

# Factors Associated with Mortality and Morbidity in Anaesthesia for Orthopaedic Surgery of the Elderly Patient in a Low-Income Country

Patrick Kintieti<sup>1</sup>, Wilfrid Mbombo<sup>1,2\*</sup> , Alphonse Mosolo<sup>1,2</sup>, Aliocha Nkodila<sup>3</sup>, Paul Kambala<sup>4</sup>, Rémy Kashala<sup>5</sup>, Joseph Nsiala<sup>1,6</sup>, Luc Mokassa<sup>7</sup>, Hugues Albini<sup>7</sup>, Médard Bula-Bula<sup>1</sup>, Berthe Barhayiga<sup>1</sup>

<sup>1</sup>Department of Anaesthesia and Intensive Care, University Clinics of Kinshasa, University of Kinshasa, Kinshasa, Democratic Republic of the Congo

<sup>2</sup>Anesthesia and Critical Care Service, Monkole Hospital Centre, Kinshasa, Democratic Republic of the Congo

<sup>3</sup>Department of Family Medicine and Primary Health Care, Protestant University in Congo, Kinshasa, Democratic Republic of the Congo

<sup>4</sup>Service of Surgery, Monkole Hospital Centre, Kinshasa, Democratic Republic of the Congo

<sup>5</sup>Medical Direction, Monkole Hospital Centre, Kinshasa, Democratic Republic of the Congo

<sup>6</sup>Department of Anaesthesia and Resuscitation, Evry Private Hospital, Evry, France

<sup>7</sup>Department of Surgery, University Clinics of Kinshasa, Kinshasa, Democratic Republic of the Congo

Email: patrickintieti@yahoo.fr, \*pwmbombo@yahoo.fr, alphonsemosolo@yahoo.fr, nkodilaaliocha@gmail.com, paulkambala@gmail.com, remykashala1@gmail.com, mnsiala78@gmail.com, lucmokassa@gmail.com, hugues.albini@unikin.ac.cd, drmebula@gmail.com, berthebarhayiga@gmail.com

**How to cite this paper:** Kintieti, P., Mbombo, W., Mosolo, A., Nkodila, A., Kambala, P., Kashala, R., Nsiala, J., Mokassa, L., Albini, H., Bula-Bula, M. and Barhayiga, B. (2025) Factors Associated with Mortality and Morbidity in Anaesthesia for Orthopaedic Surgery of the Elderly Patient in a Low-Income Country. *Open Journal of Anesthesiology*, 15, 137-159. <https://doi.org/10.4236/ojanes.2025.155010>

**Received:** April 24, 2025

**Accepted:** May 26, 2025

**Published:** May 29, 2025

Copyright © 2025 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0). <http://creativecommons.org/licenses/by/4.0/>



Open Access

## Abstract

**Background and Objective:** The peri-anaesthetic management of an elderly patient is significantly different from that of a young patient. This study was conducted to determine the morbidity and mortality of elderly patients undergoing anaesthesia for orthopaedic surgery at Monkole Hospital and the factors associated with it. **Methods:** This cross-sectional, single-centre study was carried out at Monkole Hospital from 01 January 2011 to 31 December 2022. It included all patients aged at least 60 years who underwent anaesthesia for orthopaedic surgery. The sample used was exhaustive, based on a patient register. Peri-anaesthetic data were collected ethically up to hospital discharge and analysed with SPSS 26.0 for  $p < 0.05$ . **Results:** Out of 1637 anaesthetised orthopaedic patients, a sample of 132 was collected including 69 men (52.3%) and 63 women (47.7%), with a sex ratio M/F of 1.09 with a mean age of  $68.5 \pm 6.9$ . BMI was normal in 46.2% of patients, obesity in 28%, cardiovascular (64.4%) and renal-metabolic (38.6%) co-morbidities predominated, thrombo-

embolic risk was present in 83.3%, ASA class was 2 (69.7%), 3 and 1 (15.2% each). The surgical procedures were often major, including hip (25.7%) and knee (11.3%) replacements, and osteosynthesis with (18.9%) or without an external fixator (12.1%). Patients transfused intraoperatively had significantly lower haemoglobin levels than those who were not transfused ( $p < 0.005$ ). Peri-medullary anaesthesia was used in 72% of cases and general anaesthesia in 23.5% of cases where the procedure was often scheduled (95.5%). Intraoperative incidents were mainly arterial hypotension in 21.96% of cases, and 19.7% benefited from intraoperative transfusion. Post-operative complications were pulmonary embolism (two cases, 1.5%), surgical revision (1.5%) and two deaths (1.5%) related to pulmonary embolism. **Conclusion:** Although in a low-income country, anaesthesia of the elderly in orthopaedic surgery appears to be frequent with few complications dominated by arterial hypotension probably linked to the frequent use of perimedullary anaesthesia.

