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Organizational Contributors to the Variation in Red Blood Cell Transfusion Practices in Cardiac Surgery: Survey Results from the State of Michigan

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Abstract

BACKGROUND—While large volumes of red blood cell (RBC) transfusions are given to preserve life for cardiac surgical patients, indications for lower volume transfusions (1–2 units) are less well understood. We evaluated the relationship between center-level organizational blood management practices and center-level variability in low volume transfusion rates.

STUDY DESIGN AND METHODS—All 33 non-federal, Michigan cardiac surgical programs were surveyed about their blood management practices for isolated, non-emergent coronary bypass procedures, including: (1) presence and structure of patient blood management (PBM) program, (2) policies and procedures, and (3) audit and feedback practices. Practices were compared across low (N=14, rate: 0.8–10.1%) and high (N=18, rate: 11.0–26.3%) transfusion rate centers.

RESULTS—Thirty-two (97.0%) of 33 institutions participated in this study. No statistical differences in organizational practices were identified between low and high rate groups, including: (1) the membership composition of PBM programs among those reporting having a blood management committee (p=0.27–1.0), (2) the presence of available RBC units within the operating room (4 of 14 low rate vs. 2 of 18 high-rate centers report that they store no units per surgical case, p=0.36), and (3) the frequency of internal benchmarking reporting about blood management audit and feedback practices (low rate: 8 of 14 vs. high rate: 9 of 18, p=0.43).

CONCLUSION—We did not identify meaningful differences in organizational practices between low- and high-rate intra-operative transfusion centers. While a larger sample size may have been able to identify differences in organizational practices, efforts to reduce variation in 1–2-unit, intra-operative transfusions may benefit from evaluating other determinants, including organizational culture and provider transfusion practices.

Keywords

Transfusion; Cardiac Surgery

INTRODUCTION

Background

Cardiac surgery accounts for 20–25% of all red blood cell (RBC) transfusions in the United States.[1,2] A number of studies have reported an association between the number of transfused RBC units and increased risk of morbidity and mortality following isolated coronary artery bypass grafting (CABG) surgery.[3–6] In one of the largest studies to date, patients exposed to even small, perhaps discretionary volumes (1–2 units) of RBC transfusions in the intra- and/or post-operative setting had a significant, nearly two-fold increased adjusted odd of operative mortality following CABG surgery compared to patients who had no transfusion.[7]

Rationale/Significance

Despite randomized trial[8,9] evidence and professional society-based clinical practice guidelines that advocate for restrictive blood management protocols,[10] hospital-level variability in RBC transfusion practices persists.[11–15] While provider preferences (e.g., transfusion triggers) have been the predominant focus of randomized trials, a number of studies have suggested that discrete organizational practices (e.g., blood management committees, performance feedback reporting, etc.) may contribute to lower transfusion rates.[16–21] Nonetheless, while hypothesized, few studies have actually assessed the contribution of organizational practices on lower transfusion rates. Absent knowledge concerning their influence on a hospital's blood transfusion usage, efforts aimed at designing and implementing blood conservation interventions targeting organizational practices, while well intentioned, may not achieve their desired outcome.

Study Objectives/Aims

The aim of this study was to improve our understanding of "organizational contributors" to hospital variation in low volume (1–2-unit) intra-operative transfusion rates in the setting of isolated CABG surgery. We present findings from a statewide survey of organizational blood management practices across cardiac surgical programs participating in the Michigan Society of Thoracic and Cardiovascular Surgeons Quality Collaborative (MSTCVS-QC).

METHODS

This study was approved by the Institutional Review Board (IRB) of the University of Michigan Health System.

Study Population

The Michigan Society of Thoracic and Cardiovascular Surgeons Quality Collaborative (MSTCVS-QC) is a surgeon-led voluntary multidisciplinary group consisting of all 33 non-federal hospitals performing cardiac surgical procedures on adults in the state of Michigan.[22] All programs use the Society of Thoracic Surgeons (STS) Adult Cardiac Surgery data collection form[23] and submit data on a quarterly basis to both the STS database and the MSTCVS-QC data warehouse. Participating centers are audited routinely for data validity and accuracy as part of the MSTCVS-QC audit system.

