choices as to how they were able to help. Some victims were trapped in their flooded homes and needed to be evacuated. Others were taken to shelters for food and comfort while still others needed medical care. Donating blood was only one of the many needs of this flooded community and the lines of blood donors seen on broadcasts may have contributed to the volunteers' barriers to donate. The altruistic volunteers had to choose among the many ways they could help and donating blood was only one option. The many options reduced the number of volunteers presenting to donate blood.

FTDs during the emergency were followed for one year to capture if they would return again. A limitation to this scenario was the fact some of the volunteers donating blood during the emergency may have relocated after the flood or may have been visiting and returned home. These donors were not captured as returning donors.

Another limitation of the study was the loss of the participants' race and ethnicity data since the data field was optional. This resulted in 71% of the FTDs responding to the emergency deciding not to answer the question as compared to the donors (47.8%) during the non-emergency timeframe. The loss of this data does not allow a stratified evaluation of responses related to race/ethnicity. An additional qualitative study is needed to capture the barriers related as to why a donor did or did not return and if a particular race/ethnic group was more inclined to return compared to other groups.

Recommendations for Health Education Research and Practice

In order to mitigate the loss of emergency blood availability, it is necessary to improve donor recruitment through effective interventions through education or increasing the donors' motivation to become career donors.

Health Education Research

Chou et al. (2013), Godin et al. (2012), Levitz et al. (2017), Fonte et al. (2017), and France, France, Carlson, Himawan et al., (2017) all suggested interventions including donor education and communication as effective methods to improve donor recruitment rates. The Community Blood Center, an Ohio State based educational program, provides education to grade school through senior year students, including donor prep sessions in anticipation of high school blood drives (Community Blood Center [CBC], 2018). This program introduces young students to the diversity of blood types and the need and use of blood in general terms to improve their perceptions about blood donors. As they get older, the education includes strategies to improve their attitude concerning donating and their perceived behavioral control belief that they can also donate blood. The program's goal is to encourage students and develop their self-efficacy to donate blood during their high school senior year (CBC, 2018). The program has been successful at increasing the donor pool in Ohio (CBC, 2018). Researchers should expand on this educational program to include culturally appropriate education for different races/ethnic groups. These presentations are effective intervention tools to be used in different socioeconomic neighborhoods and communities.

Community Tool Box volunteers working with the WHO also collaborate with community organizations and churches in educating their members on the need for blood for chronic conditions (e.g., sickle-cell anemia) and emergencies (CTB, 2018; Price et al., 2006; WHO, 2017). The Community Tool Box advocates collaborating with different cultural communities and neighborhoods to improve education, reduce fears, eliminate myths, and build trust in the BCs. It is important to include local leadership in helping the communities understand the health needs for blood in their neighborhoods and better health outcomes related to designing an intervention to address those needs locally.

Young Adults' Interventions

As confirmed in the study, it is during the young adults' twenties in which they are motivated to start donating blood and become career donors, yet there is a need to identify additional motivations and incentives for this age group. Livitz et al. (2017) suggested brief motivational interviews with young adults may increase their intrinsic motivation and intention which is consistent with Quéniart (2013) suggestion that young adults are more inclined to adopt health behaviors for life (Quéniart, 2013). Recruiting them in this stage of life may motivate them to embrace being a donor career throughout their lives (Alfieri, 2017).

Livitz et al. (2017) reported that communication with the young adult donors is a highly effective intervention to move them to an intention to donate and retain the donors. Livitz et al. (2017) and Montano & Kasprzyk (2015) recommended a brief motivational interview could be highly effective to increase their intrinsic motivation and help them to self-identify as blood donors consistent with the IBM theory.

Evidence-Based Steps to Improve Donor Recruitment

As the number of donors decreases and BMPs optimize their utilization plans, BCs in several countries are designing different strategies to increase the number of donors and meet their blood utilization needs. Examples are given below.

Smaller blood units. Currently, donors contribute 550cc of blood after being screened and meeting the minimum hemoglobin levels, and weight requirements. The FDA established minimums are consistent with the normal reference ranges used by healthcare institutions; the ranges do not take into account the variations that can occur among different races/ethnicity groups. In Taiwan many willing donors do not meet the height and weight requirements, therefore, Taiwanese BCs allow these smaller donors to donate a half-bag (250 cc) of blood increasing the donor pool. The adoption of this "half-bag" process could be extended to the willing donors of African descent who do not meet the hemoglobin requirement established by the FDA. Schechter (2006) confirmed that African Americans normally have slightly lower mean hemoglobin than did the Caucasian group. Therefore, healthy African American potential donors, especially women, may not meet the FDA established normal range and are deferred. Changing the amount of blood to be drawn to a half-bag (250cc) would allow more African American donors (Rose, 2014).

Monetary awards. Currently the U.S. BCs abide by the FDA and WHO standards of not providing significant monetary rewards to donors who donate blood since research suggests higher risk individuals are more inclined to donate. The risk would involve higher incidence of infectious diseases being transmitted to the blood

recipient. As BCs continue to be challenged, more individuals are advocating monetary rewards or tax credits to motivate blood donations since the donor pools are decreasing and the donors are giving away an invaluable product (Lacetera et al., 2013). Lacetera et al. (2013) suggested monetary incentives are award at presenting to donate rather than at donating to diminish self-reported health misinformation. Monetary rewards given in Argentina were shown not to affect safety, and modern infectious disease testing confirms the safe product. Lacetera et al. (2013) suggested a reward system might be offered at times of greater need or emergencies (Lacetera et al., 2013).

