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ORIGINAL RESEARCH ORTHOPEDIC ANESTHESIA

Factors associated with transfusion in anesthesia for orthopedic surgery in elderly patients in a resource-limited setting

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ABSTRACT

Background and objective. Orthopedic surgery in elderly patients is often associated with significant blood loss, exposing these patients to a high risk of transfusion. This study investigated the frequency and factors associated with transfusion in elderly orthopedic surgical patients in a resource-limited setting.

Methodology. This is a retrospective cohort study conducted at Monkole Hospital Centre from January 2011 to December 2024. It included all patients aged 60 years or older who underwent anesthesia for orthopedic surgery. The sample used was exhaustive, based on patient records. Peri-anesthetic data were collected in accordance with ethical guidelines until discharge from hospital and analyzed using SPSS 26.0 for $P < 0.05$.

Results. The study included 168 patients, representing 17.19% of elderly patients and 1.27% of all patients. Thirty-four patients (20.2%) received transfusions. The mean age was 68.7 years, with no significant difference according to transfusion status. Similarly, the anesthetic technique did not influence the need for transfusion. Factors independently associated with transfusion were hemoglobin ≤10 g/dl, ASA III-IV status, intraoperative incidents, major surgery, operative time ≥2 hours, conjunctival pallor and frailty/dependence. Conversely, alcohol consumption appeared to be a protective factor.

Conclusion. These results confirm the central role of preoperative optimization and intraoperative vigilance in reducing transfusion requirements. The integration of 'Patient Blood Management' strategies and surgical and anesthetic techniques aimed at limiting blood loss appear to be essential.

Keywords: Anesthesia; Orthopedic surgery; Patient Blood Management; Resource-limited countries; Transfusion

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1. INTRODUCTION

The ageing of the population is accompanied by an increase in the frequency of osteoarticular pathologies, particularly hip fractures, requiring surgical treatment in elderly people.[1] In this context, Orthopedic surgery is a major source of blood loss, exposing this vulnerable population to a high risk of perioperative blood transfusion.[2] Although transfusion can sometimes be lifesaving, it is not without risks, particularly immunological and infectious risks, and access to it often remains limited in resource-constrained settings.[3]

The management of perioperative anemia in elderly Orthopedic patients poses challenges in anesthesia due to the high prevalence of cardiovascular comorbidities, decreased physiological reserves and reduced tolerance to tissue hypoxia.[4] In countries with limited resources, these difficulties are exacerbated by the lack of hemovigilance, insufficient blood supplies, the frequent absence of standardized transfusion protocols, and reduced access to alternatives to transfusion, such as erythropoietin or intraoperative blood recovery.[5]

The World Health Organisation (WHO) defines an elderly person as an individual aged 60 or over. According to the WHO, by 2050, the global population aged 60 and over is expected to reach 2 billion, compared to 900 million in 2015.[6] There are three distinct profiles of elderly patients.[7]]: - The vigorous or robust: they are independent with few associated comorbidities and only exhibit physiological and pharmacological changes related to their age. - The frail: they are at higher risk of mortality, sequelae or progression to dependence in the event of an intercurrent event (confusion, fall, infection, etc.). The post-operative consequences of this frailty can be limited by screening for frailty and managing it correctly. - Dependent and multi- morbid: comorbidities and dependencies must be assessed to determine the risks and benefits of surgery.

