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Supplemental findings of the 2017 National Blood Collection and Utilization Survey

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Abstract

INTRODUCTION: This report provides supplemental results from the 2017 National Blood Collection and Utilization Survey on characteristics of the donor population, autologous and directed donations and transfusions, platelets, plasma and granulocyte transfusions, pediatric transfusions, severe donor-related adverse events, cost of blood units, hospitals policies and practices, and inventory, dosing, and supply.

METHODS: Weighting and imputation were used to generate national estimates including number of donors, donations, donor deferrals, autologous and directed donations and transfusions, severe donor-related adverse events, platelet and plasma collections and transfusions, number of cross-match procedures, irradiation and leukoreduction, and pediatric transfusions.

RESULTS: Between 2015 and 2017, successful donations decreased slightly by 2.1% with a 10.3% decrease in donations by persons aged 16–18 years and a 14.4% increase in donations by donors aged >65 years. The median price paid for blood components by hospitals decreased from $211 to $207 for leukoreduced red blood cell units, from $523 to $517 for leukoreduced apheresis platelet units, and from $54 to $51 for fresh frozen plasma units. Plasma transfusions decreased 13.6%, but group AB plasma units transfused increased 24.7%.

CONCLUSION: Between 2015 and 2017, blood donations declined slightly because of decreases in donations from younger donors, but the number of donations from older donors increased. The

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DISCLAIMER

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CONFLICT OF INTEREST

The authors have no disclosed conflict of interest.

price hospitals pay for blood has continued to decrease. Plasma transfusions have decreased, but the proportion of plasma transfusions involving group AB plasma have increased.

Blood is a critically important health resource used across numerous medical specialties and settings. It is important to monitor blood availability, blood safety, and current and emerging practice in the blood sector by following trends in blood use in the United States to inform decision making from the state and national policy level, down through the localized blood bank level.[1] The National Blood Collection and Utilization Survey (NBCUS) is a biennial, comprehensive survey of blood collectors and transfusing hospitals that has for several decades provided these data for the blood industry, policymakers, and other stakeholders. The NBCUS includes questions on collection and transfusion of blood components as well as questions designed to monitor the donor population; donor and patient adverse reactions; and practices in the collection, production, and transfusion of blood products.

The Centers for Disease Control and Prevention (CDC), in collaboration with the Office of the Assistant Secretary for Health, has administered the NBCUS since 2013. The 2017 survey is the third NBCUS administered and analyzed by CDC. Based on the experience gained from the 2013 and 2015 surveys, numerous efforts have been made to improve the survey process, response, and usefulness. First, CDC has devoted additional resources to the pre-survey protocols and to survey follow-up in order to increase participation and enhance the accuracy and representability of the NBCUS. Second, CDC has made efforts to update the survey format and questionnaire with the objective of maintaining consistency between the questions, where possible, to allow longitudinal comparison. Third, CDC continues to prioritize dissemination of the survey findings such that data collected as part of the survey are available in the scientific literature.

This article supplements the findings reported by Jones et al.[2] on collection, use, and cost of whole blood, red blood cells (RBCs), platelets (PLTs), and plasma, and by Savinkina et al.[3] on topics related to implementation of safety measures in the blood industry, including transfusion-associated adverse reactions. The remaining results from the 2017 NBCUS are presented herein with comparison to the 2015 findings.

METHODS

The 2017 NBCUS is the third iteration to be administered by CDC, following the 2013[4,5] and 2015[5–7] surveys. The structure of the survey and methods employed to analyze the data are essentially unchanged from 2015,[5] but the administration of the survey was modified based on lessons learned in 2013 and 2015 as summarized below.

Questionnaire design

The 2017 survey consisted of 20 questions for blood collection centers and 28 questions for transfusion centers. Compared to the 2015 NBCUS, several minor changes were made to questions for the 2017 survey in order to add clarity. Additionally, several questions were added. In the section on blood collection, new questions were added on implementation of Pathogen Reduction Technology (PRT), *Babesia* screening, blood center mergers and insolvency, and hematopoietic growth factor mobilization for granulocyte collections.

Several existing questions were also enhanced to include the following: male and female categorization of the number of donors presenting and donors deferred; abnormal pulse and/or blood pressure as a new category for donor deferrals; one-year age categorizations for the number of donations by donors aged 15–18 years; age categorizations for severe donor-related adverse events (≤18 years and ≥ 19 years; the "All donors" category from the 2015 survey was kept for comparison); additional questions on group O RBC collections, distributions and outdates; collections, distributions, and outdates of additional plasma components.

Survey respondents at participating hospitals were asked new questions on PRT-treated component transfusions and on neonatal patients, including the use of aliquots for neonatal patients and sub-categorization of pediatric transfusions to separate neonatal (aged ≤4 months) and pediatric patients (aged >4 months). In the 2015 NBCUS, we were unable to determine whether facilities that did not answer questions on pediatric and neonatal transfusions should be treated as a zero (e.g., facilities do not transfuse pediatric patients) or as missing (e.g., facility skipped the question or did not know). As a result of this, a question was added regarding whether facilities transfuse pediatric or neonatal patients. Finally, survey respondents were specifically asked if irradiation involved cesium and/or X-ray.

Sampling method

The construction of the sampling frame followed similar methods to the 2015 NBCUS.[5] The sampling frame for blood collection centers was based on the Food and Drug Administration (FDA) Blood Establishment Registration (FDA-BER) database retrieved in November 2016.[8] All facilities collecting or modifying blood are required to register with the FDA-BER. The sampling frame for hospitals was based on the American Hospital Association (AHA) annual survey database[9] for 2015, which was the most recently available year. The AHA annual survey database was restricted to U.S. facilities with at least 100 annual inpatient surgical operations within the 50 states and Washington, D.C., and excluded military, Department of Justice, psychiatric, rehabilitation, specialty hospitals, and long-term acute care facilities.

All community- and hospital-based blood centers were sampled at 100%. Hospitals with an annual inpatient surgical volume of between 100 and 999 were sampled at 40%. Hospitals in this category that appeared on the FDA-BER or that had collected blood in 2015 were treated as hospital-based blood centers and were excluded from the sampling protocol. All hospitals with annual inpatient surgical volume of 1000 or more were sampled at 100%.

Nonresponse to the 2015 NBCUS was partially attributed to incorrect contact information, so additional effort was made to confirm facility contacts for the 2017 survey. All community-based blood centers were contacted by email or telephone to confirm contact information. All sampled hospitals (including hospital-based blood centers) were sent a web-based contact confirmation form via email. Non-respondents to the contact confirmation form were contacted via U.S. mail or by telephone. Contact confirmation activity took place from November 2017 through April 2018.

The survey was sent to each sampled facility in April 2018 via confirmed email with each facility receiving a unique survey. Sampled facilities were given 3 months to respond. All facilities were sent a reminder letter at the end of the first month of the survey data collection period, followed by telephone outreach starting in the second month to contacts at facilities where the survey had not yet been started. Follow-up for incomplete or inconsistent response was conducted through March 2019.

Stratification, imputation, and weighting

The stratification used for blood centers and hospitals was consistent with the techniques used in 2015.[5] For the collection questions, community-based blood centers were stratified based on the number of RBC collections in 2015 with facilities stratified into four groups: less than 50,000 units, 50,000 to 199,000 units, 200,000 to 399,000 units, and 400,000 or more units. Hospital-based blood centers were stratified using the inpatient surgical volume from the AHA database used to construct the sampling frame, with facilities stratified into three groups: less than 1000 inpatient surgeries during 2015, 1000 to 7999 inpatient surgeries during 2015, and more than 8000 inpatient surgeries during 2015. For the transfusion questions, hospitals were separated into six categories based on inpatient surgical operations[10] from the AHA database used to construct the sampling frame: 100 to 999, 1000 to 1399, 1400 to 2399, 2400 to 4999, 5000 to 7999, and more than 8000 inpatient surgeries during 2015.

Missing data were imputed using the same multiple imputation techniques employed in 2013 and 2015.[5,11] All imputed variables were continuous and non-normally distributed. A two-stage imputation procedure was used for variables skewed toward zero.[12] Variables with missing data exceeding 20% of respondents were not imputed, instead being analyzed using complete case analysis.[13] Imputation was applied only for variables for which a national estimate was produced.

Responses were weighted for non-response within strata, with weights calculated as the overall number of responses to the survey divided by the total number of facilities in the sampling frame, by strata. Community-based blood centers with more than 400,000 RBC collections were assigned a weight of 1.0. All other blood centers and all transfusing hospitals were assigned a weight according to the inverse of the response rate for their strata. Facilities with fewer than 1000 annual inpatient surgeries were sampled at 40% and were therefore assigned combined weights for non-response and for sampling. Confidence intervals (CIs) were estimated for national estimates using the Taylor series method.[14]

Imputation and weighting were used to produce national estimates of number of persons presenting to donate; deferred donors; donations by age and type; repeat and allogeneic donors; donations, transfusions, donors, and recipients for autologous and directed blood components; severe donor-related adverse events; single, double, and triple apheresis PLT collections; plasma components collected and transfused; cross-match procedures performed on whole blood/RBCs; and irradiated units transfused by hospitals. An available case analysis was used to produce estimates of the number of PLT units transfused by hospital location. The remaining variables were not weighted or imputed and are presented as means,

medians, and percentages of responding facilities. In this study, whole blood/RBCs refers to whole blood, whole blood-derived RBCs, and apheresis RBCs combined.

Additional data management was required for component cost estimates. A small number of facilities appeared to have reported the total amount spent on blood products, rather than price per unit; these facilities were removed by using a threshold that was five times the standard deviation above the mean. Additional cleaning was required for whole blood-derived PLTs and cryoprecipitate because some facilities appeared to have reported the cost for pooled components. A threshold of $350 for whole blood-derived PLTs and $200 for cryoprecipitate was chosen to remove the apparent outlier pooled estimates. In order to compare 2015 and 2017, this cleaning methodology applied to 2017 was repeated for 2015 data. Cost data are presented in whole dollars.

An additional matched analysis of facilities was conducted to examine changes in the number of PLT units transfused by location within a hospital from 2015 to 2017, and changes in the number of pediatric and neonatal transfusions between 2015 and 2017. Facilities that responded to these questions in both 2015 and 2017 were matched and the median of the matched differences was used to summarize trends between the two surveys. A t-test was used to test for significant changes in the cost of blood components between 2015 and 2017, and for changes in the number of PLT units transfused by location within a hospital between 2015 and 2017; p values less than 0.05 were deemed significant. All analyses were carried out using SAS software version 9.4 (SAS Institute Inc.).

