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INCIDENCE AND FACTORS ASSOCIATED WITH BLOOD TRANSFUSION IN A SAMPLE OF SOUTH AFRICAN PATIENTS UNDERGOING PRIMARY HIP ARTHROPLASTY: A RETROSPECTIVE DATABASE STUDY

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Abstract

Background:

Despite improvements in arthroplasty and blood conservation practices, surgical blood loss remains a challenge. The blood products used to address perioperative bleeding are a scarce resource and should be effectively managed. Our study objectives were to 1) establish the cumulative incidence of peri-operative transfusion in a sample of South African primary hip arthroplasty patients and 2) identify factors associated with transfusions.

Methods:

This study was a sub-analysis of an existing database of 174 adult primary hip arthroplasty patients who underwent surgery at Inkosi Albert Luthuli Central Hospital between 01 January 2015 and 30 June 2016. A retrospective chart review process was used to collect the data which was analyzed using descriptive statistical methods, Mann-Whitney testing, and Chi-squared testing. The study outcome was perioperative blood transfusion, defined as receipt of at least 1 unit of packed red cells anytime between the surgical incision and discharge from the hospital.

Results:

The incidence of perioperative blood transfusion was 13.8% (95%CI: 9.0-19.8%). The median number of blood units received was 2.0 (Range: 1.0-4.0) units. The proportion of patients who received blood transfusions was higher in those who had longer surgery (41.7% vs. 14.7 % p=0.002) or received postoperative thromboprophylaxis (91.7% vs. 68% p=0.017).

Conclusion:

The incidence of perioperative blood transfusion observed in our study of patients undergoing primary hip arthroplasty was within range of that reported in international studies. Longer surgery and postoperative thromboprophylaxis are potentially important predictors of perioperative transfusion following hip arthroplasty in our setting.

Recommendation:

Further research is required to confirm our findings.

Keywords: Hip arthroplasty, hip replacement, blood loss, blood transfusion, South Africa,
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1. Introduction:

The utilization of primary hip arthroplasty has increased in response to the growing burden of musculoskeletal disorders (such as osteoarthritis, rheumatoid arthritis, trauma, and joint infection) (1), with the World Health Organization (WHO) reporting that an estimated 1.71 billion people were affected by this disease as of 2019 (2). As with most surgical procedures, there is a risk of complications and despite improvements in total joint arthroplasty and blood conservation practices, blood loss remains a major challenge (3,4).

Khattab and Moodley described the mean blood loss in a sample of South African patients undergoing the procedure at 1103.1 mL, or approximately 4 units of packed red cells (5). The management of bleeding in these patients varies from a conservative approach to the administration of allogenic blood transfusions. Whilst there are several other ways besides blood transfusion to counteract the risk of bleeding, these might not be effective, and patients might still require a blood transfusion to stabilize their haemodynamics and optimize their haemoglobin levels.

Amongst total joint arthroplasties, primary total knee and hip arthroplasty are usually the procedures during which blood transfusions are required (6,7). Transfusion itself carries the risk of additional postoperative complications (8,9), including an increased risk for deep venous thromboembolism, surgical site infection, and mortality following total joint arthroplasty (6,10,11). Furthermore, the inadvertent transfusion of even a single unit of blood is associated with a two-fold higher risk of perioperative cardiovascular complications (12). It is thus imperative to reduce the utilization of blood transfusions wherever possible.

Additionally, one needs to consider that blood products are a scarce resource in South Africa and their use should be effectively managed to ensure it is administered to patients who require it (13). A better understanding of the factors associated with transfusion in South African patients undergoing hip arthroplasty surgery can be used to improve our efforts at setting-specific risk stratification for perioperative transfusion. This will allow us to identify and optimize modifiable factors associated with blood transfusions, and subsequently decrease blood loss and minimize the need for transfusions. Furthermore, in patients where a transfusion is inevitable (for example in patients with non-modifiable risk factors or emergency surgery where the time factor is a limitation), we can identify patients who would require blood transfusions. This would contribute toward improved management of scarce blood products.

The objectives of our study were to 1) Establish the cumulative incidence of peri-operative transfusion in a sample of South African primary hip arthroplasty patients, and 2) Identify factors associated with perioperative transfusions in the aforementioned patient population.

