HHS Public Access

Author manuscript

Transfusion. Author manuscript; available in PMC 2019 September 10.

Published in final edited form as:

Transfusion. 2017 June ; 57(Suppl 2): 1599–1624. doi:10.1111/trf.14168.

Supplemental Findings from the National Blood Collection and Utilization Surveys, 2013 and 2015

Mathew R. P. Sapiano[1,2], **Alexandra A. Savinkina**[1,3], **Katherine D. Ellingson**[1,4], **Kathryn A. Haass**[1], **Misha L. Baker**[1,5], **Richard A. Henry**[6], **James J. Berger**[6], **Matthew J. Kuehnert**[1], **Sridhar V. Basavaraju**[1]

[1]Office of Blood, Organ, and Other Tissue Safety, Division of Healthcare Quality Promotion, National Center for Emerging and Zoonotic Infectious Diseases, Centers for Disease Control and Prevention

[2]Surveillance Branch, Division of Healthcare Quality Promotion, National Center for Emerging and Zoonotic Infectious Diseases, Centers for Disease Control and Prevention

[3]Oak Ridge Institute for Science and Education

[4]The University of Arizona College of Public Health

[5]Northrop Grumman Corporation

[6]Office of HIV/AIDS and Infectious Disease Policy, Office of the Assistant Secretary for Health, U.S. Department of Health & Human Services

Keywords

Donors; PLT Transfusion; RBC Transfusion

KEY FINDINGS

- The largest change in RBC use between 2013 and 2015 occurred in surgical settings, with a statistically significant decrease of 41.5%. RBC use was unchanged from 2013 to 2015 in critical care and emergency department settings. There was a statistically significant increase in the number of PLT units used in critical care settings, however, there were no statistically significant changes in PLT use in other settings.
- The number of donations and donors presenting for donation have decreased steadily since 2011. In 2013 and 2015, a greater proportion of donors were

Corresponding Author. Mathew R. P. Sapiano, PhD, Division of Healthcare Quality Promotion, National Center for Emerging and Zoonotic Infectious Diseases, Centers for Disease Control and Prevention, 1600 Clifton Road, NE MS A-24, Atlanta, GA 30333, Office: 404 718 5761, lof6@cdc.gov.

Authors MS, AS, KE, KH, MB, RH, JB, MK, and SB declare no conflicts of interest.

Disclaimer: The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the U.S. Centers for Disease Control and Prevention. The use of trade names is for identification purposes only and does not constitute endorsement by the U.S. Centers for Disease Control and Prevention or the Department of Health and Human Services.

<18 years of age (13.4% in 2015), ≥65 years of age (12.4% in 2015), and repeat donors (63.6% in 2015).

- Prices paid per unit decreased for all major component categories between 2013 and 2015, with statistically significant declines in price paid per unit for leukoreduced red blood cells (median price per unit: $211 in 2015; $221 in 2013), and apheresis PLTs (median price per unit: $524 in 2015; $540 in 2013). Higher surgical volume hospitals paid the lowest prices per unit across component types.

ADDITIONAL FINDINGS

- Rates of adverse recipient reactions requiring any diagnostic or therapeutic intervention out of all transfusions were similar between 2013 (1:363) and 2051 (1:373), although there was an increase in the observed rate of reactions that were life threatening (1:41,874 in 2013 and 1:10,925 in 2015).
- In 2015, relative parity between donor adverse reaction rates was observed for manual (1:854) and automated (1:786) collections in blood centers and automated collections (1:752) in hospital-based blood centers. There was a higher reaction rate for manual collections (1:237) in hospital-based blood centers.
- In 2015, 2% of hospitals and 19% of blood centers reported genotyping for RBC antigens, although at these facilities a small proportion of all units were typed.

INTRODUCTION

Blood is a critical, life-saving resource in many clinical scenarios and ensuring the safety and adequacy of the blood supply is integral to public health and patient care. Therefore, monitoring and understanding the nature of the changes in blood collection and use are important to ensure the adequacy of the national blood supply. Blood collections and transfusions in the United States have declined since 2008.[1,2] From 1997–2011, the National Blood Collection and Utilization Survey (NBCUS) was conducted biennially by AABB, with support from the Office of the Assistant Secretary for Health (OASH) in the U.S. Department of Health and Human Services, with the primary aim of quantifying blood collection and utilization in the United States.[3–6] The survey has been conducted by the Centers for Disease Control and Prevention (CDC) in collaboration with OASH[1,2] since 2013.

In addition to questions designed to elicit the quantity of blood and blood components collected, processed, tested, distributed and transfused, the NBCUS contains several sections relevant to blood supply safety and adequacy. These include: blood donor and donation characteristics, blood inventory and supply, blood product costs, PLT-related testing, transfusion dosing, clinical use, hospital policies and practices related to transfusion services

and donor and recipient adverse reactions. The survey has been modified periodically to provide better characterization of blood collection and use and additional insight into healthcare delivery, clinical practices, and adoption of health-related technologies in the United States. The information generated from the survey has been used to guide public health policy, preparedness and emergency response efforts to ensure blood supply sustainability.[7]

Findings from the 2013 and 2015 NBCUS surveys related to collection, processing, distribution and transfusion of blood products have been published previously and in this supplement.[1,2] The remaining findings of these two surveys are presented here.

METHODS

Detailed methods of the 2013 and 2015 surveys have been published previously.[1,2] Both surveys were administered electronically through a web-based portal at CDC. All sampled facilities were sent a link to the survey (specific to their institution) through email. The survey instruments were designed to allow for reliable estimation of trends and variability in blood collection and utilization practices in comparison to previous years. The 2013 survey instrument was identical in design and content to the 2011 questionnaire and utilized analogous methodology in sample frame selection. For the 2015 instrument, the questionnaire was shortened to improve response rate and reduce respondent burden. For 2015, the sampling frame was identical to previous surveys; however, respondent follow-up, sampling, and analysis techniques were modified.

Questionnaire design

The 2013 survey instrument consisted of 16 questions related to blood donation and collection, 26 questions related to blood utilization, 3 questions related to bacterial testing of PLTs, and 15 questions related to patient blood management. The questionnaire also included sections on cord blood collections, human tissue, and cellular therapies all of which had very low response rates and are not included in this report.

The 2015 survey instrument consisted of 14 questions related to blood donation and collection and 28 questions related to blood utilization. A number of questions were included in a tabular format to enhance clarity and encourage completeness. New questions were added in 2015 pertaining to genotyping of RBC antigens at blood centers, transfusion of genotyped RBC units at hospitals, the average pool size of whole-blood derived PLTs and cryoprecipitate, and the routine prophylactic dosing of PLTs. Some questions pertaining to mobile blood drives and intravenous immunoglobulin were eliminated due to poor response in the 2013 survey. Patient blood management-related questions were included in 2013 but were not included in the 2015 survey.

Sampling Methodology

Construction of the sampling frames for both surveys followed similar methodology. Blood collection centers in the 50 states and the District of Columbia were identified from the Food and Drug Administration (FDA) Blood Establishment Registration database and from the America's Blood Centers (ABC) membership list.[8] The FDA Blood Establishment

Registration databases for the 2013 and 2015 samples were retrieved in August of 2014 and 2015, respectively. Military facilities were excluded from both surveys and the remaining non-hospital (i.e., community) and hospital-based blood collection centers were sent unique links requesting a response. Transfusing hospitals in the 50 states and the District of Columbia were identified from the American Hospital Association (AHA) annual survey database. The 2012 and 2013 AHA databases were used for the 2013 and 2015 NBCUS surveys, respectively. Hospitals performing fewer than 100 inpatient surgical procedures, military, Department of Justice, psychiatric, rehabilitation, long-term acute care, specialty treatment institutions, and facilities located in U.S. territories were excluded from the sampling frame.

For the 2013 survey, all facilities in the sampling frame were sent a survey, excluding 621 for which active contact information could not be determined which gave a total of 3549 facilities surveyed. The 2013 survey opened for participation in December 2014, and data collection concluded in March 2015. Non-respondents to the 2013 survey were contacted by email and phone prior to the March 2015 deadline to enhance response rates. In the 2013 survey, all hospitals performing more than 100 inpatient surgeries annually, as reported to the American Hospital Association, were sampled.

In the 2015 survey, 40% of hospitals performing 100–999 surgeries were randomly sampled with all other eligible hospitals sampled at 100%. This change reduced the number of facilities requiring follow-up and was consistent with survey methodology from the 2011 survey and prior years. Second, to enhance the response rate, a letter was sent by U.S. mail two months prior to the survey launch to facility administrators of each blood center and hospital included in the sample to notify them of the upcoming survey. The 2015 survey opened for participation in March 2016, and data collection concluded in June 2016. Non-respondents for the 2015 survey were contacted with a reminder by email, telephone, and U.S. mail to further boost responses. Follow-up for incomplete or inconsistent responses continued through August 2016 for the 2015 survey.

Disaggregation of responses by facilities

In 2013, hospital respondents were able to include aggregated data from multiple hospitals, which was later apportioned by surgical volume.[1] In 2015, hospital respondents were unable to submit aggregated responses for multiple facilities on a single survey as each hospital was assigned a unique survey link[2]. However, five hospital respondents included data for satellite facilities that was apportioned using the same technique used in 2013. Non-hospital blood collection center respondents entered information at the blood center level, which could include blood collection data from constituent facilities in multiple locations; no disaggregation was required, however, since all blood collection data were analyzed at the administrative blood center level.

Imputation

Missing data in both the 2013 and 2015 surveys were imputed using identical multiple imputation methodology. All imputed variables were continuous and non-normally distributed. A two-stage imputation procedure was performed for variables with distributions

skewed toward zero[9]. Per established multiple imputation logic, imputation factors were considered for each variable to assure that the variables used for imputation had similar distributions to the variables requiring imputation.[10] Imputation was only applied to variables with no more than 20% missing data among the respondents. For questions where missing data exceeded 20% of respondents, an available case analysis was used. Questions that were not weighted to the national level were also not imputed.

Imputation and weighting were used to generate national annual estimates for the total number of donations, volunteer/allogeneic donors, autologous and directed donors and recipients, plasma components distributed, recipient adverse reactions, donor adverse reactions, and crossmatch procedures. The percentage of missing data was too high for reliable imputation in the generation of national estimates for the number of pediatric transfusions and recipients, units transfused by location, and plasma components transfused; for national estimates, these variables were weighted without imputation, with weights based on the available cases to ensure a reliable national estimate. The remaining variables were not weighted and are presented as means, medians, or percentages of all responding facilities. Where appropriate, hypothesis testing was conducted using survey-based regression techniques to test for statistically significant differences between years, with p-values less than 0.05 denoting statistical significance. All analyses were conducted using SAS statistical software (Version 9.3, SAS Institute, Cary, NC).

Facility stratification

In 2013 and 2015, collection facilities were stratified into groups based on previous collection volume and hospitals were stratified based on annual inpatient surgical volume. Community-based, non-hospital blood collection centers were stratified into four categories based on the following annual RBC collection volume categories: < 50,000, 50,000–199,999, 200,000–399,000, and ≥400,000 units. Annual RBC collection volume was not available for all hospital-based blood collection centers, and so inpatient surgical volume was used as a proxy for collection volume. Hospital-based blood centers were stratified into three categories based on annual inpatient surgical volume: <1000, 1000–7999, and ≥8000 inpatient surgeries. Transfusing hospitals were stratified into six categories based on annual surgical volume: 100–999, 1000–1399, 1400–2399, 2400–4999, 5000–7999, and ≥8000 inpatient surgeries.

Responses were weighted to adjust for non-response within strata. Sample weights were calculated for blood collection centers by dividing the total number of eligible participants by the number of actual respondents for each stratum, per the stratification scheme described above. Blood collection centers with an expected collection volume of ≥400,000 units were assigned a weight of 1.0; all other collection centers and transfusing hospitals were weighted according to strata-specific inverse response rates. For transfusing hospitals, weighting was conducted in a similar manner with strata defined using surgical volume, as described above. In 2015, hospitals with 100–999 surgeries per year that had been sampled at a rate of 40% were weighted for non-response and for sampling with the exception of nine facilities in this strata that also collect blood; nine such facilities were therefore sampled at 100% following the strategy for blood collection centers and were weighted for non-response only (eight out

of nine facilities responded). Confidence intervals for national collection and transfusion estimates were calculated using the Taylor Series method.[11]

To determine whether reported differences in utilization estimates generated from the 2013 and 2015 surveys were due to differences in sampling and response rates, a subset of transfusing hospitals was created with only respondents who had completed both the 2013 and 2015 surveys. Not all hospitals from the 2013 survey could be matched, due to closures, mergers, openings or differences in sampled facilities in the 100–999 surgeries per year strata. The matched subset was used to conduct sensitivity analysis of hospital policies and practices to enhance safety of recipients of blood or blood products and pediatric transfusions.

Variables analyzed for this report

National estimates for the collection and transfusion of allogeneic, autologous and directed whole blood, apheresis red blood cells, whole blood derived and apheresis PLTs, plasma and cryoprecipitate, rejected donations, outdates, and donor deferrals have been published for both surveys.[1,2] For this report, we present the remaining information collected in 2013 and 2015 to supplement the results that have already been published.

Survey participation for 2013 and 2015 is summarized by facility type, by facility size as measured by the number of collections or surgical procedures per year, and by geographic region as defined by Public Health Service (PHS) regions. Next, donor characteristics are explored with national estimates of the number of donors stratified by age and the number of first-time and repeat donors and donations for 2013 and 2015, as well as national estimates of autologous and repeat donors, donations, recipients and transfusions for red blood cells, PLTs and plasma (where surveyed). Summary statistics are presented for cost estimates based on reports of amount paid per unit by hospitals for 2013 and 2015 for all facilities and stratified by annual surgical volume for seven component types as well as more detailed stratification of unit costs for red blood cells, apheresis PLTs and fresh frozen plasma by PHS region, hospital size as measured by number of beds and group purchasing status. Policies and practices in hospitals are summarized for 2013 and 2015, including hospital policy to transfuse only leukoreduced units, programs to treat patients who refuse transfusion on religious, cultural or personal reasons, number of transfusion safety officers on staff and retention of data on data collection errors.

National estimates of adverse reactions associated with donation or transfusions are presented for a range of transfusion-related adverse reactions and for severe donor adverse reactions associated with manual and automated collections. Patient blood management is summarized for 2013, including the percentage of facilities following various practices, standards and guidelines, and the percentage of facilities implementing various interventions pre- intra- and post-operatively. Issues related to the testing and use of PLTs are presented for 2013 and 2015, including the percentage of facilities using PLT additive solutions, the percentage of facilities performing pre-transfusion bacterial testing, and the type of pre-transfusion bacterial test used. Collection and transfusion of plasma stratified by product type is presented for 2013 and 2015.

