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Utilization of blood transfusion among older adults in the United States

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Abstract

BACKGROUND—While there have been epidemiologic studies of blood donors, the characteristics of individuals who receive transfusions have not been well described for the US population.

STUDY DESIGN AND METHODS—Subjects were from the nationally representative Health and Retirement Study whose data were linked to Medicare files from 1991 through 2007 (n = 16,377). A cohort study was conducted to assess the frequency of transfusion in older Americans over time and to describe the characteristics of blood recipients.

RESULTS—Thirty-one percent (95% confidence interval [CI], 30%-33%) of older Americans received at least one transfusion within a 10-year period and 5.8% (95% CI, 5.4%-6.2%) experienced repeated transfusion-related visits within 30 days. The mean number of transfusion-related visits was 2.3 over a 10-year period (95% CI, 2.2-2.4). Older Americans who lived in the South were most likely to receive a transfusion (34%), independent of demographic and health-related factors, while those who lived in the western United States were the least likely (26%). Predictors of transfusion included smoking, low body mass index, and a history of cancer, diabetes mellitus, end-stage renal disease, and heart disease. African-Americans and Mexican-Americans had greater rates of blood utilization than other races and other Hispanics (respectively). There were also differences in transfusion utilization by education, marital status, religion, and alcohol use.

CONCLUSIONS—Transfusion is common in older Americans. Regional variations in blood use are not explained by patient characteristics alone.

While it is not uncommon to hear that the “vast majority of Americans receive a transfusion sometime within their lives,” representative data are lacking to substantiate this claim. Hay and colleagues¹ estimated this frequency through a retrospective review of blood bank and clinical records of patients who expired at the University of North Carolina Hospitals. They concluded that 40.9% to 71% of the American population receives at least one transfusion within their lifetimes. However, it is unlikely that data from this single institution are representative of the entire American population. The frequency of transfusion during a single hospital stay has been published using cross-sectional data,^{2,3} but it has not been reported in individuals over time on a population basis in the United States. Since patients

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CONFLICT OF INTEREST NB received consulting fees from CaridianBCT, Pall, and Fenwal.

may receive multiple transfusions at different times, the cross-sectional approach does not capture such repeated events in both inpatient and outpatient settings.

There are surveillance systems for tracking blood utilization in the United States, but such surveys assess donation and utilization of blood components—not the individuals who receive blood.⁴ As yet, there are no national figures from longitudinal data that characterize the types of Americans who receive blood transfusions. For example, the National Blood Collection and Utilization Survey by AABB, in collaboration with the National Blood Data Resource Foundation, reports national statistics regarding donation and utilization of specific blood components.⁴ The newly established Biovigilance Component of the National Healthcare Safety Network at the Centers for Disease Control and Prevention is piloting a voluntary surveillance program but this will specifically monitor adverse events, errors, and accidents regarding transfusion.⁵ An important gap in current data collection methods is the lack of information on the characteristics of blood recipients.

This topic is important because transfusion is the most commonly coded (International Classification of Diseases, Clinical Modification, 9th revision [ICD-9-CM]) procedure within US hospitals,⁶ yet there continues to be considerable variation in the utilization of blood components by providers among patients undergoing the same surgical procedure.⁷⁻¹² As such, patient-level factors that could potentially drive some of this variability require further attention.

We report a population-based profile of older Americans who receive transfusions. Using data from the nationally representative Health and Retirement Study (HRS) linked to Medicare files, we determined the frequency of blood use and identified patient characteristics that were associated with receiving a transfusion.

MATERIALS AND METHODS

The subjects were a nationally representative sample of the older US population.¹³ The University of Michigan HRS is a national longitudinal study that surveys more than 22,000 Americans over the age of 50 every 2 years and provides a portrait of an aging America's physical and mental health, insurance coverage, financial status, family support systems, labor market status, and retirement planning.¹⁴ The HRS core sample design is a multistage area probability sample of US households and data generated from the HRS supply longitudinal data to describe the trajectories of economic, health, and family status of older Americans. An in-depth description of the design and information collected within the HRS is publicly available at <http://hrsonline.isr.umich.edu/index.php>.

