Clinical and Economic Outcomes Associated with Blood Transfusion During Inpatient Hospitalization: An Analysis of the 2004 Healthcare Cost and Utilization Project Nationwide Inpatient Sample Database

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BACKGROUND

- Trauma, surgery, and abnormalities in hemostasis are common causes of excessive bleeding and often precipitate the need for blood transfusion.
  - In 2004, more than 14 million units of whole blood and red blood cells (RBCs) were provided to an estimated 5.3 million patients in the U.S.[1]
- For some patients, blood transfusion is a necessary and life-saving intervention; however, many transfusion medicine experts deem blood transfusion an imperfect solution to managing blood loss.[2,3]
  - Although blood transfusion has a high therapeutic index, a preponderance of evidence from studies on subgroups of surgical patients suggests that blood transfusion may be an independent predictor of negative clinical outcomes, including postoperative infection, non-infectious complications, poor postoperative functional recovery, and increased mortality.[4-6]
- The inherent risks and adverse outcomes associated with blood transfusion necessitate ongoing efforts to raise awareness of the prevalence and clinical impact of blood transfusion in hospitalized patients.
- To date, the association of blood transfusion with negative clinical outcomes has primarily been demonstrated in subgroups of surgical patients, including coronary artery bypass graft surgery (CABG), hip and knee replacement, trauma, and colorectal surgery patients.[7-11]
  - To the best of our knowledge, no study has assessed—from a national perspective—prevalence and outcomes associated with blood transfusion across the full spectrum of surgical procedures and clinical conditions warranting inpatient care.

OBJECTIVE

- To assess—from a national perspective—prevalence and outcomes associated with blood transfusion across the full spectrum of surgical procedures and clinical conditions warranting inpatient care.

METHODS

Study Design

- In this retrospective, cohort study, the prevalence of blood transfusion, as well as morbidity, mortality, and resource-use outcomes were examined for all hospitalizations (discharges) in the U.S. in 2004 using the Agency for Healthcare Research and Quality's (AHRQ) 2004 Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS) database.[12]
- All discharges from NIS 2004 were categorized into two groups by International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes for blood transfusion.
  - Discharges with at least one principal or secondary ICD-9-CM procedure code indicating perioperative autologous transfusion (99.00), transfusion of previously collected autologous blood (99.02), other transfusion whole blood (99.03), or transfusion of packed cells (99.04) were grouped in a cohort labeled "Transfused".
  - All other discharges were grouped into a second cohort labeled "Non-Transfused".
- The 10 most common primary procedures performed during the course of an inpatient stay involving blood transfusion were identified using clinical classification software (CCS) categories.
  - CCS categories are an analytic tool provided by AHRQ to support the HCUP. ICD-9-CM codes are collapsed into a smaller number of clinically meaningful categories that are sometimes more useful for presenting descriptive statistics than are individual ICD-9-CM codes.

Data Collected

- Age, gender, primary payer source, Charlson comorbidity index (one-year mortality risk attributable to comorbidity),[13] and admission type were assessed for all discharges and each study cohort.
- Length of stay (LOS), postoperative infections, non-infectious transfusion-related complications, in-hospital mortality, and total charges (hospital billings) were evaluated for all discharges.

Statistical Analyses

- The F-test and the Rao Scott chi square test were used to test for differences in means and frequencies, respectively, between the two cohorts.
- Odds ratios for death and infection, as well as incremental between-group differences in LOS and total charges were calculated after controlling for age, gender, Charlson comorbidity index, admission type, diagnosis-related group (DRG), payer (for LOS only), and LOS (for total charges only).
- Significance was determined at an alpha level less than 0.05.

RESULTS

Study Sample Composition

- Based on 2004 NIS data, of the estimated 38.7 million discharges in the U.S. in 2004, 5 percent (2.1 million) were associated with an ICD-9-CM procedure code for blood transfusion.
- The 10 most common CCS categories for procedures performed during the same hospitalization as a blood transfusion accounted for more than 10 percent of all hospitalizations and 36 percent of hospitalizations in the Transfused cohort.
- Orthopedic, cardiovascular, and colorectal procedures accounted for 13, 7, and 4 percent of discharges associated with blood transfusion (Table 1).
- Blood transfusion occurred with the greatest frequency for discharges associated with hip-related procedures (26% to 29%), followed by CABG (23%).

Table 1. Top 10 Most Common CCS Categories of Primary Procedures Performed During Same Hospitalization as Blood Transfusion

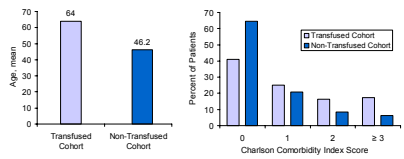
Primary CCS Procedure Category	N	Transfused	Non-Transfused	Percent of CCS Category with Transfusion (%)	Percent of All Hospital Discharges with Transfusion (%)*
Upper gastrointestinal endoscopy; biopsy	727,832	159,243	568,390	22	7.7
Hip replacement; total and partial	363,611	106,589	257,022	29	5.1
Arthroplasty knee	481,825	98,854	382,971	21	4.8
Respiratory intubation and mechanical ventilation	673,583	76,479	597,104	11	3.7
Treatment; fracture or dislocation of hip and femur	274,916	71,949	202,967	26	3.5
Coronary artery bypass graft	257,740	60,317	197,423	23	2.9
Other vascular catheterization; not heart	457,524	48,429	409,094	11	2.3
Colonoscopy and biopsy	300,227	46,141	254,086	15	2.2
Colorectal resection	279,092	44,595	234,496	16	2.2
Other OR procedures on vessels other than head and neck	269,018	38,034	230,984	14	1.8

*Out of 2.1 million discharges with transfusion in 2004

Demographic and Clinical Characteristics

- Advanced age and higher Charlson comorbidity index score were associated with a higher prevalence of blood transfusion among hospitalized patients (Figure 1).