Variables analyzed in this report

Survey participation is reported for 2017 and compared to prior years by facility type, volume of RBC collections, number of inpatient surgical operations, and by geographical region based on the Public Health Service (PHS) regions.[15] Next, the estimated number of donor deferrals stratified by deferral reason and sex, and the total number of donors presenting to donate stratified by sex are reported for 2017 and contrasted with 2015. The number of donations stratified by donor age and the number of donations by minority donors are reported for 2017, followed by the total number of individual donors for 2017, split into first-time and repeat allogeneic donors. The number of autologous and directed whole blood and RBC donors and units donated and the number of directed PLT donors and units donated in 2017 and 2015, as well as the number of autologous and directed whole blood and RBC recipients and units transfused and the number of directed PLT recipients and units in 2017 and 2015 are reported. The mean and median cost paid by hospitals for RBC (leukoreduced and nonleukoreduced), whole blood-derived PLTs, apheresis PLTs, fresh frozen plasma (FFP), plasma frozen between 8 and 24 hours of donation (PF24) and cryoprecipitate are reported for 2015 and 2017, including reanalyzed estimates for 2015 are reported. Costs paid by hospitals for leukoreduced RBCs, apheresis PLTs, and FFP are further stratified by inpatient surgical volume, and PHS region. Next, hospital policies and practices used to enhance the safety of recipients are shown for 2017 and 2015. The number of severe donor-related adverse events and rates of transfusion reactions are reported for 2017 and contrasted with 2015 estimates, stratified by collection center type, collection type, and donor age. Severe donor-related adverse events were defined as adverse events occurring

in donors attributed to the donation process that include major allergic reactions, arterial punctures, loss of consciousness of a minute or more, loss of consciousness with injury, and nerve irritation.

The number of PLTs transfused by location within facilities is shown for 2017 and compared with 2015, followed by the number of single, double, and triple apheresis PLT collections and the number of facilities using PLT additive solution to prepare apheresis PLTs. The number of apheresis and whole blood-derived plasma units collected and transfused by component type is shown for 2017 and 2015. This is followed by a tabulation of the dosing criteria used by facilities for routine dosing of plasma and for dosing of prophylactic and therapeutic PLT transfusions. The age of RBC, apheresis PLT units, and whole blood-derived PLT units at the time of transfusion by age group is shown for 2015 and 2017. The number of group O+ and O− RBC units distributed, transfused, and outdated is shown for 2017 and 2015, followed by the number of group O RBC units on the shelf on an average weekday and the number of O+ RBCs at which the supply is considered critically low, stratified by annual inpatient surgical operations. The number of cross-match procedures is shown for 2017 and 2015, stratified by cross-match procedure method. Next, the number of irradiated whole blood and RBCs and apheresis PLT units transfused in hospitals in 2017 and 2015 are shown, stratified by irradiation method. The number of adult equivalent units transfused in whole or in part for pediatric and neonatal patients and the number of pediatric and neonatal recipients is reported for 2017 and 2015, stratified by blood component; the estimates for 2017 are stratified by neonatal and pediatric patients. Finally, a summary of policies for neonatal aliquot production is shown.

RESULTS

Survey participation

The 2017 NBCUS had the highest response rate of any NBCUS over the past seven surveys with 85.7% (2588 of 3020) of sampled facilities responding (Table 1). The number of community-based blood centers meeting inclusion criteria decreased from 80 in 2015 to 65 in 2017. Of these 65 community-based blood centers, 61 (93.8%) responded to the NBCUS survey. The reduction in community-based blood centers was greatest in facilities with less than 50,000 collections per year (Table 2) with 10 fewer facilities in 2017 than in 2015. The rest of the reduction came from facilities with 50,000 to 199,000 collections per year where the number of facilities dropped from 31 in 2015 to 26 in 2017.

The number of hospital-based blood centers also declined, but more sharply than community-based blood centers, with a reduction from 142 in 2015 to 108 in 2017. However, the response rate from hospital-based blood centers increased from 71.8% in 2015 to 85.2% in 2017. This reduction was driven almost entirely by medium-sized hospital-based blood centers (with 1000 to 7999 inpatient surgeries per year), with a slight increase in the number of smaller facilities (with fewer than 1000 surgeries per year) driven by previously medium-sized facilities having lower annual inpatient surgical volume in 2017 and thus being moved into the smaller hospital-based blood center categorization.

The overall number of hospitals in the sample decreased slightly by 45 from 2892 in 2015 to 2847 in 2017. The response rate among hospitals was 85.5% and was relatively similar across the surgical operations strata (Table 3) with a range of 82.9% to 89.0%. There was slightly more variation in response rate by PHS region (Table 4), with Regions 6 and 9 having the lowest response rates (79.2% and 79.9% respectively) and Regions 1, 2, 3, and 7 all having response rates higher than 90%.

Donor characteristics

The number of potential donors presenting to donate, including successful, unsuccessful, and deferred donors, in 2017 was 14,018,000 (95% CI, 13,132,000–14,903,000) which was a 7.2% decrease over 2015 when the total presenting to donate was 15,111,000 (Table 5). Of those presenting to donate, a total of 2,544,000 (95% CI, 2,373,000–2,716,000) donors were deferred, which is an increase of 34.9% over 2015 (1,886,000 deferrals). The donor deferral rate in 2017 (18.1%) was higher than that in 2015 (12.5%). The biggest drivers of this increase were low hemoglobin or hematocrit, other non-medical reasons, and blood pressure and/or pulse (a deferral category that was newly added to the 2017 NBCUS). Deferrals attributed to blood pressure and/or pulse accounted for 288,000 (95% CI, 261,000–315,000) deferrals in 2017. Low hemoglobin/hematocrit increased by 140,000, or 14.3%, from 975,000 deferrals in 2015 to 1,115,000 (95% CI, 1,051,000–1,179,000) deferrals in 2017. Other (non-medical) deferrals increased by 135,000, or 81.4%, from 166,000 deferrals in 2015 to 301,000 (95% CI, 264,000–338,000) deferrals in 2017. Deferrals for other medical reasons (including use of medications on the medication deferral list, growth hormone from human pituitary glands, Hepatitis B Immune Globulin, etc.) increased by 19,000, or 3.7%, from 504,000 deferrals in 2015 to 523,000 (95% CI, 442,000–603,000) deferrals in 2017, deferrals for men who have sex with men (MSM) decreased by 2000 deferrals, or 25.8%, from 8000 deferrals in 2015 to 6000 (95% CI, 5000–7000) deferrals in 2017, and deferrals for tattoo/piercing increased by 12,000, or 25.1%, from 49,000 deferrals in 2015 to 61,000 (95% CI, 55,000–67,000) deferrals in 2017. Results for most other deferral categories were relatively unchanged in 2017 compared to 2015.

The 2017 survey included questions to determine how many deferred donors were male and female. The number of males and females presenting to donate in 2017 was approximately even, with 7,099,000 males and 6,919,000 females. However, the number of females deferred in 2017 was higher than the number of males, with 1,683,000 females deferred (66.1% of all deferrals) compared to 862,000 males (33.9% of all deferrals). The primary cause of this difference was deferrals for low hemoglobin/hematocrit, for which 907,000 females were deferred compared to 208,000 males. There was also a large difference in the number of male and female deferrals for other medical reasons with 319,000 females deferred compared to 203,000 males. Females were also more likely to be deferred, although in lower numbers, for an abnormal pulse and/or blood pressure (154,000 females; 134,000 males), tattoo/piercing (42,000 females; 19,000 males), and other deferral reasons (176,000 females; 125,000 males). The only category where male deferred donors exceeded female deferred donors was in deferrals for high-risk behaviors (e.g., nonmedical intravenous drug use, incarceration, high-risk sexual contact), with a combined total of 17,000 men deferred

compared with 9,000 females deferred; among the 17,000 deferred male donors, 6,000 were deferred because of a history of male sexual contact.

Of the 14,018,000 potential donors in 2017, 11,101,000 (95% CI, 10,553,000–11,649,000) resulted in successful donations (Table 6), which is only a slight decrease from the 11,339,000 successful donations in 2015. These successful donations came from a total of 7,996,000 (95% CI, 7,547,000–8,446,000) donors (Table 7), a 17.4% increase compared to 2015 (6,812,000 total individual donors). This 17.4% increase in donors was driven by a 29.0% increase in repeat allogeneic donors (from 4,589,000 in 2015 to 5,921,000 [95% CI, 5,536,000–6,306,000]) in 2017; first-time allogeneic donors decreased 6.6%, from 2,223,000 in 2015 to 2,076,000 (95% CI, 1,951,000–2,200,000) in 2017. The number of donations that came from minority donors in 2017 was 2,018,000 (95% CI, 1,605,000–2,432,000), which represents 18.2% of all donations. The number of donations collected from minority donors was not reported for the 2015 NBCUS because of insufficient data quality.

Table 6 shows the national estimates of the number of donations by donor age from the 2015 and 2017 surveys. The majority of donations came from donors between the ages of 25–64 years (63.1%) followed by donors aged ≥65 years (14.4%), donors aged 16–18 years (12.3%), and donors aged 19–24 years (10.1%). From 2015 to 2017, donations by persons aged <65 years decreased by 447,000, including 156,000 fewer donations (10.3% decrease) among donors aged 16–18 years, 119,000 fewer donations (9.6% decrease) by donors aged 19–24 years, and 172,000 fewer donations (2.4% decrease) among donors aged 25–64 years. In contrast, donations by donors aged ≥65 years increased by 202,000, or 14.4%, from 1,401,000 in 2015 to 1,603,000 (95% CI, 1,481,000–1,725,000) in 2017. The 2017 survey included expanded categories for the number of donations by donors aged 15–18 years. Donors aged 15 years provided 6000 (95% CI, 0–19,000) donations, donors aged 16 years provided 286,000 (95% CI, 256,000–316,000) donations, donors aged 17 years provided 586,000 (95% CI, 532,000–640,000) donations, and donors aged 18 years provided 493,000 (95% CI, 460,000–525,000) donations.

Autologous and directed transfusions

The number of autologous whole blood/RBC transfusions increased from 20,000 units in 2015 to 27,000 units (95% CI, 11,000–43,000) in 2017 with 25,000 recipients (95% CI, 4,000–45,000) in 2017 compared with 9,000 recipients in 2015 (Table 8). The total number of directed RBC/whole blood transfusions decreased from 66,000 units in 2015 to 56,000 (95% CI, 32,000–80,000) units in 2017 with 38,000 recipients (95% CI, 15,000–61,000) in 2017 compared with 25,000 recipients in 2015. The number of directed RBC/whole blood units transfused per recipient decreased from 2.6 in 2015 to 1.5 in 2017.

Cost

Unit cost data were removed from 146 of 2047 facilities where the value reported was more consistent with total annual spending on blood products rather than individual unit cost. The estimate of the cost of individual whole blood-derived PLT units excludes 55 of 133 facilities that reported values above $350 that are consistent with reporting of pooled

estimates rather than individual estimates. The estimate of the cost of individual cryoprecipitate units excludes 425 of 1586 facilities that reported values above $200 that appear to be more likely attributable to reporting of pooled estimates rather than individual estimates.

