Perioperative blood loss in South African primary hip arthroplasty patients

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Abstract

Background: Perioperative blood loss in South African (SA) primary hip arthroplasty patients has not been described. This information could improve patient management during the perioperative period in this setting. Our study objectives were to 1) determine perioperative blood loss in SA primary hip arthroplasty patients, and 2) determine which characteristics are associated with major perioperative blood loss in SA primary hip arthroplasty patients.

Methods: This was a retrospective cohort study of 174 patients who underwent primary hip arthroplasty over a 22-month period at the Inkosi Albert Luthuli Hospital, SA. All patients were part of a pre-existing registry. Data for each patient included: Age, gender, anthropometric measurements, comorbidity, orthopaedic variables, laboratory test results, American Society of Anesthesiologists Score, general anaesthesia, duration of surgery, preoperative tranexamic acid, postoperative thromboprophylaxis, and perioperative blood transfusion. Estimated perioperative blood loss (in mL) was calculated using the Gross Equation. Minimum, maximum, mean, and median perioperative blood loss were calculated. Major perioperative blood loss was defined as an estimated perioperative blood loss which was >75th percentile obtained for the study sample. Data were analyzed using appropriate methods.

Results: Perioperative blood loss ranged from 10.3 mL to 3041.8 mL. Mean perioperative blood loss was 1103.1 ± 556.2 mL. Median perioperative blood loss was 1008.8 mL, with an interquartile range of 706.2–1357.0 mL. Independent statistical associations were observed between major perioperative blood loss and the following characteristics: chronic obstructive pulmonary disease (OR: 3.01, 95% CI: 1.01–8.95; p=0.048), preoperative tranexamic acid (OR: 0.28, 95% CI: 0.13–0.63; p=0.002), and perioperative blood transfusion (OR: 10.18, 95% CI: 3.53–29.34; p<0.001).

Conclusion: The levels of perioperative blood loss observed in our sample of SA primary hip arthroplasty patients are consistent with the range of estimated blood loss reported in the published literature for hip arthroplasty populations in other countries. SA primary hip arthroplasty patients who suffer major perioperative blood loss are more likely to have COPD or require perioperative blood transfusion. Preoperative tranexamic acid was protective against major perioperative blood loss.

Introduction

Primary hip arthroplasty has become a commonly performed surgery due to its success in the management of orthopaedic hip disorders. It is an extensive surgical procedure, and blood loss during the perioperative period is inevitable.[1,2] The usual perioperative blood loss for patients undergoing primary hip arthroplasty varies according to setting. Blood loss following primary hip arthroplasty in Chinese settings ranges between 1155mL and 1785mL,[3,4] while perioperative blood loss in a British setting was estimated at almost 1500mL.[5] Newman and colleagues reported total blood loss in an American setting to be 1386mL.[6] In another American study, Grosflam and colleagues reported a range of blood loss following hip arthroplasty of between 1.4 and 5.8 units of red cells (420-1740mL).[7] In a Nigerian setting, blood loss following primary hip arthroplasty was estimated at 1786mL.[8] Excessive blood loss is associated with a higher risk of fatal and nonfatal perioperative complications, and might also result in the need for blood transfusion. There are several patient, anaesthetic, and procedural characteristics associated with increased perioperative bleeding following primary hip arthroplasty in non-South African (SA) settings.[2] These include: older age, female sex, obesity, rheumatoid arthritis, hypertension, high American Society of Anesthesiologists (ASA) Score, long duration of operation, general anaesthesia, not using tranexamic acid, and not using postoperative thromboprophylaxis.[2]

However, levels of perioperative blood loss in SA patients undergoing primary hip arthroplasty has not been described. While there is uncertainty with regard to the expected blood loss following primary hip arthroplasty in a South African setting, we hypothesize that this would lie within the range reported for the various countries above (between 420mL and 1786mL). Considering the aforementioned association of excessive perioperative blood loss with perioperative outcomes and blood product utilization, efforts in understanding perioperative blood loss would be beneficial in improving patient management during the perioperative period in this setting. This is even more important when one considers that if the perioperative blood loss for primary hip arthroplasty in our SA setting lies within the range reported for other non-SA settings, then it could possibly result