2. Methods:

2.1. Study design and setting:

This was a sub-analysis of an existing retrospective database of adult primary hip arthroplasty patients who underwent surgery at Inkosi Albert Luthuli Central Hospital (IALCH) between 01 January 2015 and 30 June 2016. IALCH is a quaternary hospital in Kwa-Zulu Natal, South Africa, and serves a large population along the eastern seaboard region of South Africa. IALCH seeks to provide world-class specialist, patient-centered healthcare services coordinated by trained, competent staff. The hospital has 846 beds, including 46 Burns Unit beds, 75 intensive care unit beds, and 96 high-care beds, with an additional capacity of 200 beds. There are 16 operating theatres, 2 trauma operating theatres, and burns operating theatre. There is access to a variety of laboratory specialties and accredited laboratory services, through the adjoining National Health Laboratory Services facility. Attendance at IALCH is strictly referral-based, with most of the patient referrals coming from lower-level regional healthcare facilities. The orthopaedic unit at IALCH offers a comprehensive range of specialized medical and

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surgical services to a large number of patients presenting with severe joint arthritis and deformity. The unit performs a high volume of complex primary and revision hip and knee arthroplasty for patients presenting with common joint pathologies such as osteoarthritis, inflammatory arthritis, and osteonecrosis. The hip arthroplasty registry contains data on patient demographics, comorbidities, peri-operative medications, preoperative laboratory tests, surgical variables, and postoperative outcomes of patients until discharge from the hospital.

2.2. Study sample:

There were 174 consecutive adult primary hip arthroplasty patients in the registry that were included in this sub-analysis. All patients were identified through the hospital admissions system. The inclusion and exclusion criteria for this study are provided in Table 1.

2.3. Data:

The data included in the existing registry was collected through a retrospective chart review procedure. A review was carried out of each patient's progress notes, operative notes, laboratory reports, and discharge summaries. The pre-existing registry contained the following: baseline data (gender, age), preoperative comorbidities (obesity, diabetes mellitus, hypertension, cardiovascular disease, chronic obstructive pulmonary disease - COPD, rheumatoid arthritis, HIV, smoker), pre-operative medications (aspirin or Non-steroidal anti-inflammatory drug – NSAID use within 3 days pre-operatively, preoperative tranexamic acid and peri-operative data (ASA score, urgent or emergent surgery, type of anaesthesia, operation time, surgical approach and post-operative thromboprophylaxis). The study outcome was perioperative blood transfusion, which was defined as the receipt of at least 1 unit of packed red cells between the time of surgical incision and the time of discharge from the hospital.

2.4. Statistical analysis:

The characteristics of the study sample were analyzed using descriptive statistics. This included presenting the median with an interquartile range (IQR), or minimum-maximum range for continuous variables, and the frequency with percentage for categorical variables. The cumulative incidence of transfusion was determined by dividing the number of patients who received at least 1 unit of packed red cells by the total study sample. This proportion was multiplied by 100 to obtain a cumulative incidence percentage. A 95% confidence interval was also calculated for this estimate. For those patients who received blood transfusions, the median (minimum-maximum range) of RBC units received was calculated. The association between the various demographic, comorbidities, and procedural characteristics and transfusion was tested using the Mann-Whitney test (for continuous variables) and the chi-squared test (for categorical variables). These tests yielded a p-value, with $p<0.05$ being considered a statistically significant result.

2.5. Study ethics:

This study was approved by the Biomedical Research Ethics Committee at the University of KwaZulu-Natal, South Africa (BE595/16, BREC/00004837/2022).

3. Results:

Following the application of the study eligibility criteria, the sample size was 174 patients (Figure 1). A description of the study sample is provided in Table 2. The median age was 56.0 (IQR: 44.8-65.0) years. More than half the study sample were females (96 patients, 55.2%). Obesity (84 patients, 48.3%), hypertension (80 patients, 46.0%), and HIV (40 patients, 23.0%) were amongst the most common comorbid conditions. Nearly 1 in every 4 patients were smokers (40 patients, 23.0%), and 1 in every 8 patients had chronic obstructive pulmonary disease (21 patients, 12.1%). Pre-operatively, the use of tranexamic acid was reported in 116 patients (66.7%). Preoperative NSAID use was reported in 56 patients (32.2%),

Table 1: Eligibility criteria for this study

Inclusion criteria	Exclusion criteria
Patients who underwent primary hip arthroplasty surgery at IALCH during the period between 01 January 2015 until 30 June 2016.	Patients with incomplete data collection due to inadequate recording of notes.
Patients over the age of 18 years	Repeat patients

and preoperative aspirin use was reported in 21 patients (12.1%). Sixty-five patients (37.4%) had an ASA score of ≥ 3. Most patients underwent elective surgery, with a minority of cases having urgent or emergency surgery (2 patients, 1.1%). A total of 90 patients (51.7%) received general anaesthesia. A posterior surgical approach was chosen in 117 patients (67.2%), with an extended duration of surgery noted for 32 patients (18.4%). Most patients received thromboprophylaxis post-operatively (124 patients, 71.3%).

