



Comparison of Post-Operative Nosocomial Infection Associated with Blood Management Techniques in Cardiovascular and Orthopedic Surgery

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ABSTRACT

Objectives. Numerous risks are associated with allogeneic blood transfusions, however non-allogeneic blood options can minimize the use of allogeneic blood. This study compared infection rates associated with blood management techniques in patients undergoing cardiac and orthopedic surgeries where anticipated blood loss exceeds 1,000 mL.

Methods. Patients were enrolled at nine hospitals. Post-operative infection rate (to patient discharge) was compared between patients receiving allogeneic (includes allogeneic, +/- autologous, +/- reinfused blood and volume replacement) and other (non-allogeneic and/ or volume replacement) transfusion. Relative risk and 95% confidence intervals were calculated to compare infection rates. Logistic regression analyses evaluated various factors as predictors of infection.

Results. Data were obtained from 924 patients (302 cardiovascular, 622 orthopedic). There were 249 and 675 patients in the allogeneic and other groups, respectively. The mean (SD) age was 66.0 (12.1), 48% were male, 79% were Caucasian, and 36, 28, and 25% were in ASA classes 2,3 and 4, respectively. The overall infection rate was 6.2%; 2.9% for orthopedic patients and 12.9% for cardiac patients. The infection types included: pneumonia (n=12), sepsis (n=4), urinary tract infection (n=18), incisional wound infection (n=12), catheter-associated infection (n=4), osteomyelitis (n=1), cardiovascular infection (n=2), other (n=10). Overall, the relative risk (95% CI) of post-operative infection was 3.0 (1.8, 5.0) times greater in the allogeneic group. When separated by surgery type, the relative risk of infection with allogeneic transfusion (95% CI) was 1.9 (0.7, 5.3) in orthopedic patients, and 1.9 (1.0, 3.5) in cardiac patients. Allogeneic blood management, surgery type, and patient age were identified as significant predictors of infection risk (p=0.1).

Conclusions. Overall, an increased risk of post-operative infection associated with receipt of allogeneic blood was observed; a similar trend was observed when cardiac and orthopedic patients were separately considered. Allogeneic blood management, cardiac surgery, and advancing patient age were associated with increased probability of post-operative infection.

INTRODUCTION

- Blood loss with major elective surgery can be substantial and often requires perioperative transfusion with allogeneic or autologous blood.
- Specific risks associated with allogeneic blood transfusions include the transmission of blood-borne infections and immunomodulatory effects.
- Experimental and epidemiologic observations indicate that allogeneic transfusions are associated with an increased prevalence of post-operative bacterial infections.
- A number of autologous blood options can potentially reduce or eliminate the need for allogeneic blood.
- This study compared the infection rates associated with blood management techniques in patients undergoing cardiac and orthopedic surgeries where blood loss was anticipated to exceed 1000 mL.

OBJECTIVES

- To compare the post-operative infection rate in patients undergoing major orthopedic and cardiac surgeries utilizing allogeneic versus non-allogeneic blood management.

METHODS

Study Design

- Observational, sequential sampling design study conducted at nine community hospitals.
- Standard data collection form used to record: demographic information, pre-existing medical conditions/risk factors (categorized by cardiovascular, endocrine, gastrointestinal, hepatic, renal, hematology/oncology, social history, respiratory, neurologic, surgical, and other), medical history, medication history, perioperative times, surgical and anesthesia procedures, blood transfusion and volume replacement information, and post-operative infections.
- Protocol received IRB approval and informed consent was obtained prior to enrollment.

Inclusion Criteria

- In-patient surgeries including: total or partial hip replacement/revision, total knee replacement/revision, shoulder arthroplasty, coronary artery bypass graft, replacement of any heart valve (with prosthesis/tissue graft), and thoracic vessel resection with replacement.

Exclusion Criteria

- Age < 18 years, immunocompromised from current malignancy, systemic viral or bacterial infection, trauma requiring multiple surgeries, or incompetent to provide consent

Blood Management Definitions

- Allogeneic: transfusion of donor-supplied red blood cells, plasma, platelets, or cryoprecipitate with/without receipt of other blood management techniques

Other

- Other: autologous blood transfusions and/or CT autotransfusions, orthopedic autotransfusions, cell salvage, or ANH and/or volume replacement with colloids and/or crystalloids

Clinical Outcome: Post-Operative Infection Rate

- Infections included pneumonia, sepsis, UTI, incisional or deep surgical wound infection, catheter-associated infection, osteomyelitis, septic arthritis and cardiovascular infection (all as defined by CDC) and other infections defined by the primary investigator that occurred between the time of surgery until hospital discharge.