Orthopedic surgery in elderly patients, particularly in cases of femoral neck fractures, is often associated with significant blood loss, making perioperative transfusion often essential.[8] However, this population is particularly sensitive to the side effects of transfusion, such as volume overload, immunological reactions, blood-borne infections, and immunomodulation, which can increase post-operative morbidity.[9]

In low-resource countries, logistical supply problems and limitations in transfusion safety, as well as the absence of standardized protocols, increase the risk for patients.[10, 11]

The majority of studies conducted in this field come from high-income countries, and little data is available in resource-limited settings.[12] Myung-Rae Cho.[13]], in his study of 203 elderly patients who underwent surgical fixation of intertrochanteric hip fractures, found that low preoperative hemoglobin levels, low glomerular filtration rates (GFR), general anesthesia and unstable fractures increased the risk of blood transfusion. Studies have shown that tranexamic acid is associated with a reduction in total blood loss during total knee and hip replacements, as well as during cardiac surgery.[14–16]

In a retrospective study, Dai CQ *et al*. found that the main factors affecting perioperative blood transfusion were age, fracture type and hemoglobin on admission.[17] Preoperative anemia is considered a risk factor for transfusion, particularly in major musculoskeletal surgery in elderly patients.[18-19]

The rapid increase in the elderly population is leading to an annual increase in the incidence of hip fractures. The main treatment for anemia is blood transfusion. Several studies have found that 30-70% of elderly patients with hip fractures require perioperative allogeneic blood transfusion.[20-22]

It is therefore crucial to identify the predictors of transfusion in elderly patients undergoing Orthopedic surgery according to their socio-economic context. This study aims to determine the factors associated with transfusion during Orthopedic surgery in elderly patients in a resource-limited setting.

2. METHODOLOGY

This is a retrospective cohort study, conducted at Monkole Hospital between 1 January 2011 and 31 December 2024. The study population consisted of all patients aged 60 years or older who had undergone anesthesia for Orthopedic surgery. Patients were divided into two groups: those who had received a blood transfusion and those who had not. We used non-probabilistic sampling with exhaustive and consecutive recruitment of patients from the registry. All patients aged 60 years or older who underwent anesthesia for Orthopedic surgery during the study period were included in this study. No patients were excluded from this study.

Data were extracted from the anesthesia database of the centre involved in the study, based on the data collection form created for this purpose. The data collected, in accordance with anonymity requirements, covered the pre-, intra- and post-operative periods up to discharge from hospital. The following data were collected for each patient included in the study:

Preoperative variables: age, gender, body mass index (BMI), comorbidities, ASA (American Society of Anesthesiologists) classification, available clinical and

paraclinical examinations, surgical indications and the degree of urgency of the surgery.

Intraoperative variables: premedication, tranexamic acid, anesthetic technique and products used, surgical procedure, duration of anesthesia and surgery, intraoperative complications and transfusion.

Postoperative variables: complications, postoperative transfusion and patient outcomes.

Statistical analyses

The data were entered into an Excel file. They were checked for accuracy, encoded and transferred to SPSS version 26.0 software for analysis. Qualitative variables were presented as frequencies and percentages, and quantitative variables as means and standard deviations according to the type of distribution. The student's t-test was used to compare means. Proportions were compared using Pearson's chi-square test or Fisher's exact test. Factors associated with adverse events were investigated using logistic regression. The strength of association between a factor and the adverse event was measured by calculating the odds ratio with 95% confidence intervals. The statistically significant threshold for p was set at <0.05.

Table 1: Sociodemographic characteristics of patients

Variable	All (n = 168)	No transfusion (n = 134)	Transfusion (n = 34)	P
Average age	68.7 ± 7.1	68.5 ± 7.1	69.4 ± 7.3	0.522
Age (years)				
60–69	102 (60.7)	81 (60.4)	21 (61.8)	0.920
70–79	49 (29.2)	40 (29.9)	9 (26.5)	
≥ 80	17 (10.1)	13 (9.7)	4 (11.8)	
Gender				
Male	84 (50.0)	67 (50.0)	17 (50.0)	0.576
Female	84 (50.0)	67 (50.0)	17 (50.0)	
Health insurance				
Uninsured care	112 (66.73)	85 (33.4)	27 (79.4)	0.038
Covered care	56 (33.3)	49 (36.6)	7 (20.6)	
Origin				
Health zone	22 (13.1)	17 (12.7)	5 (14.7)	0.472
Outside health zone	146 (86.9)	117 (87.3)	29 (85.3)	