Component costs as reported by hospital respondents declined between 2015 and 2017 (Table 9), continuing the steady decrease shown in previous reports.[5] The reanalyzed median costs for 2015 were similar to the costs originally reported for 2015[5] except for the costs of whole blood-derived PLTs and cryoprecipitate, which decreased by $20 and $6 respectively. Between 2015 and 2017, the median price paid per unit decreased by $4 for leukoreduced RBCs, $4 for non-leukoreduced RBCs, $3 for whole blood-derived PLTs, $6 for apheresis PLTs, $3 for FFP, and $2 for plasma frozen between 8 and 24 hours of donation (PF24). There was no change in the cost of a single unit of cryoprecipitate. Mean cost differences are less robust than median differences and may reflect differences in outliers; nevertheless, there was a statistically significant decrease of $8 in the mean cost of apheresis PLT units from $530 in 2013 to $522 in 2017. Mean costs were unchanged between 2015 and 2017 for FFP, PF24, and cryoprecipitate. Mean costs for nonleukoreduced RBCs and whole blood-derived PLTs showed an increase, but the low number of facilities reporting costs for these components (198 and 78, respectively) suggest that these may be unreliable estimates.

RBCs—The median price paid for leukoreduced RBCs reported by respondents at 1946 hospitals was $207 in 2017 (inter-quartile range [IQR], $196–$223), with a mean value of $213, which suggests only slight skew in the overall cost distribution (Table 9). The cost of leukoreduced RBCs (Table 10) was higher for facilities performing the fewest inpatient surgeries (100–999; $216) and lowest for facilities performing the most inpatient surgeries (5000–7999 and ≥8000; $203). The decline in median cost was limited to facilities performing more than 1000 in patient surgeries, with the smallest facilities (100–999 inpatient surgeries) paying a slightly higher cost for leukoreduced RBCs in 2017 ($216) than in 2015 ($215). When stratified by PHS region, the reduction in cost of leukoreduced RBCs was not geographically uniform (Table 11).

The decrease in cost of leukoreduced RBCs was driven by decreases in PHS Regions 1 (CT, MA, ME, NH, RI, VT), 2 (NJ, NY), 8 (CO, MT, ND, SD, UT, WY), and 9 (AZ, CA, HI, NV). The cost of leukoreduced RBCs increased in PHS Regions 6 (AR, LA, NM, OK, TX), 7 (IA, KS, MO, NE), and 10 (AK, ID, OR, WA) and was approximately unchanged in PHS Regions 3 (DC, DE, MD, PA, VA, WV), 4 (AL, FL, GA, KY, MS, NC), and 5 (IL, IN, MI, MN, OH, WI).

The price paid for nonleukoreduced RBCs was reported by 198 of 2435 hospitals that responded to the 2017 survey, likely reflecting the lower usage of this component type. The median price paid by hospitals for nonleukoreduced RBCs in 2017 was $200 with an IQR of $184–214 and a mean of $207. The median (mean) price paid for nonleukoreduced RBCs was $7 ($6) less than leukoreduced RBCs and decrease in the median price paid for leukoreduced and nonleukoreduced RBCs from 2015 to 2017 was the same ($4).

PLTs—The median price paid for apheresis PLTs reported by 1923 hospitals was $517 in 2017, a decrease of $6 from $523 in 2015 (Table 9). The decrease in price was highest for medium-sized hospitals, with prices unchanged for hospitals with 100–999 inpatient surgical operations and only a slight decrease for hospitals with ≥8000 inpatient surgical procedures. The decrease was largest for hospitals with inpatient surgical operations between 2400–7999, resulting in these hospitals paying a similar price as hospitals with ≥8000 inpatient surgical operations ($506–$510). The price paid for apheresis PLTs in 2017 is now at least $30 more per unit for hospitals with the 100–999 inpatient surgical operations than for hospitals with at least 2400 inpatient surgical procedures.

There are large geographic differences in the price paid for apheresis PLTs (Table 10), with respondents at hospitals in PHS Region 10 (AK, ID, OR, WA) reporting the highest median price per unit in 2017 at $567. Nearly all PHS regions saw a decrease in mean price paid for apheresis PLTs, but hospitals in PHS region 10 reported an increase of $17 in the median price. The mean price paid for apheresis PLTs decreased, reflecting a less skewed price distribution in 2017 compared to 2015 because of increasing cost for most facilities with a decrease in cost for facilities that had been paying the highest prices in 2015. The median price paid for apheresis PLTs in PHS Region 10 ($567) was still $44 more than the national median price ($523) and $77 more than the two PHS regions with the lowest median price paid (PHS Regions 7 [IA, KS, MO, NE] and 9 [AZ, CA, HI, NV]; $490).

In 2017, respondents at only 78 hospitals reported the price paid per whole blood-derived PLT unit after removing outliers. There was a slight decrease in median price paid from $75 in 2015 to $72 in 2017, although there was an increase in the mean price from $80 to $85, suggesting an increased skew in the price distribution. The median pool size of whole blood-derived PLTs was five in 2017, thus the median price of a nonleukoreduced, nonirradiated whole blood-derived PLT pool is projected as $360.

Plasma—The 2017 NBCUS asked respondents at hospitals to report the price paid for both FFP and PF24. Of 2435 hospitals that responded to the survey in 2017, 1134 reported a price for FFP and 1616 reported a price for PF24 (Table 9). The median price for each plasma product was similar in 2017 ($51 for FFP and $50 for PF24) and a decrease compared to 2015 ($54 for FFP and $52 for PF24); the IQR was the same for FFP and PF24 ($43–$60). Hospitals with 100–999 inpatient surgical operations paid the highest median price for FFP ($60) and PF24 ($58), both of which were unchanged since 2015 (Table 10). Furthermore, the decrease in median price paid was limited to hospitals with more than 1000 inpatient surgical procedures. The difference in price paid between hospitals with 100–999 inpatient surgical operations and hospitals with ≥8000 inpatient surgical operations grew to $15 (25%) more expensive for FFP and $13 (22%) more expensive for PF24.

The median price of FFP decreased in most PHS regions, although PHS Region 4 (AL, FL, GA, KY, MS, NC), showed zero decrease (Table 11). The biggest decrease occurred in PHS Region 1 (CT, MA, ME, NH, RI, VT), which became the region with the lowest price paid. The highest median price paid was reported by PHS Region 10 (AK, ID, OR, WA; $69 in 2017), followed by PHS Region 8 (CO, MT, ND, SD, UT, WY; $65 in 2017).

Hospital policies or practices related to transfusion services

The percentage of hospitals that have a Transfusion Safety Officer (TSO) on staff rose from 16.2% in 2015 to 19.3% in 2017 (Table 12). Of the 448 facilities that responded as having a TSO in 2017, 89.1% (399/448) reported that the TSO was employed by the hospital, while the remaining 10.0% (45/448) were employed by a blood center and 0.9% (4/448) did not specify who employs the TSO. The percentage of TSOs employed by blood centers increased since 2015, when 94.9% (282/297) were employed by the hospital and 5.1% (15/297) were employed by a blood center.

The percentage of transfusing facilities that collect data on sample collection errors remained relatively unchanged from 83.3% of facilities in 2015 to 82.9% of facilities in 2017. However, the mean number of sample collection errors rose slightly from 37.0 per facility in 2015 to 41.8 per facility in 2017. The percentage of facilities reporting the existence of a program to treat patients who refused blood components for religious, cultural, or personal reasons was also relatively unchanged at 73.5% in 2017 from 71.6% in 2015. The median number of samples (patient specimens submitted for testing) received by the hospital's blood bank was also unchanged at 4547 samples in 2017 from 4576 samples in 2015.

Severe donor-related adverse events

In 2017, there were a total of 14,614 severe donor-related adverse events among 12,855,000 total collections, a rate of 1:880 (Table 13). This rate is lower than the 2015 reaction rate of 1:762 (17,762 severe donor-related adverse events and 13,526,000 total collections). The reaction rate for whole blood (manual) and apheresis (automatic) collections was approximately equal in 2015, but the rate of severe donor-related adverse events associated with apheresis collections was lower in 2017 (1:940) compared to the rate associated with whole blood collections (1:867). Similar to 2015, the severe donor-related adverse event–rate associated with whole blood collections in community-based blood centers (1:896) was lower than the reaction rate associated with hospital-based collection centers (1:525) during 2017. However, the severe donor-related adverse event rates at community-based blood centers and hospital-based blood centers were approximately the same for apheresis collections, although hospital-based blood centers had very few apheresis collections overall.

Among all successful donations during 2017, 12.4% were collected from persons aged 15–18 years (1,371,000 of 11,101,000; Table 6). However, 32.5% of severe donor-related adverse events associated with whole blood collections were among donors aged ≤18 years (3904 of 12,029 total reactions). In contrast, 9.6% of severe donor-related adverse events associated with apheresis collections were among donors aged ≤18 years (248 of 2337 total reactions).

PLT-related considerations

The number of PLT units transfused by location within a healthcare facility in 2017 is shown in Table 14. Among 1,937,000 PLT units transfused during 2017,[6] the largest number were transfused in inpatient medicine (including hematology and oncology) (783,000 units; 95%

CI, 658,000–908,000) followed by critical care (375,000 units; 95% CI, 327,000–423,000), outpatient and non-acute inpatient settings (332,000 units; 95% CI, 267,000–397,000) and all surgery (including transplant) (300,000 units; 95% CI, 256,000–343,000). PLT use was relatively unchanged between 2015 and 2017, but there were minor variations by transfusion location. Small but statistically significant increases were found in PLT use in emergency departments, which increased from 79,000 PLT units in 2015 to 99,000 (95% CI, 85,000–113,000 units) in 2017, and in obstetrics/gynecology, which increased from 11,000 PLT units in 2015 to 16,000 units (95% CI, 12,000–20,000 units) in 2017. Inpatient medicine was reported to have the largest decrease in PLT unit use between 2015 and 2017, decreasing from 866,000 PLT units in 2015 to 783,000 PLT units in 2017; however, this was not statistically significant.

Table 15 shows the number of apheresis PLT units collected from either single, double, or triple collections for 2015 and 2017. The total number of collected apheresis PLT units increased from 2,234,000 units in 2015 to 2,338,000 (95% CI, 2,189,000–2,487,000) in 2017. In 2015, single apheresis PLT collections accounted for 18.1% of units, double apheresis PLT collections accounted for 49.6% of units, and triple apheresis PLT collections accounted for 32.3% of units. In 2017, the percentage of PLT units from single apheresis collections increased to 23.2%, while the percentage of PLT units collected from double apheresis collections decreased to 46.0% and those from triple apheresis collection decreased to 30.9%.

The number of blood collection centers that reported using PLT additive solution (PAS) to prepare apheresis PLT units (Table 16) was approximately the same in 2017 (n = 12 facilities) as 2015 (n = 11 facilities). The mean number of units per facility prepared using PAS in these facilities decreased to 2742 in 2017 from 3374 in 2015, although this is far higher than the reported mean in 2013 of 43. Of the 12 facilities that reported using PAS to prepare PLT units, 8 were community-based blood centers and the remaining 4 were hospital-based blood centers.