A total of 24 patients received a transfusion. The cumulative incidence of blood transfusion was 13.8% (95%CI: 9.0-19.8%). The median number of blood units received by those who were transfused was 2.0 (minimum-maximum range: 1.0-4.0) units.

A statistical comparison of characteristics between non-transfused and transfused patients is provided in Table 3. Statistically significant associations were observed between extended duration of surgery and transfusion (41.7% in the transfusion group vs. 14.7 % in the no-transfusion group, p=0.002), as well as postoperative thromboprophylaxis and transfusion (91.7% in the transfusion group vs. 68% in the no-transfusion group, p=0.017). There were no other associations between the other patient characteristics and transfusion which reached statistical significance at $p<0.05$.

4. Discussion:

Our study revealed a perioperative blood transfusion incidence of 13.8% in patients undergoing primary hip arthroplasty. The median number of blood units was found to be 2.0 amongst the sample of patients that were transfused with the range of units being a minimum of 1.0 and a maximum of 4.0 units. Perioperative blood transfusions were statistically associated with longer surgery and postoperative administration of thromboprophylaxis.

Perioperative blood transfusion rates reported for total hip arthroplasty vary and can be attributed to the differing institutional transfusion policies and population characteristics. The incidence of peri-operative blood transfusions in this study (13.8%) was found to be within the range quoted in international studies where the incidence was described as ranging from 3.9-67.0% (6,14,15). This can be attributed to the study site being a quaternary-level hospital with more skilled surgeons performing operations resulting in minimal blood loss, thus a transfusion rate that leans toward the lower end of the range reported in the published literature. Alternatively in our low-income setting, where blood products are not easily available, this can be attributed to a decrease in availability., this can also imply judicious practices of perioperative clinicians and resourceful utilization of this scarce product.

Our study findings regarding the association between longer surgical duration and blood transfusion are consistent with what is reported in the published literature. Frisch et al. reported increasing rates of blood transfusion in patients with longer operating room time (16). A study in Sweden by Carling et al. also found a positive correlation between the incidence of blood transfusion and prolonged surgical duration (7). Another study conducted by Huang and colleagues described operative time as a surgery-related risk factor for blood transfusion (17). Extended length of surgery can be due to a variety of factors including; patient (BMI and gender) (18,19), pathological (age of fracture, mechanism of injury), and