The participants in our study formed a cohort, interviewed every 2 years from 1992 through 2006. Fee-for-service Medicare files were obtained from the Centers for Medicare and Medicaid Services (CMS) for years 1991 through 2007 and were linked to the HRS files. Fee-for-service Medicare beneficiaries constituted approximately 85% of all beneficiaries during the time period of this study. The CMS files included the inpatient standard analytical files (SAFs), outpatient SAFs, carrier (Part B) SAFs, skilled nursing facility SAFs, and denominator files.¹⁵ Inpatient SAFs contain data regarding patients admitted to a hospital and outpatient SAFs contain data regarding patients seen at institutional outpatient providers such as clinics and health centers. Carrier SAFs contain information regarding patients seen by noninstitutional providers such as physicians and nurse practitioners, regardless of the location. Denominator files contain demographic and Medicare enrollment information. For purposes of this study, only those individuals who were 65 years or older at any time during the study period were included; this yielded 16,377 subjects.

Transfusion information was obtained from the inpatient, outpatient, carrier, and skilled nursing facility SAFs. For the inpatient and skilled nursing facility SAFs, this involved the extraction of transfusion-related procedure codes (ICD-9-CM 99.0x), revenue center codes (38x, 39x), and blood value codes. For the outpatient SAF, transfusion-related procedure codes (ICD-9-CM 99.0x), revenue center codes (38x, 39x), current procedural terminology codes (36430, 36455), Healthcare Common Procedure Coding System (P90xx), and blood value codes were extracted. For the carrier SAF, current procedural terminology codes (36430, 36455), Healthcare Common Procedure Coding System (P90xx), and blood value codes were used.

The characteristics of blood recipients were obtained from the HRS through interviews that occurred every 2 years. Date of birth, sex, race (African-American, Caucasian, other), ethnicity (Mexican American, other Hispanic, not Hispanic), marital status at the time of the last interview, highest educational degree (none, high school, associated degree or less than a bachelor's degree, bachelor's degree or higher), religion at the time of the first interview, tobacco smoking (ever/never), alcohol use (ever/never during the time of the interviews), and body mass index (BMI) at the time of the last interview were obtained from HRS data. For tabular purposes, age was calculated at year 2007 from the date of birth. BMI was categorized as underweight ($<18.5 \text{ kg/m}^2$), normal ($18.5\text{--}24.9 \text{ kg/m}^2$), overweight ($25.0\text{--}29.9 \text{ kg/m}^2$), and obese ($>30 \text{ kg/m}^2$). Region of residence (Northeast, Midwest, South, West) at the time of the first HRS survey was also extracted. Unknown values for race (0.23%), ethnicity (0.02%), religion (0.23%), education (0.02%), BMI (0.18%), and region (0.16%) were imputed using best-subset regression. A history of various diseases, as diagnosed by a doctor, was recorded from interview data; this included cancer (ever/never recorded), diabetes mellitus (ever/never), heart disease (ever/never), and lung disease (ever/never). End-stage renal disease (ESRD) was obtained through CMS files since it is routinely recorded to determine the type of eligibility for Medicare benefits (e.g., ESRD, disability, or old age). Information regarding major surgical procedures was extracted from the CMS Carrier files through Berenson-Eggers Type of Service codes.¹⁶ These included major cardiovascular surgeries (coronary artery bypass grafting, aneurysm repair, thromboendarterectomy, coronary angioplasty, pacemaker insertion, and other major cardiovascular procedures), major orthopedic surgeries (hip fracture repair, hip replacement, knee replacement, and other major orthopedic procedures), and other major surgeries (breast, colectomy, cholecystectomy, transurethral resection of the prostate, hysterectomy, exploration/decompression/excision of disks, other major procedures). Critical care hospital stays and emergency room visits were also obtained through Berenson-Eggers Type of Service codes within the carrier files.

Incidence rates of transfusion were calculated as a survey-weighted ratio; the numerator was the number of individuals who received at least one transfusion (red blood cells, platelets, plasma, and/or cryoprecipitate) during their time under observation and the denominator was the number of person-years observed (per 10 person-years). This is reported as the percentage of individuals who received at least one transfusion in a 10-year period. The person-time under observation was obtained through information regarding Medicare eligibility for Parts A (hospital insurance) and B (medical insurance) in the denominator file.

The frequency of transfusion was also calculated as the number of stays (hospital or skilled nursing facility) or visits (outpatient facility or physician visit) in which a transfusion occurred. For purposes of this study, we refer to these episodes as "visits" in which a transfusion occurred. In addition, individuals who experienced frequent, repeated visits were also counted; repeated use was defined as a transfusion-related visit which occurred within 30 days of the previous transfusion-related visit. Occasional use of a transfusion was defined

as those individuals who received a transfusion but did not have repeated use (within 30 days).