### Keywords

Morbidity, Mortality, Orthopaedic Surgery, Elderly Subjects

---

## 1. Introduction

The management of an elderly patient is significantly different from that of a young patient due to the physiological and pharmacological changes associated with advanced age, with an increased risk of complications [1] [2]. The World Health Organisation (WHO) defines an elderly person as an individual aged 60 or over. According to the WHO, by 2050, the world's population aged 60 and over is expected to reach 2 billion, compared with 900 million in 2015 [3]. However, in the National Institute of Aging distinguishes between three categories of older people older people: the "young old" (65-74), the "old old" (75 - 84) and the "oldest old" (75 - 84) and the "very old" (85 and over) [4]. We need to distinguish between different profiles of elderly patients, for whom risk assessment and perioperative needs will be quite different [1]: The vigorous or robust: they are autonomous with few associated co-morbidities and only present physiological and pharmacological changes related to their age. Fragile patients frail: they are at higher risk of mortality, sequelae or progression to dependency in the event of an intercurrent event (confusion, fall, infection, etc.). However, screening for frailty, combined with active physical, cognitive, nutritional and social care, can limit the consequences of this frailty on postoperative outcomes. Polypathological dependents: the identification of co-morbidities and addictions often plays a greater role in risk assessment than age itself, and enables these risks to be weighed against the expected benefits of the proposed intervention.

The ageing of the world's population represents a major challenge for healthcare systems, including in low- and middle-income countries (LMICs). According to the United Nations, the proportion of people aged 60 and over will increase sig-

nificantly over the next few decades, including in sub-Saharan Africa and other regions with limited resources [5]. This phenomenon is accompanied by a rise in degenerative musculoskeletal conditions, such as osteoarthritis and osteoporosis, leading to an increase in demand for orthopaedic surgery, particularly for femoral neck fractures and joint replacements [6] [7].

Orthopaedic surgery in the elderly is particularly risky in terms of anaesthesia. This population often has multiple co-morbidities (heart disease, diabetes, renal failure, etc.), reduced physiological reserves and an altered response to surgical stress [8]. These factors, combined with frailty and multiple medications, increase the risk of intraoperative and postoperative complications such as cardiovascular events, delirium, infections and mortality [9] [10].

In high-income countries, multidisciplinary protocols have been introduced to improve perioperative management of the elderly. Appropriate anaesthetic techniques, rigorous preoperative optimisation and continuous postoperative monitoring have significantly reduced morbidity and mortality in this population [11]. However, in low- and middle-income countries (LMICs), anaesthetic management is still subject to numerous constraints: shortage of qualified staff, lack of monitoring equipment, delays in surgical management, and lack of protocols adapted to this age group [12] [13]. These difficulties are all the more worrying given that elderly patients are particularly vulnerable, with in-hospital mortality rates of up to 20% following femoral neck fractures in certain African contexts [14].

Meta-analyses have also demonstrated a reduction in mortality, postoperative complications and hospital length of stay when a protocol of intraoperative haemodynamic control is applied to medium- and high-risk subjects undergoing major surgery [15] [16]. In Turrentine's cohort [15], 25% of patients were aged over 70, and the number of risk factors increased with age. Aubrun [1] found that age was an independent factor in postoperative morbidity and mortality, with a four-fold increase in risk after the age of 75 for surgery on the upper end of the femur. A Brazilian study of 182 patients undergoing femoral fracture surgery found a role for age, high ASA class and a history of pulmonary embolism in morbidity and mortality [17]. In Africa, studies on anaesthesia for orthopaedic surgery are rare. Chaibou [18] in Niamey found a mortality rate of 1.68% in 119 elderly patients undergoing all types of surgery. Mbombo's recently published study on anaesthesia in the elderly, taking all pathologies together, found that age was not an independent factor in mortality (which was 5.9%), but rather high ASA class, the severity of the surgical attack and anaesthesia duration of more than two hours [19]. A study conducted in Tanzania showed a post-operative complication rate of 36% in patients over 65 undergoing major orthopaedic surgery [20].

