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Evaluation of Preoperative and Intraoperative RBC Transfusion Practices at Maputo Central Hospital, Mozambique

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Abstract

BACKGROUND—The purpose of this study was to evaluate preoperative and intraoperative blood transfusion practices in Hospital Central (Maputo, Mozambique) and estimate the number of potentially avoidable transfusions.

STUDY DESIGN AND METHODS—A retrospective cohort study was performed. Age, comorbidities, hemoglobin, the potential for blood loss, and units of packed red blood cell (RBC) transfusions were recorded. Preoperative transfusions were evaluated to determine whether they met criteria established by the Mozambican Ministry of Health as well as proposed guidelines based on more restrictive protocols. Avoidable blood transfusions were defined as those preoperative transfusions that were not indicated based on these guidelines. Multivariate logistic regression was used to identify factors that predicted transfusion.

RESULTS—Two-hundred and five patients (age range: 0.1 - 86 years) underwent surgery in the main operating room during the two-week study period. Overall, thirty-five (17%) patients received sixty-eight transfusions. Of these, thirty-six transfusions were given preoperatively and thirty-two were given intraoperatively. Thirty-six percent of preoperative transfusions were avoidable according to national guidelines. Ninety-two percent were avoidable using more restrictive guidelines. The primary predictors of preoperative blood transfusion were lower hemoglobin (odd's ratio 0.390 / 1 g/dl; $p < 0.0001$) and the potential for blood loss (odd's ratio 3.73; $p = 0.0410$).

CONCLUSIONS—Adherence to existing hemoglobin thresholds recommended by national blood transfusion guidelines could significantly reduce the number of transfusions and the association risk of transfusion-transmissible infections. Adoption of more restrictive guidelines is recommended to further improve blood transfusion utilization and further reduce the transmission risk of HIV and hepatitis.

Keywords

preoperative; intraoperative; blood transfusion; HIV; transfusion-transmissible infections

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INTRODUCTION

Blood-borne infectious diseases are a major cause of morbidity and mortality in Mozambique. According to the World Health Organization (WHO), the prevalence of HIV infection in adults in Mozambique was 12% in 2009¹ While the majority of new infections are caused by sexual transmission, blood transfusions in sub-Saharan Africa have been shown to carry a significant risk of HIV transmission.² It is estimated that 6,650 HIV infections, 28,600 HBV infections, and 16,600 HCV infections were caused by blood transfusion in sub-Saharan Africa in 2011.² In Mozambique, blood transfusion was identified as a significant risk factor for the transmission of non-vertical and non-sexual transmission of HIV in a cohort of pediatric patients at Maputo Central Hospital.³

The WHO Blood Transfusion Safety program was created in 1975 to address the potential risks associated with blood transfusions in developing health systems. An essential component of this program included the appropriate utilization of blood in clinical settings. In a 2006 report on the status of blood safety in the WHO Africa Region, Mozambique was shown to be one of the countries with the most risk factors for transfusion-transmissible infections.⁴ While projects are underway to improve screening and blood donation practices, little is being done to address the clinical transfusion practices in this high-risk country. Researchers at Maputo Central Hospital investigated hospital-wide blood transfusion practice and blood usage and identified the surgical services as frequent users of blood transfusions.⁵ As a result of this study, it was specifically recommended that the surgical services review their blood transfusion practices. Thus, we sought to characterize the utilization of red blood cell (RBC) transfusions in the preoperative and intraoperative setting at Maputo Central Hospital in order to guide future interventions aimed at improving blood transfusion practices and reducing the associated risks of transfusion-transmitted HIV and hepatitis.

MATERIALS AND METHODS

Study Design

Approval was obtained from the UCLA Institutional Review Board as well as the Mozambican Ministry of Health Bioethics Committee. A retrospective analysis of all pediatric and adult patients scheduled for elective surgery during a two-week period from July 10 to July 23, 2012 in the main operating rooms of Maputo Central Hospital was performed. The following data were collected from patient charts: age, comorbidities, surgical procedure, surgical service, preoperative hemoglobin concentrations, documented American Society of Anesthesia physical status classification (ASA),⁶ the number of cross-matched RBC units requested for surgery, the number of preoperative and intraoperative RBC units transfused, estimated blood loss, and volume of crystalloid and colloid administered. All surgical cases performed during the study period were included in statistical analysis. We also identified cases that were cancelled and determined whether cancellations were affected by transfusion-related factors. Specifically, we determined the percentage of cases cancelled because requested cross-matched blood was not available, preoperative hemoglobin was not obtained, or the hemoglobin concentration was less than 10 g/dL.