Figure 1. Mean Age and Charlson Comorbidity Index Score for Transfused and Non-Transfused Cohorts*



*p<0.001 for differences in overall mean age and Charlson comorbidity index score. F-test and Rao-Scott chi-square test, as appropriate.

Outcomes

- LOS, charges, mortality risk, and infection risk were significantly higher in transfused patients than in non-transfused patients.
- Average LOS was 3.0 days higher and charges were $8,476 higher for the Transfused cohort (p<0.0001; F-test) compared to the Non-Transfused cohort (Table 2).

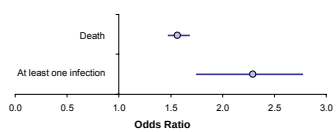
Table 2. Incremental Differences in LOS and Total Charges Between Transfused and Non-Transfused Cohorts

Outcome	Overall (N=38,661,829)	Transfused (N=2,076,068)	Non-Transfused (N=36,585,761)	p-value*
Length of stay (days)				
Mean (SE)	4.6 (0.04)	9.2 (0.14)	4.4 (0.04)	<0.0001
Incremental change‡ (se)		3.02 (0.09)		<0.0001
Total charges				
Mean (SE)	$20,439 (416)	$51,144 (1,537)	$18,709 (383)	<0.0001
Incremental change‡ (se)		$8,476 (894)		<0.0001

*F-test and Rao-Scott chi-square test for means and frequencies, respectively. Linear regression for incremental change. ‡After controlling for the following: age, gender, co-morbidities (i.e., Charlson comorbidity index), type of admission, DRG, payer (for length of stay only), and length of stay (for total charges only).

- The Transfused cohort had a 1.6 times higher odds of death (p<0.0001; Rao-Scott chi-square test) and a 2.3 times higher odds of infection (p<0.0001; Rao-Scott chi-square test) compared to the Non-Transfused cohort (Figure 2).

Figure 2. Odds of Death (95% CI) and Infection, Transfused vs. Non-Transfused Cohorts

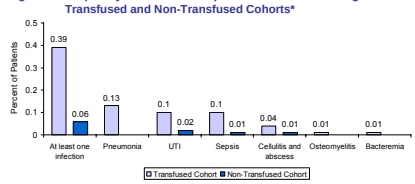


RESULTS (cont.)

Outcomes (cont.)

- The most frequently recorded postoperative infection was pneumonia, at 0.13 percent in the Transfused cohort compared to 0 percent in the Non-Transfused cohort (Figure 3).

Figure 3. Frequently Recorded Postoperative Infections Among Transfused and Non-Transfused Cohorts*



*p<0.0001 for overall infection rates between cohorts. Rao-Scott chi-square test.

STUDY LIMITATIONS

- NIS data are derived from discharge record abstractions.
  - Detailed and precise information was not available to validate that a blood transfusion procedure was performed or that a patient actually experienced a negative outcome that was directly attributable to a blood transfusion.
- Cross-sectional survey databases such as NIS do not provide preadmission or post-hospital discharge data.
  - Without this additional data, the nature or severity of blood loss, specific trigger for blood transfusion, or link between procedure and timing of blood transfusion (e.g., pre-, intra-, or post-operative) cannot be accurately determined.
- Blood transfusion procedure codes are likely to be underreported.
  - As such, we may not have captured all relevant cases, which would underestimate the true prevalence of blood transfusion in hospitalized patients, affect demographic composition of the study population, and influence other outcome measures of interest such as LOS, postoperative infection rates, and mortality.
- The association between blood transfusion type (i.e., autologous versus allogeneic) and clinical outcomes was not assessed.

CONCLUSIONS

- More than 2 million hospitalized patients receive a blood transfusion annually.
- After controlling for potentially confounding variables, transfused patients are at greater risk than non-transfused patients for experiencing adverse outcomes. These include:
  - Increased mortality and infection risk, as previously demonstrated in patients undergoing cardiac surgery.[6,7]
  - Increased hospital resource use.
- The association between blood transfusion and negative clinical outcomes warrants further investigation to better identify the appropriateness of current transfusion triggers and to develop and implement more effective approaches to reduce the non-emergent use of blood in hospitalized patients.
- Raising awareness about the potential negative clinical and economic outcomes of blood transfusion should encourage the adoption of blood conservation techniques and strategies to reduce perioperative blood loss and optimize its management; minimize the inappropriate use of blood; and ultimately, yield meaningful clinical benefits at the individual patient level.

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