Survey Development and Distribution

Our study team (health services researchers, nurses, cardiothoracic surgeons, cardiovascular perfusionists, blood bank directors, and survey methodologists) developed a survey of organizational-level blood management practices (Supplemental Survey) that was administered between July and November 2015. Survey questions were based on the 2011 update to the Society of Thoracic Surgeons and the Society of Cardiovascular Anesthesiologists blood conservation clinical practice guidelines and the CDC and the U.S. Department of Health and Human Services 2013 National Blood Collection and Utilization Survey.[10,24] Questions addressed the presence and role of organizationally-based blood management programs. Specifically, questions were focused on the following areas: presence and structure of a multidisciplinary blood management program, blood

management policies and procedures, and audit and feedback practices. Preliminary drafts of the survey questions were further revised based on feedback from clinical researchers, blood management experts, as well as survey experts at the University of Michigan's Center for Bioethics and Social Sciences in Medicine (CBSSM, http://cbssm.med.umich.edu/). Patient blood management (PBM) was defined according to the AABB as "an evidence-based, multidisciplinary approach to optimizing the care of patients who might need transfusion. PBM encompasses all aspects of patient evaluation and clinical management surrounding the transfusion decision-making process, including the application of appropriate indications, as well as minimization of blood loss and optimization of patient red cell mass."[25] This manuscript adheres to the applicable Equator guidelines (Supplemental Table 1).[26]

Electronic surveys (Qualtrics LLC, Provo, Utah) were sent to each center's STS database manager, who was advised to identify appropriate individuals within his/her center to address each survey item and question. Most database managers chose to complete surveys using pencil and paper, which were subsequently electronically entered by the project coordinator at the MSTCVS-QC data coordinating center (Ann Arbor, MI). Responses were recorded as "Yes," "No," or "Don't Know", unless otherwise specified. Follow-up with survey respondents was conducted, when necessary, to ensure completeness and clarify responses. No independent site visits or audits were conducted to verify the responses.

Statistical Analysis

We report responses to each item and question. When responses are based on prior questions, the denominator reflects the total number of responses to the first question. Responses from the survey were stratified based on each center's 1–2-unit intraoperative RBC transfusion rate for isolated, non-emergent CABG operations performed during 2013. Centers were categorized as having "low" (N=14, rate: 0.8–10.1%) or "high" (N=18, rate: 11.0–26.3%) intra-operative transfusion rates, with the defining cut-point for each category based on a natural breakpoint across centers in the distribution of the rates. We evaluated two potential thresholds for categorizing center-level transfusion rates: either a natural break point in the data based on visual inspection of center-level transfusion rates (which occurred at 11%), or an external benchmark of 8% based on the Society of Thoracic Surgeons 2013 national benchmark for 1–2-unit intraoperative transfusions in the setting of isolated CABG. The conclusions from the analysis did not change based on the choice of cut-point. Therefore, data are reported using a threshold of 11% (a natural breakpoint in our data) for defining a low vs. high 1–2 unit intra-operative transfusion rate center, as only 9 centers had intra-operative transfusion rates less than 8% during our study period. In the end, 56% received transfusions in the high rate vs. 44% in the low rate group.

The data analysis for this paper was generated using SAS software, Version 9.4 of the SAS System for Windows. Categorical comparisons were made using the chi-square test or Fisher's exact test, where appropriate. We set our threshold of significance at 0.05 for 2-sided tests.

RESULTS

Thirty-two (97.0%) of 33 MSTCVS-QC institutions agreed to participate in this study.