In Mbombo's study cited above [19] in Kinshasa on anaesthesia for elderly patients, orthopaedics ranked third behind general and digestive surgery and urology. However, several studies suggest that a small proportion of post-operative mortality is the direct consequence of the pathology that led to the surgical procedure, particularly in the case of femoral neck fractures, where 24% of deaths are

linked to the fracture. Despite the importance of the subject, few studies have been devoted to assessing the factors associated with morbidity and mortality in anaesthesia for elderly patients in countries with limited resources. Most of the available data come from high-income countries, and do not take account of specific local realities. It is therefore essential to produce contextualised data in order to gain a better understanding of the determinants of complications and to suggest ways of improving them that are adapted to local contexts.

This study is part of that effort. It aims to identify the factors associated with morbidity and mortality during anaesthesia for orthopaedic surgery in elderly patients in a hospital in a low-income country. By analysing demographic, clinical and anaesthetic characteristics, this study aims to make a contribution to the local and international scientific literature, by highlighting relevant levers for action to optimise the management of this high-risk population.

## **2. Methods**

### **2.1. Type, Setting and Period of the Study**

This cross-sectional, single-centre study was carried out at the Monkole Hospital Centre between 01 January 2011 and 31 December 2022.

### **2.2. Study Population and Sampling**

The study population consisted of all patients aged 60 or over who had undergone anaesthesia for orthopaedic surgery. We used non-probability sampling with exhaustive and consecutive recruitment of patients from the registry.

### **2.3. Selection of Patients**

All patients aged 60 or over who underwent anaesthesia for orthopaedic surgery during the study period were included in the study.

All patients whose records were missing an important study variable were excluded from this study.

### **2.4. Data Collection**

The data were extracted from the anaesthesia database of the centre involved in the study, based on the data collection form drawn up for this purpose. Data were collected anonymously for the pre-, intra- and postoperative periods up to hospital discharge. For each patient selected, the following data were collected:

- Preoperative variables: age, sex, body mass index (BMI), profile of the elderly subject (vigorous, frail or dependent), comorbidities, ASA class (American Society of Anesthesiologists), available clinical and laboratory tests, operative indications and degree of urgency of the surgery.
- Intraoperative variables: premedication, technique and anaesthetic products used, surgical procedure, duration of anaesthesia and surgery, intraoperative complications and transfusion.
- Postoperative variables: complications and patient outcomes.

In this study, a complication was defined as an undesirable event, whether expected or not, which occurred during the perioperative period, whether or not related to the anaesthetic procedure, with or without endangering vital or functional prognosis. The complications sought were cardiovascular (arrhythmias, cardiac arrest, myocardial ischaemia, thromboembolism, etc.); respiratory (pulmonary embolism, desaturation, bronchospasm, laryngospasm, etc.); neurological (stroke, neurological deficit etc.) or other (delirium, agitation, confusional syndrome, allergic reactions, etc.). A major procedure is a major and/or complex surgical operation, which mobilises significant resources (human, material and technical) and involves a certain level of risk or high technicality. In this study, the procedures considered to be major were: hip or knee arthroplasty, open-focus osteosynthesis for the axe, pelvis, femur and tibia, and amputations or disarticulations or cure of osteomyelitis in the leg or femur. Other procedures were considered minor: orthopaedic reduction, nerve release, tendon repair, tenotomy, removal of osteosynthesis devices etc.

## 2.5. Statistical Analysis

The data were entered into an Excel file. They were checked for accuracy, encoded and transferred to SPSS software version 26.0 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. Logistic regression was used to identify factors associated with adverse events. The strength of association between a factor and the adverse event was measured by calculating the Odds Ratio with their 95% CI. The statistically significant threshold of *p* was set at <0.05.

## 2.6. Regulatory and Ethical Considerations

Authorisation was obtained from the hospital hierarchy. The rules of anonymity and confidentiality were respected in accordance with the Helsinki Convention, at 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. We have no conflict of interest in this work.