MSM donors. Potential donors are deferred based on recent travel to endemic areas, health history, sexual partners, and other potential infectious sources such as cancer and tattoos. Men who have sex with men (MSM) were first permanently deferred in the 1980s when HIV was discovered to be transmitted by blood and fluids and could not be detected by any testing methodology. Since then the offending virus has been studied and is now detectable at nucleotide level.

The WHO (2018) reports that the prevalence of transfusion-transmissible infections in high income countries is lower for HIV (0.003%) as compared to HBV (0.03%), HCV (0.02%), and syphilis (0.05%) (see Appendix D for Prevalence of Transfusion-Transmissible Infections). This data has led countries such as the UK to reevaluate the permanent deferral of MSM donors to increase the blood donor pool and the blood inventory (Sturrock & Mucklow, 2018). Spence et al. (2016) stated that although transfusion-transmitted diseases can be linked with MSM donors, the requirement of 12 months with no exposure should mitigate the risk of transmission.

Recently the UK announced the deferral has been reduced to three months on MSM donors who had sexual contact with another man since increasing complex technology used to screen blood narrows the window of uncertainty (Sturrock & Mucklow, 2018).

The Advisory Committee on the Safety of Blood, Tissue and Organs in Great Britain consider the removal of the permanent ban on MSM individuals as a "step forward for equality and for reducing the stigma around these groups" (Sturrock & Mucklow, 2018, p. 304). Before the number of donors and blood supply decreases to critical levels, there is opportunity for researches to evaluate whether the US should move from a permanent deferral status for the MSM group to a temporary deferral one. Rose (2014) suggested "eliminating the lifelong ban on blood donations by men who have sex with men and increase the blood inventory without impacting the blood safety" (p. 4).

Mass casualty donors. Schweitzer (2018) reported a critical lesson was learned during several mass casualties including the Boston Marathon bombing, Florida shootings, and Paris bombings: the ready blood supply available at the time of the incident saved the victims injured. Since it was important to replace the blood immediately, the established career donor pools were requested to donate. Although many career donors responded, their blood units would require infectious disease testing taking at least 36-48 hours to complete. FTDs responding would also require the same testing period. Meanwhile the lives of the 107 victims from the Florida mass shootings were saved by using the immediately available 441 blood units in the first 24 hours (Schweitzer (2018).

In mass casualties such as in the case of shootings, and bombing, the volunteer response may be greater than the medical needs of the victims since there is social value for blood volunteers (donors) to be with neighbors, friends, and strangers in this community (Schmidt, 2002). Establishing a "home center" for these donors to gather would provide more donors and improve the donor experience. Educating these donors about how critical it is to have blood-on-the-shelves in disaster events can improve the recruitment of career donors.

Forecasting

The steady decline in the donor population over the last seven years has coincided with the lack of a concerted strategy to improve the donor populations. The redistribution of the U.S. population will make it even more difficult to sustain a sufficient and flexible blood inventory. The increasing number of mass casualties, shootings, and the aging of the population will challenge the BCs to supply the required blood units for the healthcare institutions.

Without a plan of intervention, blood shortages will occur and rationing to the most critical patients will be required. Elective surgeries will be postponed or cancelled due to lack of blood. Chemotherapy to fight cancer will not be administered since blood is not available to sustain the patient during critical phases of therapy. Burn victims will incur risks due to insufficient blood products and increased negative health outcomes will occur. Many lower income countries do not pre-stock their blood products but require family members and friends to donate to re-supply the blood stock. These countries have

not been able to motivate enough donors to establish a donor pool to provide blood to everyone.

Research is needed to better understand the motivations, barriers, and self-efficacy of volunteers to increase their intention to donate blood and build the number of career donors. This increase in blood inventory will mitigate the loss of lives in the healthcare environment and during emergency disasters and mass casualty events. Our blood supply depends on the generosity of volunteers/strangers since blood cannot be manufactured.