Presence and Structure of a Patient Blood Management (PBM) Program

Most respondents reported having a PBM program within their respective institutions. For instance, 10 of 14 low rate and 14 of 18 high rate centers (p=0.70) reported having a formal blood management committee. The membership roster (administrative, blood bank/lab, nursing, physicians, program/transfusion coordinators, quality staff, perfusion, IT, pharmacy) for blood management committees was not statistically different between groups, Table 1. Formal blood management committee meetings occurred among 8 of 10 low rate and 11 of 14 high rate centers (p=1.0). The frequency of committee meetings was not statistically different between groups, with monthly meetings reported among 8 of 14 low rate and 10 of 18 high transfusion rate centers (p=1.0). All high rate centers (18 of 18) reported having clinical decision support systems (e.g., computerized physician orders and/or best practice alerts) to guide RBC transfusion practices, while 11 of 14 low rate centers reported having such systems (p=0.12).

Blood Management Policies and Procedures

The presence of RBC units (0 RBC units vs. ≥1 RBC unit) within the operating room for isolated, non-emergent CABG operations was not statistically different between groups with 4 of 14 low rate and 2 of 18 high rate centers reporting they do not store RBC units in the operating room (Table 2; p=0.36). The majority (26 of 32) of centers surveyed reported that physicians were required to document the reason or clinical justification for RBC transfusions, with minimal variation across strata of centers (low rate: 10 of 14 and high rate: 17 of 18; p=0.15). Likewise, 11 of 14 low rate and 12 of 18 high rate centers reported that they require or suggest the laboratory hemoglobin or hematocrit level between multiple units of RBC transfusions to verify appropriateness (p=0.69).

Audit and Feedback Practices

The majority of all centers reported tracking the location (25 of 32) and date (31 of 32) of each transfused unit. Less than half of low rate (5 of 14) and high rate centers (6 of 18) reported that their hospital tracks the age of each RBC unit transfused (p=1.0). Center-level differences in the mechanisms used to set institutional blood management performance targets are reported in Table 3. There was no statistical difference between low rate and high rate centers reporting providing staff members with internal benchmarking reports (Table 4; p=0.43). Low rate centers reported using external benchmarking reports more commonly than high rate centers; however, these results were not statistically different (Table 4; p=0.18).

The majority of centers reported using one-on-one methods to educate clinical staff on blood management practices (low rate: 10 of 14 and high rate: 15 of 18; p=1.0). Half (7 of 14) of low rate centers reported using lectures/grand rounds to educate clinical staff concerning blood management, while 16 of 18 high rate centers reported doing so (p=0.32).

Responses from all survey questions are provided in Supplemental Table 2.

DISCUSSION

In our statewide experience, we did not identify statistical differences in reported organizational blood management practices as a function of a center's 1–2-unit intra-operative transfusion practice. Our findings suggest that other factors, including organizational culture or provider-level contributors (e.g., transfusion trigger) may help explain variation in center transfusion rates.

Our findings should be considered in light of the following limitations. First, we acknowledge that some respondents lacked knowledge about some practices within their institution. Nonetheless, we explored the impact of this limitation in a sensitivity analysis – our findings did not materially differ when excluding responses with a "Don't Know". Second, we recognize that findings from our survey may not be generalizable outside of Michigan; nonetheless, respondents represented 32 of the 33 non-federal cardiac surgical programs in the state of Michigan. Third, while our survey questions were based on blood conservation clinical practice guidelines and the 2013 National Blood Collection and Utilization Survey,[10,24] we cannot rule out the impact of other important organizational-level contributors of intra-operative transfusion practices (e.g. organizational culture). Fourth, while a study representing nearly all cardiac surgical programs in the state of Michigan, we acknowledge our modest sample size limits our ability to make definitive statements regarding the relationship between organizational practices and intra-operative transfusion rates. Fifth, we acknowledge that our findings may not be generalizable to CABG procedures conducted without cardiopulmonary bypass, as we did not survey practices unique to beating heart surgery. Nonetheless, the minority of CABG procedures (8%) in our state is performed without the use of cardiopulmonary bypass. Last, our present study focused on aspects of an organization's structure and function that may contribute to transfusion practices. Nonetheless, we recognize that provider-specific factors (e.g., transfusion triggers) may also contribute to variation in transfusion rates. Furthermore, we acknowledge that reporting on a practice's use may not reflect how that practice is implemented. Indeed, the way a blood management practice is implemented may impact how effective these practices are in reducing blood transfusions.