Patients undergoing procedures with the potential for significant intraoperative blood loss were defined as those for whom the WHO blood ordering schedules recommend preparation of cross-matched RBC units.⁷ For procedures not listed by the WHO, Ministry of Health blood ordering schedules were utilized.⁸

Preoperative blood transfusions were defined as those RBC transfusions administered within two weeks of surgery or last surgical intervention. Intraoperative blood transfusions were defined as those initiated during the operation or in the recovery room. Postoperative transfusions initiated on the ward were not evaluated. Preoperative hemoglobin was defined as the last recorded hemoglobin prior to the operation. Pre-transfusion hemoglobin was defined as the last recorded hemoglobin prior to a preoperative RBC transfusion; in patients who did not receive a transfusion, preoperative hemoglobin was used for statistical analysis. In adults, the volume per unit of RBCs administered was generally at a dosage of 5cc/kg. In pediatric patients, a unit was defined as 10cc/kg RBC.

Every preoperative RBC unit transfused was evaluated to determine whether it was indicated according to any of three different transfusion criteria: (1) national criteria for the use of preoperative blood transfusions as outlined by the Mozambican Ministry of Health (MOH) guidelines,⁸ (2) semi-restrictive criteria, and (3) restrictive criteria. Semi-restrictive and restrictive transfusion criteria were based on recommendations from the WHO, American Society of Anesthesia (ASA), AABB, and other sources (Table 1).^{7,9-12} Avoidable blood transfusions were defined as those preoperative transfusions that were not indicated based on these guidelines. It became apparent during the study that there was insufficient documentation of estimated blood loss and intraoperative clinical parameters to reliably determine whether intraoperative transfusions were indicated. Therefore, only preoperative transfusions were evaluated. In order to estimate the number of RBC transfusions that could be avoided yearly, we annualized the number of avoidable preoperative transfusions observed over the two-week period.

Statistical Analysis

Spearman's correlation was used to evaluate the correlation between the number of cross-matched units of RBCs recommended by the WHO guidelines and the number requested by the surgical team for the procedure. Wilcoxon rank-sum test and Fisher's exact test were utilized to compare characteristics between patients who received transfusions and those that did not. Multivariate logistic backward stepwise regression was utilized to identify factors that significantly predicted whether a patient received at least one blood transfusion. A classification tree (CART) analysis was used to identify a preoperative hemoglobin threshold that best predicted preoperative transfusion. JMP 10.0.0 (SAS Institute; Cary, NC) statistical software was utilized. Significance was defined as $p < 0.05$.

RESULTS

Study Setting

There were 282 cases scheduled in the main operating room during the two-week period of evaluation. There were 77 cancellations (27%). The majority of cancellations were due to limitations in elective time (48%), supply shortages (e.g. clean linens) (27%), and other miscellaneous reasons (11%). However, 14% of cancellations were transfusion-related. Of these, 46% were cancelled because requested cross-matched blood was not available, 27% because a preoperative hemoglobin was not obtained, and 27% because of a hemoglobin concentration < 10 g/dL. In order to avoid counting rescheduled patients more than once, only 205 patients (73%) who underwent operations were included in the analysis. Surgical cases at the main operating rooms were performed by the following specialties: orthopedic (31%), general (24%), pediatric (15%), urology (12%), otolaryngology (6%), neurosurgery (6%), maxillofacial (3%), and plastics (3%). Obstetrics, gynecology, ophthalmology, cardiothoracic, urgent, and after-hour cases were performed offsite and therefore not included in the study.

Patient Demographics

The median age of patients was 24 years (range: 0.1 to 86). Nearly all (99%) patients had a preoperative hemoglobin concentration recorded. The majority (94%) of patients with documented ASA Classification were Class I (normal healthy) or II (mild systemic disease). The remaining patients (6%) were Class III (severe systemic disease). No patients were ASA Class IV (severe systemic disease that is a constant threat to life) or V (moribund and not expected to survive without an operation). Demographic data is summarized in Tables 2 and 3 by preoperative and intraoperative transfusions.