Plasma-related results

Table 17 shows estimates of the number of plasma units collected during 2017 by plasma product type from both whole blood and apheresis collections. During 2017, 3,209,000 (95% CI, 2,879,000–3,539,000) units of plasma were collected, a decrease of 13.6% compared to 2015.[6] Of the 3,209,000 collections, the majority were distributed as PF24 (1,964,000 units; 95% CI, 1,663,000–2,266,000). Of the PF24 units, 91.3% were manufactured from whole blood collections and 8.7% of units were manufactured from apheresis collections. The total number of PF24 collections during 2017 is similar to the 2015 estimate. The majority of the other plasma units collected were distributed as FFP (974,000 units; 95% CI, 755,000–1,194,000 units), with 82.0% of FFP units manufactured from whole blood collections and the remaining 18.0% manufactured from apheresis collections. This is a decrease of 21.8% compared to the 2015 estimate of FFP, which largely explains the overall decrease in plasma collections between 2015 and 2017. A similar decrease was seen in whole blood and apheresis plasma collections, although apheresis collections fell more sharply than whole blood collections of plasma (46.3% and 13.0%,

respectively). The number of jumbo sized FFP also fell slightly from 65,000 in 2015 to 48,000 (95% CI, 15,000–82,000) in 2017. A far smaller proportion of plasma came from plasma frozen within 24 hours after collection and held at room temperature up to 24 hours after collection (PF24RT24) (169,000 units; 95% CI, 95,000–244,000 units) in 2017, a slight increase from 141,000 units in 2015. A further 83,000 (95% CI, 42,000–125,000) units of plasma were distributed as liquid plasma, a 46.1% decrease from 154,000 units in 2015.

Table 18 shows estimates of the number of transfused plasma components from 2017 and 2015. Overall, the large decrease in plasma collections was accompanied by a similarly large decline in the total number of transfused plasma units, which fell 12.9% from 2,727,000 units in 2015 to 2,374,000 (95% CI, 2,262,000–2,487,000) units in 2017.[6] In contrast to the estimates for plasma collections, plasma transfusions were more evenly split between FFP units and PF24 units. An estimated 1,021,000 (95% CI, 907,000–1,136,000) units of FFP units were transfused during 2017 and 1,183,000 (95% CI, 1,071,000–1,294,000) units of PF24 were transfused during 2017, which represents the majority of all transfused plasma units. Estimates of FFP and PF24 transfusions were higher in 2017 than in 2015. However, the sum of all transfused plasma product types was less than the total national estimate of transfused plasma in 2015, indicating a limitation of the 2015 survey to accurately capture the number of transfused plasma by plasma component type. This issue was addressed through new phrasing of the plasma questions in the 2017 NBCUS questionnaire. Other components comprised a smaller proportion of total plasma transfusions during 2017. Approximately 34,000 (95% CI, 19,000–49,000) units of pediatric size FFP, 46,000 (95% CI, 18,000–74,000) units of jumbo-sized FFP, 39,000 (95% CI, 7,000–71,000) units of PF24RT24 and 14,000 (95% CI, 8,000–20,000) units of liquid plasma were transfused.

Group AB plasma and cryoprecipitate-reduced plasma estimates are also included in Tables 17 and 18. Of the 3,209,000 plasma units collected, 312,000 (95% CI, 285,000–339,000) units were AB plasma. Of the 2,727,000 units transfused in 2017, 278,000 (95% CI, 214,000–341,000) units were AB plasma, an increase from the 223,000 units of AB plasma transfused during 2015. The number of cryoprecipitate-reduced plasma units collected during 2017 remained relatively stable at 118,000 (95% CI, 39,000–196,000) units compared to 119,000 units collected during 2015. Transfusions of cryoprecipitate-reduced plasma represented just 22.9% of collections in 2017 (27,000 units; 95% CI, 14,000–39,000) which is lower than the 76.5% from 2015.

Granulocyte collection and transfusion

National estimates of granulocyte units distributed and transfused for 2017, 2015, and 2013 are shown in Table 19. In 2017, collection centers reported 4062 (95% CI, 1809–6315) granulocyte units distributed, a 49.7% increase over the 2712 (95% CI, 1381–4045) units estimated for 2015. The number of granulocyte units distributed in 2015 and 2013 (2877 units; 95% CI, 651–5102 units) was virtually identical. The number of granulocyte units transfused in 2017 was 1717 (95% CI, 1000–2433), a 29.3% decrease from 2015 estimates (2428 units; 95% CI, 1074–3782). Blood collection centers were also asked if they used hematopoietic growth factor mobilization for granulocyte collections in 2017. Of 145 facilities that responded to the question, 18 reported using hematopoietic growth factor

mobilization for granulocyte collections, with 10 of these being community-based blood centers.

Inventory, dosing, and supply considerations

Respondents at transfusing hospitals were asked about the criteria used for routine dosing of transfusions for non-pediatric patients for plasma, prophylactic PLT, and therapeutic PLT transfusions. Table 20 shows the percentage of facilities that use each of the dosing criteria. The majority of facilities used dosages that varied based on the perceived level of coagulation factor deficiency/thrombocytopenia or degree of bleeding in 2017 (66.4% for plasma, 67.7% for prophylactic PLTs, and 70.3% for therapeutic PLTs), which was similar to percentages reported in 2015. Weight-based dosing was more likely to be used for plasma (5.4%) than for PLTs (1.7% for prophylactic PLTs and 1.5% for therapeutic PLTs) while using a dose based on a standard number of units regardless of weight was more likely to be used for PLT transfusions (11.4% for prophylactic PLTs and 11.3% for therapeutic PLTs) than plasma (8.6%). These estimates are also similar to percentages reported in 2015. Respondents at approximately one-fifth of facilities reported using dosage criteria other than weight-based, standard number of units, or varied dosage based on level of coagulation factory deficiency/thrombocytopenia or bleeding criteria (19.6% for plasma, 19.2% for prophylactic PLTs, and 16.9% for therapeutic PLTs), which is unchanged from 2015.

Table 21 shows the percentage of RBC, whole blood-derived PLTs and apheresis PLT units by age at time of transfusion in 2015 and 2017. Of the respondents at 2435 hospitals that answered survey questions in the transfusion section of the 2017 survey, only 394 (16.2%) completed the section on the age of apheresis PLT units. The majority (58.4%) of apheresis PLT units were 4 or 5 days old at transfusion in 2017, with most of the rest being 1 to 3 days old (39.6%). This represents a slight increase in the average age of PLT units at transfusion over 2015, when the proportion of apheresis PLT units that were 1 to 3 days old at transfusion (53.0%) was about the same as those that were 4 or 5 days old at transfusion (47.0%). A new option was added to this question in 2017 to allow facilities to report apheresis PLTs that were 6 or 7 days old at the time of transfusion. Facilities reported 2% of apheresis PLT units for this question were 6 or 7 days old at the time of transfusion. Respondents at a larger number of transfusing hospitals reported the age of whole blood-derived PLTs at time of transfusion (n = 1394) than reported the age of apheresis PLTs (n = 394). However, respondents at 1379 of the 1394 hospitals that answered the question on the age of whole blood-derived PLT transfusions reported 0 whole blood-derived PLT transfusions so that the total number of transfused whole blood-derived PLT units reported for this question was 8894 units compared with 220,148 transfused apheresis PLT units. Notably, whole blood-derived PLT units tended to be older at time of transfusion than apheresis PLTs. For whole blood-derived PLT units, 20.0% of transfused units were 1 to 3 days old, 80.0% of transfused units were 3 to 5 days old. Among the respondents at 194 facilities that reported data for RBC age at transfusion in 2017, 82.0% of transfused units were 1 to 35 days old and 18.0% of transfused units were 36 to 42 days old. 2017 RBC estimates are similar to those reported in 2015.

Table 22 shows the mean percentage of group O+ and O− units processed, distributed, transfused, and outdated. The questions regarding processing, distribution, and outdates in blood centers was added in 2017. Respondents at blood centers reported that 32.4% of processed RBC units were O+ in 2017 and 8.2% were O−. The percentage of group O RBC units distributed was higher than the percentage processed: 39.8% for O+ and 11.0% for O−. Group O+ and O− RBCs accounted for 12.5% and 5.3% of RBC outdates respectively, showing that these units were a smaller share of outdates compared to their share of processed units, which is consistent with their higher share of distributions. On average, O+ RBC units comprised 40.2% of all RBC transfusions and 11.2% were O−, which is very similar to the estimates from 2015. As with blood centers, the proportion of all RBC outdates that were group O was far lower than the proportion transfused: 16.4% for O+ and 12.5% for O−, which is also similar to 2015.

Facility respondents were asked to report the number of group O RBC units on the shelf on an average weekday as well as the threshold at which the O+ supply is considered critically low and the mean of the responses is shown in Table 23, by inpatient surgical operations. Respondents at hospitals with more than 8000 surgeries per year reported a mean of 145.6 group O RBC units on shelf on an average weekday, which is slightly higher than the mean from 2015 (135.3 group O RBC units). The mean number of group O RBC units on shelf on an average weekday was largely unchanged from 2015 to 2017 for the five categories of hospitals with fewer than 8000 surgeries per year. The mean number of O+ RBC units considered critically low in hospitals with fewer than 2400 surgeries per year was unchanged between 2015 and 2017 but showed a very slight increase among hospitals with more than 2400 surgeries per year. The mean estimate of the number of O+ RBC units at which the supply was considered critically low as a proportion of the number of group O RBC units on the shelf was relatively constant across inpatient surgical operations category, with larger hospitals both carrying more group O RBC units on the shelf and having a higher critical threshold.

Respondents at transfusing hospitals were asked if any surgeries were delayed longer than an hour as a result of blood inventory shortages in 2017. Of the respondents at 2351 facilities that answered this question, 140 reported experiencing such a delay and 306 replied that they did not know.

National estimates of the number of cross-match procedures performed on whole blood and RBCs are shown in Table 24. The estimate of the total number of cross-match procedures performed on whole blood/RBCs was 15,747 (95% CI, 15,136–16,358) in 2017, a slight reduction from the 16,625 procedures reported in 2015 that is consistent with the overall reduction in blood use. The percentage of cross-match procedure performed electronically increased from 40.8% in 2015 to 47.6% in 2017 while manual serologic procedures decreased from 53.8% in 2015 to 48.6% in 2017. The remaining 4.6% are being cross-matched by automated serologic methods.

Table 25 shows the number of whole blood and RBC units and the number of apheresis PLT units that were irradiated in 2015 and 2017. The percentage of whole blood and RBCs that were irradiated using any method was largely unchanged from 15.8% in 2015 to 16.0% in

2017 (1,703,000 units in 2017; 95% CI, 1,488,000–1,919,000). In 2017, facilities were also asked to report the number of units irradiated using X-Ray or cesium. Of the 1,703,000 whole blood and RBC units irradiated in 2017, 1,235,000 units (95% CI, 1,033,000–1,437,000), or 72.5%, were irradiated using cesium and 468,000 units (95% CI, 382,000–555,000), or 27.5%, were irradiated using X-rays. There was a decrease in the percentage of apheresis PLTs that were irradiated by any method from 58.0% (1,049,000 units) in 2015 to 52.5% (970,000 units; 95% CI, 841,000–1,100,000) in 2017. Of the 970,000 apheresis PLT units irradiated in 2017, 705,000 units (95% CI, 587,000–823,000), or 72.6%, were irradiated using cesium and 266,000 units (95% CI, 207,000–324,000), or 27.4%, were irradiated using X-rays.