All figures in this report were survey-weighted to reflect the overall US fee-for-service Medicare population aged 65 or older. For cell counts of 11 people or less, estimates are not shown. For graphing purposes, BMI was categorized into deciles and plotted using a quadratic fit. To evaluate which patient characteristics were independently related to the receipt of a transfusion, a survey-weighted logit model was utilized with transfusion (ever/never) as the dependent variable, offset by person-years. A survey-weighted Poisson model was used for the number of transfusion-related visits (dependent variable), offset by person-years. Since transfusions occur under medical supervision, the final models were adjusted for the total number of hospital stays, skilled nursing facility stays, and outpatient facility visits that each participant accrued over time, to account for differences in the “opportunity” of receiving a transfusion. Alpha was set at 0.05, two-tailed. Computer software (Stata/MP 11.0, StataCorp, College Station, TX) was used for the analyses. This project received human subjects approval from the institutional review board at the University of Michigan and the privacy board at CMS.

RESULTS

Thirty-one percent of older Americans received at least one transfusion within a 10-year period (Table 1), with the frequency higher for residents in the Midwest (33%) and South (34%), intermediate in the Northeast (30%), and lowest in the West (26%). When predictors were considered individually (Table 1), adults 85 years of age or older, men, African-Americans, Mexican-Americans, under-weight adults, smokers, nondrinkers, and those without a high school degree were more likely to have received a transfusion. There were also differences across marital status and religion, although the patterns were not uniformly consistent within each region of the country. Older adults with a history of cancer, diabetes mellitus, ESRD, heart disease, or lung disease were more likely to have received blood than individuals without such conditions. While 99% of those with ESRD in the South and 98% with ESRD in the Midwest had received at least one transfusion within a 10-year period, 62% of those with ESRD received a transfusion in the West.

Of blood recipients, 54% had only one visit in which a transfusion occurred; the remaining 46% had multiple transfusion-related visits. For 81.1% of older Americans, the transfusions occurred in the hospital only, while 4.3% received a transfusion in an outpatient setting only, 0.1% were transfused in a skilled nursing facility only, and 14.5% had transfusions at multiple different locations.

There was a significant association between BMI and transfusion. Individuals with low BMI had the greatest likelihood of transfusion across all regions of the country (Fig. 1). Transfusion utilization tended to be lower in those individuals who were of normal BMI, and the incidence increased somewhat in those persons who were within the highest BMI deciles in all regions except the West.

Information regarding repeated use of transfusions is given in Table 2. Repeated transfusion-related visits (within 30 days) occurred in 5.8% of older Americans and occasional use occurred in 25.6%. In those patients who received a transfusion, the mean number of transfusion-related visits was 2.3 over a 10-year period. The patterns for repeated utilization of transfusion were similar to overall use, with greater percentages in those who were of older age, men, with less education, underweight, and with a history of smoking, cancer, diabetes, ESRD, heart disease, or lung disease.

We investigated whether the greater incidence of transfusion in African-Americans was due to the differential usage of services that often require transfusions: major surgery, critical care units, or emergency department services. The results are shown in Table 3. African-Americans were significantly more likely than other racial groups to receive a transfusion across each of these services (i.e., major surgeries, critical care stay, and emergency room visit). Likewise, the frequency of transfusion was assessed by ethnicity (Table 4). Mexican-Americans who underwent major orthopedic surgery had higher blood utilization (70%) compared to persons who were of other Hispanic type (44%) or not Hispanic (53%). Similarly, blood utilization was greater in Mexican-Americans who had visited an emergency room (47%) compared to other Hispanics (33%) and non-Hispanics (38%).

Overall, 59% of older Americans who had been admitted into critical care received a transfusion within a 10-year period (Tables 3 and 4). Approximately one-half of older Americans who had undergone a major surgical procedure and 38% of those who visited an emergency department had experienced a transfusion within 10 years.