Data presented as mean ± SD or n (%); P < 0.05 is significant

3. RESULTS

During the study period, 13,227 patients were anesthetized, including 977 aged 60 years or older. Of these 977 patients aged 60 years or older, 168 (1.27% of all patients or 17.19% of all elderly patients) were anesthetized for Orthopedic surgery and constituted the sample. The patients were divided into two groups: those who did not receive a transfusion (134, or 79.8%) and those who did receive a transfusion (34, or 20.2%). Of the 34 who received a transfusion, 24 received one unit, nine received two units, and only one received three units.

Table 1 presents the sociodemographic characteristics of the patients. No differences were observed between the groups in terms of age, gender, or origin. However, transfusions were significantly more frequent among patients who did not have health insurance.

The risk of transfusion was significantly higher in vigorous and frail elderly patients, those who did not consume alcohol, those with conjunctival pallor, Mallampati I patients, those at risk of thromboembolism, ASA III patients, and those who received antibiotics.

The mean hemoglobin level was significantly lower in transfused patients (10.7g/dl versus 12.3g/dl). The mean levels of leukocytes, prothrombin time, activated partial thromboplastin time and creatinine, as well as the median platelet count, had no influence on transfusion. Table 2 shows the clinical characteristics of the patients.

There was no difference between transfused and non-transfused patients in terms of premedication, anesthetic products and techniques, the qualifications of the practitioners, and the degree of urgency. However, transfusion was significantly more frequent in patients who received vasopressors, underwent major surgery, and had procedures lasting two hours or more (Table 3) to The surgical procedures were major for 115 patients and minor for 53 patients. The major procedures were: osteosynthesis without external fixator, total hip replacement, osteosynthesis with external fixator, knee replacement and amputation. Minor procedures included Orthopedic reduction, disarticulation, closed external fixation, removal of osteosynthesis material, tendinoplasty, median nerve release, osteomyelitis treatment and others.

Intraoperative incidents were observed in 32.1% of patients, intraoperative transfusion was performed in

Table 2: Clinical characteristics of the patients

Variable		All (n = 168)	No transfusion (n = 134)	Transfusion (n = 34)	P
Nutritional status	Normal weight	76 (45.2)	58 (43.3)	18 (52.9)	0.265
	Overweight	43 (25.6)	33 (24.6)	10 (29.4)	
	Obesity	49 (29.2)	43 (32.1)	6 (17.6)	
Addiction	Vigorous	137 (81.5)	114 (85.1)	23 (67.6)	0.032
	Fragile	24 (14.3)	14 (10.4)	10 (29.4)	
	Dependent	7 (4.2)	6 (4.5)	1 (2.9)	
Comorbidities	Cardiovascular	108 (64.3)	84 (62.7)	24 (70.6)	0.258
	Respiratory	3 (1.8)	1 (0.7)	2 (5.9)	0.105
	Neurological	13 (7.8)	11 (8.3)	2 (5.9)	0.835
	Hepatobiliary	11 (6.5)	10 (7.5)	1 (2.9)	0.306
	Metabolic	67 (39.9)	54 (40.3)	13 (38.2)	0.494
	Alcohol consumption	65 (38.7)	59 (44.0)	6 (17.6)	0.003
	Paleness of the conjunctivae	13 (7.7)	7 (5.2)	6 (17.6)	0.026
Mallampati grade	I	103 (61.3)	73 (54.5)	30 (88.2)	< 0.001
	II	47 (28.0)	46 (34.3)	1 (2.9)	
	III	18 (10.7)	15 (11.1)	3 (8.8)	
Thromboembolic risk		140 (83.3)	106 (79.1)	34 (100.0)	0.001
ASA	I	25 (14.9)	22 (16.4)	3 (8.8)	0.030
	II	121 (72.0)	99 (73.9)	22 (64.7)	
	III	22 (13.1)	13 (9.7)	9 (26.5)	
Antibiotic use	No	27 (16.1)	27 (20.1)	0	0.002
	Antibiotic prophylaxis	129 (76.8)	99 (73.9)	30 (88.2)	
	Antibiotic therapy	12 (7.1)	8 (6.0)	4 (11.8)	
Mean hemoglobin (g/dl)		12.0 ± 2.1	12.3 ± 1.8	10.7 ± 2.3	<0.001
Average GB (cells/mm³)		6.62 (5.36-8.60)	6.89 (5.39-8.81)	6.38 (5.26-7.80)	0.668
Median platelet count (cells/mm³)		243.7 (190.8-287.3)	240 (179.5–182.8)	247-5 (127.5-279.3)	0.140
Mean prothrombin ratio (%)		82.9 ± 26.8	83.4 ± 29.7	81.2 ± 12.5	0.706
Mean APTT (seconds)		33.9 ± 7.7	33.8 ± 8.1	34.5 ± 6	0.768
Average creatinine level (mg/dl)		1.08 ± 0.51	1.03 ± 0.44	1.19 ± 0.62	0.309