Inventory, dosing and supply issues are presented using summary statistics to describe the following: pediatric dosing criteria for 2013 and 2015; use of various standard RBC orders for non-bleeding patients in 2013; pre-transfusion lab results by component for 2013; age of units transfused by component type for 2013 and 2015; group O red blood cells processed, distributed, transfused and outdated for 2013 and 2015; group O units on the shelf on an average day and the number of group O positive units at which the supply is critically low stratified by surgical volume for 2013 and 2015; and national estimates of the number of crossmatch procedures performed in 2013 and 2015 stratified by crossmatch procedure method. National estimates of the number of units transfused to pediatric patients and the number of pediatric transfusion recipients for 2013 and 2015 are presented. Finally, the number of RBC and PLT units transfused in 2013 and 2015, stratified by location (i.e., clinical service) within hospitals, is presented.

RESULTS

Survey participation

Since 2007, the overall response rate for the National Blood Collection and Use Survey (NBCUS) had steadily declined until 2015 (Table 1). Participation by community-based collection centers has remained steady with a response rate of at least 90% for five of the past six surveys; in 2013, the response rate for community-based collection centers was 64.8%. The largest difference in survey participation for community-based collection centers between 2013 and 2015 was among blood centers with fewer than 50,000 RBC collections annually (56.9% participation in 2013 versus 92.5% participation in 2015). Among centers with 200,000 to 399,000 RBC collections annually, the number of facilities within this category reduced from seven to four which drove the participation rate up from 42.9% in 2013 to 75.0% in 2015 (Table 2).

Response rates among hospital-based collection centers increased from 41.2% in 2013 to 71.8% in 2015 (Table 1), with the greatest increase in response among hospital-based blood collection centers performing 1000 to 7999 surgical procedures annually (35.5% in 2013 versus 73.5% in 2015) (Table 2). The response rate for hospital-based collection centers is not available for years prior to 2013. Participation among transfusing hospitals completing the utilization section was highest in 2015, when 73.9% of hospitals sampled responded to the survey (Table 1). When stratified by surgical volume, 2015 response rates for hospitals utilizing blood were within a relatively narrow range (72.3% to 75.8%). In 2013, however, the response rate among hospitals providing utilization data was 33.3%, and when stratified by surgical volume, response ranged from 26.1% to 37.5% in 2013 (Table 3). When stratified by Public Health Service (PHS) region, response rates for transfusing hospitals for the 2015 survey were highest (80.5%) for Region 2 (NJ, NY) and lowest (65.0%) in Region 9 (AZ, CA, HI, NV); in 2013, response rates were highest (39.5%) in Region 1 (CT, MA, ME, NH RI, VT) and lowest (20.0%) in Region 9 (CO, MT, ND, SD, UT, WY) (Table 4).

Donor characteristics

Table 5 shows estimates of donations and donors stratified by age category and repeat or first time donor status for 2015, 2013 and 2011. Total actual donations are defined as the number

of individuals presenting to donate excluding those who were deferred. There were fewer donations in 2015 (11,339,000; 95% CI: 10,686,000–11,989) compared with 2013 (12,869,000),[1] reflecting a continued decline since 2011, when there were 15,529,000 total donations.[6] The decrease in donations was accompanied by a slight increase in the proportion of total donations made as repeat allogeneic donations in 2015 (63.6% of donations) when compared to 2011 (61.4% of donations). The proportion of total donations made as repeat allogeneic donations could not be estimated for 2013 due to missing data and so comparison with 2011 is used where 2013 data are not available.

The number of donors decreased from 9,203,000 total individual donors in 2011[6] to 6,812,000 (95% CI: 6,343,000–7,282,000) total individual donors in 2015, which was largely driven by the decrease in repeat allogeneic donors from 6,364,000 in 2011[6] to 4,589,000 (95% CI: 4,213,000–4,966,000) in 2015. The number of first time allogeneic donors was smaller in 2015 (2,223,000; 95% CI: 2,058,000–2,388,000) than in 2011[6] (2,840,000), but increased slightly as a proportion of all donors from 30.8% to 32.6%. Table 5 displays the changes in the number of donations stratified by age as a percentage of the total donations. Donations made by persons aged 19–24 years and those aged 25–64 years declined as a percentage of all donations compared with 2013 (12.2% in 2013 to 10.9% in 2015 and 64.1% in 2013 to 63.3% in 2015 respectively). This decline was offset by donations made by the youngest and oldest donor age categories, which increased as a percentage of all donations from 2013 to 2015 (12.4% to 13.4% for donors aged 16–18 and 11.3% to 12.4% for donors aged 65 or older).

Autologous and Directed donations and transfusions

Autologous and directed donations each accounted for just 0.2% of all RBC units collected in 2015 and 0.4% of all RBC units collected in 2013 (Table 6). In both years, the question on autologous components pertained to only RBC collections, although facilities were instructed to include whole blood and apheresis collections. There was a large decrease in the number of autologous donors (52,000 in 2013 to 23,000 in 2015) and autologous donations between 2013 and 2015 (61,000 in 2013 to 25,000 in 2015). The number of autologous RBC units collected per donor declined slightly from 1.3 (2013) to 1.1 (2015). The number of recipients of autologous transfusions decreased from 25,000 (95% CI: 17,000–34,000) recipients receiving 44,000 autologous units (95% CI: 25,000–62,000) in 2013 to 9,000 (95% CI: 4,000–13,000) recipients receiving 20,000 (95% CI: 8,000–32,000) autologous units in 2015. The average number of autologous units transfused per recipient increased from 1.7 units in 2013 to 2.3 in 2015.

The number of directed units donated remained stable from 2013 to 2015. The number of recipients of directed RBC transfusions was unchanged. The number of RBC units transfused increased from 44,000 (95% CI: 25,000–64,000) in 2013 to 66,000 (95% CI: 35,000–96,000) in 2015 therefore resulting in an increase in the number of directed RBC units per recipient from 2.1 in 2013 to 2.6 in 2015. There were 9,000 (95% CI: 5000–18,000) directed red blood cells that were crossed over to the community supply in 2013. In 2013, 8,000 (95% CI: 0–18,000) directed PLT units were collected and 2,000 (95% CI:

1,000–3,000) were transfused compared with 6,000 (95% CI: 1,000–12,000) units collected and 5,000 (95% CI: 3,000–8,000) transfused in 2013.

Cost

The price paid for blood products as reported by hospitals declined in 2015 for nearly all components in comparison to 2013. The median difference reported in price paid per unit between 2013 and 2015 decreased by $10 for leukoreduced red blood cells, by $16 for apheresis PLTs, by $5 for plasma frozen within eight hours of donation, and by $6 for plasma frozen between 8 and 24 hours of donation. Declines in the reported mean price paid per unit were statistically significant for leukoreduced red blood cells and apheresis PLTs. Nonleukoreduced RBC cost was not included on the 2015 survey, but the 2013 survey shows that the mean cost of nonleukoreduced red blood cells was $10 less than leukoreduced red blood cells. The median price reported per unit of cryoprecipitate increased by $2, with a larger statistically significant increase in the mean price (Table 7).

leukoreduced red blood cells—The median price paid as reported by hospitals for leukoreduced red blood cells was $211 (IQR, $197 – $228) in 2015 and $221 (IQR, $205 – $240) in 2013 (Table 7). For both years, hospitals performing the fewest surgeries (100–999) reported paying the highest median prices for leukoreduced red blood cells, and hospitals performing the greatest number of surgeries (>8000) reported the lowest median prices (Table 8). During 2015, hospitals performing 100–999 inpatient surgeries annually reported a median price of $215 per leukoreduced RBC unit, and hospitals performing >8000 inpatient surgeries reported a median price of $208. Similarly, in 2013, hospitals performing 100–999 inpatient surgeries reported a median price of $232 and those performing >8000 inpatient surgeries reported $215.

When stratified by PHS region, the median cost reported by hospitals for leukoreduced red blood cells was lower in 2015 than in 2013 for every region (Table 9). Transfusing hospitals in PHS Region 1 (CT, MA, ME, NH, RI, and VT) reported the highest median price paid per unit for leukoreduced red blood cells during both years ($235 for 2015 and $256 for 2013). Hospitals in PHS Region 5 (IL, IN, MI, MN, OH, WI) reported the lowest median price for leukoreduced red blood cells during both years ($197 for 2015 and $206 for 2013).

Apheresis PLTs—The median price reported by hospitals for apheresis PLTs overall was $524 (IQR, $495 – $560) in 2015 and $540 (IQR, $510 – $590) in 2013 (Table 7). For both years, when stratified by annual inpatient surgical volume, hospitals performing the fewest inpatient surgeries (100–999) reported the highest median prices for apheresis PLTs, and hospitals performing the greatest number of inpatient surgeries (>8000) reported the lowest median prices (Table 8). During 2015, hospitals performing 100–999 inpatient surgeries annually reported a median price of $540 per apheresis PLT unit, and hospitals performing >8000 inpatient surgeries reported a median price of $510. Similarly, in 2013, hospitals performing 100–999 inpatient surgeries reported a median price of $550 and those performing >8000 inpatient surgeries reported $524.

When stratified by PHS region, the median cost reported per hospital was lower in 2015 than 2013 for every region, except for Region 8 (CO, MT, ND, SD, UT, WY), although the

number of hospitals contributing cost data was lowest for Region 8 in both years, and response within the region differed for each year (n=28 in 2013, and n=67 for 2015) (Table 9). Transfusing hospitals in PHS Region 10 (AK, ID, OR, WA) reported the highest median price per unit for apheresis PLTs during both years ($550 for 2015 and $573 for 2013). Hospitals in Region 7 (IA, KS, MO, NE) reported the lowest median price per unit for apheresis PLTs ($499) in 2015; and in 2013, hospitals in Region 4 (AL, FL, GA, KY, MS) reported the lowest median price per unit ($522).

Whole blood derived PLTs—Whole blood derived PLT transfusions accounted for 8.3% of all PLT transfusions, when counted as apheresis equivalent units with a median pool size of 5 in 2015.[2] The median price reported by hospitals for each unit of whole blood derived PLTs was $95 (IQR, $68 – $420) in 2015 based on 101 facilities (Table 7). Cost of whole blood derived PLTs was not asked in 2013. When stratified by annual inpatient surgical volume, hospitals performing the fewest inpatient surgeries (100–999) reported the highest median prices for whole blood derived PLTs ($159), and hospitals performing the greatest number of inpatient surgeries (>8000) reported the lowest median prices ($80) (Table 8). Larger hospitals were more likely to use whole blood derived PLT units than smaller hospitals, with 23.3% of hospitals performing the more than 8,000 inpatient surgeries reporting whole blood derived PLT usage in 2015 and only 7.5% of hospitals performing the 100 to 999 inpatient surgeries reporting whole blood derived PLT usage in 2015.

Fresh Frozen Plasma—The median price reported by hospitals for fresh frozen plasma (FFP) was $54 (IQR, $45 – $64) in 2015 and $59 (IQR, $50 – $60) in 2013 (Table 7). During 2015, hospitals performing 100–999 inpatient surgeries annually reported a median price of $60 per FFP unit, and hospitals performing >8000 inpatient surgeries reported a median price of $47. In 2013, hospitals performing 100–999 inpatient surgeries also reported a median price of $60 and those performing >8000 inpatient surgeries reported $56 (Table 8).

When stratified by PHS region, the median cost reported per hospital was lower in 2015 than 2013 for every region, except for Regions 1 and 10, which may be attributable to the small strata size in 2013 (Table 9). Transfusing hospitals in PHS Region 10 (AK, ID, OR, WA) reported the highest median price per unit for FFP in 2015 ($71), and hospitals in Region 8 (CO, MT, ND, SD, UT, WY) reported the highest price per unit in 2013 ($71). Hospitals in Region 2 (NJ, NY) reported the lowest price per unit of FFP ($49) in 2015. In 2013, hospitals in Region 2 (NJ, NY) and Region 4 (AL, FL, GA, KY, MS) reported the lowest median price per unit for FFP ($55).

Facility Characteristics—For leukoreduced red blood cells, apheresis PLTs, and FFP, the largest hospitals (≥500 beds) reported the lowest median price per unit in 2015 ($206 for LR RBCs, $517 for PLTs, and $50 for FFP) and the smallest hospitals (<200 beds) reported the highest price per unit in 2015 ($214 for LR RBCs, $530 for apheresis PLTs, and $58 for FFP). For all three components assessed, lower median prices per unit were reported by transfusing hospitals that were members of larger healthcare systems or networks, and for transfusing hospitals that participated with an in-group purchasing agreement in 2015 (Table 10).

Hospital policies/practices related to transfusion services

Table 11 displays the adoption of transfusion safety practices for transfusing hospitals that participated in the 2013 and 2015 NBCUS. The proportion of hospitals with policies to transfuse only leukoreduced components increased slightly from 76.7% in 2013 to 77.9% in 2015, with an increase of 3.0% in the matched sample. A relatively small proportion of hospitals (7.0%) had a policy to transfuse only leukoreduced components for cardiac patients only. The proportion of hospitals with programs to treat patients refusing transfusion for religious, cultural, or personal reasons increased slightly from 65.9% in 2013 to 71.6% in 2015, with a 2.1% increase in the matched sample.

The proportion of hospitals with a transfusion safety officer (TSO) on staff declined slightly from 18.0% in 2013 to 16.2% in 2015, with a 2.4% decrease in the matched sample. Of the 172 hospitals reporting a TSO in 2013, 39.0% responded that the TSO was a full time employee, and 61.0% responded that the TSO was a part time employee. The majority of TSOs (94.2% in 2013 and 94.9% in 2015) were employees of the hospitals rather than of the hospital blood center. Finally, the proportion of hospitals collecting information on sample collection errors decreased slightly from 85.3% to 83.8% in the overall sample, but increased by 1.5% in the matched sample (Table 11). The mean number of sample collection errors across responding facilities was 37.0 per facility in 2015.

In 2015, 2% of hospitals (31/1883) reported genotyping for RBC antigens in the hospital; at these hospitals, an average of 17.4% (median 2.5%) of all RBC units were genotyped. The proportion of blood centers reporting genotyping of donors was 19% (31/162); at these blood centers the average proportion of donors genotyped was 6.4% (median, 3.0%).

Adverse reactions

Estimates of transfusion-associated adverse reactions were collected for 17 different categories in 2013 and 2015. Respondents were also asked separately for the total number of reactions that required any diagnostic or therapeutic intervention and the total number of reactions considered life-threatening. Table 12 presents the total number of reactions in 2015 and 2013 with 95% confidence interval, as well as the number of reactions as a rate of the total components transfused. Estimates for 2011 are included for reference. The total components transfused decreased slightly from 20,933,000 in 2011 to 20,180,000 in 2013 with a more marked decrease to 17,398,000 in 2015. For this reason, the reaction rate is preferred for comparison between surveys.

