Transfusion did not prevent complications of scheduled surgery in California hospitals during 2012-13

Peter McNAIR PhD[a] and Terri JACKSON, PhD[b]

[a] *Palo Alto Medical Foundation Research Institute*
[b] *University of Melbourne*

Abstract

Background: Transfusion for healthy, asymptomatic post-surgery patients with a hemoglobin estimate > 7.0g/dL has been shown to be associated with increases in morbidity and mortality including increased rates of a range of hospital-acquired complications. Feedback to hospitals and physicians regarding transfusion rates in orthopedic surgery reveals dramatic variations in allogeneic transfusion rates both across California and among physicians. Physicians with high rates of allogeneic and/or autologous transfusion identified outcomes (e.g., cardiac dysrhythmia) that they were attempting to prevent with transfusion.

Objective: This study seeks to identify any unintended adverse patient outcomes associated with reduced transfusion rates.

Methods: We calculate hospital level allogeneic transfusion rates for thirteen scheduled surgery patient groups with a broad suite of patient outcomes using California-wide data from the Office of Statewide Health Planning and Development. Rates of common complications such as acute renal failure and postoperative infection, or readmissions with unexpected mechanical ventilation, with postoperative atelectasis, or heart failure were examined.

Results: Of the 50 complications associated with trasnfusion, only one was found to have a negative association, that is, was associated with worse outcomes with lower rates of allogeneic transfusion. For the suite of scheduled procedures included in this California-wide dataset, the study found that lower transfusion rates were not associated with an increase in adverse patient outcome.

Conclusion: There are well established guidelines defining when transfusion is indicated. Outside of these guidelines, this study demonstrates transfusing scheduled surgery patients to prevent complications of care is not warranted.

Keywords. Information systems, elective surgery, hospital-acquired diagnoses, quality indicators, decision support

Introduction

Evidence supporting many common clinical practices such as blood transfusion is often not available. Transfusion has undoubtedly saved the lives of many patients, particularly in the context of wartime injuries. However, the net clinical benefit (benefit minus harms) for transfusion in scheduled surgical procedures has only recently been investigated.[1] Transfusion for healthy, asymptomatic post-surgery patients with a hemoglobin estimate > 7.0g/dL has been shown to be associated with increases in morbidity and mortality including increased rates of hospital acquired infections, Transfusion Related Acute Lung Injury (TRALI), Transfusion Related Immuno-Modulation (TRIM), cardiac, respiratory, and post-operative complications.[2-4]

The Palo Alto Medical Foundation Research Institute developed the EXPLORE-Clinical Practice (EXamining Patient Level Outcomes to Reveal Excellence in Clinical Practice)[5] program to feedback hospital inpatient surgery outcome data to California hospitals and, in some cases, to individual clinicians. The program reports on average, 189 (range: 115 to 251) within-episode and 30-day readmission based outcomes for every non-Federal California hospital across thirteen scheduled surgery patient groups (AAA repair, bariatric procedures, cholecystectomy, colectomy, colo-rectal, hysterectomy, lobectomy, lumpectomy, mastectomy, oophorectomy, prostatectomy, Total Hip Replacement (THR) and Total Knee Replacement).

Feedback to hospitals and physicians regarding transfusion rates in orthopedic surgery revealed dramatic variations in allogeneic transfusion rates both across California[5] and among physicians (not shown). Physicians with high rates of allogeneic and/or autologous transfusion identified outcomes (e.g., cardiac dysrhythmia) that they were attempting to prevent with transfusion. However, when we investigated these outcomes we could not find an inverse correlation (negative association) with transfusion nor literature consistently supporting association between reduced transfusion rates and complications of care in scheduled surgery.

We followed up on this work with the Hospital Inpatient Transfusion Reduction Study. The study identified hospitals with very low transfusion rates and demonstrated that a suite of recommended structures and processes are being actively implemented to successfully reduce transfusion rates (i.e., systematic variation is present). As hospitals are increasingly implementing these structures and processes, this study sought to identify any unintended adverse patient outcomes associated with reducing transfusion rates. Associations only flag areas for further investigation, as a correlation or association does not imply temporality or causality.

Method

This study compares hospital level allogeneic transfusion rates for thirteen scheduled surgery patient groups with a broad suite of patient outcomes.

As part of the ExPLORE Clinical Practice Program, outcome rates are calculated for each hospital across thirteen patient groups selected by scheduled procedure. ExPLORE CP uses de-identified, linked, routinely collected patient data to facilitate review of surgical outcome information, to identify opportunities for practice and quality improvement, and to assist doctors and patients in making healthcare decisions. For this study, rates for each outcome are correlated with transfusion rates where each hospital-patient group pair is a separate observation.

The case threshold for inclusion for each pair is set at twice the inverse of the California-wide outcome rate to ensure that the expected number of outcomes for any measure for any hospital-patient group is at least two (e.g., where the complication rate for an outcome was 5% only hospitals with more than 40 (2*(1/0.05)) cases are included in the analyses; where the outcome rate is 0.2% hospitals with more than 1,000 (2*(1/0.002)) cases are included).