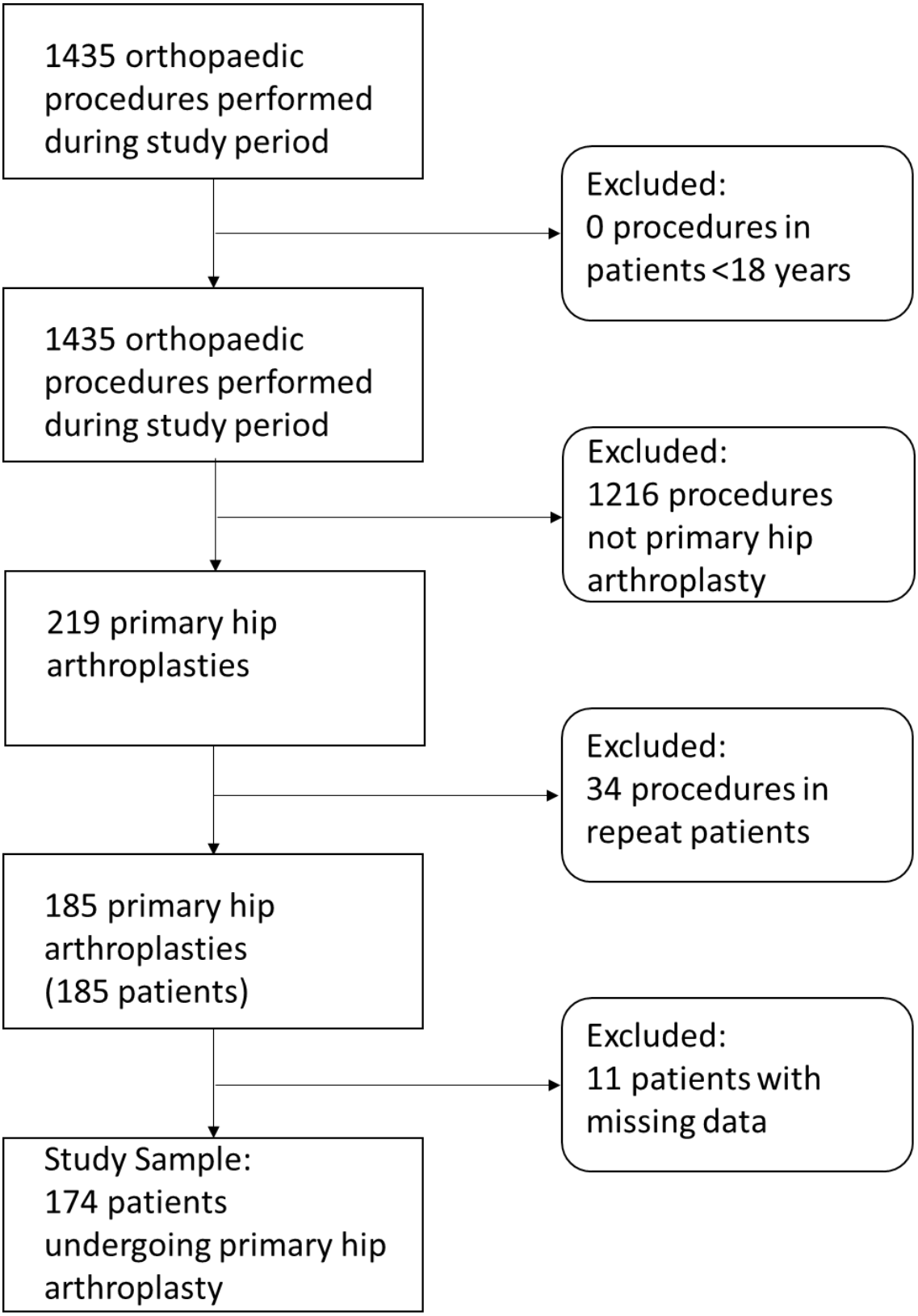

Figure 1: Derivation of the study sample

Table 2: Description of the study sample (N=174)

Characteristic	Descriptive statistic
Demographics	
Male gender, n (% of N)	78 (44.8)
Age in years, median (IQR)	56.0 (44.8-65.0)
Comorbid conditions	
Obesity, n (% of N)	84 (48.3)
Diabetes Mellitus, n (% of N)	16 (9.2)
Hypertension, n (% of N)	80 (46.0)
Cardiovascular disease, n (% of N)	10 (5.7)
COPD, n (% of N)	21 (12.1)
Rheumatoid arthritis, n (% of N)	6 (3.4)
HIV, n (% of N)	40 (23.0)
Smoker, n (% of N)	40 (23.0)
Pre-operative medications	
Aspirin within 3 days, n (% of N)	21 (12.1)
NSAID use within 3 days, n (% of N)	56 (32.2)
Pre-operative tranexamic acid, n (% of N)	116 (66.7)
Peri-operative surgical variables	
ASA score ≥ 3, n (% of N)	65 (37.4)
Urgent or emergency surgery, n (% of N)	2 (1.1)
General anaesthesia, n (% of N)	90 (51.7)
Extended duration of surgery, n (% of N)	32 (18.4)
Surgical approach: posterior, n (% of N)	117 (67.2)
Post-operative thromboprophylaxis, n (% of N)	124 (71.3)

surgical factors (level of experience of the surgeon). Prolonged surgical times predispose a patient to blood loss with subsequent depletion of clotting factors and platelets (20). With longer duration, the surgical incision remains open for an extended period, allowing more bleeding through the surgical site. Furthermore, the patients at increased risk of hypothermia which causes impaired coagulation. This relays to an increased bleeding time and a subsequent need for transfusions.

Overall, we found a clinically significant association between post-operative thromboprophylaxis and peri-operative blood transfusion. Patients undergoing hip arthroplasty surgery are at high risk for deep vein thrombosis (21,22). Wainwright and colleagues quote an incidence of deep vein thrombosis in 40 to 60% of patients who undergo hip arthroplasty (23). Patients who are deemed high risk for deep vein thrombosis usually receive perioperative thromboprophylaxis. Inaccurate risk stratification for venous thrombosis or inappropriate use of postoperative thromboprophylaxis can lead to more bleeding (24), particularly in patients who might not necessarily be at high risk for deep vein thrombosis. The strong association between post-operative thromboprophylaxis and increased transfusion in our study could be attributed to the pharmacokinetic effect of anti-coagulants on clotting factors and coagulation. The antagonistic and inhibitory effects of anti-coagulation agents can pose a challenge for

Table 3: Comparison of characteristics between non-transfused and transfused patients