The rate of adverse reactions out of all transfusions that required any diagnostic or therapeutic intervention was similar between 2015 (1 per 373 transfusions or 1:373) and 2013 (1:363). An even larger increase was observed in the rate of reactions that were life threatening, which rose from 1:41,874 in 2013 to 1:10,925 in 2015. The most common adverse reactions in 2015 and 2013 were febrile, non-hemolytic transfusion reactions (1:868 in 2015; 1:797 in 2013) and mild to moderate allergic reactions (1:1,201 in 2015; 1:1,150 in 2013), both of which occurred slightly more frequently than in 2011. There was a slight increase over 2011 rates in delayed serologic transfusion reaction (1:5383 in 2015; 1:6680 in 2013), transfusion associated circulatory overload (1:9015 in 2015; 1:11,150 in 2013),

hypotensive transfusion reaction (1:11,282 in 2015; 1:14,074 in 2013) and transfusion associated dyspnea (1:13,582 in 2015; 1:17,394 in 2013).

The remaining reactions are estimated to have occurred fewer than 1000 times in 2015. Of these, the rate of delayed hemolytic transfusion reactions (1:22,916 in 2015; 1:19,296 in 2013) and transfusion-related acute lung injury (1:60,280 in 2015; 1:57,500 in 2013) have remained stable whereas increases have occurred in the rate of post transfusion purpura (1:57,823 in 2015; 1:78,014 in 2013), severe allergic reactions (1:30,204 in 2015; 1:37,056 in 2013) and acute hemolytic transfusion reaction (other antibodies) (1:104,735 in 2015; 1:113,804 in 2013). Several of the reaction types were estimated to have occurred less than 100 times at the national level: Acute hemolytic transfusion reaction (ABO) (90 reactions in 2015; 71 reactions in 2013), transfusion transmitted viral infection (8 reactions in 2015; 13 reactions in 2013) transfusion transmitted bacterial infection (60 reactions in 2015; 187 reactions in 2013) and transfusion transmitted parasitic infection (16 reactions in 2015; not asked in 2013). A single case of transfusion-associated graft-vs-host disease was reported in 2015, with zero cases reported in 2013.

The number of severe donor adverse reactions associated with manual whole blood collections and automated (apheresis) collections stratified by facility type are shown in Table 13. There was a minor increase in donor adverse reactions for both manual whole blood (1:1,006 in 2013 to 1:756 in 2015) and automated collections (1:904 in 2013 to 1:784 in 2015), although the error associated with these estimates is large, as represented by the confidence interval for the combined estimates (14,577,000 reactions with a 95% CI of 11,462,000–17,692,000 in 2013 and 17,762,000 reaction with a 95% CI of 10,744,000–24,779,000 in 2015). The number of reactions among hospital-based blood collection centers in 2013 was very small (328 total in 2013 compared with 2431 in 2015), which may reflect the difficulty of estimating rare events with the low response rate of the 2013 survey. In 2015, relative parity between reaction rates was observed for manual (1:854) and automated (1:786) collections in blood centers and automated collections (1:752) in hospital-based collection blood centers with a higher reaction rate for manual collections (1:237) by hospital-based blood collection centers.

Patient blood management

The 2013 survey queried respondents on patient blood management and related transfusion safety efforts. This section was not included in the 2015 survey. Of the 899 responding facilities, 50.3% (452/899) reported having a patient blood management program (Table 14). Of respondents with a patient blood management program who answered descriptive questions about the program, 66.4% (286/431) reported participating in at least one performance benchmarking program related to transfusion medicine, 81.9% (393/480) reported providing formal transfusion training, and 29.8% (107/359) reported providing formal patient blood management.

Of those facilities that either reported having a patient blood management or other type of transfusion quality improvement program, 74.7% (434/581) listed the medical director as a patient blood management program coordinator, 29.8% (172/577) listed a nurse coordinator, 35.5% (205/577) listed a non-nursing coordinator, and 34.3% (198/577) listed other

personnel (Fig. 1). The majority (92.7%; 910/982) of facilities reported using transfusion guidelines, including College of American Pathologists (CAP; 32.3%, 293/908), AABB (72.5%, 658/908), American Society of Anesthesiologists (ASA; 2.3%, 21/908), or American Red Cross (ARC; 11.7%, 106/908) (Table 14). Of 615 reporting facilities, 70.2% (432/615) evaluated patients facing elective surgeries associated with high likelihood of blood loss for factors predictive of pre- and post-operative anemia; of those facilities, 284 answered a follow-up question with 69.4% (197/284) responding that they had a program to manage patient anemia before surgery. The ordering provider was required to obtain and document informed consent for transfusion in 94.1% (904/961) of facilities. Physicians were required to document the reason or clinical justification for transfusion in the patient's medical record at 81.9% (729/890) of facilities. Documentation of relevant pre-transfusion laboratory results for non- emergent transfusions was reported as being required at 79.1% (714/903) of facilities. A Computerized Physician Order Entry (CPOE) was reported as being required at 85.1% (847/995) of facilities, and 56.1% (474/845) of the CPOEs included transfusion guidelines or an algorithm to assist with proper transfusion ordering.

Facilities were asked to report on the interventions implemented to reduce the likelihood of allogeneic transfusion, (Fig. 2) regardless of whether they had a patient blood management program. In the pre-operative setting, interventions included a clinical assessment for anemia (reported by 41.7% (419/1,006) of facilities) or bleeding risk (38.9%; 391/1,006), laboratory assessment for anemia (48.5%; 488/1,006), enteral iron supplementation (10.6%; 107/1,006), parenteral iron supplementation (8.3%; 84/1,006), erythropoietin (10.3%; 104/1,006), and preoperative autologous blood donation (13.5%; 136/1,006).

In the intra-operative setting, interventions included acute normo-volemic hemodilution (reported by 17.2% (173/1,005) of facilities), intra-operative blood recovery (47.7%; 479/1,005), and use of topical/systemic hemostatic agents (25.1%; 252/1,005). 37.5% (377/1,005) of respondents did not know what intra-operative interventions were in place at their facility, and 11.1% (112/1,005) reported having no intra-operative interventions.

In the post-operative setting, interventions included restrictive use of transfusion (reported by 33.3% (335/1,005) of facilities), restrictive use of phlebotomy (12.3%; 124/1,005), use of topical/systemic hemostatic agents (11.5%; 116/1,005), judicious use of anticoagulants and PLT inhibitors (16.3%; 164/1,005), post-operative cell collection and re-administration (12.9%; 130/1,005), post-operative parenteral iron replacement (7.6%; 76/1,005), and erythropoiesis-stimulating agents (6.9%; 69/1,005).

Facilities were asked to report on how their hospital measured the success of strategies implemented to improve patient blood management. The majority of respondents (54.8%; 551/1,005) reported measuring success by total number of components transfused, 27.2% (273/1,005) reported measuring success by the number of transfusions per medical or surgical admission, 22.2% (223/1,005) reported another measure, 9.1% (91/1,005) reported no measures, and 20.3% (204/1,005) did not know.

PLT related considerations

In 2013, blood collection facilities were asked to indicate whether Intersol (Fenwal, Lake Zurich, IL) PLT additive solution (PAS) was used to prepare apheresis PLTs. In 2015, the question was expanded to include all PAS, with no specific question eliciting Intersol use. Only four of 113 (3.5%) facilities reported using Intersol PAS in 2013 with a mean number of treated PLTs of 43 units per facility treated with Intersol in 2013 (based on three of four facilities reporting). A greater number of facilities reported using PAS in 2015 (6.8%; 11/162 facilities) with a mean of 3,374 units using PAS per facility (Table 15).

Table 16 shows the proportion of responding facilities that conducted pre-transfusion bacterial testing of PLTs. In 2013, 46.0% (23/50) of hospital-based collection centers performed pretransfusion bacterial testing of PLTs compared with 37.9% (36/95) in 2015. Among hospitals, the percentage of facilities that performed pre-transfusion bacterial testing of PLTs in 2013 was 3.1% (27/882), compared with 2.0% (35/1782) in 2015.

Table 17 describes the testing methods reported by responding facilities for pre-transfusion bacterial testing of PLTs in community-based collection centers for 2013 and for hospitals (including hospital-based collection centers) in 2013 and 2015. As previously described in Table 16, the number of hospitals performing pre-transfusion bacterial testing of PLTs for 2013 and 2015 represents a small percentage of all hospitals (3.1% and 2.0% respectively) so that the aggregated test results in Table 16 are based on a small sample. Not all facilities that reported doing pre-transfusion bacterial testing of PLTs responded to the question on test type. In community blood banks, the most common testing method for apheresis PLTs was culture-based testing (35/42 facilities in 2013). Culture-based tests were also the most common for whole blood derived PLTs (10/42 facilities for pooled units and two facilities for single units). Rapid immunoassay was rarely used by community blood centers (one facility each for single and pooled units out of 42 facilities that performed bacterial testing of PLTs). Positive results occurred in 76 of 308,941 (0.025%) tests.

Hospitals and hospital-based blood centers that performed pre-transfusion bacterial testing of PLTs used rapid tests more often than culture-based testing for whole blood derived units, but culture-based tests were the most common test type for apheresis PLTs, aside from hospitals reporting in 2015, which reported slightly more rapid tests than culture based tests for apheresis PLTs. Among hospitals responding to this section, culture-based testing resulted in 31 positive results among 109,253 tests (0.028%) in 2013 and 15 positive results among 35,433 tests (0.042%) in 2015. Rapid immunoassay testing in hospitals led to one positive results in 5,914 tests (0.017%) in 2013 and six positive results from 4,771 tests (0.126%) in 2015. Among hospital-based blood centers responding to this section, culture-based testing resulted in 25 positive results among 83,604 tests (0.030%) in 2013 and 35 positive results among 51,722 tests (0.068%) in 2015. Rapid immunoassay testing in hospital-based blood centers led to one positive results in 363 tests (0.275%) in 2013 and two positive results from 17,008 tests (0.012%) in 2015.

Plasma-related considerations

National estimates of total plasma distributed and transfused were previously published, with 4,338,000 (95% CI: 3,432,000–5,244,000) plasma units distributed and 3,624,000 (95% CI: 3,304,000–3,943,000) plasma units transfused in 2013[1] and 3,713,000 (95% CI: 3,306,000–4,121,000) plasma units distributed and 2,727,000 (95% CI: 2,594,000–2,859,000) plasma units transfused in 2015.[2] Table 18 displays plasma distributions stratified by plasma type. The majority of plasma distributions in 2013 and 2015 were distributed as frozen between eight and 24 hours (PF24): 2,378,000 units in 2013 (95% CI: 1,954,000–2,803,000) and 2,006,000 units in 2015 (95% CI: 1,695,000–2,317,000). FFP accounted for 1,658,000 units in 2013 (95% CI: 1,251,000–2,065,000) and 1,246,000 units in 2015 (95% CI: 815,000–1,677,000). In 2013, FFP transfusions accounted for 1,436,000 units (95% CI: 1,230,000–1,641,000) whereas PF24 accounted for 1,108,000 units (95% CI: 899,000–1,318,000).

In 2015, distributions were surveyed for whole blood derived and apheresis plasma. Most plasma distributed came from whole blood collections, but the proportion of apheresis collections that were processed into FFP units (26.3%) was higher than the proportion of collections that were processed into PF24 units (6.8%). The number of units transfused as pediatric size FFP (29,000; 95% CI: 20,000–38,000 in 2015 and 28,000; 95% CI: 18,000–39,000 in 2013), jumbo size FFP (37,000; 95% CI: 15,000–59,000 in 2015 and 28,000; 95% CI: 11,000–44,000 in 2013), liquid plasma (12,000; 95% CI: 5–19,000 in 2015 and 12,000; 95% CI: 0–26,000 in 2013) and group AB plasma (223,000; 95% CI: 184,000–262,000 in 2015 and 259,000; 95% CI: 210,000–308,000 in 2013) was similar for 2013 to 2015. Additionally, in 2013, 6,825,000 (95% CI: 6,045,000–7,604,000) plasma units were distributed for further manufacture by blood centers. This question was not asked in 2015.

Inventory, dosing, and supply related considerations

In 2013 and 2015, hospitals were asked to report dosing criteria for plasma transfusions, and in 2015 hospitals were additionally asked to report dosing criteria for prophylactic and therapeutic PLT transfusions. Table 19 displays the number of facilities that used each listed dosing criteria for plasma or PLT dosing. The majority of hospitals responding to this question reported using dosage that varied based on level of thrombocytopenia or bleeding (63.8% of facilities in 2013, 67.2% of facilities in 2015) for plasma dosing. Of the remaining facilities, 8.5% of facilities in 2013 and 9.0% of facilities in 2015 reported using a standard number of units per dose for plasma, 6.3% of facilities in 2013 and 5.8% of facilities in 2015 reported using weight-based dosing for plasma and 21.4% of facilities in 2013 and 18.0% of facilities in 2015 reported using a method inconsistent with the choices given. A similar pattern was observed for PLTs (not included on the 2013 survey) with 67.0% of prophylactic PLT transfusions and 71.5% of therapeutic PLT transfusions using dosage that varied based on level of thrombocytopenia or bleeding, 12.0% of prophylactic PLT transfusions and 10.8% of therapeutic PLT transfusions using a standard number of units per dose, 1.6% of prophylactic PLT transfusions and 1.3% of therapeutic PLT transfusions using weight-based dosing and 19.4% of prophylactic PLT transfusions and 16.4% of therapeutic PLT transfusions using a method inconsistent with the choices given.

Hospitals were asked to report their average pre-transfusion laboratory test results for red blood cells (RBCs), PLTs, plasma, and cryoprecipitate. This question was not included on the 2015 survey. The mean and standard deviation (SD) from those facilities that reported lab results are shown in Table 20. Of the 1101 facilities that responded to the 2013 survey, pretransfusion lab results were provided by 433 facilities for RBCs, 363 for PLT, between 137 and 242 for plasma, and 139 for cryoprecipitate. In patients undergoing red cell transfusion, the estimated mean pre-transfusion hemoglobin was 10.2 g/dL (SD 15.0 g/dL) (Table 20). In patients undergoing PLT transfusion, the estimated mean pre-transfusion PLT count was 9,590.4/ μL (SD 17,698.2/ μL).