## 3. Results

### 3.1. Patient Flow Diagram

**Figure 1** shows the patient flow diagram.

During this period, 10,916 were anaesthetised. 10,209 were aged under 60 and 707 were aged 60 and over. Of these 707, 132 or 18.67% of elderly subjects or 1.2% of all patients were anaesthetised for orthopaedic surgery and constituted our sample and therefore analysed in this study. In relation to orthopaedic surgery, 1637 patients were anaesthetised, including 132 elderly patients, *i.e.* 0.8% of all orthopaedic surgery.

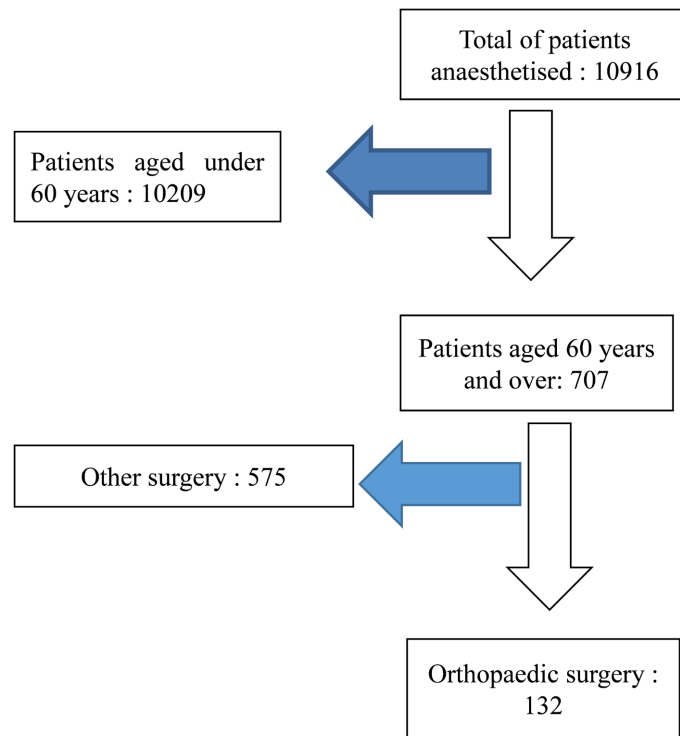


Figure 1. Patient flow diagram.

### 3.2. Socio-Demographic Characteristics of Patients

Table 1 shows the socio-demographic characteristics of the patients.

The mean age was 68.5 with a standard deviation of 6.9 and extremes of 60 to 92. The majority of patients were aged 60 to 69 (60.6%), those aged 70 to 79 (30.3%) and those aged 80 and over (9.1%). The majority of patients were male (52.3%), with a sex ratio M/F of 1.09.

Table 1. Socio-demographic characteristics of patients.

Variables	Frequency (n = 132)	%
<b>Age (X ± SD)</b>	68.561 (±6.9417)	
60 to 69 years	80	60.6
70 to 79 years	40	30.3
80 years and over	12	9.1
<b>Sex</b>		
Male	69	52.3
Female	63	47.7

Legend: X = mean, SD = standard deviation.

### 3.3. Clinical Characteristics of Patients

Table 2 presents the clinical characteristics of the patients. Table 3 presents the profile of the elderly subject (autonomy) and the occurrence of intraoperative

complications.

The mean BMI was 26.457 ( $\pm 5.4335$ ) with extremes from 16.16 to 44.03. Patients with a normal BMI accounted for the majority (46.2%); obese patients represented 28% and overweight patients 25.8%. Cardiovascular comorbidities were the most frequent at 64.4%, followed by renal-metabolic pathologies at 38.6% and neuropsychiatric pathologies at 9.4%. Patients with a history of alcohol consumption accounted for 37.9%. In terms of the profile of the elderly subject, 107 (81.1%) were vigorous, 18 (13.3) were frail and 7 (5.3%) were dependent. Dependent patients had more intraoperative complications with no significant difference ( $p = 0.257$ ), whereas patients classified as frail benefited from more intraoperative transfusions ( $p=0.019$ ). The risk of venous thromboembolism (VTE) was present in 83.3% of patients. All these patients at risk of VTE had received thromboprophylaxis with enoxaparin 40 - 80 mg for at least three weeks (direct oral anticoagulants are of limited availability). The ASA class had the following distribution: ASA II: 69.7%; ASA I and III: 15.2 respectively.