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in transfusions between 2 and 6 units of red cells in order to restore preoperative blood volumes. Blood products are a scarce resource in SA,[9] and elective procedures are often cancelled or deferred as a result of low blood product stocks. The burden of certain bleeding risk factors could also be different between surgical populations from different settings, therefore necessitating the identification of setting-specific characteristics associated with major perioperative blood loss. Therefore, the objectives of this study were to 1) determine perioperative blood loss in SA primary hip arthroplasty patients, and 2) determine which characteristics (patient, anaesthetic, and procedural characteristics) are associated with major perioperative blood loss in SA primary hip arthroplasty patients.

Methods

This was a retrospective cohort study involving adult patients who were admitted for primary hip arthroplasty at the Inkosi Albert Luthuli Central Hospital (IALCH) in KwaZulu-Natal, SA, between 23 September 2014 and 28 July 2016. All patients were part of a pre-existing registry. These patients were identified from theatre lists during the specified study period. Specific inclusion and exclusion criteria (Table 1) were used when identifying eligible patients for the study sample.

Table 1. Inclusion and exclusion criteria used in this study

Inclusion criteria	Exclusion criteria
Patients aged 18 years or older	Patients previously included in this study (i.e. patients were included only once in the analysis)
Patients who underwent primary hip arthroplasty at IALCH between 23 September 2014 and 28 July 2016	Patients with height and weight missing in their medical records (required for calculation of blood loss)

Data

During the chart review process for the pre-existing registry, various patient, clinical, and procedural characteristics were collected for each eligible patient in a Microsoft Excel® spreadsheet. This included patient age and gender, anthropometric measurements, comorbidity, orthopaedic condition and other orthopaedic variables, laboratory test results (including pre- and postoperative haematocrit), American Society of Anaesthesiologists Score, general anaesthesia, duration of surgery, preoperative tranexamic acid use, postoperative thromboprophylaxis use, and perioperative blood transfusion. In addition, use of medications such as aspirin and nonsteroidal anti-inflammatory drugs was also recorded. Estimated perioperative blood loss (in mL) for each patient was calculated using the Gross Equation.[10,11] The equation uses the estimated blood volume of the patient, as well as preoperative, lowest postoperative, and average haematocrit measurements to calculate estimated perioperative blood loss.[10,11] Major perioperative blood loss was defined as an estimated perioperative blood loss which was >75th percentile obtained for the study sample. We chose to use the 75th percentile of blood loss in mL (as estimated by the Gross Equation) as the threshold for major perioperative blood loss in this study, as values which lie above the 75th percentile for a continuous variable are considered to be in the highest statistical quartile for that variable.[12] We also believe that determining a setting-specific threshold for major perioperative blood loss was appropriate as there is great variation in perioperative blood loss reported between settings.[3-8]

Statistical Analysis

The minimum, maximum, mean with standard deviation, and median with interquartile range (IQR) perioperative blood loss were calculated using conventional methods.[13] Potential associations between various characteristics and major perioperative blood loss were investigated initially investigated using univariate statistical methods (χ^2 test, or Fisher's exact test for categorical variables and the Mann-Whitney test for continuous variables). This was done in order to determine the distribution of major perioperative blood loss between the different categories of characteristics, and also to select the most appropriate characteristics for inclusion in the multivariate statistical analysis. Characteristics with $p<0.100$ in the univariate analysis were selected for inclusion in the multivariate statistical analysis (logistic regression) in an attempt to obtain the most parsimonious model possible.[14] The Hosmer-Lemeshow test was used to assess the goodness of fit for the final logistic regression model. Results for the univariate statistical analysis are presented as frequencies and percentages, or medians and IQR, where applicable. Results for the multivariate statistical analysis are presented as odds ratios (OR) with 95% confidence interval (CI). A p-value of <0.050 was considered to be a statistically significant result. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM Corp, USA).