In patients undergoing plasma transfusion, the estimated mean pre-transfusion PT was 15.0 seconds (SD 24.9 seconds) and PTT was 59.7 seconds (SD 36.6 seconds). In patients undergoing cryoprecipitate transfusion, the estimated mean pre-transfusion fibrinogen was 108.4 mg/dL (SD 64.9 mg/dL). In 2013, 995 facilities reported their standard RBC order for non-bleeding patients. The majority of facilities (51%) reported a standard order of 2 units of RBCs, while 33% of facilities reported a standard order of 1 unit.

In 2013, the mean average age for components transfused was 18.8 (SD=7.1) days for red blood cells (508 reporting facilities), 2.9 (SD=1.1) days for whole blood-derived PLTs (84 reporting facilities), and 3.0 (SD=1.0) days for apheresis PLTs (529 reporting facilities). In 2015, the mean age of transfused components was asked based on age range categories. In 2015, 79.3% (44,240/55,798 reported units) of red blood cells were transfused between 1–35 days (185 reporting hospitals), 95.7% (11,270/11,780) of WBD PLTs were transfused at 1–3 days of age (1160 reporting facilities) and 53.0% (6,686/12,605) of apheresis PLTs were transfused at 1–3 days of age (312 reporting facilities).

In 2013, among blood collection centers that reported group O RBC collection, distribution, and outdates, on average 9.7% (SD=5.4%) of RBC units processed, 10.2% (SD=5.2%) of RBC units released for distribution, 9.7% (SD=3.4%) of RBC units distributed, and 2.6% (SD=3.4%) of RBC units outdated were group O-negative (Table 21). Among transfusing hospitals that reported group O RBC transfusion, 9.7% (SD=5.6%) of RBC units transfused in 2013 were group Onegative, and slightly increased to 10.8% (SD=7.3%) in 2015. Additionally, group O negative units accounted for on average 11.5% (SD=19.3%) of all outdated units among hospitals who reported group O outdates. In 2013, among blood collection centers that reported group O RBC collection distribution, and outdates, on average 37.9% (SD=13.7%) of RBC units processed, 39.5% (SD=12.0%) of RBC units released for distribution, 40.0% (SD=11.5%) of RBC units distributed, and 13.6% (SD=17.9%) of RBC units outdated at the blood center were group O positive. Among transfusing hospitals who reported group O unit transfusion, group O positive transfusions were similar in 2013 and 2015. In 2015, group O positive units accounted for on average 16.9% (22.7%) of RBC units outdated in transfusing hospitals who reported group O RBC outdates.

In 2013, 934 of 1101 facilities reported average weekday inventories of Group O RBC units that varied by hospital size, from 15.9 units in hospitals performing 100–999 inpatient surgeries per year to 137.6 units in hospitals performing >8,000 inpatient surgeries per year

(Table 22). The number of group O positive RBC units at which supply was considered critically low ranged from a mean of 7.1 units in hospitals performing 100–999 inpatient surgeries per year to a mean of 71.0 units in hospitals performing > 8,000 inpatient surgeries per year. In 2015, the group O RBC supply maintained by hospitals on an average weekday was 13.3 RBC units in hospitals performing 100–999 inpatient surgeries per year and 135.3 units in hospitals performing > 8,000 inpatient surgeries per year, as reported by 1,883 hospitals. The number of group O positive RBC units at which supply was considered critically low decreased from 2013, from 5.7 units in hospitals performing 100–999 inpatient surgeries per year to 61.2 units in hospitals performing >8,000 inpatient surgeries per year.

The number of crossmatch procedures performed on whole blood and red blood cells in 2013 and 2015 is shown in Table 23. There was an overall decline in the number of crossmatch procedures by any method from 19,042,000 in 2013 to 16,625,000 in 2015. This represents a 12.7% decline form 2013, which is a larger decrease than the decline from 2011 to 2013 (3.1%) and 2008 to 2011 (1.2%). Much of this decline came from manual serologic crossmatch procedures which decreased from 61.6% of procedures in 2013 to 53.8% in 2015, while the number of electronic (6,113,000 in 2013 and 6,776,000 in 2015) and automated serologic (815,000 in 2013 and 774,000 in 2015) crossmatch procedures both remained approximately constant. The number of electronic serologic crossmatch procedures as a percentage of all crossmatch procedures increased from 32.1% in 2013 to 40.8% in 2015.

Pediatric transfusions by U.S. blood centers and hospitals

The number of adult-equivalent units transfused to pediatric patients is shown in Table 24 along with the number of pediatric recipients. The number of adult equivalent units (all components) used for pediatric patients was lower in 2015 than in 2013. The number of whole blood/RBC units, apheresis PLT units, and plasma units transfused decreased. Similarly the total number of pediatric transfusion recipients decreased in 2015 in comparison with 2013.

Transfusion location

The number of red blood cells and PLTs transfused by in-hospital location type in 2013 is shown in Table 25 along with the number of respondents. Approximately half of all responding facilities answered this question, with a slightly higher response rate among smaller facilities than larger facilities. In 2013, the largest number of RBC units were used in general medicine (2,872,000; 95% CI: 2,534,000–3,210,000), followed by hematology/oncology (1,842,000; 95% CI: 1,457,000–2,226,000), intensive care units (1,638,000; 95% CI: 1,417,000–1,859,000), general surgery (1,238,000; 95% CI: 983,000–1,494,000) and emergency departments (1,024,000; 95% CI: 893,000–1,155,000). The rest of the locations used fewer than one million RBC units: cardiac surgery (752,000; 95% CI: 600,000–905,000), orthopedic surgery (597,000; 95% CI: 416,000–777,000), nephrology (285,000; 95% CI: 233,000–336,000), obstetrics/gynecology (230,000; 95% CI: 191,000–268,000), pediatrics/neonatology (187,000; 95% CI: 126,000–247,000) and transplantation services (129,000; 95% CI: 53,000–205,000). The largest number of PLT units were used in hematology/oncology (645,000; 95% CI: 408,000–882,000) followed by general medicine

(269,000; 95% CI: 213,000–326,000), critical care units (261,000; 95% CI: 201,000–322,000), cardiac surgery (170,000; 95% CI: 135,000–205,000) and general surgery (139,000; 95% CI: 111,000–168,000).

The questionnaire modification for the 2015 survey included amalgamating surgical subspecialties into a single category, all surgery (including transplant). General medicine and hematology/oncology were combined into inpatient medicine. As with the 2013 survey, approximately half of all responding facilities answered this question, with a slightly higher response rate among smaller facilities than larger facilities. The pediatrics/neonatology location was separated into pediatrics and neonates (Table 26). In 2015, the largest number of red blood cells were used in inpatient medicine, including hematology/oncology (4,293,000; 95% CI: 3,966,000–4,620,000), followed by critical care (1,817,000; 95% CI: 1,689,000–1,946,000), outpatient and non-acute inpatient settings (1,631,000; 95% CI: 1,477,000–1,786,000), all surgery, including transplant (1,431,000; 95% CI: 1,284,000–1,578,000), emergency departments (1,007,000; 95% CI: 900,000–1,114,000), obstetrics/gynecology (194,000; 95% CI: 173,000–215,000), pediatrics (149,000; 95% CI: 89,000–208,000) and neonates (103,000; 95% CI: 79,000–128,000). The largest number of PLTs were also used in inpatient medicine, including hematology/oncology (866,000; 95% CI: 626,000–1,105,000), followed by critical care (400,000; 95% CI: 349,000–451,000), outpatient and non-acute inpatient settings (302,000; 95% CI: 240,000–365,000), and all surgery (including transplant) (300,000; 95% CI: 245,000–356,000).

To compare transfusions by location for 2013 and 2015, locations were combined so that they could be matched (Table 27). The largest change in RBC use between 2013 and 2015 occurred in the all surgery category with a statistically significant decrease of 41.5%. Increases were observed in RBC transfusion in pediatrics/neonatology (24.4%) and critical care (10.9%) but these differences were not statistically significant. There was a statistically significant increase in PLTs used in critical care settings. However, there were no statistically significant changes in PLT use in other settings.

DISCUSSION

The findings presented here from the NBCUS for 2013 and 2015 provide further insight into the declining utilization of blood in the United States. The number of units transfused in surgical settings declined significantly between 2013 and 2015, which supports evidence that improvements in surgical techniques and adoption of patient blood management programs have resulted in decreased routine use of blood.[16–18] The overall decline in blood use may be attributable to decreasing use for surgical procedures.. While questions related to patient blood management were not included in the 2015 survey, data from respondents in 2013 suggest that a large proportion of hospitals in the United States had adopted these programs, which include transfusion training, implementation of transfusion guidelines, anemia management, and evaluation for likelihood of blood loss during surgery. Despite progress towards reducing the need for transfusions for certain clinical indications, blood use in emergency and critical care settings did not decrease between 2013 and 2015. Blood remains a critical, life-saving intervention for patients with urgent or complex clinical needs even though there has been an overall reduction in use.

Implications for maintaining an adequate blood supply

Findings from the NBCUS suggest an evolution in donor recruitment strategies by blood centers to address supply and adequacy. In 2015, blood centers reported a decline in first-time donors and an increase in repeat donors in comparison to 2013. Repeat donors are critical to maintaining overall volume of the blood supply, and have lower incidence of infectious diseases than first-time donors.[19,20] Repeat donations are likely to be a factor in the lower number of deferrals in 2015 when compared to 2011. Previously, due to concerns for an aging blood donor population, collection centers began to target younger age groups for donation[21]. Recruitment of young first-time donors, who are then encouraged to donate again within one year, can secure long-term donation commitment.[22] The 2015 NBCUS findings reflect these efforts, suggesting continued shifts in blood donor age distributions with increases in the proportion of younger (i.e., <18) and older (i.e., ≥65) donors, with a corresponding decrease in the proportion of donors between 18 and 65 years of age.

The increasing proportions of donors in the youngest and oldest age categories, particularly younger donors, has several implications for the blood supply. Young donors are more susceptible to adverse events such as injury related to falls from vasovagal syncopal reactions and phlebotomy-related complications.[23,24] Additionally, younger donors are more susceptible to development of iron deficiency, which has prompted consideration for strategies to mitigate short-term and long-term consequences of repeat donation in this age group.[25–27] A careful approach to recruiting, maintaining, and assuring the safety of young donors is underscored by literature demonstrating that donors are less likely to return to donate if they experience an initial adverse reaction, which could discourage commitment to long-term repeated donation.[28] Reliance on older donors, aged over 65 years, may also result in future supply challenges. Older donors may experience medical conditions or receive prescription medications that result in deferral. Recently, FDA changed the qualification standards for the acceptable minimum hemoglobin and hematocrit levels for allogeneic male donors from 12.5 g/dL (38%) to 13.0 g/dL (39%).[29] This may decrease the number of eligible male donors and result in higher numbers of deferrals for low hemoglobin. As a result of these concerns, blood centers may consider different approaches to donor recruitment and retention by targeting donors in early adulthood. Previous studies have projected that changes in the donor age demographic, coupled with an aging patient population that requires more blood, could lead to an inadequate supply unless offset by an increase in young and middle-age donors.[21]

Costs

Declines in the demand for blood products may have contributed to decreases in the median cost paid per unit by transfusing hospitals. When comparing 2015 median prices per unit to 2013 prices paid by hospitals, declines were noted across all primary blood component types, including red blood cells, PLTs, and plasma. Further, the price paid per unit varied inversely for all product types when stratified by surgical volume and bed size, with higher volume hospitals paying the lowest price per unit and the lowest volume hospitals paying the highest prices. These findings are further consistent with published data showing that hospitals affiliated with major academic medical centers pay lower prices for blood products.[30] Reported prices were lower for hospitals which were members of group

purchasing agreements or hospitals part of larger healthcare systems. The 2015 findings also demonstrate cost variations by public health service (PHS) region, which is consistent with previous findings showing significant variation in prices paid for blood products by census region.[30] These declines in prices paid by hospitals for blood products may affect the ability of blood centers to maintain donations while absorbing and incorporating new safety interventions such as pathogen reduction technology.[31]

Adverse Events

The risks associated with transfusion in the United States are low due to improvements in donor screening, automated data systems, and standardization of clinical transfusion practices.[32] However, the 2015 survey findings suggest an increase in life threatening reactions which required major medical interventions. It is not clear which specific reaction types drove this increase in severe reactions, but the increase coincided with the recommended use of severity and imputability definitions for NBCUS, which are based on the National Healthcare Safety Network (NHSN) Hemovigilance module.[33] The incorporation of NHSN case definitions for NBCUS in 2013 and 2015 could have led to more complete reporting of severe reactions among survey respondents.[34–36] Enhanced recognition of these reactions is important in order to prevent transfusion-related morbidity and mortality. The increased recipient adverse reaction rate points to the need for increased participation in national hemovigilance, which can enhance transfusion safety by allowing for ongoing monitoring of incidence and prevalence of reactions, identifying areas for intervention, and assessing the impact of safety measures. The NHSN Hemovigilance Module was developed to implement national surveillance of transfusion-associated adverse events. However, participation in the module is voluntary, with the exception of facilities in Massachusetts, and not yet nationally representative. Therefore, the NBCUS provides additional insight into the burden of recipient transfusion reactions nationally.

Respiratory reactions including transfusion-related acute lung injury (TRALI), transfusion associated circulatory overload (TACO), and transfusion-associated dyspnea have been the subject of recent efforts to reduce severe recipient reactions and to better define and harmonize case definitions[37,38]. The occurrence of these reactions as reported to NBCUS by hospitals is consistent with results from analyses of the NHSN Hemovigilance Module data.[39] In both data systems, the rate of TRALI has remained stable or slightly declined which is likely a result of risk mitigation strategies, while rates of TACO and transfusion associated dyspnea are increasing.[40] The apparent increase in these two respiratory reactions may reflect improved recognition, but should be the subject of further study. Enhanced recognition of respiratory reactions is vital as TRALI and circulatory overload are the leading causes of transfusion reaction-related deaths in the US.[32] In addition to the respiratory reactions, rates of transfusion-transmitted infections as reported to NBCUS are consistent with the NHSN Hemovigilance Module. The increase in transfusion-transmitted bacterial and parasitic infections observed in both systems points to the need for further safety interventions.

Donor adverse reactions can be mild to severe, have short or long term implications for the donor (e.g. nerve damage), and can have a negative effect on blood donor return rate.[41,42]

Donor reaction rates vary by donor characteristics (e.g., age, sex, and weight) which can limit direct comparison between blood centers.[43] Donor hemovigilance is an important element of improving donor safety and preventing blood supply shortages. While improvements in donor hemovigilance are underway, such as the development of standardized definitions for donor reactions by AABB and International Hemovigilance Network (IHN),[44] there are surveillance gaps with current donor hemovigilance activities. Large blood centers monitor reactions internally; however, external comparison is limited.[43] DonorHART is a voluntary prospective surveillance system intended to monitor and analyze donor adverse reactions which was developed by the Department of Health and Human Services (HHS) and is now solely operated by AABB,[45,46] however, participation is limited.[47] Therefore, NBCUS currently offers the only national estimates of donor adverse reactions. The present surveys demonstrate a slight increase in donor reaction rates from 2013 to 2015. Donor adverse reaction rates were similar for automated and manual collections in blood centers, consistent with previous observations, but higher for manual collections in hospital-based blood centers.[43] Previously, American Red Cross data have suggested high levels of variability in donor adverse reactions related to geographic location and donor demographics.[43] Though the present survey does not elicit specific reaction data, some explanations for higher reaction rates may be related to a higher proportion of donations from younger donors.