Transfusions

Overall, thirty-five (17%) patients were transfused with sixty-eight units during the preoperative and intraoperative periods. Nineteen patients (9%) received thirty-six RBC units during the preoperative period. The median hemoglobin for patients undergoing preoperative transfusion was 8.8 g/dL. During the intraoperative period, twenty-two patients (11%) received a total of thirty-two RBC units. Median preoperative hemoglobin for patients receiving an intraoperative transfusion was 10.7 g/dL. Only six (17%) patients were transfused during both preoperative and intraoperative periods.

Cross-matched Blood - Potential for Significant Intraoperative Blood Loss

A total of eighty-four units of cross-matched blood were requested to be made available in the operating room for fifty-eight patients (28%). According to WHO blood ordering schedules, a total of eighty-two cross-matched units were recommended for thirty-nine patients (19%) undergoing procedures with the potential for significant intraoperative blood loss. There was a significant correlation between the number of cross-matched units recommended by WHO blood ordering schedules and the number requested by physicians at the hospital (Spearman's correlation coefficient 0.48; $p < 0.001$).

Avoidable Preoperative Transfusions (Table 4)

Comparison of current practices with national guidelines demonstrated that eight patients (42%) received a total of thirteen (36%) RBC units that were not indicated during the preoperative period. Using semi-restrictive and restrictive transfusion criteria, fifteen (79%) and eighteen (95%) patients respectively received at least one avoidable transfusion (Table 5). Based on these results, the estimated number of preoperative transfusions that could be avoided annually by adherence to national guidelines is 338 RBC units. Furthermore, adoption and adherence to either semi-restrictive or restrictive guidelines could lead to the avoidance of the preoperative transfusion of 702 or 858 RBC units, respectively, each year.

Predictors of Preoperative Transfusion

Factors found to be significantly different between patients who received preoperative transfusion and those who did not were hemoglobin concentration, ASA classification, and potential for significant blood loss (Table 2). In multivariate analysis, lower hemoglobin and potential for significant blood loss were significant predictors of preoperative transfusion (Table 5). A hemoglobin threshold of <10 g/dL best predicted preoperative transfusions using classification tree analysis.

Predictors of Intraoperative Transfusions

Preoperative factors found to be significantly different between patients who received an intraoperative transfusion and those who did not were the potential for significant blood loss, age, and ASA classification (Table 3). In multivariate analysis, potential for significant blood loss, older age, and lower hemoglobin were predictive of intraoperative transfusions (Table 5).

Of those patients who received an intraoperative blood transfusion, documentation for estimated blood loss was present in only 32%. Of these, the median estimated blood loss was 580 mL (range: 100 to 1500). The volume of crystalloid and/or colloid was recorded in 82% of patients with a median of 2.5 L (range: 0.25 to 11). No hemoglobin values were obtained or documented in the operating room or recovery room.

DISCUSSION

It is estimated that thousands of HIV, HBV, and HCV infections are caused by blood transfusions in sub-Saharan Africa annually.² Blood transfusion has been identified as an independent risk factor for HIV infection in Maputo Central Hospital.³ In order to reduce the risk of transfusion-transmissible infections in countries with high HIV prevalence, it has been proposed that the use of transfusions should be limited to their “indispensable indications.”^{11,13,14} However, blood products are often overutilized in sub-Saharan Africa,^{14,15} an observation that is supported by our study. We found that adherence to existing national guidelines could avoid more than one third of blood transfusions administered preoperatively, and that adoption of more stringent restrictive guidelines could avoid nearly all preoperative transfusions.

The number of avoidable transfusions is particularly alarming in the setting of a country with a high prevalence of HIV and other blood-borne diseases. Based on mathematical models, 7 (range 2 to 17) transmissions of HIV, 7 (range 2 to 15) transmissions of HBV, and 4 (range 1 to 8) transmissions of HCV are estimated per 1000 blood transfusions in Mozambique [courtesy of Sudha Jaramayan].² Using these estimates, adherence to current national guidelines could prevent transmission of two HIV infections annually in the study setting alone. Adoption of restrictive guidelines could avoid an estimated six HIV infections per year. These estimates apply only to the preoperative period in the study setting described. When these findings are extrapolated to the intraoperative and postoperative periods, all services at Maputo Central Hospital, and across the entire country, the number of avoidable transfusions and associated transfusion-transmissible infections is likely substantial.