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APPENDIX A

Integrated Behavioral Model

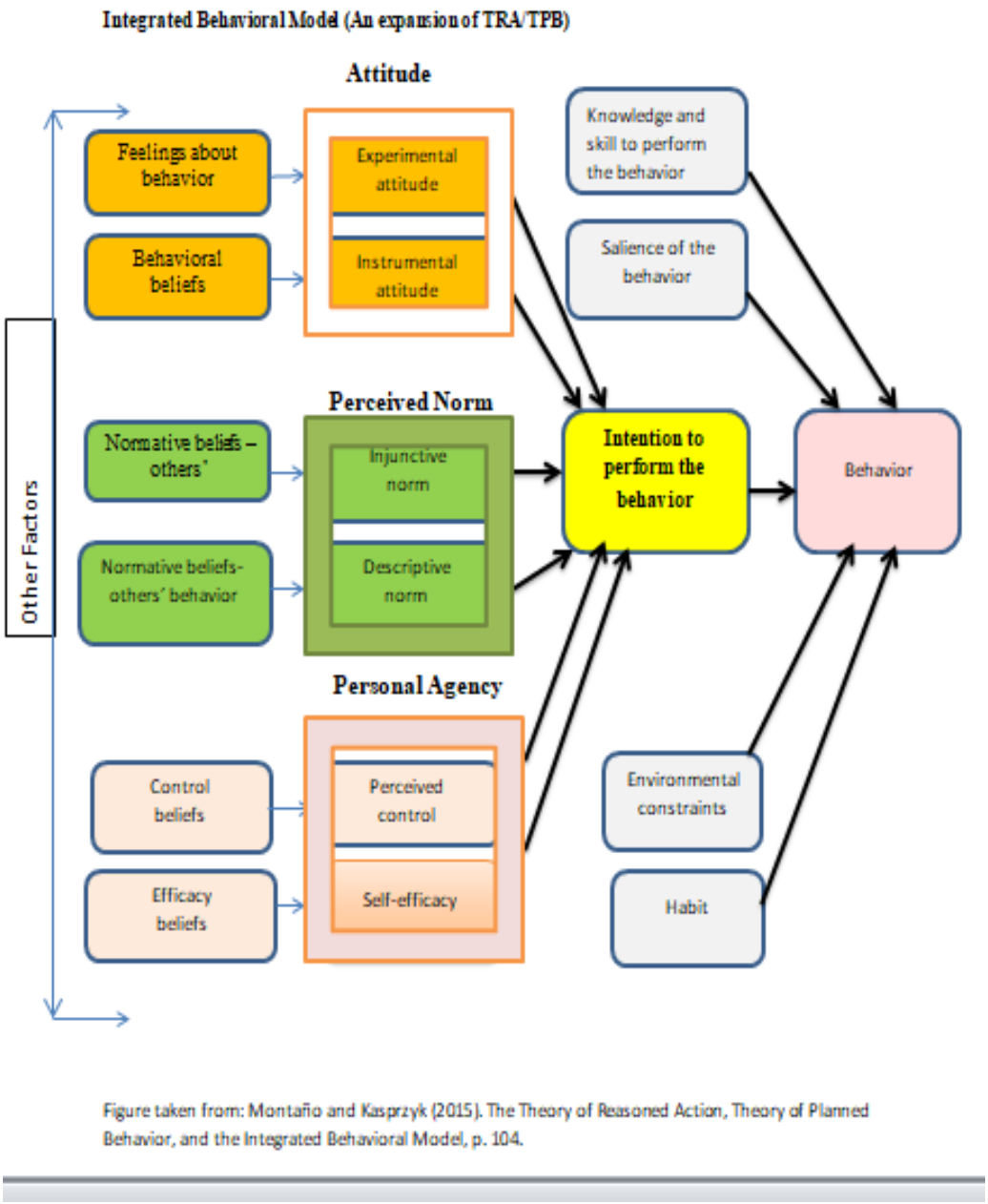

Figure 1. Integrated Behavioral Model: Montano and Kasprzyk (2015). The theory of reasoned action, theory of planned behavior, and the integrated behavioral model, p. 104.

APPENDIX B

Collection and Utilization

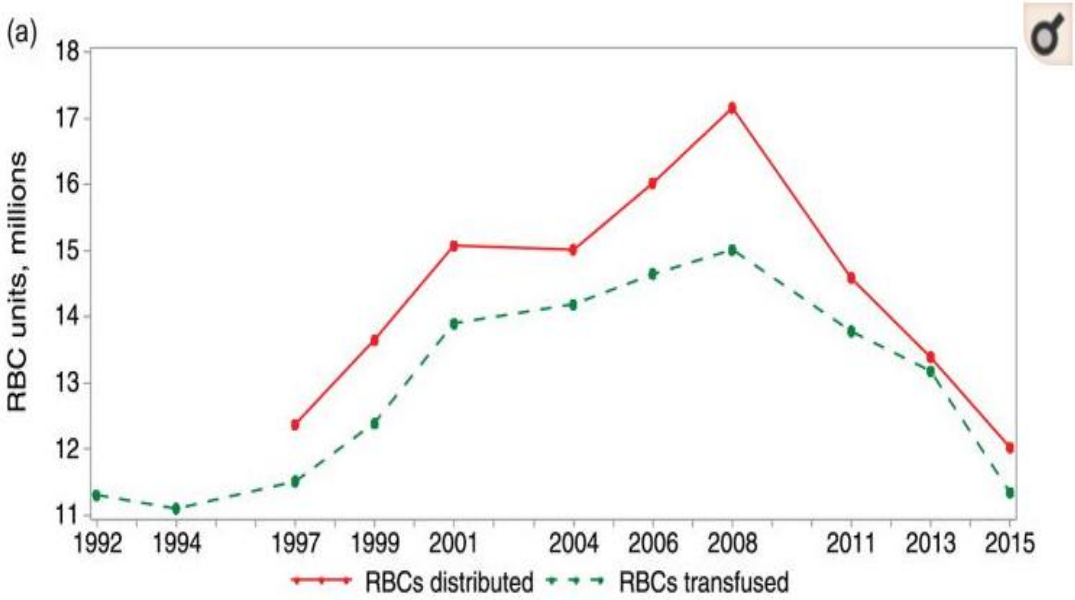

Figure 2. Collection and Utilization. Ellingson, K. D., Sapiano, M. R. P., Haass, K. A., Savinkina, A. A., Baker, M. L., Chung, K.-W., … Basavaraju, S. V. (2017). Continued decline in blood collection and transfusion in the United States–2015. *Transfusion*, *57*(Suppl 2), 1588–1598. https://doi.org/10.1111/trf.14165
Retrieved from:
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5556921/figure/F2/?report=objectonly