**Table 2.** Clinical characteristics of patients.

Variables	Frequency (n = 132)	%
<b>BMI (X <math>\pm</math> SD)</b>	26.457 ( $\pm 5.4335$ )	
Normal	61	46.2
Overweight	34	25.8
Obesity	37	28
<b>Comorbidities</b>		
Cardiovascular	85	64.5
Renal-metabolic	51	38.6
Neuropsychiatric	12	9.4
Hepato-digestives	8	6.1
Respiratory	3	2.3
<b>Intoxication</b>		
Tobacco	5	3.8
Alcohol	50	37.9
<b>Risk of VTED</b>	<b>110</b>	<b>83.3</b>
<b>ASA Class</b>		
I	20	15.2
II	92	69.6
III	20	15.2

Legend: BMI = body mass index, X = mean, SD = standard deviation, ASA= American Society of Anesthesiologists, VTED = venous thromboembolic disease.

**Table 3.** Profile of the elderly (autonomous) patient and intraoperative complications and transfusion.

Profile of elderly	No intraoperative complications	With intraoperative complications	Total	P 0.257
Vigorous	73 (68.2)	34 (31.8)	107 (100)	
Frail	14 (77.77)	4 (22.23)	18 (100)	
Dependent	3 (42.9)	4 (57.1)	7 (100)	

Profile of elderly	No intraoperative transfusion	With intraoperative transfusion	Total	P 0.019
Vigorous	90 (84.1)	17 (15.9)	107 (100)	
Frail	10 (55.55)	8 (44.45)	18 (100)	
Dependent	6 (85.7)	1 (14.3)	7 (100)	

### 3.4. Biological Characteristics of Patients

**Table 4** shows the biological characteristics of the patients.

No variable showed a significant difference between the “with complications” and “without complications” groups (all p values > 0.05), except haemoglobin. Transfused patients had a lower mean haemoglobin than non-transfused patients: 10.4/g and 12.2 g/dl (p < 0.001).

**Table 4.** Biological characteristics of patients.

Variables	Without intraoperatives complications	With intraoperatives complications	Total	p
Haemoglobin (g/dl)	11.9 ± 2.0	11.8 ± 2.2	11.9 ± 2.1	0.737
Leukocytes /mm <sup>3</sup>	7.4 ± 2.9	7.4 ± 2.9	7.4 ± 2.9	0.936
Neutrophils %	60.5 ± 16.8	62.1 ± 13.6	61.0 ± 15.8	0.765
Lymphocytes %	17.0 (8.0 - 33.0)	15.0 (8.0 - 49.0)	16.0 (13.0 - 19.0)	0.998
Platelets (×10 <sup>3</sup> )	237.0 (172 - 434)	131 (75 - 181)	181 (131 - 248)	0.276
PT (%)	78.9 ± 26.0	82.6 ± 23.1	80.2 ± 24.9	0.483
APTT (secondes)	35.1 ± 8.2	32.6 ± 7.5	34.2 ± 8.0	0.165
Serum creatinine (mg/dl)	1.4 (1.0 - 2.3)	1.1 (0.8 - 1.5)	1.3 (1.0 - 1.5)	0.562

Variables	Without intraoperative transfusion	With intraoperative Transfusion	Total	p
Haemoglobin (g/dl)	12.2 ± 1.8	10.4 ± 2.4	11.9 ± 2.1	<0.001
Leukocytes/mm <sup>3</sup>	7.4 ± 2.8	7.3 ± 3.6	7.4 ± 2.9	0.839
Neutrophils	61.0 ± 15.3	60.8 ± 19.0	61.0 ± 15.8	0.968
Lymphocytes	16.0 (13.0 - 33.0)	13.5 (8.0 - 19.0)	16.0 (13.0 - 19.0)	0.938
Platelets (×10 <sup>3</sup> )	172 (125 - 226)	431 (428 - 434)	181 (131 - 248)	0.455
PT (%)	80.3 ± 27.5	79.9 ± 12.3	80.2 ± 24.9	0.957
APTT (seconde)	34.2 ± 8.5	34.1 ± 6.5	34.2 ± 8.0	0.950
Serum creatine (mg/dl)	1.1 (1.0 - 1.5)	1.9 (1.5 - 2.3)	1.3 (1.0 - 1.5)	0.348

Legend: PT = prothrombin rate, APTT = activated partial thromboplastin time.