While our survey found no significant differences in the usage and roster membership for PBM programs across centers, an existing literature supports the use and value of PBM programs. First, a body of evidence has described the relationship between the implementation of PBM programs and decreases in short and long-term risk of morbidity and mortality[1,3–5,7,8] and resource utilization.[27–30] Second, investigators have identified the effectiveness of PBM programs at reducing blood product utilization.[20,30–32] Oliver and colleagues,[31] for example, evaluated hospital-wide RBC transfusion practices before and after the implementation of a PBM program at the University of Alabama at Birmingham Hospital in 2007. The investigators employed several methods to promote restrictive transfusion practices including some factors that we measured in our study, as well as others, such as, setting a transfusion trigger of hemoglobin ≤ 7 g/dL. The authors found a 43% decrease (0.96 vs. 0.55 units per patient) in the mean number of RBC units transfused per discharged patient from 2007 to 2011. Furthermore, the largest absolute change was

observed in cardiovascular surgery, with a decrease of 1.5 units per patient (3.3 vs. 1.8 units per patient, $p < 0.0001$).

Importantly, our study is not able to assess the effectiveness of PBM programs compared with centers not having a PBM program, as all centers had some form of a PBM program. Future work should focus on understanding differences in PBM programs that may offer insight into their potential role as a lever for reducing variation in intra-operative transfusions. For instance, while our findings did not suggest differences in the membership roster for these programs across centers, further details are warranted to understand potential differences in the effectiveness of PBM programs across centers. Additional studies should focus on defining the appropriate membership composition that maximizes the effectiveness of a PBM program; nonetheless, we hypothesize that a PBM program should include multi-disciplinary team members (i.e., physicians [surgeons, anesthesiologists] and non-physicians [e.g., perfusionists]) whose collective input influences intra-operative blood transfusion decision-making. Indeed, the spectrum of activity within PBM programs could potentially range from rudimentary (e.g., a committee that reports adverse events) to robust (e.g., regular committee meetings that focus on proactively addressing blood management issues, development of action plans, and feedback reporting). Future work should focus on identifying features of a PBM program that may differentiate low vs. high transfusion rate centers. Such evaluation of PBM programs would benefit from a mixed methods design, including, but not limited to, qualitative site visits of low and high intra-operative transfusion rate centers.

Above and beyond the membership within a center's blood management committee, we noted no significant differences in organizational approaches for engaging and educating clinical providers in blood conservation practices through feedback reporting and clinical decision support (CDS) systems. Clinical decision support systems may facilitate informed transfusion decision-making by providing information concerning a patient's vital signs and hemoglobin levels preceding a transfusion decision. We surveyed the content, use, and existence of CDS and feedback reporting systems (e.g., internal and external benchmarking, blinded and unblinded feedback reporting, performance target reporting, and types of CDS systems used). Our findings suggest that feedback reporting and CDS systems in and of themselves may not help explain variation in the use low volume, intra-operative transfusion rates. Keeping in mind the findings of Goodnough et al.,[21] who demonstrated the effectiveness of real-time CDS systems in the reduction of RBC transfusions, future research should further investigate the content and role of feedback reports and CDS systems across hospitals of varying transfusion rates.