APPENDIX C1

Donor History Questionnaire

MDAnderson Cancer Center

Donor History Questionnaire

Please Print Clearly – Use Black / Blue Ink Only

Location: ☐ HH ☐ Main ☐ Mays ☐ Mobiles: ☐ Huskies ☐ Rockets ☐ Texans

Site:

MDA Employee: ☐ No ☐ Yes

Unit Number

Date	Last Name	Legal First Name	Gender ☐ M ☐ F	Date of Birth / /	Ethnicity ☐ C ☐ B ☐ H ☐ A ☐ N ☐ O

Local Address (Street, P.O. Box, etc)	Apt#	City	State	Zip Code	Local Phone	Alternate Phone	Email

Photo ID checked by: | Beneficiary Name and MRN:

PHYSICAL EXAMINATION

Vital Signs	Hemocue #	Hgb (≥ 12.5 g/dl) Females Hgb (≥ 13.0 g/dl) Males	Temperature (≤ 99.5° F)	Pulse (50 – 100 / min)	Weight-Lbs	B/P (90-180 / 50-100 mm Hg):	Height	Screener
First								
Second								

Arms Suitable: ☐ Yes ☐ No | ☐ 2nd Vein Check (Prescreens Only) _____ / _____

MEDICAL HISTORY QUESTIONNAIRE

Y	N		Y	N	
		Q01. Have you read the educational materials and had your questions answered?			Q16. had a graft such as bone or skin?
		Q02. Are you feeling healthy and well today?			Q17. come in contact with someone else's blood?
		Q03. In the past 48 hours, have you taken aspirin, aspirin-like products, anti-inflammatory medications or herbal supplements?			Q18. had an accidental needle stick?
		Q04. Are you currently taking an antibiotic?			Q19. had sexual contact with anyone who has HIV/AIDS or has had a positive test for the HIV/AIDS virus?
		Q05. Are you currently taking any other medications for an infection?			Q20. had sexual contact with a prostitute or anyone else who takes money for drugs or other payments for sex?
		Q06. Are you now taking or have you ever taken any medications on the Medication Deferral List?			Q21. had sexual contact with anyone who has ever used needles to take drugs or steroids, or anything not prescribed by their doctor?
		Q07. ☐ I am Male, **FEMALE DONORS**: Have you ever been pregnant?			Q22. had sexual contact with anyone who has hemophilia or has used clotting factor concentrates?
		Q08. ☐ I am Male, **FEMALE DONORS**: In the past 6 weeks, have you been pregnant or are you pregnant now?			Q23. ☐ I am Male, **FEMALE DONORS**: had sexual contact with a male who has ever had sexual contact with another male?
		Q09. ☐ I am Male, **FEMALE DONORS**: Have you had three or more pregnancies?			Q36. ☐ I am Female, **MALE DONORS**: had sexual contact with another male, even once?
		In the past 8 weeks, have you			
		Q10. had any vaccination or other shots?			Q24. had sexual contact with a person who has hepatitis?
		Q11. have you had close contact with the smallpox vaccination site of someone else?			Q25. had or been treated for syphilis or gonorrhea?
		Q12. donated blood, platelets, plasma or granulocytes?			Q26. lived with a person who has hepatitis?
		In the past 16 weeks, have you			Q27. had a tattoo or ear or body piercing?
		Q13. donated a double unit of red cells using an apheresis machine?			Q28. been in juvenile detention, lockup, boot camp, jail, or prison for more than 72 hours?
		In the past 12 months, have you			Q29. received a cornea transplant?
		Q14. had a blood transfusion?			Q2X. **In the past 4 weeks**, have you been to any U.S. Zika risk areas?
		Q15. had a transplant such as organ, tissue, or bone marrow?			Q30. **In the past three years**, have you been outside of the United States or Canada?

Figure 3. Donor History Questionnaire

APPENDIX C2

Donor History Questionnaire (reverse side)

MDAnderson Cancer Center

Donor History Questionnaire

Please Print Clearly – Use Black / Blue Ink Only

Location: ☐ HH ☐ Main ☐ Mays ☐ Mobiles: ☐ Huskies ☐ Rockets ☐ Texans

Site:

MDA Employee: ☐ No ☐ Yes

Unit Number

Date	Last Name	Legal First Name	Gender ☐ M ☐ F	Date of Birth / /	Ethnicity ☐ C ☐ B ☐ H ☐ A ☐ N ☐ O

Local Address (Street, P.O. Box, etc)	Apt#	City	State	Zip Code	Local Phone	Alternate Phone	Email

Photo ID checked by:	Beneficiary Name and MRN:

PHYSICAL EXAMINATION

Vital Signs	Hemocue #	Hgb (≥ 12.5 g/dl) Females Hgb (≥ 13.0 g/dl) Males	Temperature (≤ 99.5° F)	Pulse (50 – 100 / min)	Weight-Lbs	B/P (90-180 / 50-100 mm Hg):	Height	Screener
First								
Second								

Arms Suitable: ☐ Yes ☐ No

☐ 2nd Vein Check (Prescreens Only) _____ / _____

MEDICAL HISTORY QUESTIONNAIRE

Y	N		Y	N	
		Q01. Have you read the educational materials and had your questions answered?			Q16. had a graft such as bone or skin?
		Q02. Are you feeling healthy and well today?			Q17. come in contact with someone else's blood?
		Q03. In the past 48 hours, have you taken aspirin, aspirin-like products, anti-inflammatory medications or herbal supplements?			Q18. had an accidental needle stick?
		Q04. Are you currently taking an antibiotic?			Q19. had sexual contact with anyone who has HIV/AIDS or has had a positive test for the HIV/AIDS virus?
		Q05. Are you currently taking any other medications for an infection?			Q20. had sexual contact with a prostitute or anyone else who takes money for drugs or other payments for sex?
		Q06. Are you now taking or have you ever taken any medications on the Medication Deferral List?			Q21. had sexual contact with anyone who has ever used needles to take drugs or steroids, or anything not prescribed by their doctor?
		Q07. ☐ I am Male, **FEMALE DONORS**: Have you ever been pregnant?			Q22. had sexual contact with anyone who has hemophilia or has used clotting factor concentrates?
		Q08. ☐ I am Male, **FEMALE DONORS**: In the past 6 weeks, have you been pregnant or are you pregnant now?			Q23. ☐ I am Male, **FEMALE DONORS**: had sexual contact with a male who has ever had sexual contact with another male?
		Q09. ☐ I am Male, **FEMALE DONORS**: Have you had three or more pregnancies?			Q36. ☐ I am Female, **MALE DONORS**: had sexual contact with another male, even once?
		In the past 8 weeks, have you			
		Q10. had any vaccination or other shots?			Q24. had sexual contact with a person who has hepatitis?
		Q11. have you had close contact with the smallpox vaccination site of someone else?			Q25. had or been treated for syphilis or gonorrhea?
		Q12. donated blood, platelets, plasma or granulocytes?			Q26. lived with a person who has hepatitis?
		In the past 16 weeks, have you			Q27. had a tattoo or ear or body piercing?
		Q13. donated a double unit of red cells using an apheresis machine?			Q28. been in juvenile detention, lockup, boot camp, jail, or prison for more than 72 hours?
		In the past 12 months, have you			Q29. received a cornea transplant?
		Q14. had a blood transfusion?			Q2K. **In the past 4 weeks**, have you been to any U.S. Zika risk areas?
		Q15. had a transplant such as organ, tissue, or bone marrow?			Q30. **In the past three years**, have you been outside of the United States or Canada?

Figure 4. Donor History Questionnaire (reverse side)
Figure 3 and 4: M. D. Anderson Cancer Center. (2017). *Donor history questionnaire*.

APPENDIX D

Prevalence of Transfusion-Transmissible Infections in Blood Donations

Table 18.

Prevalence of Transfusion-Transmissible Infections in Blood Donation (Median, Interquartile range), by Income Groups.

Income Group	HIV	HBV	HCV	Syphilis
High-income countries	0.003%	0.03%	0.02%	0.05%
	(0.001% - 0.04%)	(0.008% - 0.18%)	(0.003% - 0.16%)	0.005% - 0.26%)
Upper middle-income countries	0.08%	0.39%	0.21%	0.31%
	(0.006% - 0.2%)	(0.16% - 0.69%)	(0.05% - 0.42%)	(0.12% - 1.07%)
Lower middle-income countries	0.20%	1.60%	0.40%	0.58%
	(0.05% - 0.44%)	(0.94% - 4.13%)	(0.19% - 1.5%)	(0.18% - 1.47%)
Low-income countries	1.08%	3.70%	1.03%	0.90%
	(0.56% - 2.69)	(3.34% - 8.47%)	(0.67% - 1.80%)	(0.31% - 1.88%)

Note. These differences reflect the variation in prevalence among populations who are eligible to donate blood, the type of donors (such as voluntary unpaid blood donors from lower risk populations) and the effectiveness of the system of educating and selecting donors.

Table 1. Prevalence of Transfusion-Transmissible Infections in Blood Donations. World Health Organization (WHO). (2019). Blood transfusion safety, and availability. Retrieved 08.20.2019 http://www.who.int/news-room/fact-sheets/detail/blood-safety-and-availability