Study Ethical Approval

This study received ethical approval from the Biomedical Research Ethics Committee of the University of KwaZulu-Natal, SA (Protocol: BE046/18).

Results

The process through which the final study sample of 174 patients was derived is shown in Figure 1. Perioperative blood loss ranged from 10.3mL to 3041.8mL. Mean perioperative blood loss was 1103.1 ± 556.2 mL. Median perioperative blood loss was 1008.8 mL (IQR: 706.2–1357.0 mL). The 75th percentile for perioperative blood loss in the study population was 1357 mL.

The distribution of various characteristics in the study sample is shown in Table 2. The median age of the study sample was 56.0 (IQR: 44.8-65.0). The median height and weight of the study sample were 162 cm (IQR: 155.9-169.3 cm) cm and 78.6 kg (IQR: 67.5-86.1 kg), respectively. A total of 96/174 patients (55.2%) were female.There were 65/174 patients (37.4%) who had an ASA score ≥3. A total of 40/174 patients (23.0%) were current smokers. The prevalence of comorbidity ranged from 5.7% (10/174 patients) for cardiovascular disease to 48.3% (84/174 patients) for obesity. A total of 6/174 patients (3.4%) were undergoing surgery for rheumatoid arthritis, an established risk factor for perioperative bleeding in primary hip arthroplasty patients. Twenty-four patients (13.8% of the study sample) had a fixed flexion deformity of >30 degrees. Mobilization using an assistive device was reported in 75.3% of the study population (131/174 patients). Visual analogue score (VAS) was ≥7 in 96/174 patients (55.2%). A total of 49/174 pa-

tients (28.1%) could not walk a distance of 100m or more. Urgent/emergent surgery was performed in two patients (1.1% of the study population). General anesthesia was used in 90/174 patient surgeries (51.7%). Surgery was performed via the posterior approach in 117/174 patient surgeries (67.2%). The duration of surgery was extended for 32/174 patients (18.4%). With regard to perioperative medications which might have influenced perioperative blood loss, preoperative tranexamic acid was administered in 116/174 patients (66.7%) and all patients in the study population received postoperative thromboprophylaxis. No patients had used acetylsalicylic acid within three days prior to their surgery. A total of 24/174 patients (13.8%) received a perioperative blood transfusion.

The results of the univariate statistical analysis are also shown in Table 2. The proportion of patients with chronic obstructive pulmonary disease (COPD) was higher in the major perioperative blood loss group versus the control group (20.9% versus 9.2%, p=0.040). The proportion of patients who received preoperative tranexamic acid was lower in the major perioperative blood loss group versus the control group (44.2% versus 74.0%, p<0.001). The proportion of patients who received a perioperative blood transfusion was higher in the major perioperative blood loss group versus the control group (39.5% versus 5.3%, p<0.001). There were four characteristics which met the criteria (p<0.100) for inclusion in the multivariate statistical analysis: COPD, extended duration of surgery, preoperative tranexamic acid, and perioperative blood transfusion.