Adoption of restrictive guidelines could also avoid noninfectious risks of blood transfusions including transfusions reactions and immunosuppression. Perioperative blood transfusions are associated with a higher adjusted risk of death, wound problems, and other complications.¹⁶ The risks of blood transfusion are likely higher in low-income countries like Mozambique, where non-leukocyte depleted blood is utilized.¹⁷

Our study demonstrated that the primary predictor of preoperative transfusions at Hospital Central was a hemoglobin less than 10 g/dL. Mounting evidence supports lowering the hemoglobin threshold for preoperative blood transfusions.^{16,18-21} The WHO Clinical Use of Blood Handbook states that “there is rarely a justification for the use of preoperative blood transfusion simply to facilitate elective surgery.”⁷ Restrictive transfusion thresholds with significantly lower hemoglobin concentrations can be used without compromising outcomes.^{12,18,22,23} In fact, several studies have shown that restrictive hemoglobin thresholds (e.g. < 7 g/dL) are not only safe but may result in improved outcomes when compared to liberal thresholds (e.g. < 10 g/dL).^{18,22,24}

The potential for significant blood loss was found to be a predictor of both preoperative and intraoperative transfusions. The number of cross-matched RBC units requested for procedures at Maputo Central Hospital correlated positively with, and in most cases exceeded, those recommended by WHO blood ordering schedules. This suggests that physicians may be over-ordering cross-matched units in order to assure availability in the

operating room. Further supporting this theory, several cases were cancelled due to lack of cross-matched blood. In order to avoid preoperative transfusions intended solely to accommodate potential blood loss, a reliable blood supply in the operating room is required to reassure physicians that it is safe to delay transfusions until clinically-significant intraoperative blood loss is confirmed. In practice, reductions in the utilization of preoperative transfusions could help to conserve cross-matched blood and improve availability for intraoperative use.

Our study found that intraoperative transfusions had insufficient documentation of estimated blood loss and intraoperative clinical parameters to reliably determine whether transfusions were indicated. In order to help guide decisions about intraoperative transfusions, more accurate estimations of blood loss and assessment of hemoglobin are necessary. Several strategies can be employed: 1) implement gravimetric and lap sponge techniques to better estimate blood loss, 2) train anesthesiologists to evaluate for clinical signs of poor perfusion, and 3) introduce hemoglobin analyzers that provide rapid results.²⁵ Quality improvement projects mandating recording of intraoperative data could aid with monitoring of intraoperative transfusion practices.

Our study is limited by the retrospective design and the short duration of data collection. It is conceivable that annual estimates based on the study period may not accurately reflect seasonal variations in malaria and trauma that might impact preoperative hemoglobin concentrations. However, in order to avoid the potential confounder of patients with active bleeding from trauma for whom hemoglobin values may not accurately represent perfusion status and need for blood transfusion, we limited our study to the main operating rooms where primarily elective cases are performed. Similarly, we did not evaluate whether intraoperative transfusions were avoidable because the data was insufficient. Thus, our estimates of avoidable transfusions are likely low.

In summary, a large number of preoperative blood transfusions at Maputo Central Hospital could potentially be avoided. It has been shown that introduction of blood transfusion guidelines in the surgical setting can effectively reduce the number of unnecessary transfusions.^{26,27} In addition to reducing the risk of transfusion-transmitted infections, decreasing the number of unnecessary transfusions could decrease associated costs and preserve the limited blood supply. In the future, several steps must be employed to improve transfusion practice and reduce the number of unnecessary transfusions: 1) lower hemoglobin thresholds and promote the utilization of clinical indicators of poor perfusion (e.g. pallor, delayed capillary refill, tachycardia, and decreased urine output) to guide decision-making about blood transfusions, 2) improve availability and reliability of cross-matched blood, 3) improve methods of estimating and recording intraoperative blood loss, and 4) establish a blood transfusion committee to update local guidelines and routinely audit transfusion practices.¹⁴

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Table 1
Preoperative RBC Transfusion Criteria Utilized for Analysis

National guidelines were obtained from the Mozambican Ministry of Health. Restrictive and semi-restrictive criteria were adapted from several sources including World Health Organization (WHO), American Society of Anesthesia, and AABB.

Criteria	Absolute hemoglobin indication	Additional hemoglobin indications
National⁸	< 8 g/dL	< 10 g/dL in children up to age 13 when alternative therapy does not improve anemia sufficiently < 10 g/dL in patients with severe respiratory insufficiency or unstable coronary artery disease
Semi-restrictive^{7,9}	< 7 g/dL	<7 g/dL in hospitalized stable adults and children with little/no expected blood loss <8 g/dL in hospitalized stable adults and children with 1 unit suggested on WHO blood ordering schedule <9 g/dL in hospitalized stable adults and children with 2+ units suggested on WHO blood ordering schedule
Restrictive¹⁰⁻¹²	< 6 g/dL	< 8 g/dL in patients with evidence of myocardial ischemia, recent stroke, age>80, evidence of ongoing organ ischemia, or the actual or potential presence of ongoing bleeding

Table 2
Preoperative Transfusion Baseline Demographics

Characteristics of patients who underwent preoperative RBC transfusions within 2 weeks of surgery.