APPENDIX E

Allogenic Donor History

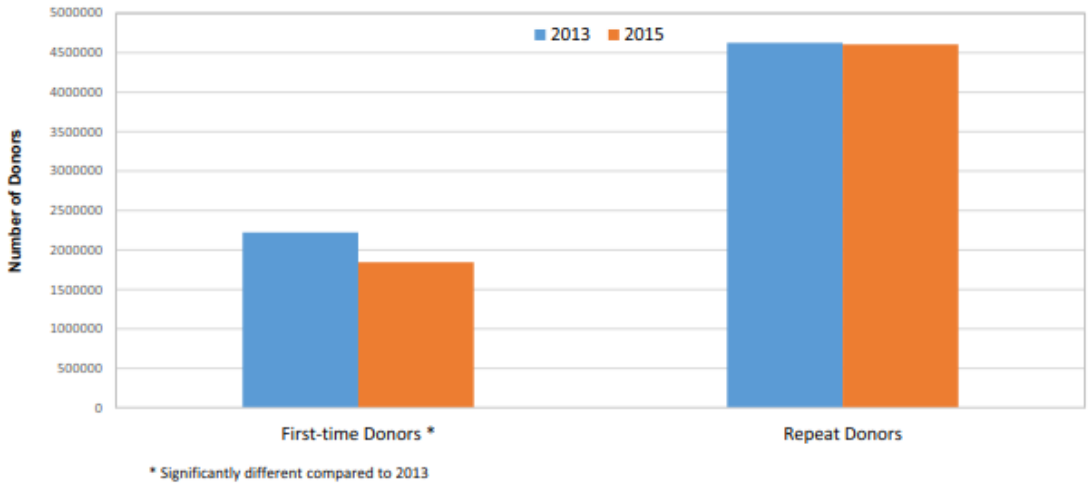

Figure 4-7. Allogeneic donors by donation history.

Figure 5. Allogenic Donor History. Rajbhandary, S., Whitaker, B. I., & Perez, G. E. (2018). *The 2014-2015 AABB blood collection and utilization survey report*. AABB.

APPENDIX F

Distribution of U.S. Population

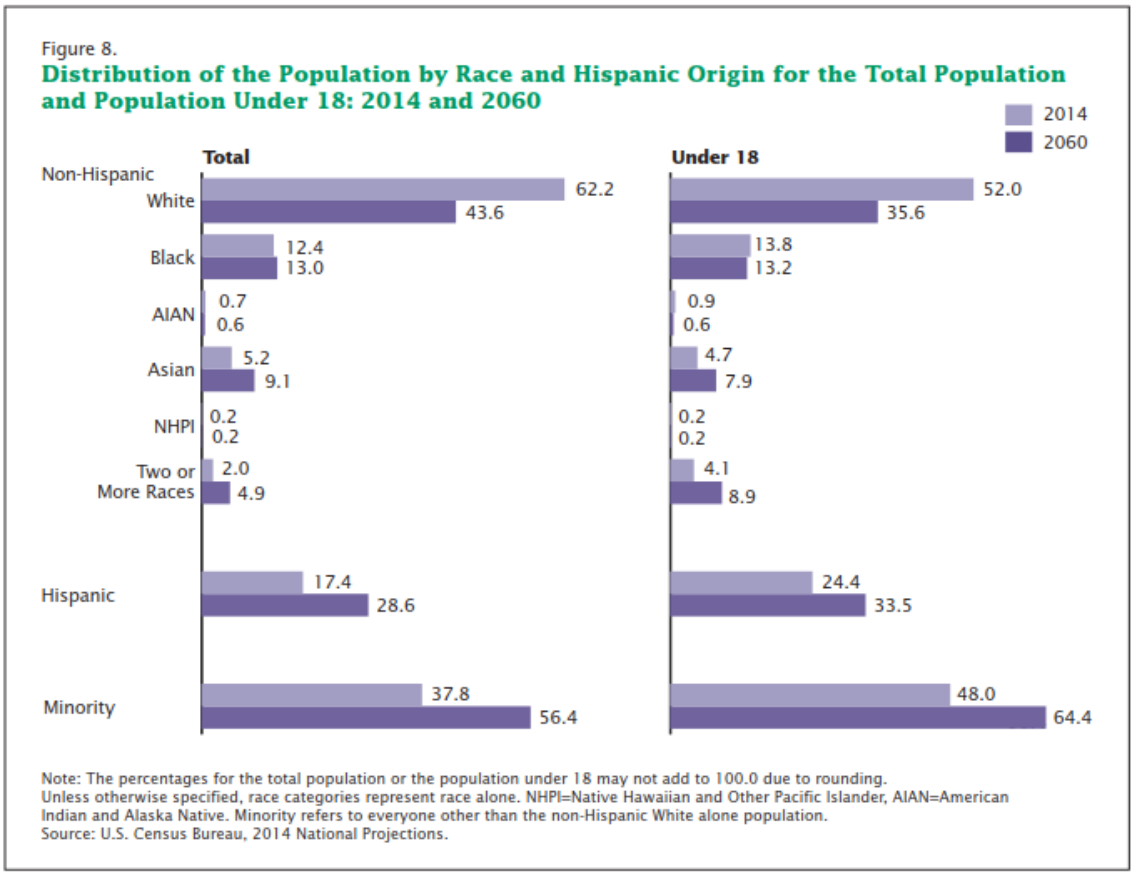

Figure 6. Distribution of U.S. Population. Colby, S. L., & Ortman, J. M. (2015, March). Projections of the size and composition of the U.S. population: 2014 to 2060. U. S. Census Bureau. Retrieved from https://www.census.gov/content/dam/Census/library/publications/2015/demo/p25-1143.pdf