Pediatric transfusions

In the 2017 NBCUS, respondents at 938 of 2435 hospitals (38.5%) reported that their hospitals transfuse blood to pediatric or neonatal patients. Table 26 shows the number of adult-equivalent units used in whole or in part for pediatric and neonatal patients as well as the number of pediatric or neonatal recipients. The number of whole blood and RBC units transfused to pediatric or neonatal patients increased by 9.2% from 346,000 units in 2015 to 378,000 (95% CI, 274,000–482,000) units in 2017. When the matched percentage difference for facilities that responded in both 2015 and 2017 is used, this increase is slightly less at 7.7%. There was a corresponding increase in the number of pediatric and neonatal recipients from 80,000 recipients in 2015 to 92,000 (95% CI, 74,000–111,000) recipients in 2017. Almost two-thirds (240,000 units; 95% CI, 147,000–333,000) of whole blood or RBC units were transfused to pediatric patients (e.g., aged >4 months), with the other third (141,000 units; 95% CI, 116,000–166,000) transfused to neonates (e.g., aged <4 months). However, the number of recipients was similar between pediatric (44,000 recipients; 95% CI, 32,000–57,000) and neonatal (48,000 recipients; 95% CI, 37,000–59,000) age groups.

An estimated 90,000 (95% CI, 70,000–109,000) apheresis PLT units were transfused to pediatric and neonatal patients in 2017, a 45.5% decrease from the 2015 estimate. However, among 164 facilities that reported transfusing apheresis PLTs to pediatric and neonatal patients in both 2015 and 2017, the matched mean difference showed an increase of 13.6%. Pediatric and neonatal apheresis PLT recipients decreased from 80,000 in 2015 to 24,000 (95% CI, 18,000–29,000) in 2017. In 2017, slightly more apheresis PLT units were used by pediatric patients (49,000 units; 95% CI, 34,000–64,000) than were used by neonatal patients (41,000 units; 95% CI, 31,000–51,000), but the number of recipients was similar between pediatric (12,000 recipients; 95% CI, 8000–16,000) and neonatal (12,000 recipients; 95% CI, 8000–15,000) age groups.

There were 76,000 (95% CI, 55,000–97,000) plasma units transfused to pediatric and neonatal patients in 2017, a slight decrease over the 2015 estimate of 74,000 plasma units. Based on 148 facilities that answered in both 2015 and 2017, the mean matched percentage increased 10.8%, but the number of recipients decreased in 2017 (16,000 recipients; 95% CI, 13,000–20,000) compared to 2015 (29,000 recipients). Of the 76,000 plasma units that were transfused to pediatric or neonatal patients, 63.1% (48,000 units; 95% CI, 30,000–66,000) were transfused to pediatric patients and 36.9% (28,000 units; 95% CI, 21,000–35,000) were

transfused to neonates. Conversely, 37.5% (6000 recipients; 95% CI, 4000–8000) of the plasma recipients were pediatric patients and 62.5% (10,000 recipients; 95% CI, 8000–13,000) were neonatal recipients.

Of the respondents at 937 facilities that replied to a question on neonatal aliquot production, 523 (56%) reported using a syringe to make neonatal aliquots from full-size units, and 436 (47%) reported using pedipacks for neonatal transfusions (Table 27). Of 931 facilities responding, 768 (82%) reported attempting to use the aliquots from the same full-size unit for every transfusion for neonatal patients.

DISCUSSION

This analysis reports on trends in the collection and utilization of blood in the United States up to 2017.

Donors

The decline in the number of successful blood donations has slowed, with a 2.1% decline from 2015 to 2017 compared to an 11.9% decline from 2013 to 2015. This decline appears to be a response to decreased demand for blood from transfusion hospitals.[2] However, the decline in the number of donations from 2015 to 2017 was only seen among donations by donors aged <65 years and the number of donations by donors aged ≥65 years increased. The greatest decline was seen among donors aged 16–18 years followed by donors aged 19–24 years. The proportion of total donations by donors who were aged ≤18 years decreased between 2015 and 2017, a reverse of the trend during 2011–2015 when this proportion was increasing. The previous increase in donations by adolescent donors was thought to be in response to an aging donor population and a need for younger donors.[5,16] The number of source plasma collections continues to increase in the United States.[17–19] In part because over half of plasma donors are aged 18–34 years,[18] some concerns have been reported that younger donors are donating plasma rather than blood because of financial compensation with plasma donation.[17,19] Additionally, evidence indicates that adolescent (aged ≤18 years) donors face a greater risk of iron depletion and vasovagal reactions than adult donors.[20–24] Blood collection facilities might potentially be recruiting fewer adolescent donors as a result of these concerns. The number of donors aged 15 years was added to the 2017 survey. During 2017, only California state law allowed donations from donors aged 15 years, and donors aged 15 years required written authorization from a physician.[19] The results presented in this report illustrate that younger donors continue to experience a greater risk of severe donor adverse events. The rate of severe donor-related adverse events among donors aged 18 years and younger was 0.30% (4152/1,371,000) which was higher than the rate among donors aged 18 years and older which was 0.11% (10,462/9,730,000). Among donors who experienced severe adverse events associated with whole blood collections, the proportion who were aged ≤18 years (32.5%) was substantially higher than the proportional of all donations by donors who were aged ≤18 years (12.4%).

The 2017 NBCUS indicates that the number of first-time donors continues to decrease while the number of repeat donors increased during 2015–2017. Recruiting new donors can be more expensive than mobilizing donations from repeat donors[25] and this might reflect

efforts by blood collection facilities to decrease recruitment costs. Additionally, younger donors are more likely to be first-time donors than older donors,[26] and the decrease in first-time donors might reflect the decreasing proportion of younger donors in combination with a decrease in demand for blood. Although concerns exist about the elderly donating blood with the World Health Organization's blood donor selection guidelines recommending a usual upper age limit for blood donation of 65 years,[26] evidence supports the safety and quality of blood donation by donors aged >65 years.[27] Donors aged >65 years experience donation-associated adverse events and decreased iron stores less frequently than adolescent donors[17,27,28] and evidence suggests elderly donors do not experience declines in physical fitness after donation.[29]

Several changes were evident among donor deferrals. Donor deferral reporting was stratified by sex for the first time in 2017. Women were more likely to be deferred than men, mostly because of low hemoglobin/hematocrit, and to a lesser extent because of pulse and/or blood pressure, other medical reasons, tattoo/piercing, and other reasons. Women are more likely to be deferred than men for low hemoglobin because premenopausal women have a greater risk of lower baseline iron stores associated with menstruation compared to men.[22] Women also might be more likely to be deferred because women may be more likely than men to experience low blood pressure events,[30] women >60 years of age have been reported to have a high prevalence of hypertension,[31] and women more frequently obtain body piercings.[32] Fewer men were deferred because of sex with other men in 2017 compared to 2015, possibly because MSM donor deferral criteria was changed from a lifetime deferral to 12-months from most recent sexual contact in 2016.[33] MSM deferrals decreased by 25.8%, but this resulted in only 2000 fewer deferred donors between 2015 and 2017, suggesting a minimal impact on the total number of donations. Although, since 2016, donors who have undergone tattooing within the most recent 12 months have been able to donate blood if the tattoo was applied by a state-regulated entity with sterile needles and non-reused ink[33] tattoo deferrals increased by 25.1% between 2015 and 2017. This might be attributable to an increase in the prevalence of tattoos among the general population.[34]

The total number of deferrals increased 35% from 2015 to 2017. This increase is likely partially explained by the 2016 change in donor eligibility criteria. Minimum hemoglobin levels for male donors increased from 12.5 to 13.0 g/dL and definitions for eligible pulse and blood pressure were established.[35] Additionally, per new recommendations, for donors with pulse or blood pressure outside the acceptable ranges, a physician must evaluate the donor prior to donation. Total deferrals for low hemoglobin increased by 14% (trends by sex are not possible because 2015 data was not stratified by sex). Deferrals because of pulse and/or blood pressure were not specified in the 2015 NBCUS reporting and were likely reported as deferrals grouped as "other medical reasons." Deferrals because of other medical reasons increased from 504,000 in 2015 to 523,000 in 2017. However, if deferrals because of pulse and/or blood pressure are combined with deferrals because of "other medical reasons," the 2017 total is 811,000, a 61% increase. This increase is unlikely to be explained just by increases in deferrals because of pulse and/or blood pressure; a previous study of four blood centers reported only a 0.2% increase in deferrals because of an abnormal pulse and 0.2% increase in deferrals because of an abnormal blood pressure after implementation of the updated donor eligibility regulations.[35] The NBCUS does not ask the specific reasons for

deferrals because of “other, non-medical reasons”, so the causes of the increase in this category from 2015 to 2017 are unknown. The reasons for the increase in total reported deferrals are unclear, but trends in deferrals will be followed in future surveys.

The United States is becoming more racially and ethnically diverse, with 39.6% of the population identifying as non-white or of Hispanic ethnicity in 2018.[36] However, 18.2% of donations were from minority donors. Persons with the same race and ethnicity are more likely to have the same major and minor blood antigens and transfusing blood to recipients from donors with the same race and ethnicity can reduce the risk of complications related to mismatched antigens.[37] For example, persons with sickle cell disease can require frequent transfusions and are at a high risk of developing alloantibodies; recruiting donors from racially diverse populations for blood antigen matching can reduce the risk of alloimmunization.[38–40] New thresholds which have increased the minimum Hgb for male donors may have resulted in more deferrals of black males compared to other races, likely because healthy black males have been reported to have lower Hgb level than white males.[25,35,41] Strategic planning tools to increase African-American blood donation are available,[37] but additional studies to determine effective methods to increase donations among minorities are needed.[42]

Cost and mergers

Prices paid for blood components continued to decrease from 2015 to 2017, although at a slower rate compared to prior survey years. The declines in price paid were mostly experienced by larger facilities. Respondents at smaller facilities reported a slight increase in the cost of components. Infectious disease testing (e.g., Zika, *Babesia*), product modifications (e.g., PRT), and other safety enhancements (e.g., RBC genotyping) can result in an increase in the cost to produce blood components; however, additional blood donor testing requirements did not result in an increase in the cost of blood products paid by hospitals.[7,10,43,44] The decrease in price paid per unit coupled with increased production costs and decreased demand for blood products[2] likely continues to place a strain on the finances of blood collection facilities and may be a factor contributing to mergers of blood collection centers.[2] This financial strain and negative margins might have prompted many hospitals to cease blood collection operations.[2]