More hospitals are included in correlations for outcomes that occur more frequently, increasing the power of these analyses. Correlation matrix confidence intervals are tested at the 6% level (95% level Bonferroni corrected for 122 outcomes; JMP 10. SAS Institute Inc., Cary, NC).

While other programs aggregate similar complications of care (e.g., the Classification of Hospital Acquired Diagnoses),[6] ExPLORE Clinical Practice identifies

every individual diagnosis not present on admission (hospital-acquired) and every procedure undertaken, along with the surgical procedure of interest in the patient report group (e.g., THR). The outcomes are ordered by descending frequency. In concert with surgeons who perform each of the procedures, a suite of potential outcomes is assembled. The suite is designed to be inclusive and in many cases outcomes are clinically related (e.g., post-operative hemorrhage, anemia arising during the admission and allogeneic transfusion).

Results

We used the ExPLORE Clinical Practice Program (aggregated) report data to test for associations between the rates of transfusion and the rates of adverse patient outcomes that either arose during the index (initial) admission or were present during a readmission within 30 days. Of the 206 candidate outcomes, data was available for 122, that is, for 84 outcomes, our threshold for adequate volume of cases was not met.

Statistically significant associations (i.e., the 99.96% confidence interval did not include zero) are thus estimated for 50/122 outcomes (Table 1). Only one of these, urinary retention, was found to have a negative association, that is, may have worse outcomes at lower rates of allogeneic transfusion.

Table 1. Correlation coefficients for outcomes associated with allogeneic transfusion, selected scheduled surgery, OSHPD* public discharge dataset 2012-13.

Patient Outcome (co-procedure or complication)	Correlation (99.96%)
Readmission[#] with Unexpected Mechanical Ventilation	0.88 (0.12-0.99)
Readmission[#] with Postoperative Atelectasis	0.84 (0.17-0.98)
Readmission[#] with Heart Failure - Diastolic	0.81 (0.06-0.98)
Anemia	0.66 (0.62-0.70)
Leukocytosis	0.64 (0.20-0.87)
Hemodialysis for Acute Renal Failure	0.63 (0.35-0.81)
Readmission[#] with Intra-abdominal Drain Placement	0.62 (0.47-0.74)
Unexpected Mechanical Ventilation	0.60 (0.49-0.69)
Intra-abdominal Drain Placement	0.60 (0.39-0.74)
Insertion of Endotracheal Tube (outside the operating room)	0.56 (0.40-0.68)
Readmission[#] with Ileus and long hospital stay	0.53 (0.07-0.80)
Ileus with long hospital stay	0.52 (0.43-0.59)
Readmission[#] with Peritonitis	0.51 (0.24-0.71)
Readmission[#] with Bowel Obstruction	0.50 (0.21-0.71)
Readmission[#] with Total Parenteral Nutrition	0.50 (0.11-0.76)
Total Parenteral Nutrition	0.50 (0.35-0.62)
Readmission[#] with Transfusion	0.49 (0.39-0.59)
Complications of intestinal anastomosis	0.49 (0.40-0.57)

Postoperative infection	0.48 (0.34-0.60)
Respiratory Failure, Postoperative - AHRQ PSI[@] 11	0.48 (0.28-0.64)
Ileus	0.48 (0.40-0.55)
Sepsis, Postoperative - AHRQ PSI[@] 13	0.47 (0.29-0.62)
Abnormal Electrolytes	0.45 (0.37-0.51)
Readmission[#] with Ileus	0.43 (0.24-0.60)
Iatrogenic hypotension	0.41 (0.29-0.52)
Tubular necrosis or Acute Renal Failure	0.40 (0.29-0.50)
Readmission[#] with Sepsis, Postoperative - AHRQ PSI[@] 13	0.39 (0.18-0.57)
Pulmonary insufficiency following surgery	0.38 (0.20-0.53)
Readmission[#] with Complications of intestinal anastomosis	0.37 (0.19-0.52)
Pleural Effusion with Catheter Insertion	0.36 (0.19-0.51)
Pneumonia (CMS[^] Definition)	0.36 (0.18-0.51)
Patient Outcome (co-procedure or complication)	**Correlation (99.96%**
Readmission[#] with Tubular necrosis or Acute Renal Failure	0.34 (0.15-0.51)
Cardiac Dysrhythmia	0.34 (0.26-0.41)
Volume Depletion	0.33 (0.16-0.48)
Long Hospital Stay	0.33 (0.25-0.40)
Urinary tract infection	0.32 (0.19-0.44)
Readmission[#] with Volume Depletion	0.32 (0.16-0.47)
Postoperative hemorrhage	0.32 (0.19-0.45)
Postoperative Atelectasis	0.32 (0.22-0.41)
Readmission[#] with Heart Failure	0.31 (0.09-0.50)
Puncture or Laceration, Accidental - AHRQ PSI[@] 15	0.31 (0.18-0.43)
Autologous Transfusion	0.31 (0.15-0.45)
Readmission[#] with Abnormal Electrolytes	0.30 (0.19-0.41)
Urinary complications	0.28 (0.04-0.49)
Readmission[#] with Postoperative infection	0.26 (0.13-0.38)
Readmission[#] with Anemia	0.24 (0.14-0.34)
Hypotension	0.23 (0.06-0.39)
Cardiac Arrest	0.19 (0.03-0.33)
Readmission[#] with Cardiac Dysrhythmia	0.12 (0.01-0.24)
Retention of urine	-0.13 (-0.25- -0.02)