### 3.5. Intra-Anaesthetic Characteristics of Patients

**Table 5** presents the intra-anaesthetic characteristics of the patients.

Pre-medication with drugs was used in 3.8% of patients. Loco-regional anaesthesia (LRA) was used in the majority of patients (95 or 72%), including 91 cases of spinal anaesthesia (SA) and 4 cases of epidural anaesthesia (EDA). General anaesthesia (GA) was used in 31 patients (23.5%). Combined anaesthesia (LRA + GA) was used in 6 patients (4.5%). The products used for LRA were: Bupivacaine (74.2%) and morphine (73.4%) were the most commonly used products for LRA, Clonidine (29.6%), Fentanyl (19.7%), and Sufentanyl (6.1%). The drugs used in GA were: Most frequent: Propofol (28%), induction agent. Others: Isoflurane (18.9%), Sevoflurane (3.8%), Suxamethonium (17.4%), Atracurium (9.1%), Fentanyl (9.8%) and Sufentanyl (18.9%). Twenty-four patients, or 18.2% of patients, required the use of a vasopressor. The surgical procedure was major in 99 patients (75%) and minor in 33 (25%). The duration of anaesthesia was  $\geq 120$  minutes in 74 patients (56.1%) and less than 120 minutes in 58 patients (43.9%). The duration of surgery was less than 120 minutes in 84 patients (67.4%). The majority of operations were scheduled, *i.e.* 95.5% of patients.

**Table 5.** Per-anaesthetic characteristics of patients.

Variables	Frequency (n = 132)	%
Drugs premedication	5	3.8
<b>Anaesthetic technique</b>		
LRA (SA et EDA)	95 (91 et 4)	72
General anaesthesia	31	23.5
Combined anaesthesia	6	4.5
<b>Drugs used in LRA</b>		
Bupivacaine	98	74.2
Morphine	97	73.4
Clonidine	39	29.6
Fentanyl	26	19.7
Sufentanyl	8	6.1
<b>Drogues for general anaesthesia</b>		
Propofol	37	28
Isoflurane	25	18.9
Sevoflurane	5	3.8
Suxamethonium	23	17.4
Atracurium	12	9.1
Fentanyl	13	9.8
Sufentanyl	25	18.9
<b>Use of vasopressor</b>	24	18.2

**Continued**

<b>Acte chirurgical</b>		
Major	99	75
Minor	33	25
<b>Duration of anaesthesia (mediane)</b>		
<120 minutes	58	43.9
≥120 minutes	74	56.1
<b>Duration of surgery (mediane)</b>		
<120 minutes	89	67.4
≥120 minutes	43	32.6
<b>Degree of urgency</b>		
Program	126	95.5
Urgency	6	4.5

Legend: LRA: loco-regional anaesthesia, SA: spinal anaesthesia, EDA: epidural anaesthesia, <: inferior, >: superior, and =: equal.

**3.6. Patient Outcome Characteristics**

**Table 6** presents the patient outcome characteristics.

**Table 6.** Patient characteristics.

<b>Variables</b>	<b>Frequency (n = 132)</b>	<b>%</b>
<b>Intraoperative complications</b>	42	31.8
Arterial hypotension	29	21.96
High blood pressure	6	4.5
Spinal anaesthesia failure	4	3
Delayed spinal block	1	0.75
High spinal anaesthesia	1	0.75
Discomfort	1	0.75
Intraoperative transfusion	26	19.7
<b>Postoperative complications</b>	<b>7</b>	<b>5.3</b>
Pulmonary embolism	2	1.5
Surgical revision	2	1.5
Gastrointestinal bleeding	1	0.75
Agitation	1	0.75
Anemia/Transfusion	1	0.75
Death	2	1.5

### 1) Intraoperative Complications:

The total frequency of complications was 42 patients, or 31.8% of cases. The most frequent complication was arterial hypotension: 29 cases (21.96%). Other complications were: arterial hypertension: 6 cases (4.5%), failure of spinal anaesthesia: 4 cases (3%), delayed spinal block, high spinal anaesthesia, and discomfort: 1 case each (0.75%), and 26 patients (19.7%) received intraoperative transfusion.

### 2. Postoperative complications:

These were observed in 7 patients (5.3%): pulmonary embolism: 2 cases (1.5%); surgical revision (1.5%); and death: 2 cases (1.5%). Both deaths were caused by pulmonary embolism. Other complications included: agitation (0.75%) and gastrointestinal bleeding (0.75%).