Inventory

Among transfused RBCs, the proportion that are group O has increased. Although overall blood use is decreasing, this increased proportion could result in shortages, particularly for group O Rh(D)-negative blood. Other countries have described similar trends.[45,46] Recommendations for blood collection centers and transfusion services have been published to reduce the use of group O Rh(D)-negative RBCs (Group O[47]). Group O Rh(D)-negative blood use could be reduced by an estimated 44.5% by transfusing only age and sex groups at the highest risk of D aolloimmunization.[45]

Similarly, although the quantity of transfused plasma continues to decrease, the proportion that is group AB increased. This observation has also been reported in other countries.[48] The proportional increase might be attributable to massive transfusion protocols which require an

available reserve supply of thawed plasma, which is often group AB plasma reserved for potential recipients with unknown ABO type.[48]

During 2017, the majority of PLT units were transfused 4–5 days after collection. This contrasts with 2015, when the majority of PLT units were transfused ≤3 days after collection. This increase in the proportion of PLT units transfused 4–5 days after collection was not associated with the number of reported transfusion-transmitted bacterial infections. Fewer transfusion-transmitted bacterial infections were reported in the 2017 NBCUS compared to the 2015 NBCUS.[3] Changes in the age of transfused PLT units might be associated with changes in testing for bacterial contamination of PLTs. PLT units can be stored beyond 5 days if additional safety testing is performed[49] but, during 2017, only 2% of transfused apheresis PLTs were transfused 6–7 days after collection. This proportion might increase if additional safety measures are implemented to extend PLT shelf life.[50]

Limitations

While the response rates for the 2017 survey are high, many of the non-required questions (i.e., respondents could submit the survey without answering these questions) included in this report had response rates that were lower than the overall response rate. Weighting and imputation were used to produce national estimates for a number of questions but have inaccuracies reflected by the confidence intervals provided. The accuracy of the survey results is reliant on the sampling frame. The sampling frame of hospitals was based on the AHA annual survey database from 2015. Although efforts were made to verify the accuracy of this database for 2017 (e.g., verifying hospitals on the database were still in operation), sampling frame inaccuracies remain a possibility, including misclassification of hospitals based on 2015 inpatient surgical operations estimates. Data are self-reported by respondents at participating facilities and were not verified. Because 2015 transfusion estimates of plasma products (e.g., FFP, PF24) were likely underreported and inconsistent with the 2015 transfusion estimate of all plasma in 2015, specific plasma product transfusion trends from 2015 to 2017 might be inaccurate. Respondents at some facilities reported the cost of pooled whole blood-derived PLTs and cryoprecipitate units rather than the cost of individual units and some facilities reported the total spent on blood components rather than the cost per unit. The threshold approach used to remove these values is approximate and the cost estimates for whole blood-derived PLTs and cryoprecipitate may be less accurate than the estimates for the other component types. Additional limitations of the NBCUS are mentioned elsewhere.[2]

CONCLUSION

The 2017 NBCUS illustrates continued change in blood collection and utilization in the United States. Hospitals continue to pay less for blood even though implementation of additional safety measures has likely resulted in an increased cost to produce blood. The donor population is changing, possibly as a result of increased awareness of the risks associated with young donors and changes in donor eligibility policies. While overall transfusions of RBCs and plasma have continued to decrease, use of group O Rh(D)-negative blood and AB plasma is proportionally increasing. Monitoring changes in blood

collection and transfusion policies and practices is important to ensure blood safety and availability.

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TABLE 1.

Response rates to the NBCUS, 2005 to 2017

Facility type	2017	2015	2013	2011	2009	2007	2005
Community-based collection centers	93.8% (61/65)	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	85.2% (92/108)	71.8% (102/142)	41.2% (63/153)	N/A [†]	N/A [†]	N/A [†]	N/A [†]
Hospitals (utilizing blood)	85.5% (2435/2847) [‡]	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	85.7% (2588/3020) [‡]	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 subcenters of collection centers in their total facility count. Number of individual responding collection centers was not available for 2005 to 2011.

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

[‡] The 2011, 2015, and 2017 surveys included a sample of 40% of surgical volume Category 1 (100–999 inpatient surgical operations annually) hospitals.

[§] The 2013 survey did not use sampling, but contact information was unavailable for 610 of 3915 hospitals, and these were not sampled.

[‖] The 2009 survey included a sample of 33% of surgical volume Category 1 (999–1000 inpatient surgical operations annually).

[¶] The 2007 survey included a sample of 33% of surgical volume Category 1 (999–1000 inpatient surgical operations annually) and 66% of surgical volume Category 2 (1000–1399 inpatient surgical operations annually).

[**] The 2005 survey included a sample of 32.6% of surgical volume Category 1 (999–1000 inpatient surgical operations annually), 86% of surgical volume Category 2 (1000–1399 inpatient surgical operations annually), and 88.4% of surgical volume Category 3 (1400–2399 inpatient surgical operations annually).

TABLE 2.

Response rates for collection facilities stratified by annual volume of RBC collections and annual inpatient surgical operations, 2013 to 2017

		2017		2015		2013	
Collection center type	**Strata**	**Percent**	**n/N**	**Percent**	**n/N**	**Percent**	**n/N**
Community-based	Less than 50,000 RBC collections per year	90.0	27/30	92.5	37/40	56.9	29/51
Community-based	50,000–199,000 RBC collections per year	96.2	25/26	87.1	27/31	74.2	23/31
Community-based	200,000–399,000 RBC collections per year	100.0	6/6	75.0	3/4	42.9	3/7
Community-based	400,000 or more RBC collections per year	100.0	3/3	100.0	5/5	100.0	4/4
Hospital-based	Less than 1000 surgeries per year	94.7	18/19	58.3	7/12	38.5	5/13
Hospital-based	1000–7999 surgeries per year	86.7	39/45	73.5	61/83	35.5	33/93
Hospital-based	8000 or more surgeries per year	79.5	35/44	72.3	34/47	53.2	25/47

TABLE 3.

Response rates for transfusion facilities to the NBCUS stratified by annual inpatient surgical operations, 2013 to 2017

	2017		2015		2013*	
Surgical volume category	**Percent**	**n/N**	**Percent**	**n/N**	**Percent**	**n/N**
100–999 surgeries	82.9	525/633	73.6	495/673	26.1	426/1634
1000–1399 surgeries	87.1	352/404	72.4	283/391	28.8	117/406
1400–2399 surgeries	85.7	504/588	72.3	416/575	27.3	155/567
2400–4999 surgeries	84.7	611/721	75.2	547/727	28.6	219/765
5000–7999 surgeries	89.0	251/282	75.3	225/299	31.2	97/311
8000 or more surgeries	87.7	192/219	75.8	172/227	37.5	87/232

* The 2013 survey did not use sampling, but contact information was unavailable for 610 of 3915 hospitals, and these were not sampled.

TABLE 4.

Response rates for transfusing facilities to the NBCUS stratified by PHS region, 2013 to 2017

	2017		2015		2013*	
PHS region	**Percent**	**n/N**	**Percent**	**n/N**	**Percent**	**n/N**
1 (CT, MA, ME, NH, RI, VT)	94.4	119/126	71.2	94/132	39.5	70/177
2 (NJ, NY)	91.3	189/207	80.5	165/205	32.9	77/234
3 (DC, DE, MD, PA, VA, WV)	91.0	252/277	78.5	219/279	33.8	114/337
4 (AL, FL, GA, KY, MS, NC, SC, TN)	84.9	496/584	75.2	436/580	25.4	197/777
5 (IL, IN, MI, MN, OH, WI)	85.7	437/510	77.2	407/527	26.9	201/746
6 (AR, LA, NM, OK, TX)	79.2	316/399	70.3	281/400	31.5	182/577
7 (IA, KS, MO, NE)	90.1	145/161	71.1	118/166	26.7	70/262
8 (CO, MT, ND, SD, UT, WY)	88.2	97/110	75.8	91/120	20.0	38/190
9 (AZ, CA, HI, NV)	79.9	282/353	65.0	234/360	25.1	112/446
10 (AK, ID, OR, WA)	85.0	102/120	75.6	93/123	23.7	40/169
All regions	85.5	2435/2847	73.9	2138/2892	28.1	1101/3915

*The 2013 survey did not use sampling, but contact information was unavailable for 610 of 3915 hospitals, and these were not sampled.

TABLE 5.

Estimated number of donors and deferrals in the United States, 2017 (expressed in thousands)*

	2017				% of total deferrals		
	Males	Females	Total (95% CI)	Total, 2015	2017	2015	% change 2017–2015
Donor deferrals							
Low hemoglobin/hematocrit†	208	907	1115 (1051–1179)	975	43.8	51.7	14.3
Prescription drug use	28	28	56 (49–62)	54	2.2	2.9	3.1
Pulse and/or blood pressure	134	154	288 (261–315)		11.3		
Other medical reasons‡	203	319	523 (442–603)	504	20.5	26.7	3.7
High-risk behavior, MSM only§	6	0	6 (5–7)	8	0.2	0.4	−25.8
High-risk behavior, all other behaviors	11	9	20 (18–23)	16	0.8	0.9	27.6
Travel‖	56	58	114 (103–124)	113	4.5	6	0.7
Tattoo/piercing	19	42	61 (55–67)	49	2.4	2.6	25.1
Other non-medical reasons	125	176	301 (264–338)	166	11.8	8.8	81.4
Total deferrals	862	1683	2544 (2373–2716)	1886			
Total presenting to donate	7099	6919	14,018 (13,132–14,903)	15,111¶			

*Excludes directed and autologous donors.

†Donors deferred for low hemoglobin included those that do not meet the current FDA blood hemoglobin level requirements for blood donation.

‡Other medical reasons may include the use of medications on the medication deferral list, growth hormone from human pituitary glands, Hepatitis B Immune Globulin (HBIG), unlicensed vaccines, or presenting with physical conditions or symptoms that do not qualify a person to be a blood donor.

§High-risk behavior deferrals include deferrals intended to reduce the risk of transmission of infectious diseases including HIV and hepatitis viruses. Examples of questions intended to identify these risks are sexual contact (men who have sex with men [MSM]) and non-medical injection drug use questions.

‖Travel deferrals are deferrals for travel to a specific region of the world.

¶Total presenting to donate in 2015[5] excluded total deferrals and is corrected here to be consistent with the 2013 and 2017 estimates.

TABLE 6.

Donations stratified by donor age and type in the United States, 2015 and 2017 (expressed in thousands)*

	All facilities		% of total donations		
	2017 (95% CI)	2015	2017	2015	% change 2017–2015
Donations by donor age (years)					
15	6 (0–19)		0.1		
16	286 (256–316)		2.6		
17	586 (532–640)		5.3		
18	493 (460–525)		4.4		
16–18	1365 (1276–1453)	1521	12.3	13.4	−10.3
19–24	1117 (1041–1193)	1236	10.1	10.9	−9.6
25–64	7010 (6630–7391)	7182	63.1	63.3	−2.4
65 or older	1603 (1481–1725)	1401	14.4	12.4	14.4
Minority donations	2018 (1605–2432)		18.2		
Total successful donations	11,101 (10,553–11,649)	11,339			−2.1

*Excludes directed and autologous donors.