Key: ASA = American Society of Anesthesiologists, APTT = activated partial thromboplastin time;

Data presented as mean ± SD or n (%) or mean (Range); P < 0.05 is significant

20.2% of patients, and postoperative complications were reported in 6.0% of patients. a death by pulmonary embolism was recorded in the third postoperative period of a hip arthroplasty, despite the prophylaxis and curative treatment established.

In multivariate analysis, alcohol consumption was a protective factor against transfusion Ora 0.19 (0.05-0.77). Pallor of the palpebral conjunctiva ORa 3.12 (2.23-4.87), ASA classes III-IV ORa 3.63 (2.70-5.45), hemoglobin level less than or equal to 10g/dl ORa 5.43 (2.67-8.99), the presence of intraoperative incidents ORa 3.83 (2.55-5.09), major surgery ORa 3.35 (2.70-5.38), surgery lasting two hours or more ORa 2.15 (1.59-4.89), patient frailty ORa 1.98 (1.45-2.97) and patient dependency ORa 2.78 (1.98-3.90) were factors associated with blood transfusion (Table 5).

4. DISCUSSIONS

This study was conducted to determine the factors

Table 3: Anesthetic characteristics

Variable	All (n = 168)	No transfusio n (n = 134)	Transfusio n (n = 34)	p- value
Premedicatio n	5 (3.0)	4 (3.0)	1 (2.9)	—
Type of anesthesia				—
Spinal	117 (69.6)	90 (67.2)	27 (79.4)	
GA with intubation	28 (16.7)	23 (17.2)	5 (14.7)	
GA without intubation	10 (6.0)	10 (7.5)	0	
Epidural	6 (3.6)	6 (4.5)	0	
Spinal + GA	7 (4.2)	5 (3.7)	2 (5.9)	
Use of vasopressors				0.003
No	139 (82.7)	117 (87.3)	22 (64.7)	
Yes	29 (17.3)	17 (12.7)	12 (35.3)	
Primary surgical procedure				< 0.001
Major	123 (73.2)	90 (67.2)	33 (97.1)	
Minor	45 (26.8)	44 (32.8)	1 (2.9)	
Duration of anesthesia ≥2 h	92 (54.8)	65 (48.5)	27 (79.4)	0.001
Duration of surgery ≥2 h	54 (32.1)	36 (26.9)	18 (52.9)	0.004
Urgent procedure	6 (3.6)	5 (3.7)	1 (2.9)	0.649

Data presented as n (%) or mean (Range); P < 0.05 is significant

Table 4: Surgical procedures (n = 168)