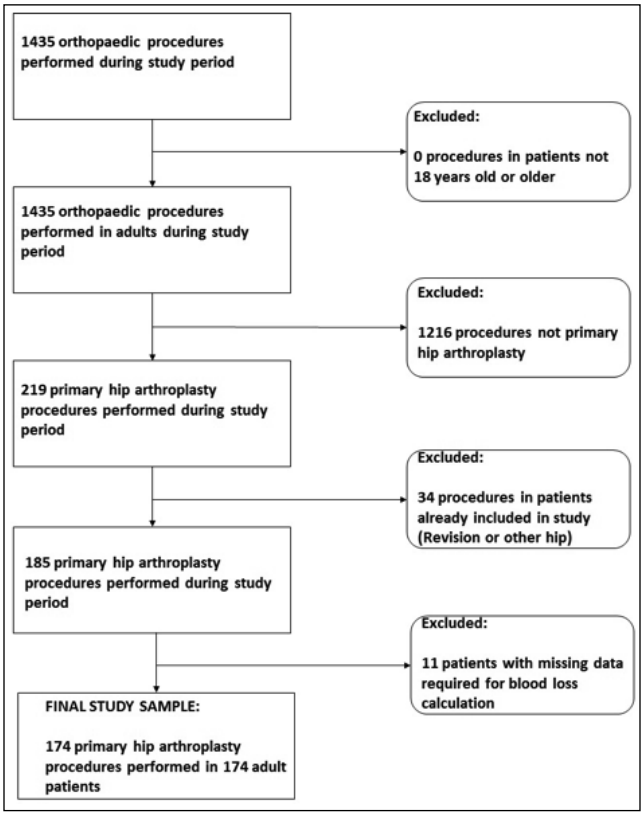

Figure 1. Derivation of the final study sample

Table 2. Distribution of characteristics in the study sample and results of the univariate statistical analysis*

Characteristic	Subcategory	All patients (N=174)	Major perioperative blood loss (n=43)	No major perioperative blood loss (n=131)	p-value
Median age, years (IQR)	N/A	56.0 (44.8-65.0)	58.0 (46.0-65.0)	55.0 (43.0-65.0)	0.656
Median height, cm (IQR)	N/A	162.0 (155.9-169.3)	162.5 (157.0-172.0)	162.0 (155.0-169.0)	0.328
Median weight, kg (IQR)	N/A	78.6 (67.5-86.1)	79.6 (70.3-89.0)	78.3 (66.4-85.4)	0.258
Gender					0.421
	Female	96 (55.2)	26 (60.5)	70 (53.4)	
	Male	78 (44.8)	17 (39.5)	61 (46.6)	
ASA score ≥3					0.699
	Yes	65 (37.4)	15 (34.9)	50 (38.2)	
	No	109 (62.6)	28 (65.1)	81 (61.8)	
Current smoker					0.641
	Yes	40 (23.0)	11 (25.6)	29 (22.1)	
	No	134 (77.0)	32 (74.4)	102 (77.9)	
Cardiovascular disease					0.710
	Yes	10 (5.7)	3 (7.0)	7 (5.3)	
	No	164 (94.3)	40 (93.0)	124 (94.7)	
COPD					0.040
	Yes	21 (12.1)	9 (20.9)	12 (9.2)	
	No	153 (87.9)	34 (79.1)	119 (90.8)	
HIV					0.712
	Yes	40 (23.0)	9 (20.9)	31 (23.7)	
	No	134 (77.0)	34 (79.1)	100 (76.3)	
Diabetes					0.764
	Yes	16 (9.2)	3 (7.0)	13 (9.9)	
	No	158 (90.8)	40 (93.0)	118 (90.1)	
Median preoperative serum creatinine, μmol/l (IQR)	N/A	67.5 (56.8-79.0)	66.0 (58.0-73.0)	68.0 (56.0-82.0)	0.303
Median preoperative haemoglobin, g/dl (IQR)	N/A	13.1 (12.1-14.1)	13.3 (12.3-14.8)	13.0 (11.9-13.9)	0.119
Median preoperative platelet count, x10^9/l (IQR)	N/A	290.0 (250.5-339.3)	290.0 (252.0-333.0)	290.0 (249.0-340.0)	0.760
Obesity					0.662
	Yes	84 (48.3)	22 (51.2)	62 (47.3)	
	No	90 (51.7)	21 (48.8)	69 (52.7)	
Hypertension				0.432	
	Yes	80 (46.0)	22 (51.2)	58 (44.3)	
	No	94 (54.0)	21 (48.8)	73 (55.7)	
Rheumatoid arthritis					0.638
	Yes	6 (3.4)	2 (4.7)	4 (3.1)	
	No	168 (96.6)	41 (95.3)	127 (96.9)	

Table 2. Distribution of characteristics in the study sample and results of the univariate statistical analysis* (continued)