	Not transfused	Transfused	Total	p-value
Patients (#)	186	19	205	
Median Age in Years (range)	25 (0.1-86)	20 (0.5-65)	24 (0.1-86)	0.557
Median Hg in g/dL (range)	11.9 (7.6-18.3)	8.8 (6.1-15.7)	11.8 (6.1-18.3)	<0.0001
Potential Significant Blood Loss				0.013
Yes	31 (17%)	8 (42%)	39	
No	155 (83%)	11 (58%)	166	
ASA				0.0055
I	93 (50%)	3 (16%)	96	
II	72 (39%)	11 (58%)	83	
III	8 (4%)	3 (16%)	11	
Not Recorded	13 (7%)	2 (10%)	15	
Number of Cases by Service (%)				0.87
Orthopedic	59 (32%)	5 (26%)	64	
General	43 (23%)	5 (26%)	48	
Pediatric	28 (15%)	2 (11%)	30	
Other	56 (30%)	7 (37%)	63	

Values are represented as either median (range) or number (%). Potential Significant Blood Loss was determined based on WHO blood ordering schedules. ASA – American Society of Anesthesia physical status classification. p-values were obtained using Wilcoxon rank-sum or Fisher's exact test.

Table 3
Intraoperative Transfusion Baseline Demographics

Characteristics of patients who underwent intraoperative packed red blood cell transfusions.

	Not transfused	Transfused	Total	p-value
Patients (#)	183	22	205	
Median Age in Years (range)	22 (0.1-86)	39 (4-78)	24 (0.1-86)	0.0005
Median Hg in g/dL (range)	11.9 (7.6-18.3)	10.7 (8.3-17.1)	11.8 (6.1-18.3)	0.0807
Potential Significant Blood Loss				<0.0001
Yes	24 (13%)	15 (68%)	39	
No	159 (87%)	7 (32%)	166	
ASA				0.0054
I	92 (50%)	4 (18%)	96	
II	69 (38%)	14 (64%)	83	
III	8 (4%)	3 (14%)	11	
Not Recorded	14 (8%)	1 (4%)	15	
Number of Cases by Service (%)				0.096
Orthopedic	55 (30%)	9 (41%)	64	
General	46 (25%)	2 (9%)	48	
Pediatric	29 (16%)	1 (5%)	30	
Other	53 (29%)	10 (45%)	63	

Values are represented as either median (range) or number (%). Potential Significant Blood Loss was determined based on WHO blood ordering schedules. ASA – American Society of Anesthesia physical status classification. p-values were obtained using Wilcoxon rank-sum or Fisher's exact test.

Table 4
Avoidable Preoperative Transfusions

Each RBC unit transfused preoperatively was classified as indicated or avoidable based on criteria defined in Table 1. The number and percentage of patients that received avoidable transfusions was also determined.

	National	Semi-Restrictive	Restrictive
Number of RBC Units (%)			
Indicated	23 (64%)	9 (25%)	3 (8%)
Avoidable	13 (36%)	27 (75%)	33 (92%)
Number of Patients (%)			
All Transfusions Indicated	11 (56%)	4 (21%)	1 (5%)
1 Avoidable Transfusion	8 (42%)	15 (79%)	18 (95%)

Table 5**Results of Multivariate Analysis**

Results of multivariate logistic regression to identify predictors of transfusion. Odds ratios for hemoglobin are calculated for every 1g/dl increase in hemoglobin concentration. Odds ratios for age are calculated for every 1-year increase in age.

Predictors of Preoperative Transfusion			
	Odds Ratio	95% CI	p-value
Hemoglobin	0.39	0.25-0.55	<0.0001
Potential Blood Loss	3.73	1.06-13.2	0.041

Predictors of Intraoperative Transfusion			
	Odds Ratio	95% CI	p-value
Potential for Significant Blood Loss	10.7	3.73-33.8	<0.0001
Age	1.03	1.01-1.06	0.016
Preoperative Hemoglobin	0.697	0.50-0.41	0.018