Predictors of transfusion, adjusted for all other study variables, are listed in Table 5. Independent factors that predicted greater utilization of transfusion were African-American race, no high school degree, residence in the South, underweight, and a history of smoking, cancer, diabetes, ESRD, heart disease, or lung disease. Independent factors that predicted lesser utilization of blood included other religious affiliation (includes Jehovah's Witnesses, Christian Scientists, Mormons, Quakers, Muslims, Buddhists, Hindus, and other religions), widowed, alcohol users, non-Mexican Hispanics ("other" Hispanics), and those who were overweight but not obese. To directly compare Mexican-Americans with other Hispanics (reference), we conducted a similar regression (with reference group recoded) and found that Mexican-Americans were 6.48 times more likely to have received a transfusion (95% confidence interval [CI], 1.58-26.56) than other types of Hispanics, after adjustment for all variables in Table 5.

When the number of transfusion-related visits was modeled (i.e., Poisson regression), the results were generally similar but with a few differences (Table 5). The number of transfusion-related visits decreased with increasing age. There were no significant differences by race or ethnicity, but there were by religion. Educational degree was not predictive of the number of transfusion-related visits but region of residence, smoking, no use of alcohol, BMI, and history of cancer, diabetes, ESRD, and heart disease were independently associated with the number of transfusion-related visits.

DISCUSSION

Approximately one-third of older Americans receive at least one transfusion in a 10-year period, with significant variation by region of the country in which the person resides. In particular, there was a considerable difference in the likelihood of transfusion in the South compared to the West. An older person living in the South was 3.14 times more likely to have received a transfusion during a 10-year period than those living in the West. Our study suggests that this variation in transfusion was not likely due to regional differences in age, sex, race, various personal characteristics, and health-related conditions that were measured here, implicating that other factors may be involved. Friedman and colleagues¹⁷ reported similar findings in a survey of 300 US hospitals in 1974. It is possible that transfusion practices in one area of the country may differ from practices in other areas which may drive some of these findings. Reports of hospital-specific variation in transfusion practices have been recognized.⁷⁻¹² We previously found that 30% of the variability in transfusion practices after coronary artery bypass graft surgery was attributable to hospital site.⁷

Our data show that the probability of transfusion was significantly elevated in African-Americans, even after adjustment for other patient-level factors and with consideration of specific services such as emergency room visits and critical care-related hospital stays. Anemia is more prevalent in African-Americans.¹⁸ Hematocrit, hemoglobin (Hb), mean corpuscular volume, and serum transferrin saturation have been shown to be lower in African-Americans than Caucasians and therefore this may have influenced the decision to transfuse.¹⁹

Greater utilization of blood by Mexican-Americans is a novel finding. Unlike African-Americans, the increased frequency was not exhibited uniformly across all major transfusion-intensive services. Transfusion frequency was significantly higher in Mexican-Americans who had had major orthopedic surgery and emergency room visits than in other Hispanics or non-Hispanics. Mexican-Americans have particularly high rates of diabetes mellitus and this could influence the types of services received.²⁰ However, adjustment for diabetes was included in our final logit regression model and the results were still significantly different (Mexican-American vs. other Hispanics) with this adjustment.

Smoking was a predictor of transfusion, independent of heart disease, cancer, lung disease, race, and age. This was not likely due to lower Hb levels because Hb has been found to be higher in smokers compared to nonsmokers, which is thought to be a compensatory mechanism for the increased carbon monoxide binding to Hb in smokers.²¹ Cigarette smoking, however, is a risk factor for a wide variety of conditions other than heart disease, cancer, and lung disease; this includes injuries and accidents.²² Since transfusion is common in traumatic injuries, a possible explanation for the greater likelihood of transfusion in smokers may be their greater frequency of injuries.

The inverse relationship between alcohol use and transfusion cannot be explained solely by our data. Previous studies indicate that individuals who drink alcohol are less likely to develop cardiovascular disease and, therefore, this could provide an explanation if not all cardiovascular diseases in our study were captured with the adjustment for heart disease.²³ Alternatively, people who refrain from alcohol in their latter years may be doing so at the recommendation of their physician due to existing medical conditions; such comorbidities may place them at greater risk of a transfusion.

The association between low BMI and anemia has long been recognized in the literature.²⁴ Our results agree with this existing literature and suggest that older, underweight persons have a greater prevalence of anemia which, in turn, may result in a greater likelihood of disability and utilization of transfusion-related services.