Characteristic	Subcategory	All patients (N=174)	Major peri-operative blood loss (n=43)	No major perioperative blood loss (n=131)	p-value
FFD >30 degrees					0.407
	CNBE	40 (23.0)	13 (30.2)	27 (20.6)	
	Yes	24 (13.8)	6 (14.0)	18 (13.7)	
	No	110 (63.2)	24 (55.8)	86 (65.7)	
Mobilizes with assistive device					0.285
	Yes	131 (75.3)	35 (81.4)	96 (73.3)	
	No	43 (24.7)	8 (18.6)	35 (26.7)	
VAS ≥7					0.347
	CNBE	56 (32.2)	13 (30.2)	43 (32.8)	
	Yes	96 (55.2)	27 (62.8)	69 (52.7)	
	No	22 (12.6)	3 (7.0)	19 (14.5)	
Walking distance <100m					0.347
	CNBE	69 (39.7)	13 (30.2)	56 (42.7)	
	Yes	49 (28.1)	14 (32.6)	35 (26.7)	
	No	56 (32.2)	16 (37.2)	40 (30.6)	
Urgent/emergent surgery					0.999
	Yes	2 (1.1)	0 (0.0)	2 (1.5)	
	No	172 (98.9)	43 (100.0)	129 (98.5)	
Surgery with general anesthesia					0.332
	Yes	90 (51.7)	25 (58.1)	65 (49.6)	
	No	84 (48.3)	18 (41.9)	66 (50.4)	
Posterior approach to hip					0.732
	Yes	117 (67.2)	28 (65.1)	89 (67.9)	
	No	57 (32.8)	15 (34.9)	42 (32.1)	
Extended duration of surgery#					0.063
	Yes	32 (18.4)	12 (27.9)	20 (15.3)	
	No	142 (81.6)	31 (72.1)	111 (84.7)	
Preoperative tranexamic acid					<0.001
	Yes	116 (66.7)	19 (44.2)	97 (74.0)	
	No	58 (33.3)	24 (55.8)	34 (26.0)	
Preoperative aspirin within 3 days					0.999
	Yes	0 (0.0)	0 (0.0)	0 (0.0)	
	No	174 (100.0)	43 (100.0)	131 (100.0)	
Preoperative Nonsteroidal anti-inflammatory drug within 3 days					0.752
	Yes	56 (32.2)	13 (30.2)	43 (32.8)	
	No	118 (67.8)	30 (69.8)	88 (67.2)	
Postoperative thromboprophylaxis					0.999
	Yes	174 (100.0)	43 (100.0)	131 (100.0)	
	No	0 (0.0)	0 (0.0)	0 (0.0)	
Perioperative blood transfusion					<0.001
	Yes	24 (13.8)	17 (39.5)	7 (5.3)	
	No	150 (86.2)	26 (60.5)	124 (94.7)	

*Results expressed as frequencies (%).
p<0.050 was considered a statistically significant result.
ASA: American Society of Anesthesiologists; COPD: Chronic obstructive pulmonary disease; IQR: Interquartile range; N/A: Not applicable; CNBE: Could not be established; FFD: Fixed flexion deformity; VAS: Visual analogue score.
#Defined as duration of surgery >75th percentile obtained for the study sample.

The results of the multivariate statistical analysis are shown in Table 3. Of the four characteristics entered into the logistic regression analysis, only three were found to be independently associated with major perioperative blood loss. Harmful associations were observed for COPD (OR: 3.01, 95% CI: 1.01-8.95; p=0.048) and perioperative blood transfusion (OR: 10.18, 95% CI: 3.53-29.34; p<0.001). A protective association was observed for preoperative tranexamic acid use (OR: 0.28, 95% CI: 0.13-0.63; p=0.002). The Hosmer-Lemeshow test indicated that the model fit was appropriate (p>0.05).