Adoption of practices and technologies

The 2013 and 2015 surveys contain valuable information regarding the adoption of practices and technologies to enhance blood safety including molecular genotyping of blood donors and units within hospitals and pre-transfusion bacterial testing of PLTs. While blood bank laboratories routinely type donors and patients for ABO and Rh(D), serological typing for other antigens can be labor intensive and may delay the identification of compatible blood products for patients with multiple antibodies.[48] To obviate the need for serological typing, high throughput molecular assays have been developed which can rapidly identify compatible units containing the appropriate profile of other antigens.[49] The present findings suggest that one in five blood collection centers genotyped donors in 2015, but those centers genotyped less than 10% of all donors; very few hospitals (2%) reported genotyping units, and among those that did, fewer than one in five units were subjected to genotyping on average. As this technology has become only recently available for testing blood donors, the adoption of molecular genotyping will likely grow in the future.

The results indicate that many hospital-based blood centers performed non-culture testing for bacterial detection of PLTs. Recently, the FDA released guidance regarding bacterial risk control strategies to enhance safety and availability of PLTs.[50] These recommendations include culture-based primary testing of PLT products or subjecting apheresis PLTs to pathogen-reduction technology.[50] Future surveys will continue to monitor implementation of safety measures to reduce bacterial contamination of PLTs, such as primary culture-based testing and pathogen reduction technology.

Limitations

These findings are subject to several limitations. The response rate for 2013 was lower than previous surveys and the response rate for 2015 was substantially higher than in previous years. As a result of this disparity, the uncertainty (as reflected by confidence intervals) in 2013 was higher than in 2015 and the chance of bias due to non-response is also higher for 2013. Confidence intervals reflect errors due to sampling and imputation but cannot include data input, transmission or other errors and cannot be corrected for biases. Chung et al. estimated that as many as one-third of non-respondents may not have received the 2013 survey and the impact of the non-response is not clear.[1] Additionally, respondents were allowed to aggregate responses over several facilities in 2013, so that these responses had to be approximately apportioned for analysis, a practice that introduces more uncertainty for 2013 estimates. These problems were resolved for the 2015 survey.

For both surveys, weighting and multiple imputation were used to produce national estimates. These procedures are reliant on homogeneous strata, which were defined using annual inpatient surgical volume for hospitals or number of RBC collections for blood centers. Annual inpatient surgical volume information was based on AHA estimates for 2012 for the 2013 survey and based on 2013 for the 2015 survey, which were the most recent available at the time of survey development. This may have led to incorrect strata categorization. The impact on the estimates presented here are likely to be minimal. In addition, sampling of hospitals was designed using inpatient surgical volume consistent with previous surveys. However, as demonstrated in 2015, blood use for surgical procedures is declining. Future surveys should consider alternative sampling methodologies, based on different proxies for blood use.

Conclusions

While blood collection and use have declined in the United States, blood remains a critical resource for patients with urgent or complex clinical needs. Continued challenges in maintaining an adequate blood supply include declining costs paid per blood products and recruiting and retaining blood donors while considering donor safety. While the NBCUS provides additional information regarding transfusion-related reactions, findings from the 2013 and 2015 surveys support the participation in national hemovigilance. Future surveys will continue to monitor the adoption of new technologies related to blood collection and transfusion, including molecular genotyping and pathogen-reduction technology.

References

1. Chung KW, Basavaraju SV, Mu Y, et al. Declining blood collection and utilization in the United States. Transfusion. 2016; 56(9):2184–2192. [PubMed: 27174734]
2. Ellingson KD, Sapiano MR, Haass KA, Savinkina AA, Baker ML, Chung K, Henry RA, Berger JJ, Kuehnert MJ, Basavaraju SV. 2017; Continued decline in blood collection and transfusion in the United States-2015. Transfusion. 57:1588–1598. DOI: 10.1111/trf.14165 [PubMed: 28591469]
3. Sullivan MT, McCullough J, Schreiber GB, Wallace EL. Blood collection and transfusion in the United States in 1997. Transfusion. 2002; 42(10):1253–1260. [PubMed: 12423507]
4. Sullivan MT, Wallace EL. Blood collection and transfusion in the United States in 1999. Transfusion. 2005; 45(2):141–148. [PubMed: 15660821]

5. Sullivan MT, Cotten R, Read EJ, Wallace EL. Blood collection and transfusion in the United States in 2001. Transfusion. 2007; 47(3):385–394. [PubMed: 17319817]
6. The 2011 National Blood Collection and Utilization Survey Report. Washington (DC): US Department of Health and Human Services; 2013.
7. Recommendations of the 48th ACBTSA Meeting. Washington (DC): U.S. Department of Health and Human Services; 2015; Nov 28–29, 2015
8. United States Food and Drug Administration. [Accessed 02/27, 2017] Blood Establishment Registration and Product Listing. https://www.fda.gov/BiologicsBloodVaccines/GuidanceComplianceRegulatoryInformation/EstablishmentRegistration/BloodEstablishmentRegistration/default.htm
9. He Y. Raghunathan Tukey's gh Distribution for Multiple Imputation. American Statistical Association. 2006; 60(3):251–256.
10. Rubin, D, , et al. Multiple imputation for nonresponse in surveys. Hoboken (NJ): 2004.
11. Woodruff R. A simple method for approximating the variance of a complicated estimate. Journal of the American Statistical Association. 1971; 66(334):411–414.
12. Vajpayee, NGS, Bem, S. Basic examination of blood and bone marrow. In: McPherson, RAPM, editor. Henry's Clinical Diagnosis and Management by Laboratory Methods. 22. Philadelphia, PA: Elsevier Saunders; 2011.
13. Prothrombin time test [Internet]. Rochester (MN): Mayo Clinic; c1998-2017. Available from: http://www.mayoclinic.org/tests-procedures/prothrombin-time/details/results/rsc-20163828 [[cited January 16, 2017]]
14. Normal lab values [Internet]. San Francisco: University of California San Francisco; yyyy. Available from: http://missinglink.ucsf.edu/lm/ids_106_lowergi/lower%20gi/mainpages/normallabvalues.htm [[cited January 16, 2017]]
15. Schmaier, AH. Laboratory evaluation of hemostatic and thrombotic disorders. In: Hoffman, R, Benz, EJ, Silberstein, LE. , et al., editors. Hematology: basic principles and practice. 6th ed. Vol. Chapter 131. Philadelphia (PA): Elsevier Saunders; 2012.
16. Goodnough LT. Blood management: transfusion medicine comes of age. Lancet. 2013; 381(9880): 1791–1792. [PubMed: 23706789]
17. Stokes EA, Wordsworth S, Bargo D, et al. Are lower levels of RBC transfusion more cost-effective than liberal levels after cardiac surgery? Findings from the TITRe2 randomised controlled trial. BMJ Open. 2016; 6:e011311.
18. Xydas S, Magovern CJ, Slater JP, et al. Implementation of a comprehensive blood conservation program can reduce blood use in a community cardiac surgery program. J Thorac Cardiovasc Surg. 2012; 143:926–35. [PubMed: 22285327]
19. Williams AE, Thomson RA, Schreiber GB, et al. Estimates of infectious disease risk factors in US blood donors. Retrovirus Epidemiology Donor Study. JAMA. 1997; 277:967–72. [PubMed: 9091668]
20. Glynn SA, Kleinman SH, Schreiber GB, et al. Trends in incidence and prevalence of major transfusion-transmissible viral infections in US blood donors, 1991 to 1996. Retrovirus Epidemiology Donor Study (REDS). JAMA. 2000; 284(2):229–235. [PubMed: 10889598]
21. Zou S, Musavi F, Notari EPt, Fang CT, Group AR. Changing age distribution of the blood donor population in the United States. Transfusion. 2008; 48(2):251–257. [PubMed: 18005327]
22. Schreiber GB, Sharma UK, Wright DJ, et al. First year donation patterns predict long-term commitment for first-time donors. Vox sanguinis. 2005; 88(2):114–121. [PubMed: 15720609]
23. Trouern-Trend JJ, Cable RG, Badon SJ, Newman BH, Popovsky MA. A case-controlled multicenter study of vasovagal reactions in blood donors: influence of sex, age, donation status, weight, blood pressure, and pulse. Transfusion. 1999; 39(3):316–320. [PubMed: 10204597]
24. Eder AF, Hillyer CD, Dy BA, Notari EPt, Benjamin RJ. Adverse reactions to allogeneic whole blood donation by 16- and 17-year-olds. JAMA. 2008; 299(19):2279–2286. [PubMed: 18492969]
25. Simon TL, Garry PJ, Hooper EM. Iron stores in blood donors. JAMA. 1981; 245(20):2038–2043. [PubMed: 7230400]

26. Cable RG, Glynn SA, Kiss JE, et al. Iron deficiency in blood donors: analysis of enrollment data from the REDS-II Donor Iron Status Evaluation (RISE) study. Transfusion. 2011; 51(3):511–522. [PubMed: 20804527]
27. United States Food and Drug Administration Blood Products Advisory Committee. Topic IA. Considerations for iron management in blood donors. 2016
28. Notari EP, Zou S, Fang CT, Eder AF, Benjamin RJ, Dodd RY. Age-related donor return patterns among first-time blood donors in the United States. Transfusion. 2009; 49(10):2229–2236. [PubMed: 19903284]
29. United States Food and Drug Administration Blood Products Advisory Committee. Requirements for Blood and Blood Components Intended for Transfusion or for Further Manufacturing Use. 2016
30. Toner RW, Pizzi L, Leas B, Ballas SK, Quigley A, Goldfarb NI. Costs to hospitals of acquiring and processing blood in the US: a survey of hospital-based blood banks and transfusion services. Applied health economics and health policy. 2011; 9(1):29–37. [PubMed: 21174480]
31. Mulcahy, AKK, Briscombe, B, Uscher-Pines, L, Chaturvedi, R, Case, S, Hlávka, J, Miler, B. Towards a Sustainable Blood Supply in the United States. Santa Monica, CA: RAND Corporation; 2016.
32. United States Food and Drug Administration Center for Biologics Evaluation and Research. Fatalities Reported to FDA Following Blood Collection and Transfusion (FY2015). 2015. http://www.fda.gov/downloads/BiologicsBloodVaccines/SafetyAvailability/ReportaProblem/TransfusionDonationFatalities/UCM518148.pdf
33. Centers for Disease Control and Prevention. [Accessed 1/30/2017] National Healthcare Safety Network Biovigilance Component Hemovigilance Module Surveillance Protocol. 2017. https://www.cdc.gov/nhsn/PDFs/Biovigilance/BV-HV-protocol-current.pdf
34. Case definitions for infectious conditions under public health surveillance. Centers for Disease Control and Prevention. MMWR Recomm Rep. 1997; 46(RR-10):1–55.
35. Ertel SH, Nelson RS, Cartter ML. Effect of surveillance method on reported characteristics of Lyme disease, Connecticut, 1996–2007. Emerg Infect Dis. 2012; 18(2):242–247. [PubMed: 22304873]
36. Kleinman S, Caulfield T, Chan P, et al. Toward an understanding of transfusion-related acute lung injury: statement of a consensus panel. Transfusion. 2004; 44:1774–89. [PubMed: 15584994]
37. International Society of Blood Transfusion Working Party on Haemovigilance. Transfusion-associated circulatory overload (TACO) Draft revised reporting criteria. 2016Accessed 1/31/2017
38. Badami KG, Joliffe E, Stephens M. Transfusion-associated dyspnea--shadow or substance? Vox sanguinis. 2015; 109(2):197–200. [PubMed: 25854631]
39. Harvey AR, Basavaraju SV, Chung KW, Kuehnert MJ. Transfusion-related adverse reactions reported to the National Healthcare Safety Network Hemovigilance Module, United States, 2010 to 2012. Transfusion. 2015; 55(4):709–718. [PubMed: 25371300]
40. Basavaraju SVHK, Sapiano MRP, Kuehnert MJ. Transfusion-related adverse reactions reported to the National Healthcare Safety Network Hemovigilance Module, United States, 2013 to 2015. ISBT Conference Abstract. 2016
41. Kasprisin DO, Glynn SH, Taylor F, Miller KA. Moderate and severe reactions in blood donors. Transfusion. 1992; 32(1):23–26. [PubMed: 1731431]
42. Newman BH, Newman DT, Ahmad R, Roth AJ. The effect of whole-blood donor adverse events on blood donor return rates. Transfusion. 2006; 46(8):1374–1379. [PubMed: 16934074]
43. Eder AF, Dy BA, Kennedy JM, et al. The American Red Cross donor hemovigilance program: complications of blood donation reported in 2006. Transfusion. 2008; 48(9):1809–1819. [PubMed: 18631167]
44. Goldman M, Land K, Robillard P, et al. Development of standard definitions for surveillance of complications related to blood donation. Vox Sang. 2016; 110:185–8. [PubMed: 26361365]
45. AABB donor hemovigilance report [Internet]. Bethesda: AABB; 2012. Available from: http://www.aabb.org/research/hemovigilance/Documents/aabb-donor-hemovigilance-report-2012.pdf [[cited January 8, 2017]]

46. DonorHART donor hemovigilance analysis & reporting tool: user manual 2.0 [Internet]. Bethesda: AABB; 2014. http://www.aabb.org/research/hemovigilance/Documents/biovigilancemanual.pdf [[cited January 8, 2017]]

47. Rajbhandary S, Stubs JR, Land KJ, Whitaker BI. AABB Donor Hemovigilance Report: 2012–2014 on behalf of the AABB US Donor Hemovigilance Working Group. 2016

48. Hillyer CD, Shaz BH, Winkler AM, Reid M. Integrating molecular technologies for RBC typing and compatibility testing into blood centers and transfusion services. Transfusion medicine reviews. 2008; 22(2):117–132. [PubMed: 18353252]

49. Liu Z, Liu M, Mercado T, et al. Extended blood group molecular typing and next-generation sequencing. Transfus Med Rev. 2014; 28:177–86. [PubMed: 25280589]

50. Bacterial risk control strategies for blood collection establishments and transfusion services to enhance the safety and availability of PLTs for transfusion. Silver Spring (MD): US Food and Drug Administration, Center for Biologics Evaluation and Research; 2016.