While not the focus of our investigation, we cannot rule out that low transfusion rate centers may use other practices to enhance the role and value of feedback reporting. Other investigators have noted that feedback reporting in and of itself does significantly impact a clinician's practice.[33] Gutsche and colleagues investigated the role of provider engagement and retrospective performance audit and feedback, and were able to demonstrate that the implementation of a transfusion clinical practice guideline that included both of these items was able to successfully reduce transfusions in cardiac surgery patients (14.7% to 8.1%, $p=0.016$).[34] In a study of stable, low-risk surgical intensive care unit patients from the

Massachusetts General Hospital, the authors similarly found that the implementation of a multimodal intervention (e.g., educational lecture, peer-to-peer email feedback and monthly audit) within their blood management program improved adherence to restrictive transfusion guidelines over a 6-month period.[35] This study, however, did not include high-risk patients, including those having a history of coronary artery disease or coronary intervention (e.g., CABG and angioplasty). Further work, nonetheless, is necessary to enhance our understanding of how to use performance feedback to maximize provider engagement concerning transfusion practices.

While we were unable to identify distinct differences across centers in their organizational blood management, other investigative teams have reported a relationship between organization-level differences and blood transfusion rates. Jin and colleagues conducted an observational, multi-center study of 9,329 patients undergoing nonemergency, first-time isolated CABG.[19] The authors found that 86% of the variation in the amount of RBC units transfused could be explained by the hospital, whereas 14% could be explained by surgeon. The authors conclude that “institutional culture,” or the way in which provider socialization influences and/or creates behaviors, is a dominant determinant of blood transfusion practices. Further research is warranted to measure and assess the impact of important facets of institutional culture, including PBM programs that seek to engage clinician stakeholders.

In conclusion, we did not identify differences between high and low transfusion rate centers regarding organizational blood management practices. Therefore, efforts aimed at reducing unwarranted variation in blood transfusion practices would benefit from an improved understanding of how low rate centers use and leverage these blood management practices.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Personnel make-up of patient blood management programs by center type[a]

	Center Type		
Type of Personnel	**Low rate**	**High rate**	***P*-value[c]**
Other (e.g., perfusion, pharmacy, IT[b])	3 of 10	1 of 14	1.0
Quality Staff	8 of 10	11 of 14	0.27
Program/Transfusion Coordinators	6 of 10	9 of 14	0.62
Administrative	7 of 10	12 of 14	1.0
Nursing	6 of 10	9 of 14	1.0
Blood Bank/Lab	10 of 10	13 of 14	1.0
Physicians	10 of 10	14 of 14	1.0

[a]Only 24 out of 32 centers reported having a patient blood management program

[b]IT: Information technology

[c]Differences between groups were compared with the use of a chi-square test or Fisher's exact test, where appropriate.

Table 2

Presence of RBC[a] units within the operating room for isolated, non-emergent CABG[b] by center type

	Center Type		
Presence of RBC Units within the OR for Isolated, Non-emergent CABG	**Low rate**	**High rate**	***P* value[c]**
No blood present in OR	4 of 14	2 of 18	0.36
Blood present in OR	10 of 14	16 of 18	

[a] RBC: Red blood cell

[b] CABG: Coronary artery bypass grafting

[c] Differences between groups were compared with the use of Fisher's exact test.

Table 3

Mechanisms used to set institutional blood management performance targets by center type

	Center Type		
Mechanism	**Low rate**	**High rate**	***P*-value[a]**
Turnaround time for emergency/stat requests	4 of 9	5 of 10	0.36
Reporting of near-miss events	6 of 9	10 of 10	0.09
Reporting of adverse events	7 of 9	10 of 10	0.21
Blood usage within institutional guidelines	6 of 9	6 of 10	0.23
Wastage of all blood components	7 of 9	10 of 10	0.21
Adherence to massive transfusion guidelines	7 of 9	10 of 10	0.21

[a]Differences between groups were compared with the use of a chi-square test or Fisher's exact test, where appropriate.

Table 4

Type of benchmarking reports provided by hospital to staff (internal vs. external) by center type

	Center Type		
Type of Benchmarking Reports Provided by Hospital to Staff Members	**Low rate**	**High rate**	***P*-value[a]**
Internal	8 of 14	9 of 18	0.43[a]
External	5 of 14	2 of 18	0.19[b]

[a]Differences between groups were compared with the use of a chi-square test.

[b]Differences between groups were compared with the use of a Fisher's exact test.