Statistical Methods

- Blood management comparisons performed using chi-square or Fisher exact test for categorical variables, and t-tests or Wilcoxon rank-sum tests for continuous variables.
- Logistic regression analysis assessed influence of blood management technique and other patient factors on post-operative infection risk.
- Univariate model – factors tested included: demographic factors, pre-existing medical conditions, blood management technique, surgery type.
- Multivariable model: factors considered if the following criteria met: univariate p-value ≤ 0.20 , ≥ 5 events in each level of a categorical factor, factor assessed either pre- or intra-operatively.
- All first-order interaction terms were tested in final multivariable model and assessed for statistical significance.
- Model fit assessment: Hosmer-Lemeshow GOF test, area under the ROC curve, and overall precision of the estimates.

RESULTS

- 924 patients included in the analysis: average age (SD) was 66.0 (12.1) years, average (SD) body mass index was 30.0 (6.8) kg/m², with 446 (48.3%) males and 478 (51.7%) females in the population, majority of the patients were Caucasian 730 (80.4%) and most patients had an ASA class of 2, 3, or 4.
- Cardiac surgery was performed on 302 (32.7%) patients and orthopedic surgery on 622 (67.3%) patients; the most common pre-existing medical condition overall was cardiovascular disease (701 patients, 75.9%).

Table 1: Patient Demographic Characteristics by Blood Management Technique

Demographic Characteristic	Blood Management Technique		p-value
	Allogeneic Transfusion	Other ¹	
Age (years)			
Number of Subjects	249	675	0.0001
Mean (SD)	68.66 (11.94)	65.03 (12.07)	
Weight (kg)			
Number of Subjects	249	673	0.0003
Mean (SD)	80.91 (19.41)	86.68 (20.95)	
Body Mass Index (kg/m ²)			
Number of Subjects	246	664	0.0002
Mean (SD)	28.68 (6.44)	30.44 (6.83)	
Gender			
Males, n (%)	124 (49.8%)	322 (47.7%)	0.5720
Females, n (%)	125 (50.2%)	353 (52.3%)	
Surgery Type			
Cardiovascular, n (%)	146 (58.63%)	156 (23.11%)	<0.0001
Orthopedic, n (%)	103 (41.37%)	519 (76.89%)	
Age Group			
< 65, n (%)	80 (32.13%)	308 (45.63%)	0.0002
≥ 65 , n (%)	169 (67.87%)	367 (54.37%)	
Race			
Caucasian, n (%)	196 (78.71%)	534 (79.11%)	0.9280
Other, n (%)	53 (21.29%)	141 (20.89%)	
ASA Class			
= 3, n (%)	148 (59.44%)	545 (80.86%)	<0.0001
= 4, n (%)	101 (40.56%)	129 (19.14%)	

¹ Other refers to both non-allogeneic blood transfusion and volume replacement combined.

Figure 1: Occurrence of Post-Operative Infection by Blood Management Technique

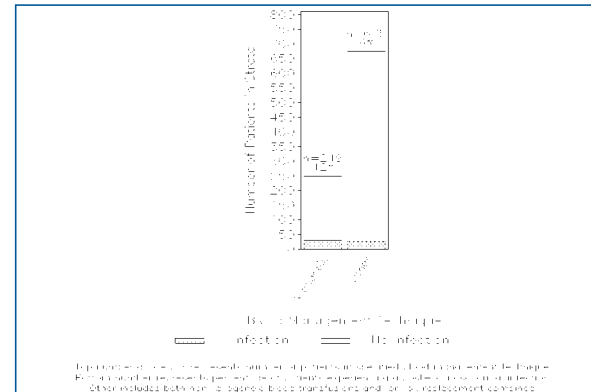
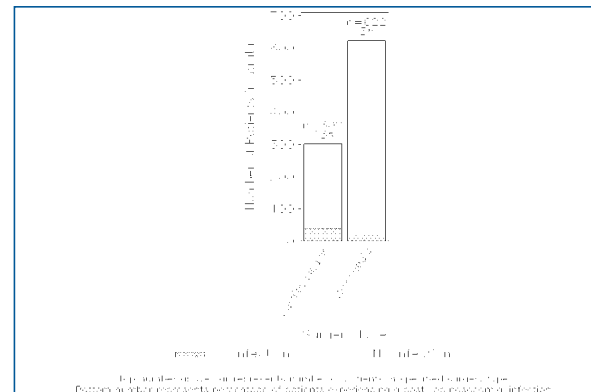


Figure 2: Occurrence of Post-Operative Infection in Cardiac versus Orthopedic Surgery



- Overall, the relative risk (95% CI) of post-operative infection was 3.0 (1.8, 5.0) times greater in the allogeneic group. When separated by surgery type, the relative risk of infection with allogeneic transfusion (95% CI) was 1.9 (0.7, 5.3) in orthopedic patients, and 1.9 (1.0, 3.5) in cardiac patients.