TABLE 7.

Number of blood donors in the United States, 2015 and 2017 (expressed in thousands)*

	All facilities		% of total donors		
	2017 (95% CI)	2015	2017	2015	% change 2017–2015
First time, allogeneic	2076 (1951–2200)	2223	26.0	32.6	−6.6
Repeat, allogeneic	5921 (5536–6306)	4589	74.0	67.4	29.0
Total individual donors*	7996 (7547–8446)	6812			17.4

*Excludes directed and autologous donors. Only includes donors from which blood products were successfully collected.

TABLE 8.

Autologous and directed transfusions in the United States, 2015 and 2017 (expressed in thousands)

	2017			2015		
Component transfused	**Recipients (95% CI)**	**Units (95% CI)**	**Units per recipient**	**Recipients**	**Units**	**Units per recipient**
Autologous RBCs/WB *	25 (4 − 45)	27 (11–43)	1.1	9	20	2.3
Directed RBCs/WB *	38 (15–61)	56 (32–80)	1.5	25	66	2.6
Directed PLTs		21 (0–46)			5	
Total directed units		77 (35–120)			70	

* RBCs/whole blood estimate includes whole blood, whole blood–derived RBCs, and apheresis RBCs.

TABLE 9.

Median and mean dollar amount paid per blood product unit (in U.S. dollars) as reported by hospitals in the United States, 2015 and 2017

	Amount paid, 2017 ($)			Amount paid, 2015 ($)				Difference, 2017 − 2015 ($)	
Component	**Median (N)**	**IQR**	**Mean**	**Median (N)**	**IQR**	**Mean**	**Original median (N)**	**Median**	**Mean**
RBCs, leukoreduced	207 (1946)	196–223	213	211 (1619)	197–227	215	211 (1630)	−4	−2
RBCs, nonleukoreduced	200 (198)	184–214	207	204 (259)	185–222	204	204 (262)	−4	3
Whole blood–derived PLTs, each unit, not leukoreduced, not irradiated	72 (78)	63–95	85	75 (68)	64–95	80	95 (101)	−3	6
Apheresis PLTs, leukoreduced	517 (1923)	490–550	522	523 (1659)	495–559	530	524 (1668)	−6	−8*
FFP	51 (1134)	43–60	57	54 (1055)	45–64	57	54 (1062)	−3	0
Plasma frozen between 8 and 24 hours of donation (PF24)	50 (1616)	43–60	55	52 (1376)	45–60	55	52 (1389)	−2	0
Cryoprecipitate, each unit	50 (1161)	43–61	54	50 (1069)	43–61	53	56 (1356)	0	0

*Significant difference between 2015 and 2017 with $p < 0.05$.

TABLE 10.

Median and mean dollar amount paid per blood product unit, as reported by hospitals and stratified by annual inpatient surgical operations in the United States, 2015 and 2017

			Amount paid, 2017 ($)		Amount paid, 2015 ($)		Difference, 2017–2015 ($)	
Component	**Surgical operations per year**	**N, 2017**	**Median**	**Mean**	**Median**	**Mean**	**Median**	**Mean**
RBCs, leukoreduced	100–999	398	216	224	215	221	1	3
	1000–1399	286	206	212	213	218	−7	−6
	1400–2399	386	208	214	213	216	−5	−2
	2400–4999	496	205	208	210	212	−5	−4
	5000–7999	217	203	207	208	208	−5	−1
	≥8000	163	203	207	206	209	−3	−2
Apheresis PLTs, leukoreduced	100–999	347	540	549	540	550	0	−1
	1000–1399	288	518	523	525	535	−7	−12
	1400–2399	389	519	523	525	535	−6	−12
	2400–4999	515	510	513	520	524	−10	−12
	5000–7999	220	506	511	520	506	−15	4
	≥8000	164	509	506	510	510	−2	−4
FFP	100–999	145	60	72	60	65	0	7
	1000–1399	151	54	58	57	63	−3	−5
	1400–2399	232	51	57	54	56	−3	2
	2400–4999	330	50	54	53	55	−3	−1
	5000–7999	151	49	54	50	51	−1	3
	≥8000	125	45	50	47	52	−2	−2
Plasma frozen between 8 and 24 hours of donation (PF24)	100–999	276	58	65	58	62	0	3
	1000–1399	238	51	55	55	57	−4	−2
	1400–2399	325	50	54	50	54	0	−1
	2400–4999	435	50	52	51	53	−1	−1
	5000–7999	195	48	50	49	50	−1	0
	≥8000	147	45	50	47	51	−2	−1
Cryoprecipitate, each unit	100–999	122	55	58	55	57	1	1
	1000 − 1399	170	50	55	51	55	−1	−0

Component	Surgical operations per year	N, 2017	Amount paid, 2017 ($)		Amount paid, 2015 ($)		Difference, 2017–2015 ($)	
			Median	Mean	Median	Mean	Median	Mean
	1400–2399	234	51	54	50	55	1	−0
	2400–4999	339	50	54	50	53	0	1
	5000–7999	164	50	52	48	52	2	0
	≥8000	132	48	48	48	49	1	−0

TABLE 11.

Median and mean dollar amount paid per blood product unit as reported by hospitals (in U.S. dollars) and stratified by PHS region in the United States, 2015 and 2017

		Leukoreduced RBCs		Apheresis PLTs		FFP	
PHS Region	**Year**	**Median (N)**	**Mean (SD)**	**Median (N)**	**Mean (SD)**	**Median (N)**	**Mean (SD)**
1 (CT, MA, ME, NH, RI, VT)	2015	235 (77)	239 (24)	533 (80)	536 (104)	60 (53)	62 (31)
	2017	222 (93)	226 (26)	502 (97)	511 (80)	41 (62)	54 (24)
	2017–2015	−13	−13	−31	−24	−20	−9
2 (NJ, NY)	2015	218 (133)	222 (26)	535 (143)	553 (87)	49 (104)	51 (13)
	2017	214 (157)	217 (28)	531 (162)	548 (88)	45 (105)	49 (15)
	2017–2015	−4	−5	−5	−5	−4	−2
3 (DC, DE, MD, PA, VA, WV)	2015	207 (153)	213 (25)	533 (162)	532 (66)	55 (102)	55 (15)
	2017	207 (214)	214 (29)	520 (209)	538 (79)	51 (118)	76 (61)
	2017–2015	−1	0	−13	6	−4	21
4 (AL, FL, GA, KY, MS, NC)	2015	200 (326)	201 (28)	520 (335)	523 (75)	51 (200)	53 (14)
	2017	199 (393)	207 (34)	520 (388)	520 (65)	51 (242)	54 (23)
	2017–2015	−1	6	0	−3	0	1
5 (IL, IN, MI, MN, OH, WI)	2015	197 (307)	203 (25)	515 (311)	518 (55)	52 (182)	52 (13)
	2017	197 (365)	201 (22)	503 (360)	504 (56)	50 (203)	51 (15)
	2017 − 2015	0	−2	−12	−14	−2	−1
6 (AR, LA, NM, OK, TX)	2015	214 (206)	218 (24)	530 (214)	538 (78)	54 (144)	58 (23)
	2017	216 (241)	218 (29)	525 (233)	534 (93)	53 (138)	57 (19)
	2017–2015	2	−0	−5	−4	−1	−1
7 (IA, KS, MO, NE)	2015	199 (96)	208 (30)	499 (92)	497 (66)	55 (51)	58 (16)
	2017	200 (121)	206 (20)	490 (116)	493 (83)	52 (47)	58 (34)
	2017 − 2015	2	−2	−9	−4	−3	0
8 (CO, MT, ND, SD, UT, WY)	2015	220 (72)	223 (38)	540 (67)	542 (83)	65 (40)	71 (32)
	2017	216 (70)	217 (35)	521 (70)	530 (93)	65 (42)	66 (32)
	2017–2015	−4	−7	−20	−11	0	−5
9 (AZ, CA, HI, NV)	2015	229 (175)	234 (26)	500 (183)	516 (86)	55 (130)	64 (43)
	2017	220 (208)	225 (29)	490 (206)	504 (75)	49 (125)	54 (31)

PHS Region	Year	Leukoreduced RBCs		Apheresis PLTs		FFP	
		Median (N)	Mean (SD)	Median (N)	Mean (SD)	Median (N)	Mean (SD)
10 (AK, ID, OR, WA)	2017–2015	−9	−9	−10	−12	−6	−9
	2015	213 (74)	232 (55)	550 (72)	598 (173)	71 (49)	69 (18)
	2017	218 (84)	230 (37)	567 (82)	579 (179)	69 (52)	71 (19)
	2017 – 2015	5	−2	17	−19	−3	1

TABLE 12.

Hospital policies and practices to enhance safety of recipient of blood or blood components, 2015 and 2017

	2017		2015	
	Percent	**n / N**	**Percent**	**n / N**
Transfusion Safety Officer (TSO) on staff	19.3%	(448/2319)	16.2%	(305/1885)
Data on sample collection error	82.9%	(1931/2330)	83.8%	(1571/1875)
Program to treat patients who refused blood components for religious, cultural, or personal reasons	73.5%	(1697/2310)	71.6%	(1332/1860)

TABLE 13.

Severe donor-related adverse events and rate by type of collection method in the United States, 2015 and 2017

			Number of severe donor-related adverse events*			Reaction rate		
Year	**Collection type**	**Donor age**	**Blood centers**	**Hospitals**	**Combined (95% CI)**	**Blood centers**	**Hospitals**	**Combined**
2017	Whole blood collections	All Donors	11,078	951	12,029 (9251–14,807)	1:896	1:525	1:867 (0.12%)
		18 years and younger	3663	241	3904 (2681–5127)			
		Older than 18 years	7415	709	8125 (6065–10,184)			
	Apheresis collections	All Donors	2498	88	2585 (2072–3098)	1:937	1:1037	1:940 (0.11%)
		18 years and younger	244	4	248 (113–384)			
		Older than 18 years	2253	84	2337 (1676–2998)			
	All collections	All donors	13,576	1038	14,614 (11,664–17,564)	1:903	1:568	1:880 (0.11%)†
2015	Whole blood collections (manual, all donors)		11,996	2275	14,271 (9036–19,507)	1:854	1:237	1:756 (0.13)
	Apheresis collections (automated, all donors)		3335	156	3491 (1088–5894)	1:786	1:752	1:784 (0.13)
	All collections (all donors)		15,331	2431	17,762 (10,744–24,779)	1:839	1:270	1:762 (0.13)†

*Severe donor-related adverse events were defined as events occurring in donors attributed to the donation process that include, for example, major allergic reaction, arterial puncture, loss of consciousness of a minute or more, loss of consciousness with injury, nerve irritation, etc.

†The total number of collections was 12,855,000 in 2017 and 13,526,000 in 2015.