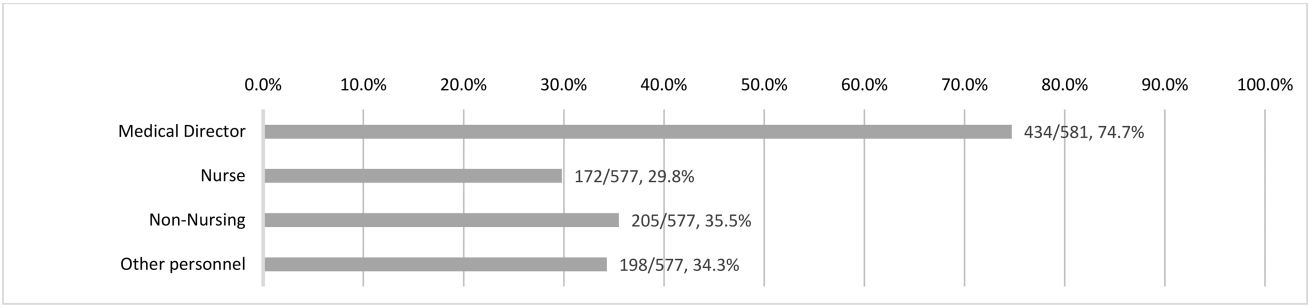

Figure 1. Coordinator of patient blood management (PBM) program*, as reported to the National Blood Collection and Utilization Survey: United States, 2013

* Facilities were allowed to select multiple overlapping categories and not all facilities answered the question, therefore percentages do not sum to 100%.

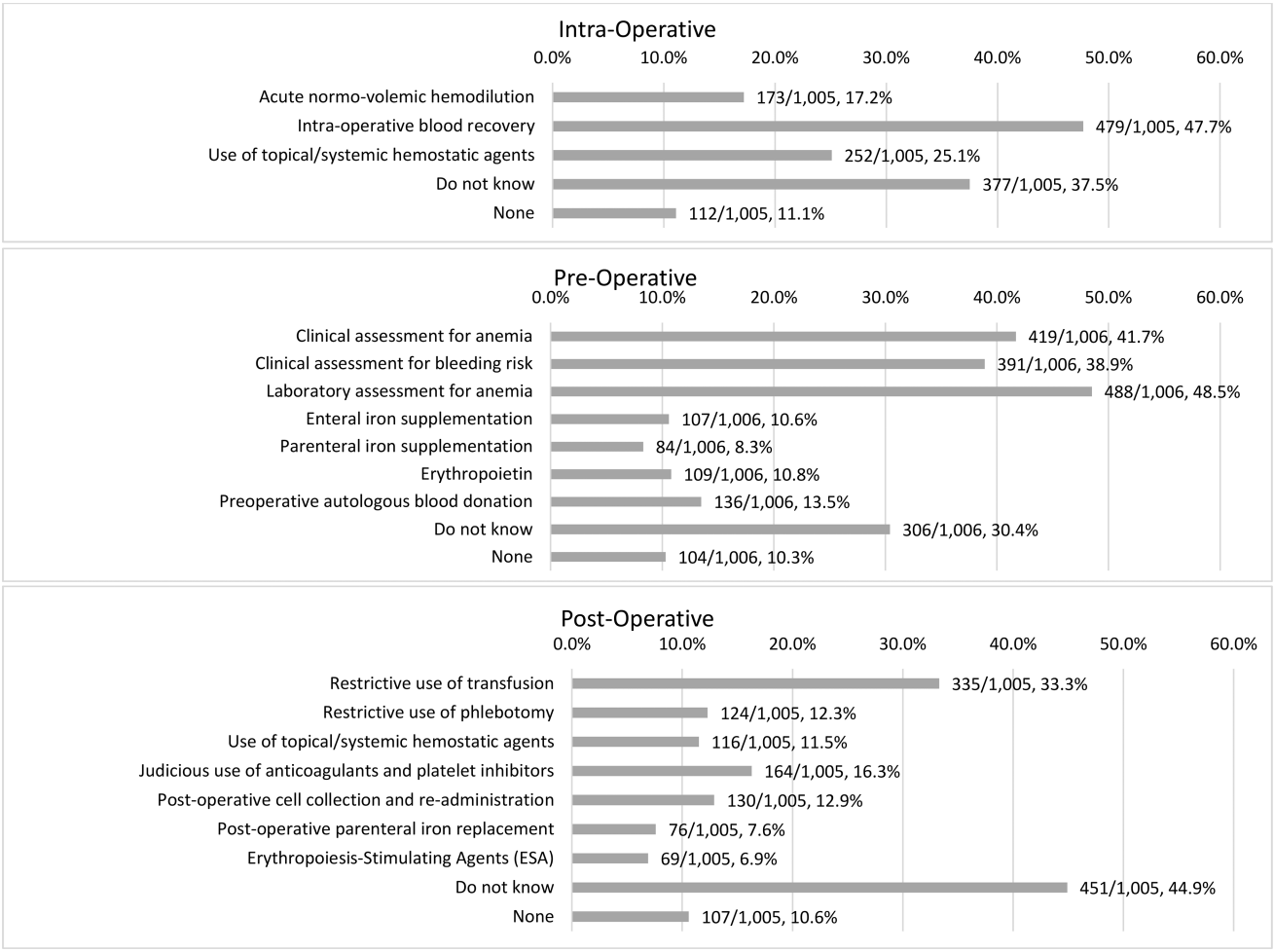

Figure 2. Number of facilities using specified pre-operative, intra-operative, and post-operative measures to reduce the likelihood of allogeneic transfusions*: United States, 2013

* Question was asked of all facilities, including those without a formal patient blood management program.

TABLE 1

Response rates to the National Blood Collection and Utilization Survey, 2005–2015.

Facility Type	2015	2013	2011	2009	2007	2005
Community-based Collection Centers	90.0% (72/80)	64.8% (59/91)	96.3% (131/136 [*])	93.3% (126/135 [*])	91.4% (128/140 [*])	92.3% (131/142 [*])
Hospital-based Collection Centers	71.8% (102/142)	41.2% (63/153)	N/A [†]	N/A [†]	N/A [†]	N/A [†]
Hospitals (Utilizing Blood)	73.9% (2138/2892) [‡]	33.3% (1101/3305) [§]	42.3% (1342/3175) [‡]	51.5% (1529/2970) [‖]	59.9% (1707/2848) [¶]	56.8% (1604/2825) [**]
Overall response rate	74.2% (2312/3114)	34.5% (1223/3549) [§]	44.5% (1473/3311) [‡]	53.3% (1655/3105) [‖]	61.4% (1835/2988) [¶]	58.5% (1735/2967) [**]

[*] Surveys conducted by AABB (2005–2011) included regional sub-centers of collection centers in their total facility count. Number of individual responding collection centers was not available for 2005–2011.

[†] Surveys conducted prior to 2011 did not report the unique number of hospital-based collection centers.

[‡] The 2011 and 2015 surveys included a sample of 40% of surgical volume Category 1 (100–999 inpatient surgical procedures annually) hospitals.

[§] The 2013 survey did not use sampling, but contact information was unavailable for 610/3,915 hospitals, and these were not sampled.

[‖] The 2009 survey included a sample of 33%% of surgical volume category 1 (999–1,000 inpatient surgical procedures annually).

[¶] The 2007 survey included a sample of 33% of surgical volume category 1 (999–1,000 inpatient surgical procedures annually) and 66% of surgical volume category 2 (1,000–1,399 inpatient surgical procedures annually).

[**] The 2005 survey included a sample of 32.6% of surgical volume category 1 (999–1,000 inpatient surgical procedures annually), 86% of surgical volume category 2 (1,000–1,399 inpatient surgical procedures annually) and 88.4% of surgical volume category 3 (1,400–2,399 patient surgical procedures annually).

TABLE 2

Response rates for collection facilities to the National Blood Collection and Utilization Survey stratified by collection type annual volume of RBC collections, 2015 and 2013.

		2015		2013	
Facility type	**Strata**	**%**	**n/N**	**%**	**n/N**
Community-based collection centers	Less than 50,000 RBC collections per year	92.5%	37/40	56.9%	29/51
	50,000–199,000 RBC collections per year	87.1%	27/31	74.2%	23/31
	200,000–399,000 RBC collections per year	75.0%	3/4	42.9%	3/7
	400,000 or more RBC collections per year	100.0%	5/5	100%	4/4
Hospital-based collection centers	Less than 1,000 surgeries per year	58.3%	7/12	38.5%	5/13
	1,000–7,999 surgeries per year	73.5%	61/83	35.5%	33/93
	8,000 or more surgeries per year	72.3%	34/47	53.2%	25/47

* The 2013 survey did not use sampling, but contact information was unavailable for 610/3,915 hospitals, and these were not sampled.

TABLE 3

Response rates for transfusion facilities to the National Blood Collection and Utilization Survey stratified by annual inpatient surgical volume, 2015 and 2013.

	2015		2013	
Surgical volume category	**%**	**n/N**	**%**	**n/N**
100–999 surgeries	73.6%	495/673	26.1%	426/1634
1,000–1,399 surgeries	72.4%	283/391	28.8%	117/406
1,400–2,399 surgeries	72.3%	416/575	27.3%	155/567
2,400–4,999 surgeries	75.2%	547/727	28.6%	219/765
5,000–7,999 surgeries	75.3%	225/299	31.2%	97/311
8,000 or more surgeries	75.8%	172/227	37.5%	87/232

* The 2013 survey did not use sampling, but contact information was unavailable for 610/3,915 hospitals, and these were not sampled.

TABLE 4

Response rates for transfusing facilities to the National Blood Collection and Utilization Survey stratified by Public Health Service (PHS) region, 2015 and 2013.

	2015		2013*	
Public Health Service Region	**%**	**n/N**	**%**	**n/N**
PHS Region 1 (CT, MA, ME, NH, RI, VT)	71.2%	94/132	39.5%	70/177
PHS Region 2 (NJ, NY)	80.5%	165/205	32.9%	77/234
PHS Region 3 (DC, DE, MD, PA, VA, WV)	78.5%	219/279	33.8%	114/337
PHS Region 4 (AL, FL, GA, KY, MS, NC, SC, TN)	75.2%	436/580	25.4%	197/777
PHS Region 5 (IL, IN, MI, MN, OH, WI)	77.2%	407/527	26.9%	201/746
PHS Region 6 (AR, LA, NM, OK, TX)	70.3%	281/400	31.5%	182/577
PHS Region 7 (IA, KS, MO, NE)	71.1%	118/166	26.7%	70/262
PHS Region 8 (CO, MT, ND, SD, UT, WY)	75.8%	91/120	20.0%	38/190
PHS Region 9 (AZ, CA, HI, NV)	65.0%	234/360	25.1%	112/446
PHS Region 10 (AK, ID, OR, WA)	75.6%	93/123	23.7%	40/169
All regions	73.9%	2138/2892	28.1%	1101/3915

*The 2013 survey did not use sampling, but contact information was unavailable for 610/3,915 hospitals, and these were not sampled.

TABLE 5

Estimated number of donations stratified by age, and estimated number of donors stratified by donation type (expressed in thousands): United States, 2013 and 2015.

	All facilities, 2015 (95% CI)	All facilities, 2013 (95% CI)	All facilities, 2011[//]	% of total		
				2015	2013	2011[//]
Donations by donor age						
16–18 years old	1,521 (1,406–1,636)	1,591 (1,458–1,724)	1,646	13.4%	12.4%	10.5%
19–24 years old	1,236 (1,165–1,308)	1,569 (1,470–1,668)	1,556	10.9%	12.2%	10.0%
25–64 years old	7,182 (6,737–7,627)	8,252[†]	11,108[†]	63.3%	64.1%	71.5%
65 years or older	1,401 (1,297–1,504)	1,457 (1,363–1,550)	1,219	12.4%	11.3%	7.8%
Repeat allogeneic donations	7,216 (6,545–7,886)	≠	9,534	63.6%		61.4%
Total successful donations	11,339 (10,689–11,989)	12,869[§]	15,529			
Number of donors						
First time allogeneic	2,223 (2,058–2,388)	2,530 (2,288–2,771)	2,840	32.6%		30.8%
Repeat allogeneic	4,589 (4,213–4,966)	≠	6,364	67.4%		69.2%
Total individual donors[*]	6,812 (6,343–7,282)	≠	9,203			

[*] Excludes directed and autologous donors.

[†] Not specifically asked, calculated from other categories.

[≠] Repeat donations and repeat donors could not be estimated in 2013 due to non-response.

[§] 2013 total donations were obtained from Chung et al.[1]

[//] 2011 total donations were obtained from AABB[6]

TABLE 6

Autologous and directed donors, donations, recipients, and transfusions (expressed in thousands): United States, 2013 and 2015.

		Donations			Transfusions			Units crossed over into community supply[†]
Year	**Component**	**Donors (95% CI)**	**Units (95% CI)**	**Units per donor**	**Recipients (95% CI)**	**Units (95% CI)**	**Units per recipient**	
2015	Autologous RBC/WB[*]	23 (18–27)	25 (19–31)	1.1	9 (4–13)	20 (8–32)	2.3	
2013	Autologous RBC/WB[*]	52 (37–67)	61 (48–74)	1.3	25 (17–34)	44 (25–62)	1.7	
	Directed							
2015	RBC/WB[*]		21 (14–28)		25 (12–38)	66 (35–96)	2.6	
	PLTs		6 (1–12)			5 (3–8)		
	Total	25 (12–38)	27 (16–38)	1.1		70 (40–101)		
2013	RBC/WB[*]		24 (15–32)		24 (6–43)	44 (25–64)	2.1	9 (5–18)
	PLTs		8 (0–18)			2 (1–3)		
	Total	26 (10–42)	30 (19–41)	1.2		47 (11–84)		

[*] Red blood cells/whole blood estimate includes whole blood, whole blood-derived RBC, and apheresis RBC collections.

[†] Units crossed into community supply were not included in the 2015 survey.

TABLE 7

Median and mean dollar amount paid per blood product unit (in U.S. dollars) as reported by hospitals: United States, 2013 and 2015.