The frequency of blood use for a given hospital stay has been reported using CMS data and with the Healthcare Cost and Utilization Project, a collection of health care databases and products available for research purposes by the Agency for Healthcare Research and Quality.^{2,3} Transfusion occurred in 6.8% of hospital stays using CMS data (year 2001) and in 5.8% with Healthcare Cost and Utilization Project data (year 2004).^{2,3} Both of such reports, however, use cross-sectional data of hospital stays, not individual patients followed longitudinally over time. Moreover, these investigations may have resulted in an underreporting of transfusions, which was due to the sole use of ICD-9-CM procedure codes or the clinical classification categories derived from such codes. Donated blood and purchased blood are coded differently for billing purposes.²⁵ Blood that is donated is often reimbursed through revenue codes that are not available with MedPAR files but are available with inpatient SAFs. Since many hospitals use blood donated from the American Red Cross or other nonprofit blood centers, the failure to capture such transfusions will lead to an underestimation of the frequency of transfusion. For example, if we had used only

ICD-9-CM procedure codes in our data files, this would yield a transfusion frequency of 6.2% for all hospital stays (similar to the previous reports). However, when sources of both purchased and donated blood were considered, 17.8% of hospital stays involved the use of a transfusion. This suggests that the underreporting from previous studies could be quite substantial.

One limitation of our study was the lack of complete information from skilled nursing facilities. Medicare only pays for 100 days of care at a skilled nursing facility after a qualifying hospital stay.²⁶ In a previous study using complete records from skilled nursing facilities (i.e., the minimum data set), we found that 3.5% of residents had received a transfusion sometime within their stay.²⁷ Some of these transfusions may have been included within our current study, although it is possible that not all of the transfusions were administered during the 100-day period.

In conclusion, the frequency of transfusion in older Americans varies substantially across various demographic and health-related factors. African-Americans and Mexican-Americans have high utilization rates. Differences also exist across education, marital status, religion, smoking and drinking habits, and BMI. Transfusion is common in older adults with ESRD, heart disease, lung disease, cancer and diabetes. However, such personal characteristics and conditions do not explain the wide variation in transfusion utilization in different areas of the country. Older Americans living in the western states experience significantly fewer transfusions than those living in the southern states.

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ABBREVIATIONS

BMI	body mass index
CMS	Centers for Medicare and Medicaid Services
ESRD	end-stage renal disease
HRS	Health and Retirement Study
ICD-9-CM	International Classification of Diseases, Clinical Modification, 9th revision
SAF(s)	standard analytical file(s).

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Fig. 1.
The relationship between BMI and frequency of transfusion in older Americans, by region of residence.

Percentage of older Americans who received a transfusion within a 10-year period by demographic and health-related characteristics

TABLE 1

Characteristics	Northeast		Midwest		South		West		All Regions	
	Use (%)	95% CI	Use (%)	95% CI	Use (%)	95% CI	Use (%)	95% CI	Use (%)	95% CI
Age (years)										
65-74	21	17-25	30	25-35	31	27-34	21	17-25	27	25-29
75-84	23	20-27	28	24-31	29	27-30	21	17-25	26	25-27
>85	41	36-45	39	37-41	42	38-46	32	27-37	39	37-41
Sex										
Men	31	29-33	34	31-37	36	32-39	28	25-31	33	31-34
Women	30	26-33	32	30-34	33	31-35	23	20-27	31	29-32
Race										
African-American	30	26-35	41	34-47	37	34-40	29	20-37	36	34-38
Caucasian	30	28-33	32	30-35	34	31-36	26	23-29	31	30-32
Other	23	7-39	24	16-33	35	26-44	18	9-27	26	21-31
Ethnicity										
Mexican-American			38	12-64	45	40-51	24	18-31	35	27-42
Other Hispanic	28	21-36	26	2-50	27	22-32	17	8-26	25	21-29
Not Hispanic	30	28-33	33	31-35	34	32-36	26	23-29	32	30-33
Marital status										
Married	29	26-32	33	31-35	33	30-36	25	22-28	31	29-32
Partnered	26	5-46	40	23-56	28	17-38	26	1-52	29	20-38
Divorced or separated	25	17-32	29	21-37	34	29-39	32	27-37	31	28-34
Never married	33	25-41	37	28-46	32	21-43	21	9-34	32	27-37
Widowed	32	28-37	33	29-37	36	34-39	25	20-29	33	31-34
Religion										
Protestant	29	26-32	33	30-35	35	33-37	25	21-29	32	30-33
Catholic	31	27-35	34	32-36	33	28-37	24	21-27	31	29-33
Jewish	38	33-43	35	28-43	35	27-42	44	30-58	38	34-41
Other	20	10-31	20	5-35	32	20-45	24	16-33	25	20-31
None	20	13-27	29	21-37	25	20-31	30	24-36	27	24-30
Highest education										