APPENDIX G

Blood Type Distribution

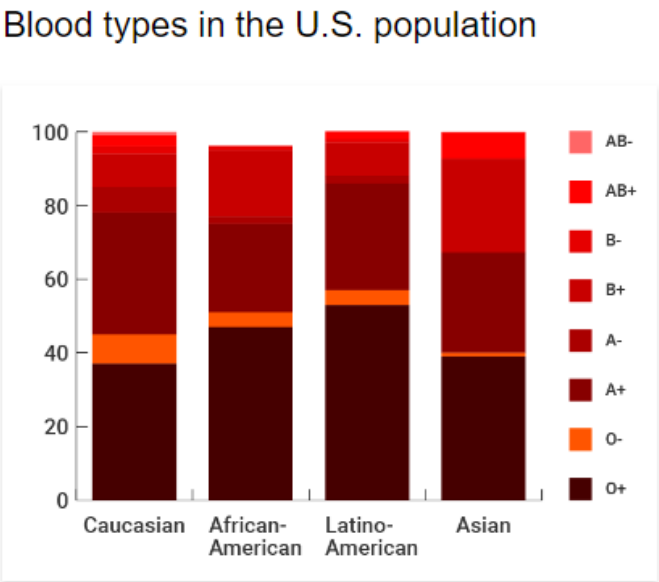

Figure 7. Blood Type Distribution. American Red Cross (ARC). (2018a). Blood Needs & Blood Supply. Retrieved September 3, 2018, from https://www.redcrossblood.org/donate-blood/how-to-donate/how-blood-donations-help/blood-needs-blood-supply.html

APPENDIX H

Distribution of RBCs and Platelets per Specialty

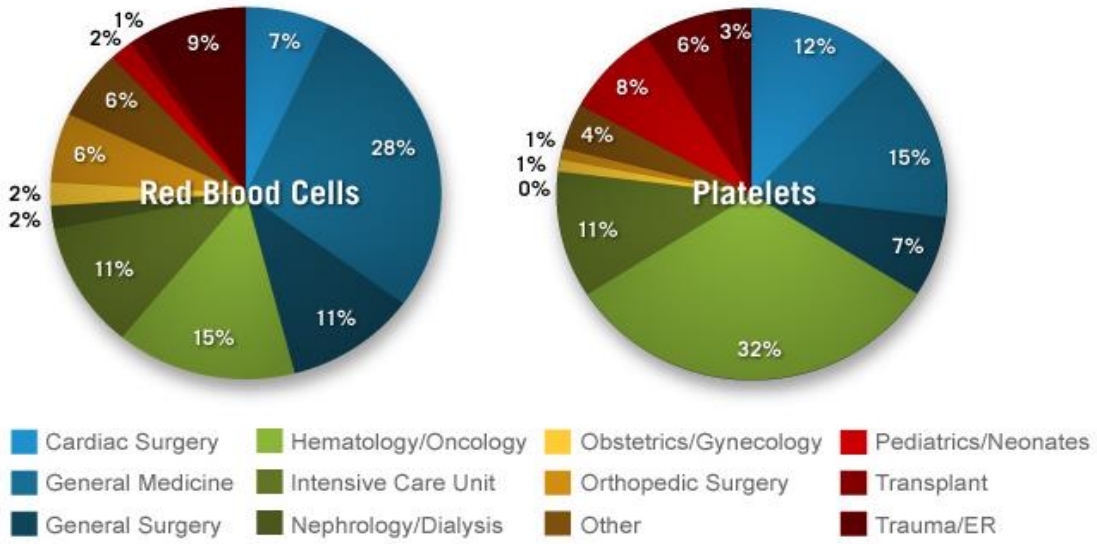

Figure 8. Distribution of RBCs and Platelet per Specialty. America's Blood Centers (ABC). (2018). Retrieved September 3, 2018, from http://www.americasblood.org/about-blood/facts-figures.aspx

APPENDIX I

Theory of Self-Determination

Nonself determined ← → Self-determined

Type of Motivation	Amotivation	Controlled (External) Motivation		Autonomous (Internal) Motivation		
Type of Behavior Regulation	**Non-regulation**	**External regulation**	**Introjected regulation**	**Identified regulation**	**Integrated regulation**	**Intrinsic regulation**
Reason for Acting	NA (No intent to act)	To gain rewards or avoid punishments	To gain others' approval or avoid guilt	Because it is important and has value	Because it is consistent with my goals and values	Because it is inherently enjoyable and satisfying.
Blood Donor Identity Survey (sample items)	"I really do not think about donating blood"	"I donate blood for thank-you gifts, such as T-shirts or water bottles."	"I would feel bad about myself if I did not donate blood."	"Donating blood is very important for the health of others."	"Donating blood is consistent with my life goals."	"I enjoy donating blood."