Table 2: Types of Post-Operative Nosocomial Infections by Blood Management Technique

Post-Operative Infection	Blood Management Technique	
	Allogeneic Transfusion (n=249)	Other ¹ (n=675)
Pneumonia	9 (3.6%)	3 (0.4%)
Sepsis	1 (0.4%)	3 (0.4%)
Urinary Tract Infection	9 (3.6%)	10 (1.5%)
Incisional Surgical Wound Infection	9 (3.6%)	3 (0.4%)
Deep Surgical Wound Infection	0 (0.0%)	0 (0.0%)
Catheter Associated Infection	4 (1.6%)	0 (0.0%)
Osteomyelitis	0 (0.0%)	1 (0.2%)
Septic Arthritis	0 (0.0%)	0 (0.0%)
Cardiovascular Infection	0 (0.0%)	2 (0.3%)
Other	4 (1.6%)	6 (0.9%)

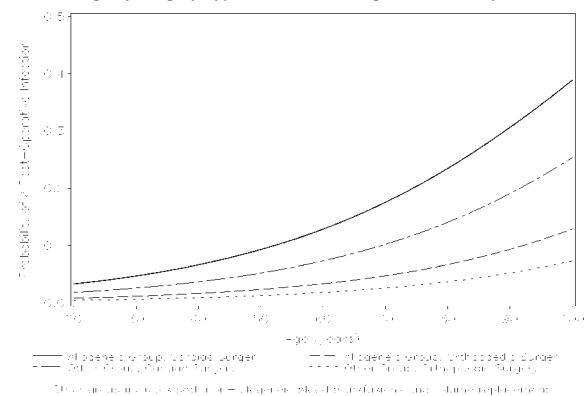
Table 3: Univariate Logistic Regression Analyses of Post-Operative Nosocomial Infection

Variable	Odds Ratio	Lower 95% Confidence Limit for Odds Ratio	Upper 95% Confidence Limit for Odds Ratio	p-value
Age (years)	1.04	1.02	1.07	0.0018
Body Mass Index (kg/m ²)	0.96	0.92	1.00	0.0575
Male Gender	1.30	0.76	2.22	0.3411
Allogeneic Blood	3.29	1.91	5.65	<0.0001
Cardiac Surgery	4.98	2.79	8.86	<0.0001
Caucasian	1.02	0.52	2.01	0.9524
ASA Class > 3	4.16	2.40	7.22	<0.0001
Cardiac Disease	6.12	1.89	19.77	0.0025
Diabetes	1.36	0.74	2.51	0.3207
Gastrointestinal Disease	1.50	0.82	2.74	0.1859
Hepatic Disease	15.47	0.96	250.56	0.0539
Renal Disease	4.37	2.12	9.00	<0.0001
Hematology/Oncology Disease	1.34	0.66	2.72	0.4213
Social History	1.47	0.84	2.59	0.1802
Neurological Disease	3.21	1.43	7.20	0.0048
Respiratory Disease	1.61	0.83	3.14	0.1586

Table 4: Final Multivariable Logistic Regression Model for Post-Operative Nosocomial Infection

Parameter	Odds Ratio	Lower 95% Confidence Limit for Odds Ratio	Upper 95% Confidence Limit for Odds Ratio	p-value
Allogeneic Blood	1.811	0.991	3.310	0.0536
Cardiac Surgery	4.832	2.523	9.254	<0.0001
Age (years)	1.035	1.006	1.064	0.0168
Hosmer-Lemeshow Goodness-of-Fit Test p-value = 0.0806		Area Under ROC Curve = 0.762		

Figure 3: Final Logistic Regression Model for Post-Operative Infection versus Age by Surgery Type and Blood Management Technique



CONCLUSIONS

- Allogeneic blood management was shown to significantly increase the risk of post-operative infections.
- Other factors identified that significantly influence the risk of infection were surgery type and patient age.
- Cardiac surgery and advancing age were associated with a higher probability of post-operative infection.