Characteristics	Northeast		Midwest		South		West		All Regions	
	Use (%)	95% CI	Use (%)	95% CI	Use (%)	95% CI	Use (%)	95% CI	Use (%)	95% CI
No degree	35	30-39	38	35-41	38	35-41	30	24-37	36	34-38
High school or GED	27	24-31	31	28-34	32	30-35	24	22-27	29	28-31
AA-less than BA	33	30-36	30	27-32	30	26-35	22	17-28	29	26-31
BA or higher	25	18-32	34	28-40	31	25-37	26	18-34	29	26-33
Smoking										<0.01
Ever	30	28-33	36	34-39	35	32-39	27	24-29	33	31-34
Never	30	27-33	29	27-31	33	31-35	24	19-28	30	28-31
Alcohol use										<0.01
Yes	27	25-30	31	29-34	32	29-34	24	22-27	29	28-30
No	38	33-42	36	32-39	37	35-40	29	22-37	36	34-38
BMI										<0.01
Underweight	44	36-53	42	35-50	46	41-51	25	15-35	41	37-45
Normal	32	29-36	33	30-37	37	34-40	28	24-32	33	32-35
Overweight	28	26-31	31	28-34	30	27-33	24	20-28	29	27-31
Obese	26	22-30	33	29-37	33	29-37	23	20-27	30	28-32
Diseases										<0.01
Cancer	36	32-41	41	37-44	42	38-46	33	24-43	39	36-41
Diabetes	37	32-41	42	38-47	42	38-45	31	27-34	39	37-41
ESRD	74	57-91	98	84-100	99	83-100	62	42-81	88	80-97
Heart disease	37	34-40	43	40-46	44	41-47	35	31-39	41	39-42
Lung disease	38	33-43	39	35-42	38	34-42	31	25-37	37	35-39
All subjects	30	28-33	33	31-35	34	32-37	26	23-29	31	30-33

Repeated (within 30 days) and occasional use of transfusion and mean number of transfusion-related visits in older Americans within a 10-year period

TABLE 2

Characteristics	Frequency of use within 10 years				Number of visits with transfusion [†]		
	Repeated use, within 30 days			Occasional use [*]	Mean		p value
	Percent	95% CI	p value		Mean	95% CI	
Age (years)							
65-74	5.2	4.4-6.0		21.7	19.8-23.5	2.3	2.0-2.7
75-84	5.1	4.6-5.7		20.8	19.6-22.0	2.5	2.2-2.8
>85	6.8	5.9-7.6	<0.01	32.4	30.7-34.0	2.2	2.1-2.3
0.17							
Sex							
Men	6.6	5.9-7.3		26.1	24.7-27.4	2.4	2.2-2.5
Women	5.2	4.7-5.7	0.02	25.3	24.1-26.5	2.3	2.1-2.5
0.62							
Race							
African-American	7.4	6.0-8.8		28.6	26.9-30.4	2.4	2.2-2.6
Caucasian	5.6	5.2-6.1		25.5	24.4-26.7	2.3	2.2-2.5
Other	6.0	3.4-8.6	0.06	20.0	15.3-24.6	2.0	1.6-2.3
0.09							
Ethnicity							
Mexican-American	6.7	4.7-8.7		27.9	21.0-34.7	2.2	2.0-2.5
Other Hispanic	4.6	2.9-6.3		20.4	16.8-24.1	2.3	1.8-2.8
Not Hispanic	5.8	5.4-6.2	0.46	25.7	24.6-26.7	2.3	2.2-2.4
0.62							
Marital status							
Married	6.0	5.3-6.6		24.7	23.5-25.8	2.4	2.3-2.5
Partnered	7.3	3.3-11.3		22.0	13.7-30.3	2.2	1.7-2.8
Divorced or separated	6.0	4.7-7.4		24.7	22.0-27.4	2.5	1.8-3.3
Never married	5.5	2.9-8.1		26.8	22.2-31.4	1.9	1.7-2.2
Widowed	5.6	4.9-6.2	0.37	27.0	25.6-28.5	2.3	2.0-2.5
0.05							
Religion							
Protestant	5.5	5.0-5.9		26.3	25.1-27.6	2.2	2.1-2.3
Catholic	6.6	5.8-7.4		24.4	22.6-26.1	2.7	2.3-3.1
Jewish	8.2	5.2-11.2		30.0	26.7-32.7	2.4	2.0-2.8
None	4.7	3.1-6.2		22.3	19.4-25.3	2.2	1.7-2.8