	Amount paid, 2015 ($)			Amount paid, 2013 ($)			Difference, 2015–2013 ($)	
Component	**Median (N)**	**Inter-quartile range**	**Mean**	**Median (N)**	**Inter-quartile range**	**Mean**	**Mean**	**Median**
Red cells, leukoreduced	$211 (N=1,630)	$197–$228	$217	$221 (N=843)	$205–$240	$228	−11*	−10
Red cells, non leukoreduced	$204 (N=262)	$185–$225	$207					
Whole blood derived PLTs, each unit, not leukoreduced, not irradiated	$95 (N=101)	$68–$420	$242					
Apheresis PLTs, leukoreduced	$524 (N=1,668)	$495–$560	$537	$540 (N=812)	$510–$590	$557	−20*	−16
Plasma, single donor, frozen within 8 hours of phlebotomy (FFP)	$54 (N=1,062)	$45–$64	$60	$59 (N=499)	$50–$68	$63	−3	−5
Plasma, frozen between 8 and 24 hours of phlebotomy (PF24)	$52 (N=1,389)	$45–$60	$63	$58 (N=667)	$48–$65	$60	3	−6
Cryoprecipitate, each unit	$56 (N=1,356)	$45–$80	$115	$54(N=625)	$45–$69	$101	13*	2

*Statistically significant difference between 2013 and 2015 with p<0.05.

Transfusion. Author manuscript; available in PMC 2019 September 10.

Table 8

Median and mean dollar amount paid per blood product unit (in U.S. dollars), as reported by hospitals and stratified by annual inpatient surgical volume: United States: 2013 and 2015.

		Amount paid, 2015 ($)		Amount paid, 2013 ($)		Difference, 2015-2013 ($)	
Component	**Surgical procedures per year**	**Median**	**Mean**	**Median**	**Mean**	**Mean**	**Median**
Red cells, leukoreduced	100–999	$215	$227	$220	$232	−5	−5
	1,000–1,399	$213	$219	$225	$229	−10	−12
	1,400–2,399	$214	$219	$225	$229	−9	−11
	2,400–4,999	$211	$213	$221	$225	−12	−11
	5,000–7,999	$208	$208	$220	$223	−16	−12
	≥8,000	$206	$209	$215	$219	−10	−10
Red cells, non- leukoreduced	100–999	$206	$226				
	1,000–1,399	$205	$205				
	1,400–2,399	$204	$204				
	2,400–4,999	$205	$204				
	5,000–7,999	$198	$193				
	≥8,000	$201	$201				
WBD PLTs, each unit, not leukoreduced, not irradiated	100–999	$159	$342				
	1,000–1,399	$90	$217				
	1,400–2,399	$95	$198				
	2,400–4,999	$96	$322				
	5,000–7,999	$84	$227				
	≥8,000	$80	$107				
Apheresis PLTs, leukoreduced	100–999	$540	$580	$550	$580	0	−10
	1,000–1,399	$525	$538	$538	$572	−34	−13
	1,400–2,399	$525	$538	$542	$548	−10	−17
	2,400–4,999	$520	$526	$530	$545	−19	−10
	5,000–7,999	$520	$506	$533	$535	−29	−13
	≥8,000	$510	$510	$524	$515	−5	−14

Component	Surgical procedures per year	Amount paid, 2015 ($)		Amount paid, 2013 ($)		Difference, 2015-2013 ($)	
		Median	Mean	Median	Mean	Mean	Median
Plasma, single donor, frozen within 8 hours of phlebotomy	100–999	$60	$72	$60	$69	3	0
	1,000–1,399	$57	$63	$61	$68	−6	−4
	1,400–2,399	$55	$66	$58	$60	6	−4
	2,400–4,999	$53	$55	$57	$65	−10	−4
	5,000–7,999	$50	$51	$51	$54	−3	−1
	≥8,000	$47	$52	$56	$56	−4	−9
Plasma, frozen between 8 and 24 hours of phlebotomy	100–999	$58	$90	$60	$66	24	−2
	1,000–1,399	$55	$60	$58	$63	−4	−3
	1,400–2,399	$51	$64	$57	$57	8	−6
	2,400–4,999	$51	$54	$55	$56	−2	−4
	5,000–7,999	$49	$50	$53	$55	−5	−4
	≥8,000	$47	$51	$55	$54	−3	−8
Cryoprecipitate, each unit	100–999	$61	$130	$55	$96	34	6
	1,000–1,399	$56	$114	$57	$124	−11	−1
	1,400–2,399	$57	$128	$54	$102	25	3
	2,400–4,999	$56	$120	$56	$114	6	0
	5,000–7,999	$51	$96	$50	$92	4	1
	≥8,000	$48	$77	$49	$61	17	−1

TABLE 9

Median and mean dollar amount paid per blood product unit as reported by hospitals (in U.S. dollars) and stratified by Public Health Service region: United States, 2013 and 2015.

Public Health Service region		Amount paid per unit, leukoreduced RBC ($)		Amount paid per unit, apheresis PLTs ($)		Amount paid per unit, fresh frozen plasma ($)	
		Median (N)	Mean (SD)	Median (N)	Mean(SD)	Median (N)	Mean (SD)
1 (CT, MA, ME, NH, RI, VT)	2013	$256 (51)	$255 ($47)	$560 (51)	$563 ($136)	$58 (28)	$56 ($14)
	2015	$235 (78)	$243 ($47)	$533 (80)	$536 ($104)	$61 (55)	$74 ($68)
2 (NJ, NY)	2013	$232 (69)	$230 ($20)	$561 (68)	$640 ($541)	$55 (51)	$56 ($14)
	2015	$218 (134)	$225 ($36)	$535 (143)	$553 ($87)	$49 (104)	$51 ($13)
3 (DC, DE, MD, PA, VA, WV)	2013	$225 (98)	$229 ($51)	$550 (97)	$562 ($140)	$59 (56)	$63 ($39)
	2015	$208 (154)	$215 ($38)	$534 (163)	$537 ($93)	$55 (102)	$55 ($15)
4 (AL, FL, GA, KY, MS, NC,	2013	$209 (143)	$209 ($28)	$522 (139)	$534 ($48)	$55 (84)	$55 ($14)
	2015	$200 (331)	$207 ($55)	$520 (337)	$532 ($149)	$51 (201)	$54 ($26)
5 (IL, IN, MI, MN, OH, WI)	2013	$206 (146)	$214 ($45)	$533 (137)	$545 ($149)	$58 (90)	$60 ($28)
	2015	$197 (308)	$204 ($31)	$518 (314)	$534 ($189)	$52 (184)	$58 ($56)
6 (AR, LA, NM, OK, TX)	2013	$221 (132)	$227 ($30)	$551 (126)	$559 ($77)	$60 (76)	$60 ($14)
	2015	$214 (206)	$218 ($24)	$530 (215)	$545 ($126)	$54 (144)	$58 ($23)
7 (IA, KS, MO, NE)	2013	$215 (52)	$216 ($26)	$525 (50)	$526 ($84)	$60 (22)	$67 ($23)
	2015	$199 (96)	$208 ($30)	$499 (92)	$497 ($66)	$55 (52)	$67 ($69)
8 (CO, MT, ND, SD, UT, WY)	2013	$225 (29)	$261 ($85)	$529 (28)	$556 ($133)	$71 (14)	$81 ($27)
	2015	$220 (73)	$227 ($49)	$540 (67)	$542 ($83)	$65 (40)	$71 ($32)
9 (AZ, CA, HI, NV)	2013	$242 (92)	$254 ($58)	$535 (90)	$550 ($132)	$60 (60)	$83 ($102)
	2015	$230 (176)	$236 ($41)	$500 (184)	$521 ($110)	$55 (130)	$64 ($43)
10 (AK, ID, OR, WA)	2013	$228 (31)	$242 ($57)	$573 (26)	$573 ($166)	$69 (18)	$76 ($26)
	2015	$213 (74)	$232 ($55)	$550 (73)	$607 ($190)	$71 (50)	$82 ($91)

TABLE 10

Costs paid per blood product unit as reported by hospitals and stratified by hospital bed size, profit status, network membership, group purchasing agreement, and academic affiliation: United States, 2015.

	Amount paid, leukocytereduced blood cells ($)		Amount paid, apheresis PLTs ($)		Amount paid, fresh frozen plasma ($)	
	Median	Mean (S.D.)	Median	Mean (S.D.)	Median	Mean (S.D.)
Hospital bed size						
<200	$214	$222 ($49)	$530	$554 ($182)	$58	$68 ($62)
200–499	$210	$213 ($34)	$520	$524 ($68)	$51	$55 ($21)
≥500	$206	$209 ($25)	$517	$508 ($70)	$45	$50 ($12)
Member of system/network						
Yes	$206	$212 ($36)	$520	$524 ($100)	$53	$55 ($28)
No	$214	$219 ($40)	$525	$544 ($142)	$55	$62 ($49)
Group purchasing agreement						
Yes	$210	$215 ($38)	$524	$533 ($126)	$53	$59 ($43)
No	$225	$231 ($46)	$550	$562 ($96)	$57	$65 ($35)
Affiliated with medical school						
Yes	$210	$215 ($42)	$520	$524 ($79)	$50	$54 ($24)
No	$211	$218 ($42)	$525	$545 ($164)	$56	$64 ($55)

* Includes all federally-run and governmental non-federal hospitals

TABLE 11

Hospital policies and practices to enhance safety of recipients of blood or blood products: United States, 2013 and 2015.

	2015		2013			
	%	n/N	%	n/N	Percent Change, 2015–2013	Percent Change (Matched)*
Policy to transfuse only leukoreduced components	77.9%	(1,514/1,943)	76.7%	(749/977)	1.3%	3.0% (n=939)
Program to treat patients who refused blood components for religious, cultural, or personal reasons	71.6%	(1,332/1,860)	65.9%	(627/952)	5.8%	2.1% (n=915)
Transfusion Safety Officer on staff	16.2%	(305/1,885)	18.0%	(172/953)	−1.9%	−2.4% (n=915)
Facility collects information on sample collection errors	83.8%	(1,571/1,875)	85.3%	(808/947)	−1.5%	1.5% (n=910)

*Facilities providing estimates for 2013 and 2015 were matched, where possible, and the mean percentage difference is presentedx with the number of matched facilities (n).

TABLE 12

Transfusion-associated adverse reactions reported to the National Blood Collection and Utilization Survey: United States, 2013 and 2015.

Adverse transfusion reactions	Number of reactions (95% CI)			Reactions : Components transfused		
	2015	2013	2011	2015*	2013*	2011*
Total number of reactions that required any diagnostic or therapeutic intervention‡	47,297 (44,042 – 50,553)	55,623 (49,022 – 62,224)	50,570	1:373	1:363	1:414
Febrile, non-hemolytic transfusion reaction	20,339 (18,856 – 21,822)	25,316 (22,717 – 27,915)	21,865	1:868	1:797	1:957
Mild to moderate allergic reactions	14,694 (13,397 – 15,991)	17,552 (15,173 – 19,931)	14,106	1:1,201	1:1,150	1:1,484
Delayed serologic transfusion reaction	3,280 (2,673 – 3,887)	3,021 (2,322 – 3,720)	2,560	1:5,383	1:6,680	1:8,177
Transfusion-associated circulatory overload	1,958 (1,746 – 2,170)	1,810 (1,493 – 2,127)	1,512	1:9,015	1:11,150	1:13,845
Hypotensive transfusion reaction	1,565 (1,359 – 1,771)	1,434 (1,115 – 1,752)	1,132	1:11,282	1:14,074	1:18,492
Delayed hemolytic transfusion reaction	770 (596 – 944)	1,046 (728 – 1,364)	1,018	1:22,916	1:19,296	1:20,563
Transfusion-associated dyspnea	1,300 (1,062 – 1,538)	1,160 (856 – 1,464)	909	1:13,582	1:17,394	1:23,029
Severe allergic reactions	584 (405 – 764)	545 (365 – 724)	491	1:30,204	1:37,056	1:42,633
Transfusion-related acute lung injury	293 (224 – 362)	351 (243 – 459)	327	1:60,280	1:57,500	1:64,015
Post Transfusion Purpura	305 (128 – 482)	259 (90 – 427)	209	1:57,823	1:78,014	1:100,158
Acute hemolytic transfusion reaction (other antibodies)	169 (101 – 236)	177 (110 – 245)	168	1:104,735	1:113,804	1:124,601
Acute hemolytic transfusion reaction (ABO)	90 (0 – 244)	71 (4 – 137)	42	1:196,473	1:286,158	1:498,405
Transfusion-transmitted viral infection	8 (0 – 16)	13 (0 – 26)	36	1:2,204,355	1:1,562,558	1:581,472
Transfusion-transmitted bacterial infection (previously asked as post-transfusion sepsis)	60 (20 – 99)	187 (0 – 487)	59	1:296,660	1:107,949	1:354,797
Transfusion-transmitted parasitic infection	16 (4 – 28)			1:1,106,463		
Transfusion-associated graft-vs-host disease	1 (0 – 4)	0†	22	1:12,771,478		1:951,500
Reactions that were life-threatening, requiring major medical intervention§	1,616 (951 – 2,281)	482 (294 – 670)	317	1:10,925	1:41,874	1:66,035

*Total components transfused was 17,398,000 in 2015, 20,180,000 in 2013 and 20,933,000 in 2011.

†Zero events reported in the sample for 2013, so no national estimate of the number of occurrences could be made.

‡Diagnostic tests were defined as “any test to confirm a reaction occurred” and therapeutic intervention was defined as “intervention to treat a reaction (e.g., vasopressors, intubation, transfer to intensive care to prevent impairment, permanent damage, or death)”.

§E.g. vasopressors, blood pressure support, intubation, or transfer to the intensive care unit.

TABLE 13

Severe donor adverse reactions and rate by type of collection method reported to the National Blood Collection and Utilization Survey: United States, 2013 and 2015.

		Number severe donor reactions				Reaction Rate		
Year	**Collection type**	**Blood centers**	**Hospitals**	**Combined (95% CI)**	**Combined collections**	**Blood centers**	**Hospitals**	**Combined (rate as %)**
2015	Manual	11,996	2,275	14,271 (9,036–19,507)	10,788,777	1:854	1:237	1:756 (0.13%)
	Automated	3,335	156	3,491 (1,088–5,894)	2,736,756	1:786	1:752	1:784 (0.13%)
	Total	15,331	2,431	17,762 (10,744–24,779)	13,525,534	1:839	1:270	1:762 (0.13%)
2013	Manual	11,900	300	12,200 (9,162–15,238)	12,275,542	1:977	1:2,153	1:1,006 (0.10%)
	Automated	2,349	28	2,377 (2,205–2,549)	2,148,044	1:878	1:2,982	1:904 (0.11%)
	Total	14,249	328	14,577 (11,462–17,692)	14,423,586	1:961	1:2,225	1:989 (0.10%)

TABLE 14

Specific components of patient blood management programs implemented among facilities, 2013.