Table 3. Results of the multivariate statistical analysis*

Characteristic	Sub-Category	OR (95% CI)	p-value
COPD	Yes	3.01 (1.01–8.95)	0.048
	No	Reference	-
Extended duration of surgery#	Yes	1.39 (0.52–3.74)	0.516
	No	Reference	-
Preoperative tranexamic acid	Yes	0.28 (0.13–0.63)	0.002
	No	Reference	-
Perioperative blood transfusion	Yes	10.18 (3.53–29.34)	<0.001
	No	Reference	-

*Results adjusted for confounders. Only characteristics with p<0.100 in the univariate statistical analysis were included in the multivariate statistical analysis.
#Defined as duration of surgery >75th percentile obtained for the study sample.
p<0.050 was considered a statistically significant result.
OR: Odds ratio; CI: Confidence interval; COPD: Chronic obstructive pulmonary disease.

Discussion

The levels of perioperative blood loss observed in our sample of SA primary hip arthroplasty patients are in keeping with the range of estimated blood loss observed in the published literature.[3-8] However, around 25% our study population experienced blood loss equivalent to just over 3 units of packed red cells, which is a scarce resource in our setting.[9] Besides possible implications for healthcare resource utilization (i.e. utilization of blood products), excessive blood loss during the perioperative period might result in anaemia,[15] which can predispose pa-

tients to a variety of postoperative complications.[16,17] A recent meta-analysis by Fowler and colleagues found that anaemic surgical patients were at an almost 3-fold higher risk of suffering postoperative mortality when compared with non-anaemic surgical patients (OR: 2.87, 95% CI: 2.10–3.93).[16] One of the studies included in the meta-analysis suggested that even mild anaemia could be potentially harmful in surgical patients.[17] Furthermore, the study by Musallam and colleagues of 227,425 noncardiac surgery patients (of which 30.4% were anaemic) found that anaemia was associated with 45-77% higher risk of cardiac complications, a 33-70% higher risk of respiratory complications, a 5-16% higher risk of neurological complications, and a 24-88% higher risk of sepsis when compared with a non-anaemic patient group.[17] In a sub-analysis of the European Surgical Outcomes Study (EuSOS), Baron and colleagues reported increased length of hospital stay and postoperative admission to intensive care in anaemic versus non-anaemic patients ($p<0.001$ for both postoperative outcomes).[18] Anaemia is also an important determinant of perioperative blood transfusion, which in itself is associated with a higher risk of postoperative complications.[19,20] Most of the perioperative complications associated with anaemia are consequences of the hypoxia associated with the condition. Our results for blood loss suggest that primary hip arthroplasty patients in our setting are potentially at risk of anemia, and subsequent complications.

We found that patients with COPD were at a three-fold increased risk of major perioperative blood loss. This is not the first time that COPD has been found to be associated with excessive perioperative blood loss in an orthopaedic surgery population. Oberweis and colleagues reported a similar harmful association between COPD and excessive perioperative blood loss in an American orthopaedic surgery population (OR: 2.69 in the Oberweis study, and OR: 3.01 in our study).[21] It is possible that this finding might actually be related to the pharmacologic management of COPD. Glucocorticoids are commonly used to manage COPD. Studies of non-orthopaedic surgical populations report increased perioperative blood loss in patients taking glucocorticoids.[22,23] Impaired surgical wound healing has been postulated as the mechanism which contributes to this increased blood loss in patients who use glucocorticoids.[22] This appears to be supported by studies of certain clotting factors, which appear to be found in lower concentrations in patients who are taking glucocorticoids versus patients who do not take these medications.[24] A variety of approaches could be used to reduce the risk of major bleeding in patients with COPD. Glucocorticoids might not be necessary in all COPD patients, and patients who do not require glucocorticoids should be advised against the preoperative use of these medications.[25] Non-pharmacologic approaches for the preoperative optimization of COPD, such as smoking cessation and promoting increased physical activity, should also be considered.[25] Surgeons and anaesthesiologists should also consider deferring surgery in patients with recent exacerbations of COPD,[25] at least until these exacerbations have resolved.