Characteristic	No-transfusion (N=150)	Transfusion (N=24)	p
Demographics			
Male gender, n (% of N)	71 (47.3)	7 (29.2)	0.097
Age in years, median (IQR)	54.5 (43.8-65.0)	62.0 (49.5-69.3)	0.097
Comorbid conditions			
Obesity, n (% of N)	69 (46.0)	15 (62.5)	0.133
Diabetes Mellitus, n (% of N)	14 (9.3)	2 (8.3)	0.875
Hypertension, n (% of N)	66 (44.0)	14 (58.3)	0.191
Cardiovascular disease, n (% of N)	7 (4.7)	3 (12.5)	0.126
COPD, n (% of N)	17 (11.3)	4 (16.7)	0.456
Rheumatoid arthritis, n (% of N)	4 (2.7)	2 (8.3)	0.158
HIV, n (% of N)	35 (23.3)	5 (20.8)	0.787
Smoker, n (% of N)	36 (24.0)	4 (16.7)	0.428
Preoperative medications			
Aspirin within 3 days, n (% of N)	18 (12.0)	3 (12.5)	0.944
NSAID use within 3 days, n (% of N)	51 (34.0)	5 (20.8)	0.200
Pre-operative tranexamic acid, n (% of N)	104 (69.3)	12 (50.0)	0.062
Peri-operative surgical variables			
ASA score ≥ 3, n (% of N)	55 (36.7)	10 (41.7)	0.638
Urgent or emergency surgery, n (% of N)	2 (1.3)	0 (0)	0.569
General anaesthesia, n (% of N)	79 (52.7)	11 (45.8)	0.534
Extended duration of surgery, n (% of N)	22 (14.7)	10 (41.7)	0.002
Surgical approach: posterior, n (% of N)	102 (68.0)	15 (62.5)	0.594
Post-operative thromboprophylaxis, n (% of N)	102 (68.0)	22 (91.7)	0.017

surgeons during attempts to achieve haemostasis, as a result of an increase in bleeding time. This results in an increased risk of blood loss (25), and subsequently an increase in transfusion requirements. This emphasizes the importance of balancing the risks and benefits of anticoagulation therapy in this subset of orthopaedic patients.

Our study findings display some similarities with the published literature, in terms of thromboprophylaxis and duration of surgery. However, several characteristics are reported as being associated with transfusion in the literature and did not reach statistical significance in our study. This is possibly due to an element of recall bias in the data due to the retrospective nature of the data collection.

Limitations to our study include those intrinsic to a retrospective, single-center study.This includes the possibility of selection and recall bias. Our study did not account for race group as this information was not consistently recorded during hospital admission. Furthermore, our study did not investigate the implications of perioperative transfusion on subsequent complications in

this subset of orthopaedic patients due to the low rate of postoperative complications recorded at our quaternary-level facility.

5. Recommendations:

The results from this study assist us in risk-stratifying patients undergoing primary hip arthroplasty and reiterating guidelines to minimize the need for transfusion. Further investigations need to be carried out to determine the prognostic significance of a longer duration of surgery. Furthermore, this study highlighted the importance of judicious use of anticoagulants postoperatively. A larger sample size might be required to thoroughly investigate some of the other patient characteristics which failed to reach statistical significance in this study.

6. Conclusion:

During hip arthroplasty surgery, blood loss is an inevitable complication, with concern raised where patients require blood transfusions. The rate of blood transfusion in our study is within the range of reported rates in the literature and only slightly lower than the average rate of 18%. This is most likely due to the skill of the orthopaedic surgeons and demonstrates the conservation of blood products in a resource-constrained country is possible. More research needs to be done to confirm these findings.

7. Acknowledgements:

Special thanks to Dr. M. Khattab for establishing the orthopaedic patient database used in this study.

8. List of abbreviations:

ASA: American Society of Anaesthesiology
COPD: Chronic Obstructive Pulmonary Disease
HIV: Human Immunodeficiency Virus
IALCH: Inkosi Albert Luthuli Central Hospital
IQR: Interquartile range
NSAID: Non-steroidal anti-inflammatory
RBC: Red blood cells
WHO: World Health Organisation

9. Conflict of interest:

No conflicts to report.

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Author biography

Safwana Essa (MBChB) received her medical degree from the University of Kwa-Zulu Natal, South Africa in 2015. She developed an interest and passion for anaesthetics during medical internship and community service training. She is currently a third-year registrar in Anaesthetics at the University of KwaZulu-Natal and hopes to improve perioperative healthcare practices on the African continent through her future research. This research manuscript is a compulsory component of Safwana Essa's registrar training.

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