Program Component	Positive responses	
	%	n/N*
Presence of a patient blood management program	50.3%	452/899
Participation in at least 1 performance benchmarking program related to transfusion medicine	66.4%	286/431
Formal transfusion training provided	81.9%	393/480
Formal patient blood management training provided	29.8%	107/359
Transfusion guidelines are used	92.7%	910/982
Type of transfusion guidelines in use		
College of American Pathologists	32.3%	293/908
AABB	72.5%	658/908
American Society of Anesthesiologists	2.3%	21/908
American Red Cross	11.7%	106/908
Other	16.2%	147/908
Don't know	7.0%	64/908
Evaluation of patients facing elective surgeries associated with high likelihood of blood loss for factors predictive of pre- and post-operative anemia	70.2%	432/615
Program to manage patient anemia before surgery	69.4%	197/284
Ordering provider required to obtain and document informed consent for transfusion	94.1%	904/961
Physician required to document the reason or clinical justification for transfusion in the patient medical record	81.9%	729/890
Documentation of relevant pre-transfusion laboratory results required for non-emergent transfusions	79.1%	714/903
Presence of Computerized Physician Order Entry	85.1%	847/995
CPOE includes transfusion guidelines or an algorithm to assist with proper transfusion ordering	56.1%	474/845

* n/N gives the number of respondents who answered yes over the total number of respondents.

TABLE 15

Use of PLT additive solution (PAS) to prepare apheresis PLTs, 2013 and 2015.

	2013*	2015
Percentage of facilities using PLT additive solution	3.5% (4/113)	6.8% (11/162)
Mean number of units prepared using PLT additive solution	43 (n=3)	3,374 (n=11)

* In 2013, this question pertained specifically to Intersol only.

TABLE 16

Percentage of facilities performing pre-transfusion bacterial testing of PLT units for 2013 and 2015.

	Facilities performing pre-transfusion bacterial testing on PLTs							
	Hospitals		Hospital-based collection centers		Community-based collection centers*		All facility types	
Survey year	%	n/N	%	n/N	%	n/N	%	n/N
2013	3.1%	27/882	46.0%	23/50	93.3%	42/45	9.0%	94/1047
2015	2.0%	35/1782	37.9%	36/95		0/0	3.8%	71/1877

* In 2015, this question was included in the transfusion questions section and was therefore not answered by community-based collection centers that do not routinely transfuse blood.

TABLE 17

Testing method for pre-transfusion bacterial testing of PLT units and number of tests performed: United States, 2013 and 2015.

Facility type	Survey year	Test method	Number of facilities performing tests on:			True positive results / Total tests (false positives, indeterminate results)
			Apheresis PLTs	Whole blood Derived PLTs		
				Single	Pooled	
Hospitals	2013	Culture-based testing	9	0	3	31 / 109,253 (50, 12)
		Rapid immunoassay (e.g., VERAX)	4	8	5	1 / 5,914 (17, 0)
		Other	3	2	1	2 / 9,578 (1, 0)
		Not tested	8	4	3	
		Not applicable	3	13	15	
	2015	Culture-based testing	9	3	4	15 / 35,433 (7, 0)
		Rapid immunoassay (e.g., VERAX)	11	12	4	6 / 4,771 (29, 5)
		Other	6	3	1	0 / 784 (0, 0)
		Not tested	11	2	6	
		Not applicable	19	35	40	
Hospital-based collection centers *	2013	Culture-based testing	19	2	2	25 / 83,604 (65, 3)
		Rapid immunoassay (e.g., VERAX)	1	1	3	1 / 363 (14, 0)
		Other	2	0	0	0 / 1,814 (4, 0)
		Not tested	0	0	0	
		Not applicable	1	20	18	
	2015	Culture-based testing	24	0	1	35 / 51,722 (55, 1)
		Rapid immunoassay (e.g., VERAX)	3	6	8	2 / 17,008 (21, 0)
		Other	5	0	0	0 / 1,945 (1, 4)
		Not tested	1	0	0	
		Not applicable	3	30	27	
Community-based collection centers	2013	Culture-based testing	35	2	10	76 / 308,941 (206, 38)
		Rapid immunoassay (e.g., VERAX)	0	1	1	1 / 3,020 (5, 0)
		Other	5	2	3	2 / 51,591 (85, 0)
		Not tested	0	8	1	
		Not applicable	2	29	27	

Author Manuscript

Author Manuscript

Author Manuscript

* Excludes community-based collection centers.

TABLE 18

Estimated number of apheresis and whole blood derived plasma units (expressed in thousands) distributed and transfused by type in 2013 and 2015.

Plasma product	2015 (95% CI)				2013 (95% CI)	
	Whole blood derived distributions	Apheresis, distributions	All distributions	Transfusions	All distributions	Transfusions
Frozen within 8 hours of collection (FFP)	918 (580–1,256)	328 (185–471)	1,246 (815–1,677)	969 (833–1,104)	1,658 (1,251–2,065)	1,436 (1,230–1,641)
FFP, pediatric size (100mL)				29 (20–38)		28 (18–39)
FFP, jumbo size (>400mL)		65 (3–128)		37 (15–59)		28 (11–44)
Plasma, frozen between 8–24 hours of collection (PF24)	1,870 (1,584–2,155)	136 (73–200)	2,006 (1,695–2,317)	1,086 (904–1,267)	2,378 (1,954–2,803)	1,108 (899–1,318)
Plasma, frozen within 24 hours after up to 24 hours at room temperature		141 (109–172)		39 (6–73)		
Liquid	154 (19–290)			12 (5–19)	181 (0–447)	12 (0–26)
Cryoprecipitate reduced	119 (15–222)			91 (54–129)	153 (103–203)	
Group AB				223 (184–262)	374 (343–406)	259 (210–308)

TABLE 19

Percentage of hospitals using various criteria for routine dosing of transfusions for non-pediatric patients: United States, 2013 and 2015

	2013		2015					
	Plasma		Plasma		Prophylactic PLTs		Therapeutic PLTs	
Dosing Criteria	**%**	**n/N**	**%**	**n/N**	**%**	**n/N**	**%**	**n/N**
Weight-based dosing (e.g., 20mL/kg)	6.3%	61/968	5.8%	102/1,770	1.6%	29/1,759	1.3%	22/1,754
Standard number of units regardless of weight	8.5%	82/968	9.0%	159/1,770	12.0%	211/1,759	10.8%	190/1,754
Dosage varies based on level of thrombocytopenia or bleeding	63.8%	618/968	67.2%	1,189/1,770	67.0%	1,177/1,759	71.5%	1,253/1,754
Number of units ordered not consistent with any of the above	21.4%	207/968	18.0%	319/1,770	19.4%	341/1,759	16.4%	288/1,754

TABLE 20

Average pre-transfusion laboratory results for red blood cells, PLTs, plasma, and cryoprecipitate transfusions; 2013.

	Mean	Standard deviation	N	Reference Range
Red cells, average pre-transfusion hemoglobin	10.2	15.0	433	12.1–17.2 g/dL[47]
PLTs, average pre-transfusion PLT count	9,590.4	17,968.2	363	150,000–450,000/mcL[47]
Plasma, average pre-transfusion, PT/INR*	15.0	24.9	242	PT: 11–14 seconds INR: <1.1[48]
Plasma, average pre-transfusion, PTT	59.7	36.6	137	25–35 seconds[44]
Cryoprecipitate, average pre-transfusion fibrinogen	108.4	64.9	139	200–400mg/dL[50]

Abbreviations: PT=Prothrombin Time. INR=International Normalized Ratio. PTT=Partial Thromboplastin Time

TABLE 21

Percent of Group O (positive and negative) RBC distributed, transfused, and outdated (as a percentage of all allogeneic RBC): United States, 2013 and 2015.

	2013 % (SD, N)		2015 % (SD, N)	
	Group O-Negative	**Group O-Positive**	**Group O-Negative**	**Group O-Positive**
Units processed	9.7% (5.4%, n=62)	37.9% (13.7%, n=62)		
Units released for distribution	10.2% (5.2%, n=59)	39.5% (12.0%, n=59)		
Units distributed	9.7% (4.1%, n=68)	40.0% (11.5%, n=68)		
Units outdated (collection center)	2.6% (3.4%, n=60)	13.6% (17.9%, n=60)		
Units transfused	9.7% (5.6%, n=661)	39.4% (15.2%, n=659)	10.8% (7.3%, n=939)	40.2% (12.7%, n=933)
Units outdated (hospital)			11.5% (19.3%, n=670)	16.9% (22.7%, n=663)

TABLE 22

Group O and group O+ RBC units in inventory and group O and group O+ supply considered critically low stratified by annual inpatient surgical volume: United States, 2013 and 2015.

Annual inpatient surgeries	Group O RBC units on shelf, average weekday		Group O+ RBC units at which supply considered critically low	
	2015 mean (S.D.)	2013 mean (S.D.)	2015 mean (S.D.)	2013 mean (S.D.)
100–999	13.3 (8.1)	15.9 (20.5)	5.7 (8.1)	7.1 (20.5)
1,000–1,399	22.7 (12.5)	25.6 (33.3)	10.1 (12.5)	10.9 (33.3)
1,400–2,399	29.8 (20.2)	30.2 (22.7)	13.7 (20.2)	13.0 (22.7)
2,400–4,999	45.7 (32.0)	49.2 (43.1)	20.4 (32.0)	21.6 (43.1)
5,000–7,999	70.7 (41.3)	72.2 (49.4)	30.6 (41.3)	32.2 (49.4)
More than 8,000	135.3 (106.2)	137.6 (93.0)	61.2 (106.2)	71.0 (93.0)

TABLE 23

Crossmatch procedures performed on whole blood and red blood cells (expressed in thousands): United States, 2015 and 2013.

Crossmatch procedure method	2015		2013	
	Number of procedures (95% CI)	% of any method	Number of procedures (95% CI)	% of any method
Any method	16,625 (15,838–17,411)		19,042 (17,819–20,265)	
Electronic	6,776 (6,036–7,516)	40.8%	6,113 (5,075–7,151)	32.1%
Manual serologic	8,946 (8,442–9,449)	53.8%	11,726 (10,779–12,672)	61.6%
Automated serologic	774 (445–1,103)	4.7%	815 (571–1,060)	4.3%

TABLE 24

Pediatric transfusions (in 1000s of units) by US blood collection centers and hospitals: 2015 and 2013.

Component	Adult equivalent units used in whole or part for pediatric patients						Total number of pediatric recipients	
	% change 2015–2013	Matched† % change 2015–2013	2015	2013*	2011	2008	2015	2013*
Whole blood/red blood cells	−22%	−20.0% (n=199)	346 (259 – 433)	442 (263 – 620)	265	383	80 (47 – 113)	110 (56 – 163)
Apheresis PLTs	−10%	−38.3% (n=128)	165 (120 – 210)	182 (107 – 258)	127	170	48 (36 – 60)	58 (10 – 106)
Plasma	−49%	−39.7% (n=102)	74 (56 – 93)	145 (80 – 209)	58	101	29 (18 – 41)	46 (5 – 88)

*Weighted, not imputed.

†Facilities providing estimates for 2013 and 2015 were matched, where possible, and the mean percentage difference is presented with the number of matched facilities (n).

TABLE 25

RBC and PLT units (expressed in thousands) transfused by location within a healthcare facility as reported to the National Blood Collection and Utilization Survey: United States 2013.

Hospital location	Red blood cells (95% CI)	PLTs (95% CI)	Number of responses*
Surgery (general)	1,238 (983 – 1,494)	139 (111 – 168)	613
Orthopedic surgery	597 (416 – 777)	24 (13 – 35)	552
Cardiac surgery	752 (600 – 905)	170 (135 – 205)	549
Transplantation services	129 (53 – 205)	45 (16 – 74)	555
Emergency Department	1,024 (893 – 1,155)	82 (60 – 104)	603
General medicine	2,872 (2,534 – 3,210)	269 (213 – 326)	620
Hematology/Oncology	1,842 (1,457 – 2,226)	645 (408 – 882)	562
Obstetrics/Gynecology	230 (191 – 268)	15 (10 – 20)	596
Pediatrics/Neonatology	187 (126 – 247)	72 (39 – 106)	573
Intensive Care Unit	1,638 (1,417 – 1,859)	261 (201 – 322)	560
Nephrology	285 (233 – 336)	11 (6 – 16)	537

*Total number of responses for 2013 was 1101.

TABLE 26

RBC and PLT units (expressed in thousands) transfused by location within a healthcare facility as reported to the National Blood Collection and Utilization Survey: United States 2015.

Hospital location	Red blood cells (95% CI)	PLTs (95% CI)	Number of responses*
All Surgery (including transplant)	1,431 (1,284 – 1,578)	300 (245 – 356)	903
Emergency Department	1,007 (900 – 1,114)	79 (68 – 91)	921
Inpatient Medicine (including hematology/oncology)	4,293 (3,966 – 4,620)	866 (626 – 1,105)	942
Obstetrics/Gynecology	194 (173 – 215)	11 (9 – 13)	917
Pediatrics	149 (89 – 208)	71 (37 – 105)	950
Neonates	103 (79 – 128)	28 (20 – 36)	979
Critical Care	1,817 (1,689 – 1,946)	400 (349 – 451)	835
Outpatient and non-acute inpatient settings†	1,631 (1,477 – 1,786)	302 (240 – 365)	927

*Total number of responses for 2015 was 2138.

†Includes outpatient dialysis, rehabilitation and long-term care.

TABLE 27

Comparison of RBC and PLT units (expressed in thousands) transfused by location within a healthcare facility as reported to the National Blood Collection and Utilization Survey: United States, 2015 and 2013.

	Red blood cells (95% CI)			PLTs (95% CI)		
Hospital location	**2015**	**2013**	**% change***	**2015**	**2013**	**% change***
All Surgery (including transplant)	1,431 (1,284 – 1,578)	2,445 (1,978 – 2,912)	−41.5% *	300 (245 – 356)	340 (275 – 405)	−11.7%
Emergency Department	1,007 (900 – 1,114)	1,024 (893 – 1,155)	−1.7%	79 (68 – 91)	82 (60 – 104)	−3.8%
Inpatient Medicine (including hematology/oncology)	4,293 (3,966 – 4,620)	4,518 (4,011 – 5,025)	−5.0%	866 (626 – 1,105)	878 (624 – 1,131)	−1.4%
Obstetrics/Gynecology	194 (173 – 215)	230 (191 – 268)	−15.5%	11 (9 – 13)	15 (10 – 20)	−25.2%
Pediatrics/Neonatology	232 (166 – 298)	187 (126 – 247)	24.4%	91 (57 – 126)	72 (39 – 106)	26.2%
Critical Care	1,817 (1,689 – 1,946)	1,638 (1,417 – 1,859)	10.9%	400 (349 – 451)	261 (201 – 322)	53.1% *

* Indicates statistically significant difference.