* OSHPD - State of California Office of Statewide Health Planning and Development
 # Readmissions are limited to those within 30 days of discharge

@ *Agency for Healthcare Quality Patient Safety Indicators*
^*US Centres for Medicare and Medicaid*

The negative correlation between transfusion and retention of urine was further investigated at the patient procedure group level. Retention of urine was found to be associated with transfusion for scheduled cholecystectomy (r2=0.91; 99.96% CI: 0.79-0.96), oophorectomy (r2=0.54; 99.96% CI: 0.19-0.77) and hysterectomy (r2=0.34; 99.96% CI: 0.05-0.58) procedures. Prostatectomy was the only procedure group for which a significant negative association was detected (r2=-0.29; 99.96% CI: -0.53--0.01).

Discussion

Adverse outcomes (e.g., mechanical ventilation), although they do occur on occasion, are not on the expected clinical path for any of the scheduled surgery patient groups studied here. We identified 50 adverse outcome types associated with transfusion. The associations identified in this study only flag areas for further investigation, as a correlation or association does not imply temporality or causality. Clear examples from our findings include anemia and post-operative hemorrhage (i.e., anemia and post-operative hemorrhage are more likely to be treated with transfusion rather than being the result of transfusion). What these findings do suggest, however, is that 'prevention of adverse outcomes' by liberal transfusion policy may be unwise.

Urinary retention was the only outcome found to be negatively associated with transfusion rates, and we found this to be limited to scheduled prostatectomy. There could be a range of reasons for this finding, but the current study did not have the capacity to further investigate this negative association. There may be outcomes associated with lower transfusion rates that have not been detected in this analysis. The most likely candidates are outcomes that occur infrequently and outcomes that arise later than 30 days post-discharge.

For the suite of scheduled procedures included in this California-wide dataset, the study found that lower transfusion rates (within the confines of current California hospital practices) were not associated with an increase in any adverse patient outcome with one exception. ExPLORE CP is one of many initiatives attempting to lever available data to improve patient outcomes. The program has evolved from the initial intent of automated, statistically robust, clinically relevant detailed data feedback alone to a more sophisticated user friendly, web-based reporting service that identifies and propagates exemplary practice.

Strategies, including pre-admission anemia correction and the implementation of an evidence based transfusion trigger protocol, have been shown to reduce the need for transfusion in scheduled surgery.[5] There are well established guidelines defining when transfusion is indicated.[4] Outside of these guidelines, this study could not, with one possible exception, identify complications of scheduled surgery that could be prevented by transfusion.

References

[1] Carson JL, Grossman BJ, Kleinman S, et al on behalf of the Clinical Transfusion Medicine Committee of the AABB. Red blood cell transfusion: a clinical practice guideline from the AABB. *Ann Intern Med*. 2012;157(1):49-58 doi: 10.7326/0003-4819-157-1-201206190-00429.

[2] Salpeter SR, Buckley JS, Chatterjee S. Impact of More Restrictive Blood Transfusion Strategies on Clinical Outcomes: A Meta-analysis and Systematic Review. *The American Journal of Medicine* 2014 Feb:127(2);124‑131. DOI: 10.1016/j.amjmed.2013.09.017.

[3] Glance LG, Dick AW, Mukamel DB, et al. Association between intraoperative blood transfusion and mortality and morbidity in patients undergoing noncardiac surgery. *Anesthesiology.* 2011 Feb;114(2):283-92. doi: 10.1097/ALN.0b013e3182054d06.

[4] Engelbrecht S, Wood EM, Cole-Sinclair MF. Clinical transfusion practice update: haemovigilance, complications, patient blood management and national standards. *Medical Journal of Australia* 2013;199(6):397-401.

[5] McNair, Peter D.; Fang, Jade; Schwarzwaelder, Stephan; and Jackson, Terri (2015) "Development and Implementation of ExPLORE Clinical Practice, a Web-accessible Comparative Outcomes Tool for California Hospitals and Physicians," *eGEMs (Generating Evidence & Methods to improve patient outcomes)*: Vol. 3: Iss. 1, Article 2. DOI: http://dx.doi.org/10.13063/2327-9214.1066 Available at: http://repository.academyhealth.org/egems/vol3/iss1/2

[6] Jackson TJ, Michel JL, Roberts R, Jorm C, Wakefield J (2009). A Classification of Hospital Acquired Diagnoses for use with routine hospital data. *Medical Journal of Australia* (2009) 191(10):544-548.