Characteristics	Frequency of use within 10 years					Number of visits with transfusion [†]		
	Repeated use, within 30 days			Occasional use [*]		Mean	95% CI	p value
	Percent	95% CI	p value	Percent	95% CI			
Other	5.1	1.3-8.9	0.02	20.3	15.9-24.7	2.0	1.6-2.4	0.13
Highest education								
No degree	7.1	6.3-7.8		29.2	27.6-30.9	2.2	2.1-2.3	
High school or GED	5.3	4.9-5.7		24.0	22.7-25.2	2.4	2.1-2.6	
AA, less than BA	5.2	3.8-6.6		23.3	21.1-25.5	2.7	2.0-3.3	
BA or higher	4.8	3.4-6.2	<0.01	24.6	21.3-27.9	2.2	1.9-2.5	0.43
Region of residence								
Northeast	5.7	4.5-6.9		24.4	22.1-26.8	2.3	2.0-2.7	
Midwest	6.4	5.9-7.0		26.4	24.5-28.4	2.4	2.2-2.5	
South	6.1	5.5-6.8		28.2	26.1-30.2	2.3	2.1-2.5	
West	4.5	3.5-5.4	0.01	21.1	19.0-23.2	2.3	2.1-2.5	0.92
Smoking								
Ever	6.5	6.0-7.0		26.3	25.0-27.7	2.4	2.2-2.5	
Never	4.9	4.4-5.4	<0.01	24.7	23.5-25.8	2.3	2.1-2.4	0.43
Alcohol use								
Yes	5.4	5.0-5.8		23.5	22.4-24.6	2.4	2.2-2.6	
No	6.5	5.7-7.3	<0.01	29.3	27.7-31.0	2.2	2.1-2.4	0.27
BMI								
Underweight	7.6	5.5-9.7		33.0	29.4-36.6	2.5	1.9-3.2	
Normal	6.2	5.5-7.0		26.9	25.6-28.3	2.5	2.2-2.7	
Overweight	5.2	4.6-5.9		23.6	22.1-25.1	2.2	2.1-2.3	
Obese	5.4	4.5-6.4	0.01	24.5	22.7-26.3	2.2	1.9-2.4	0.15
Disease or condition								
Cancer	8.9	7.8-10.1	<0.01	29.8	27.7-31.9	2.9	2.5-3.3	<0.01
Diabetes	8.6	7.4-9.7	<0.01	30.4	28.7-32.0	2.6	2.4-2.8	0.03
ESRD	37.7	29.9-45.5	<0.01	50.8	42.6-59.0	4.5	3.9-5.2	<0.01
Heart disease	7.5	7.0-8.1	<0.01	33.2	31.8-34.7	2.4	2.2-2.5	0.41
Lung disease	7.4	6.2-8.5	<0.01	29.6	27.6-31.6	2.3	2.0-2.6	0.96
All subjects	5.8	5.4-6.2		25.6	24.6-26.7	2.3	2.2-2.4	

* Transfusion use, without reuse within 30 days.

† Mean number in those who received a transfusion.

TABLE 3
 Percentage of older Americans who received a transfusion within a 10-year period by type of medical service and race

Type of medical service	African-American		Caucasian		Other races		All races	
	Use (%)	95% CI	Use (%)	95% CI	Use (%)	95% CI	Use (%)	95% CI
Major surgical procedures								
Cardiovascular	62	58-66	51	50-53	46	35-56	52	51-54
Orthopedic	66	62-70	52	50-54	49	39-59	53	51-55
Other	59	55-63	47	45-49	44	34-55	48	47-49
Critical care, hospital	66	60-71	58	56-60	47	36-57	59	57-61
Emergency room visit	42	39-45	38	37-39	34	28-40	38	37-39

TABLE 4

Percentage of older Americans who received a transfusion within a 10-year period by type of medical service and ethnicity