Surgical procedures	N (%)
Major procedures	
Osteosynthesis other than external fixation	37 (22)
Total hip replacement	35 (20.8)
Osteosynthesis using external fixator	15 (8.9)
Total knee replacement	15 (8.9)
Aboveand below-knee amputation	13 (7.7)
Minor procedures	
Orthopedic reduction	18 (0.7)
Disarticulation	9 (5.3)
Osteotaxis by closed external fixator	7 (4.2)
Removal of osteosynthesis material	7 (4.2)
Tendon repair	4 (2.4)
Median nerve release	2 (1.2)
Treatment of osteomyelitis	1 (.6)
Other	7 (4.2)

associated with blood transfusion in anesthesia for Orthopedic surgery in elderly patients in a resource-limited setting. It found that this type of anesthesia accounts for 1.27% of all anesthesia procedures and 17.19% of elderly patients, and that one in five patients receives a transfusion. The factors associated with transfusion are preoperative anemia, major surgery, ASA class III-IV, surgery lasting two hours or more, and frailty and dependence in elderly patients. There is also the paradox of alcohol consumption protecting against blood transfusion.

The frequency of transfusion found in our study is similar to that reported in the literature, ranging from 15% to 40% depending on the type of procedure and patient profile.[23–24] This high frequency illustrates the importance of perioperative management of anemia and bleeding in this at-risk population. No significant differences were noted based on age or gender, which is consistent with data from several studies showing that advanced age alone is not an independent factor for transfusion.[21] Lack of health insurance was found to be associated with an increased likelihood of transfusion. This observation could be related to malnutrition as a factor in preoperative anemia. In our context, patients with health insurance have a monthly salary that can guarantee them food, unlike those who are self-employed. Their preoperative optimization also poses problems.[25]

Frail or dependent patients had a significantly higher risk of transfusion. These results are consistent with those of Carson *et al*..[4]], who showed that frailty and functional dependence were associated with increased transfusion requirements. Furthermore, conjunctival

Table 5: Factors associated with blood transfusion

Variable		Univariate analy		Multivariate analysis	
		P	OR (95% CI)	P	ORa (95% CI)
Respiratory comorbidity	No		1		1
	Yes	**0.038**	2.65 (1.33–4.76)	0.105	1.17 (0.19-1.47)
Use of Alcohol	No		1		1
	Yes	**0.025**	0.32 (0.22-0.85)	**0.020**	0.19 (0.05-0.77)
Palpebral conjunctiva	Colored		1		1
	Pale	**0.010**	2.81 (1.56-7.10)	**0.037**	3.12 (2.23–4.87)
Mallampati	I-II		1		1
	III-IV	**0.002**	3.63 (2.54-5.93)	0.179	1.31 (0.37-2.33)
ASA	I		1		1
	II	0.214	1.52 (0.40–2.88)	0.760	1.33 (0.22-1.88)
	III	**0.001**	4.10 (2.58–6.72)	**0.001**	3.63 (2.70–5.45)
Hemoglobin	>10 g/L		1		1
	≤10 g/L	**< 0.001**	6.34(2.79-14.37	**< 0.001**	5.43(2.67-8.99)
Intraoperative incidents	No		1		1
	Yes	**0.001**	3.89 (2.63-5.74)	**0.001**	3.83 (2.55–5.09)
Primary surgical procedure	Minor		1		1
	Major	**0.012**	4.81 (2.40–6.53)	**0.003**	3.35(2.70-5.38)
Duration of anesthesia	<2 hours		1		1
	≥2 hours	**0.012**	3.21 (2.29-5.63)	0.842	1.17 (0.26–1.86)
Duration of surgery	<2 hours		1		1
	≥2 hours	**0.018**	2.53(1.10-4.09)	**0.025**	2.15 (1.59–4.89)
Degree of dependence	Vigorous		1		1
	Fragile	**0.028**	2.69 (1.50-3.76)	**0.023**	1.98 (1.45-2.97)
	Dependent	**0.016**	2.98 (1.91–6.94)	**0.001**	2.78 (1.98-3.90)