TABLE 14.

Platelet units transfused by hospital location in the United States, 2015 and 2017 (expressed in thousands)

	2017 (95% CI)	2015	% diff	Matched median % diff
All Surgery (including transplant)	300 (256–343, n = 1168)	300	−0.1%	−1.2% (n = 306)
Emergency Department	99 (85–113, n = 1163) *	79	19.9%	16.9% (n = 281)
Inpatient Medicine (including hematology/oncology)	783 (658–908, n = 1207)	866	−10.6%	−5.1% (n = 365)
Obstetrics/Gynecology	16 (12–20, n = 1174) *	11	29.5%	0.0% (n = 141)
Pediatrics	84 (48–120, n = 1250)	71	15.8%	9.8% (n = 47)
Neonates	34 (24–44, n = 1276)	28	17.1%	10.2% (n = 94)
Critical Care	375 (327–423, n = 1116)	400	−6.8%	−4.3% (n = 277)
Outpatient and non-acute inpatient settings †	332 (267–397, n = 1206)	302	9.0%	0.0% (n = 256)

* Indicates significant difference.

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

TABLE 15.

Estimated number of apheresis platelet units collected as single, double and triple collections in the United States, 2015 and 2017 (expressed in thousands)

	2017		2015	
Apheresis platelet collections	**Number units (95% CI)**	**% all platelets**	**Number units (95% CI)**	**% all platelets**
Single	541 (382–701)	23.2%	405	18.1%
Double	1075 (981–1168)	46.0%	1109	49.6%
Triple	722 (627–816)	30.9%	720	32.3%
Total	2338 (2189–2487)		2234	

TABLE 16.

Use of PAS to prepare apheresis PLTs, 2015 and 2017

	2017	2015
Percentage of facilities using PAS	8.5% (12/141)	6.8% (11/162)
Mean number of units prepared using PAS	2742 (n = 11)	3374 (n = 11)

TABLE 17.

Estimated number of apheresis and whole blood-derived plasma units collected by in the United States, 2015 and 2017 (expressed in thousands)

	2017 (95% CI)			2015		
Plasma product	**Whole blood-derived units**	**Apheresis units**	**All units**	**Whole blood-derived units**	**Apheresis units**	**All units**
All plasma products			3209 (2879–3539)			3714
FFP	799 (608–990)	176 (106–245)	974 (755–1194)	918	328	1246
FFP, jumbo size (>400 mL)		48 (15–82)			65	
PF24	1794 (1505–2083)	171 (105–237)	1964 (1663–2266)	1870	136	2006
Plasma, PF24RT24 *		169 (95–244)			141	
Liquid	83 (42–125)			154		
Cryoprecipitate reduced	118 (39–196)			119		
Group AB †			312 (285–339)			

* Plasma, frozen within 24 hours after up to 24 hours at room temperature.

† Group AB plasma is not an exclusive category and includes units counted as other product types.

TABLE 18.

Estimated number of plasma units transfused in the United States, 2015 and 2017 (expressed in thousands)

Plasma product	2017 (95% CI)	2015
All plasma products	2374 (2262–2487)	2727
FFP	1021 (907–1136)	969
FFP, pediatric size (100 mL)	34 (19–49)	29
FFP, jumbo size (>400 mL)	46 (18–74)	37
PF24	1183 (1071–1294)	1086
Plasma, PF24RT24[*]	39 (7–71)	39
Liquid	14 (8–20)	12
Cryoprecipitate reduced	27 (14–39)	91
Group AB[†]	278 (214–341)	223

[*] Plasma, frozen within 24 hours after up to 24 hours at room temperature.

[†] Group AB plasma is not an exclusive category and includes units counted as other product types.

TABLE 19.

Estimated of the number of granulocyte units collected and transfused in the United States, 2015 and 2017

	Units (95% CI)		
Granulocytes	**2017**	**2015**	**2013**
Granulocytes distributed	4062 (1809 – 6315)	2713 (1381–4045)	2877 (651–5102)
Granulocytes transfused	1717 (1000 – 2433)	2428 (1074–3782)	

TABLE 20.

Percentage of hospitals using various criteria for routine dosing of transfusions for non-pediatric patients, 2015 and 2017

	2017			2015		
Dosing criteria	**Plasma % (n)**	**Prophylactic PLTs % (n)**	**Therapeutic PLTs % (n)**	**Plasma % (n)**	**Prophylactic PLTs % (n)**	**Therapeutic PLTs % (n)**
Weight-based dosing (e.g., 20 mL/kg)	5.4 (119)	1.7 (36)	1.5 (33)	5.8 (102)	1.6 (29)	1.3 (22)
Standard number of units regardless of weight	8.6 (188)	11.4 (248)	11.3 (246)	9.0 (159)	12.0 (211)	10.8 (190)
Dosage varies based on level of thrombocytopenia or bleeding	66.4 (1454)	67.7 (1475)	70.3 (1535)	67.2 (1189)	67.0 (1177)	71.5 (1253)
Number of units ordered not consistent with any of the above	19.6 (429)	19.2 (419)	16.9 (368)	18.0 (319)	19.4 (341)	16.4 (288)

TABLE 21.

Age of units at transfusion, 2015 and 2017

	2017		2015	
Component, age	**Percent**	**N**	**Percent**	**N**
Red blood cells				
Units transfused 1–35 days	82.0 (630,433/768,450)	194	79.3 (442,397/557,980)	185
Units transfused 36–42 days	18.0 (138,017/768,450)	194	20.7 (115,583/557,980)	185
Apheresis platelets				
Units transfused 1–3 days	39.6 (87,070/220,148)	394	53.0 (66,861/126,050)	312
Units transfused 4–5 days	58.4 (128,623/220,148)	394	47.0 (59,189/126,050)	312
Units transfused 6–7 days	2.0 (4,455/220,148)	394		
Whole blood-derived platelets				
Units transfused 1–3 days	20.0 (1,775/8,894)	1394		
Units transfused 4–5 days	80.0 (7,119/8,894)	1394		

TABLE 22.

Percent of Group O (positive and negative) RBC distributed, transfused, and outdated (as a percentage of all allogeneic RBC), 2015 and 2017

	2017 percent (SD, n)		2015 percent (SD, n)	
	Group O−	**Group O+**	**Group O−**	**Group O+**
Units processed	8.2 (5.5, n = 97)	32.4 (19.5, n = 98)		
Units distributed	11.0 (5.5, n = 62)	39.8 (13.9, n = 61)		
Units outdated (Blood center)	5.3 (9.1, n = 62)	12.5 (15.3, n = 63)		
Units transfused	11.2 (7.3, n = 1498)	40.2 (13.6, n = 1480)	10.8 (7.3, n = 939)	40.2 (12.7, n = 933)
Units outdated (Hospital)	12.5 (19.6, n = 1055)	16.4 (22.1, n = 1053)	11.5 (19.3, n = 670)	16.9 (22.7, n = 663)

SD = standard deviation.

TABLE 23.

Group O red blood cell (RBC) units in inventory and group O suppled considered critically low stratified by annual inpatient surgical operations, 2015 and 2017

	Group O RBC units on shelf, average weekday		Group O+ RBC units at which supply considered critically low	
Annual inpatient surgical operations	**2017 mean (S.D.)**	**2015 mean (S.D.)**	**2017 mean (S.D.)**	**2015 mean (S.D.)**
100–999 surgeries per year	12.9 (8.0)	13.3 (8.1)	5.7 (4.3)	5.7 (4.2)
1000–1399 surgeries per year	23.5 (15.3)	22.7 (12.5)	10.8 (8.0)	10.1 (6.7)
1400–2399 surgeries per year	28.8 (15.7)	29.8 (20.2)	13.7 (11.6)	13.7 (10.1)
2400–4999 surgeries per year	45.5 (26.3)	45.7 (32.0)	21.1 (16.1)	20.4 (14.7)
5000–7999 surgeries per year	71.4 (40.1)	70.7 (41.3)	31.9 (21.2)	30.6 (24.6)
>8000 surgeries per year	145.6 (101.9)	135.3 (106.2)	63.4 (52.8)	61.2 (49.8)

TABLE 24.

Cross-match procedures performed on whole blood and red blood cells in the United States, 2015 and 2017 (expressed in thousands)

	2017		2015	
Cross-match procedure method	**Number of procedures (95% CI)**	**% of any method**	**Number of procedures**	**% of any method**
Any method	15,747 (15,136–16,358)		16,625	
Electronic	7491 (6880–8102)	47.6	6776	40.8
Manual serologic	7658 (7214–8101)	48.6	8946	53.8
Automated serologic	723 (599–846)	4.6	774	4.7

TABLE 25.

Irradiated units used by hospitals by component and irradiation method in the United States, 2015 and 2017 (expressed in thousands)

		Units		% of total	
Component	**Method**	**2017 (95% CI)**	**2015 (95% CI)**	**2017**	**2015**
Whole blood/red blood cells	Any	1703 (1488 – 1919)	1761 (1507–2015)	16.0	15.8
	Cesium	1235 (1033 – 1437)		11.6	
	X-ray	468 (382–555)		4.4	
Apheresis platelets	Any	970 (841–1100)	1049 (912–1186)	52.5	58.0
	Cesium	705 (587–823)		38.1	
	X-ray	266 (207–324)		14.4	

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TABLE 26.

Pediatric transfusions and recipients in the United States, 2015 and 2017 (expressed in thousands)

		Adult-equivalent units used in whole or part for pediatric patients				Total number of pediatric recipients	
Component	**Patient age group***	**2017 (95% CI)**	**2015**	**Percentage change 2017–2015**	**Matched percentage change 2017–2015†**	**2017 (95% CI)**	**2015**
Whole blood or RBCs	Pediatric and neonatal	378 (274–482)	346	9.2%	7.7% (n = 280)	92 (74–111)	80
	Pediatric	240 (147–333)				44 (32–57)	
	Neonatal	141 (116–166)				48 (37–59)	
Apheresis PLTs	Pediatric and neonatal	90 (70–109)	165	−45.5%	13.6% (n = 164)	24 (18–29)	48
	Pediatric	49 (34–64)				12 (8–16)	
	Neonatal	41 (31–51)				12 (8–15)	
Plasma	Pediatric and neonatal	76 (55–97)	74	2.8%	10.8% (n = 148)	16 (13–20)	29
	Pediatric	48 (30–66)				6 (4–8)	
	Neonatal	28 (21–35)				10 (8–13)	

*Neonatal patients were defined as those aged less than 4 months, and pediatric patients were defined as those aged 4 months and older.

†Facilities providing estimates for 2015 and 2017 were matched, where possible, and the mean percentage difference is presented with the number of matched facilities (n).

TABLE 27.

Hospital policies for neonatal aliquot production, 2017

	Facilities	
Neonatal aliquot production	**n/N**	**%**
Neonatal aliquots made by syringe from full-size units	523/937	56%
Pedipacks used for pediatric aliquots	436/937	47%
Attempt to use same full-size unit for aliquots for neonatal patients	768/931	82%