Preoperative tranexamic acid administration was found to be associated with an almost four-fold reduction in the risk of major perioperative blood loss in our study. This is an antifibrinolytic agent which inhibits dissolution of blood clots, thereby contributing to haemostasis during the perioperative period.26 A systematic review and meta-analysis of randomized controlled trials of tranexamic acid in hip arthroplasty populations reported significant reductions in total blood loss in patients who received tranexamic acid versus controls (mean reduction of 289mL).[26] In the same systematic review and meta-analysis, fewer patients who received tranexamic acid required allogenic blood transfusion when compared with controls. Furthermore, the rate of perioperative complications was similar between tranexamic acid and control groups.[26] Therefore, we recommend preoperative tranexamic acid be considered for the control of perioperative blood loss in SA primary hip arthroplasty patients, unless contraindicated. Contraindications for tranexamic acid use include hypersensitivity, a history of thrombosis/thromboembolism or if a patient has an intrinsic risk for thrombosis/thromboembolism (for example a patient with thrombophilia), a history of sub-arachnoid hemorrhage, or concomitant hormonal oral contraceptive use.[27]

Our findings of an independent association between perioperative transfusion and major perioperative blood loss is to be expected. Excessive blood loss might prompt surgeons or physicians to administer a blood transfusion.[2] There is a proportion of patients however, where excessive blood loss and subsequent transfusion can be avoided through careful patient management and risk reduction. In our setting this could be done through addressing the risk factors for major perioperative blood loss (COPD in our setting) and implementation of preventative strategies for perioperative blood loss (preoperative tranexamic acid in our setting), as mentioned earlier. Blood products for transfusion are a limited resource in some settings, and the use of these products is usually guided by strict perioperative blood management protocols.[28,29] Aside from the resource implications associated with perioperative blood transfusion, perioperative blood transfusion itself has also been shown to be associated with increased perioperative complications, an association which is independent of anaemia.[30] This further emphasizes the importance of addressing major perioperative blood loss.

Our study was not without limitations. A larger sample size might have provided more significant data. This study also involved patient data from a single SA hospital, and so our study findings lack generalizability. There were some patients who had missing data for height and/or weight, and we had to exclude these patients from the final study sample. In addition, there were other variables included in our analysis where a proportion of patient data was missing (specifically several orthopaedic-related variables). There might have also been additional variables relevant to perioperative blood loss in primary hip arthroplasty patients, but which were not collected as part of the retrospective patient registry and could therefore not be investigated in this study. Examples of these variables include socioeconomic status, race, surgeon skill, and other medications such as vitamin supplements and herbal medications which might be associated with increased perioperative bleeding. Socioeconomic status might impact individual food security, and hence determine nutritional status.[31] Malnutrition is known to impair wound healing, and could therefore contribute toward perioperative blood loss.[32] There is published

evidence to suggest that blood coagulates faster in persons of African ethnicity when compared with persons of Caucasian ethnicity.[33] It is therefore possible that patients of African ethnicity could have achieved perioperative haemostasis quicker and lost less blood than patients from other ethnic groups in this study. With regard to surgeon skill, Glance and colleagues found that in surgeries where trainee surgeons performed critical parts of the procedure under the supervision of specialist surgeons, there was a significantly higher risk of intraoperative transfusion as a result of blood loss than if the procedure was performed by a specialist surgeon alone.[34] Lastly, medications such as vitamin supplements, herbal medicines, and selective serotonin reuptake inhibitor antidepressants are known to increase perioperative blood loss.[35]

Conclusion

The levels of perioperative blood loss observed in our sample of SA primary hip arthroplasty patients are in keeping with the range of estimated blood loss reported in the published literature. We found that patients who experienced major perioperative blood loss were more likely to have COPD or require a perioperative blood transfusion. Preoperative tranexamic acid administration was found to be protective against major perioperative blood loss. Although our study has important implications for perioperative protocols in SA orthopaedic surgery settings, we recommend further prospective, multicenter research studies be conducted to confirm our findings and address the limitations we have outlined.

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