P 0.05 is considered significant; Data presented as OR (95% CI)

pallor and a hemoglobin level ≤ 10 g/dl were strongly associated with transfusion, confirming that preoperative anemia remains one of the major determinants.[26] High ASA (III-IV) was also correlated with transfusion, reflecting the vulnerability of patients with a significant burden of comorbidity, which is consistent with the work of Muñoz *et al.*.[18] Conversely, alcohol consumption was found to be protective against transfusion. This paradoxical result was observed in certain cohorts where moderate alcohol consumption could influence hematopoiesis and tolerance to anemia.[27] Nevertheless, this association should be interpreted with caution and requires further study.

Major surgical procedures, an operating time of ≥ 2 hours and the use of vasopressors were independent predictors of transfusion. These data are consistent with previous studies showing that the complexity of the surgical procedure and the operating time are strongly correlated with blood loss and therefore with transfusion requirements.[28,29]

Intraoperative incidents were also an independent risk factor. This confirms the importance of anesthetic and surgical vigilance in limiting hemorrhagic events, as emphasized in the recommendations of the European Society of Anesthesiology.[30]

In our series, 6% of patients experienced post-operative complications, which is lower than the figures reported in other studies (10–20%).[31,32] This difference could be explained by different follow-up criteria. However, the literature agrees on the fact the blood transfusion itself is a factor in infectious and cardiovascular complications.[33,34]

5. Strengths

• Specific target population: the study focuses on patients aged 60 and over, a particularly vulnerable

population in Orthopedic surgery, providing relevant data in a context where transfusion needs are high.

- Multivariate analysis: the use of a multivariate model identified independent factors associated with transfusion, reinforcing the internal validity of the results.

- Under-documented context: this is one of the few studies conducted in an African setting, providing new and useful information for clinical practice in resource-limited environments.

- Multiple parameters taken into account: sociodemographic, clinical, biological and intraoperative characteristics were all studied, providing a comprehensive overview of the determinants of blood transfusion.

6. LIMITATIONS

- Single-center study: conducting the study in a single center limits the generalizability of the results to other hospitals or regions.

- Small number of transfused patients (34 patients, or 20.2%): this may reduce statistical power and lead to wider confidence intervals.

- Lack of quantitative data on blood loss: the assessment of intraoperative bleeding was based solely on whether or not a transfusion was required, which may introduce bias.

- Limited follow-up period: only early post-operative complications were recorded, which does not allow for an assessment of the medium- or long-term impact of transfusion.

- Potential reporting bias: certain clinical parameters (conjunctival pallor, fragility) are based on subjective assessment by healthcare professionals, which may lead to inter- observer variability.

7. CONCLUSION

These results confirm the central role of preoperative optimization and intraoperative vigilance in reducing transfusion requirements. The integration of *Patient Blood Management* (PBM) strategies appears essential, including the screening and treatment of anemia, nutritional assessment, and surgical and anesthetic techniques aimed at limiting blood loss. Looking ahead, a prospective multicenter study before and after the implementation of Patient Blood Management seems necessary to improve transfusion practices in adult Orthopedic surgery in our resource-limited settings.

7. Data availability

The numerical data generated during this research is available with the authors.

8. Regulatory and ethical considerations

Authorization was obtained from the hospital hierarchy. The rules of anonymity and confidentiality were respected in accordance with the Helsinki Convention during all stages of data collection and processing. The protocol was approved by the Ethics Committee of the School of Public Health under number ESP/CE/109/2024.

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10. Conflicts of Interest

The authors declare no conflicts of interest.

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12. Author Contributions

EMo and WM: Study conception and design, data collection, manuscript drafting.
AMo and FM: Data collection.
ANk: Statistical analysis and data interpretation.
All authors read and approved the final version and agree to be accountable for all aspects of the work.

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