Type of medical service	Mexican-American		Other Hispanic		Not Hispanic		All ethnicities	
	Use (%)	95% CI	Use (%)	95% CI	Use (%)	95% CI	Use (%)	95% CI
Major surgical procedures								
Cardiovascular	58	50-65	47	39-56	52	51-54	52	51-54
Orthopedic	70	60-80	44	34-55	53	51-55	53	51-55
Other	55	49-61	48	38-57	48	46-49	48	47-49
Critical care, hospital	65	60-71	55	48-62	59	57-61	59	57-61
Emergency room visit	47	39-55	33	29-37	38	37-39	38	37-39

TABLE 5

Predictors of transfusion and number of transfusion-related visits in older Americans

Predictors	Model with transfusion-related stay, ever vs. never			Model with number of transfusion-related stays		
	Odds ratio	95% CI	p value	Relative risk	95% CI	p value
Age	1.02	0.99-1.05	0.15	0.98	0.97-0.99	<0.01
Male	1.35	0.94-1.93	0.10	1.14	0.99-1.31	0.07
Race						
Caucasian	1.00	(Reference)		1.00	(Reference)	
African-American	1.76	1.10-2.82	0.02	1.16	0.96-1.41	0.12
Other	0.57	0.20-1.59	0.28	0.94	0.64-1.37	0.75
Ethnicity						
Mexican American	2.29	0.56-9.33	0.24	0.93	0.67-1.28	0.64
Other Hispanic	0.35	0.17-0.74	<0.01	0.76	0.53-1.09	0.13
Not Hispanic	1.00	(Reference)		1.00	(Reference)	
Marital status						
Married or partnered	1.00	(Reference)		1.00	(Reference)	
Divorced or separated	1.27	0.64-2.49	0.49	1.31	0.98-1.76	0.07
Never married	1.26	0.43-3.69	0.67	0.80	0.56-1.13	0.20
Widowed	0.28	0.19-0.42	<0.01	0.75	0.65-0.86	<0.01
Religion						
Protestant	1.00	(Reference)		1.00	(Reference)	
Catholic	1.30	0.87-1.92	0.19	1.39	1.12-1.72	<0.01
Jewish	2.35	0.97-5.70	0.06	1.37	1.07-1.76	0.01
Other	0.29	0.10-0.80	0.02	0.60	0.40-0.91	0.02
None	0.80	0.43-1.49	0.48	1.00	0.72-1.38	1.00
No high school degree	1.89	1.25-2.86	<0.01	0.99	0.83-1.20	0.96
Region of residence						
Northeast	1.87	1.00-3.50	0.05	1.11	0.83-1.49	0.48
Midwest	2.09	0.99-4.42	0.05	1.20	0.92-1.57	0.17
South	3.14	1.49-6.62	<0.01	1.32	1.01-1.71	0.04
West	1.00	(Reference)		1.00	(Reference)	
Smoking, ever	2.57	1.77-3.72	<0.01	1.22	1.04-1.42	0.01

Predictors	Model with transfusion-related stay, ever vs. never			Model with number of transfusion-related stays		
	Odds ratio	95% CI	p value	Relative risk	95% CI	p value
Alcohol use	0.35	0.24-0.50	<0.01	0.82	0.70-0.97	0.02
BMI						
Underweight	4.34	2.34-8.05	<0.01	1.90	1.31-2.77	<0.01
Normal	1.00	(Reference)		1.00	(Reference)	
Overweight	0.43	0.29-0.63	<0.01	0.71	0.61-0.83	<0.01
Obese	0.72	0.44-1.17	0.18	0.78	0.64-0.95	0.01
Diseases or conditions						
Cancer	4.30	2.68-6.90	<0.01	1.65	1.36-2.01	<0.01
Diabetes	3.38	2.20-5.19	<0.01	1.48	1.23-1.78	<0.01
ESRD	3055.9	850.5-10,979.4	<0.01	5.39	3.35-8.68	<0.01
Heart disease	5.15	3.76-7.04	<0.01	1.29	1.12-1.49	<0.01
Lung disease	1.96	1.26-3.05	<0.01	1.16	0.94-1.42	0.16
Total number of visits*	1.011	1.004-1.019	<0.01	1.003	1.002-1.005	<0.01

* Total number of hospital stays, skilled nursing facility stays and outpatient facility visits.