### 2) Postoperative complications:

These were observed in 7 patients (5.3%): pulmonary embolism: 2 cases (1.5%); surgical revision (1.5%) and death: 2 cases (1.5%). Both deaths were due to pulmonary embolism. Other complications were agitation (0.75%) and digestive haemorrhage (0.75%). Thromboprophylaxis was administered to all patients at risk of thromboembolism with enoxaparin forth ours after surgery at dose between 40 and 80 mg according to the weight of patient and continued for three weeks. Direct oral anticoagulants are not widely available.

## 3.7. Indications and Frequent Surgical Procedures

**Table 7** shows the indications and surgical procedures.

**Table 7.** Indications and frequent surgical procedures.

Indications of surgery	n (%)	Frequent surgical procedures	n (%)
Hip fracture	21 (15.9)	<b>Major procedures</b>	99 (75)
Femoral shaft fracture	19 (14.3)	Total hip replacement	34 (25.7)
Leg bone fractures	17 (12.8)	Osteosynthesis without EF	25 (18.9)
Coxarthrosis	16 (12.1)	Osteosynthesis with EF	16 (12.1)
Gonarthrosis	15 (11.3)	Total knee replacement	15 (11.3)
Gangrene	7 (5.3)	Amputation/disarticulation	8 (6)
Removal of osteosynthesis devices	7 (5.3)	Arthrodesis	1 (0.7)
Femoram head necrosis	5 (3.7)	<b>Minor procedures</b>	33 (25)
Bone malformations	5 (3.7)	Orthopaedic reduction	11 (8.3)
Dislocations	5 (3.7)	Removal of osteosynthesis devices	7 (5.3)
Humerus fractures	4 (3)	Tendon repair	2 (1.5)
Vicious callus	2 (1.5)	Nerve release	1 (0.7)
Tendon rupture	2 (1.5)	Cure of osteomyelitis	1 (0.7)
Others	7 (5.3)	Others	11 (8.3)

Legend: EF = external fixator.

The indications for surgery were: hip fractures (femoral head and neck) 21 cases (15.9%), femoral shaft fractures 19 cases (14.3%), leg bone fractures 17 cases (12.8%), coxarthrosis 16 cases (12.1%), gonarthrosis 15 cases (11.3%), gangrene 7 cases (5.3%), removal of osteosynthesis devices 7 cases (5.3%), femoral head necrosis 5 cases (3.7%), bone malformations 5 cases (3.7%), dislocations 5 cases (3.7%), humerus fractures 4 cases (3%), vicious callus 2 cases (1.5%), tendon rupture 2 cases (1.5%) and others which included: carpal tunnel (2), chronic osteomyelitis (1), traumatic amputation (1), infection on total hip prosthesis (1), symphyseal disjunction (1) and foreign body in the knee (1).

Major surgical procedures were: total hip replacement 34 cases (25.7%), osteosynthesis other than with external fixator 25 cases (18.9%), osteosynthesis with external fixator 16 cases (12.1%), total knee replacement 15 cases (11.3%), amputation/disarticulation 8 cases (6%), arthrodesis one case (0.7%). Minor surgical procedures were: orthopaedic reduction 11 cases (8.3%), removal of osteosynthesis devices 7 cases (5.3%), tendon repair 2 cases (1.5%), nerve release 2 cases (1.5%), tenotomy one case (0.75%) and others 11 cases (8.3%).

### 3.8. Factors Associated with Complications

#### 3.8.1. Factors Associated with Intraoperative Complications

**Table 8** presents the factors associated with intraoperative incidents.

**Table 8.** Factors associated with intraoperative complications.

Variable	Univariate analyse		Multivariate analyse	
	p	OR (IC95%)	p	OR (IC95%)
<b>Sex</b>				
Male		1		1
Female	<b>0.047</b>	2.01 (1.56 - 4.24)	0.105	2.01 (0.86 - 4.70)
<b>Cardiovascular comorbidity</b>				
No		1		1
Yes	<b>0.043</b>	2.34 (1.03 - 5.33)	<b>0.028</b>	2.83 (1.12 - 7.15)
<b>VTED risk</b>				
No		1		1
Yes	<b>0.023</b>	2.71 (1.27 - 5.73)	<b>0.022</b>	3.07 (2.51 - 8.39)
<b>Surgical procedure</b>				
Minor		1		1
Major	<b>0.008</b>	4.52 (2.47 - 6.86)	<b>0.016</b>	2.61 (1.70 - 4.80)
<b>Duration of anaesthesia</b>				
<2 hours		1		1
≥2 hours	<b>0.046</b>	1.91 (1.19 - 4.10)	0.907	1.06 (0.42 - 2.62)
<b>Degree of urgency</b>				
Program		1		1
Urgency	<b>0.013</b>	4.63 (2.82 - 6.37)	<b>0.011</b>	4.89 (2.68 - 6.90)