Figure 9. Theory of Self-Determination" self-determination theory continuum with the associated types of motivation, types of behavior regulation, reasons for acting, and samples items from the Blood Donor Identity Survey" as per France, C. R., France, J. L., Carlson, B. W., Frye, V., Duffy, L., Kessler, D. A., … Shaz, B. H. (2017). Applying self-determination theory to the blood donation context: the blood donor competence, autonomy, and relatedness enhancement (blood donor CARE) trial. *Contemporary Clinical Trials*, *53*, 44–51. https://doi.org/10.1016/j.cct.2016.12.010

APPENDIX J1

Disaster Education Poster #1

Figure 10. Disaster Education Poster #1. Community Blood Center (CBC). (2018). Educational programs of Community Blood Center. Retrieved November 28, 2018, from http://givingblood.org/educational-programs.aspx

APPENDIX J2

Disaster Education Poster #2

Figure 11. Disaster Education Poster #2. Community Blood Center (CBC). (2018). Educational programs of Community Blood Center. Retrieved November 28, 2018, from http://givingblood.org/educational-programs.aspx

APPENDIX J3

Disaster Education Poster #3

Figure 12. Disaster Education Poster #3. Community Blood Center (CBC). (2018). Educational programs of Community Blood Center. Retrieved November 28, 2018, from http://givingblood.org/educational-programs.aspx

APPENDIX J4

Disaster Education Poster #4

Figure 13. Disaster Education Poster #4. Community Blood Center (CBC). (2018). Educational programs of Community Blood Center. Retrieved November 28, 2018, from http://givingblood.org/educational-programs.aspx

APPENDIX K

Comparison of Study Variables

Nature of Question	Number of Independent Variables	Number of Dependent Variables	Number of Control Variables	Type of Score IV/DV Variables	Distribution Of scores	Statistical Test	What the test yields
Association Between groups	1	1	0	Categorical/ categorical	Non-normal	Chi-square	An association between two variable measured by categories
Group comparisons	1 or more	1	0	Categorical/ Continuous	Normal	t-test	A comparison of two groups in terms of outcomes
Relate Variables	2 or more	1	0	Continuous/ Continuous	Normal	Logistic Regression	Discover relationship between predictor variables (IVs) and on outcome variable (DV). Provides relative prediction of one variable among many in terms of the outcome.

Figure 14. Comparison of Study Variables
Note. Analysis in this study was performed on both continuous and categorical values to best determine the characteristics of FTDs and returning donors.

APPENDIX L

Growth Forecast for U.S.

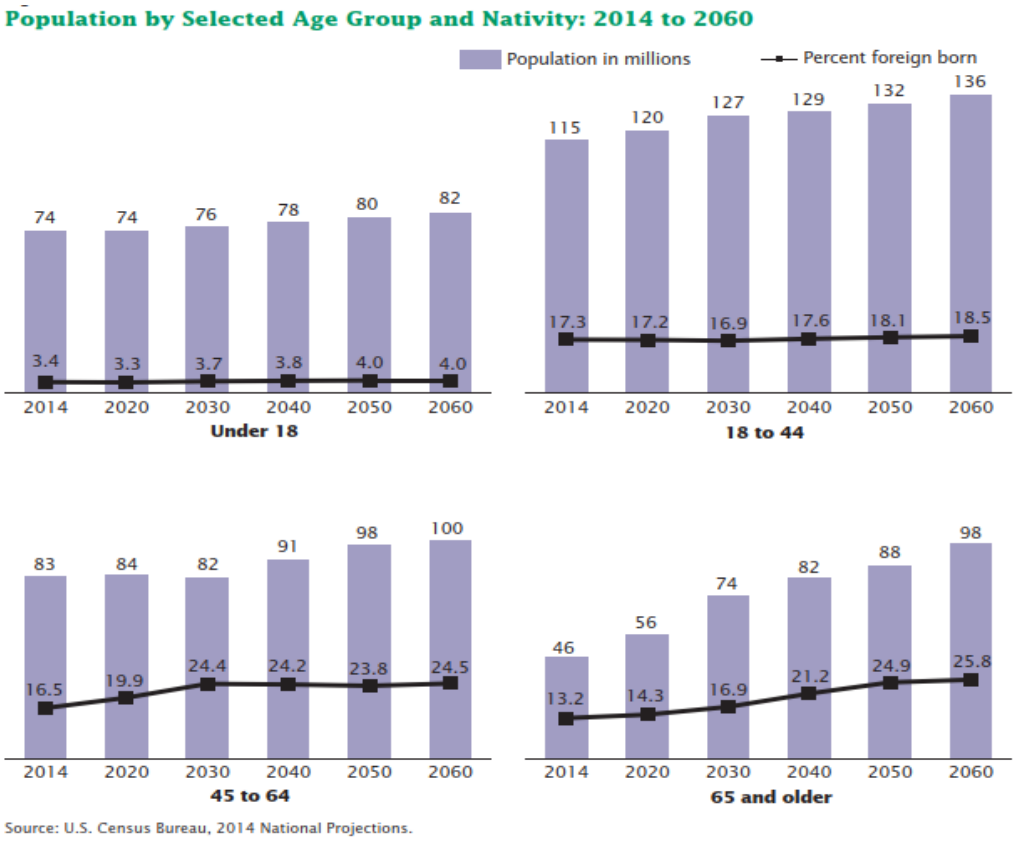

Figure 15. Growth Forecast for U.S. Colby, S. L., & Ortman, J. M. (2015, March). Projections of the size and composition of the U.S. population: 2014 to 2060. U. S. Census Bureau. Retrieved from https://www.census.gov/content/dam/Census/library/publications/2015/demo/p25-1143.pdf