**Legend:** VTED = venous thromboembolic disease, OR = odds ratio, CI (95%) = 95% confidence interval.

In multivariate analysis, only the presence of cardiovascular comorbidity, the presence of thromboembolic risk, major surgery, and emergency surgery were factors associated with the occurrence of intraoperative complications ( $p < 0.05$ ).

### 3.8.2. Factors Associated with Intraoperative Transfusion

**Table 9** presents the factors associated with intraoperative transfusion.

In the multivariate analysis, only ASA III class, the presence of intraoperative complications, major procedure, and surgical duration greater than or equal to two hours persisted as factors associated with intraoperative transfusion, while non-alcohol consumption remained protective against transfusion.

**Table 9.** Factors associated with intraoperative transfusion.

Variable	Univariate analyse		Multivariate analyse	
	P	OR (IC 95%)	P	OR (IC 95%)
<b>Respiratory comorbidity</b>				
No		1		1
Yes	<b>0.048</b>	2.75 (1.76 - 4.97)	0.305	1.15 (0.19 - 1.47)
<b>Alcohol consumption</b>				
Yes		1		1
No	<b>0.035</b>	0.32 (0.11 - 0.92)	<b>0.020</b>	0.19 (0.05 - 0.77)
<b>ASA class</b>				
I		1		1
II	0.421	1.90 (0.40 - 8.99)	0.760	1.33 (0.22 - 1.78)
III	<b>0.004</b>	4.00 (2.08 - 6.27)	<b>0.010</b>	3.63 (2.70 - 5.45)
<b>Intraoperative complications</b>				
No		1		1
Yes	<b>0.002</b>	3.99 (1.63 - 9.74)	<b>0.007</b>	3.83 (2.55 - 5.09)
<b>Surgical procedure</b>				
Minor		1		1
Major	<b>0.022</b>	3.81 (1.40 - 8.32)	<b>0.003</b>	3.35 (2.70 - 6.38)
<b>Duration of anaesthesia</b>				
<2 hours		1		1
≥2 hours	<b>0.021</b>	3.21 (1.19 - 8.63)	0.842	1.17 (0.26 - 5.26)
<b>Duration of surgery</b>				
<2 hours		1		1
≥2 hours	<b>0.038</b>	2.53 (1.05 - 6.09)	<b>0.025</b>	2.15 (1.59 - 4.89)
<b>Profile of elderly</b>				
Vigorous		1		1
Frail	0.910	1.13 (0.12 - 2.34)	0.813	1.11 (0.34 - 1.67)
Dependent	0.018	4.80 (2.48 - 8.46)	0.184	2.12 (0.54 - 3.12)

Legend: ASA = American Society of Anesthesiologists. OR = Odds ratio. CI (95%) = 95% confidence interval.

## 4. Discussion

This study was conducted to determine the morbidity and mortality encountered during anaesthesia for orthopaedic surgery in the elderly and the factors associated with it. This type of anaesthesia concerns 1.2% of all anaesthetised patients, 18.67% of all elderly patients and 0.8% of all orthopaedic surgery patients. The average age is 68.5, with a slight male predominance, and the surgical procedures are often major. Spinal anaesthesia is the most commonly used anaesthetic technique and arterial hypotension is the most frequent intraoperative complication, while intraoperative transfusion accounts for 20%. Pulmonary embolism (1.5%) was the complication responsible for two deaths. The presence of cardiovascular co-morbidity or thromboembolic risk, major surgery and urgency were factors associated with the occurrence of intraoperative complications. ASA III class, the presence of intraoperative complications, major surgery and duration of surgery greater than or equal to two hours were factors associated with intraoperative transfusion, whereas non-consumption of alcohol was protective against transfusion. The mean haemoglobin level was lower in the transfused group (10.4 g/dl) than in the non-transfused group (12.2 g/dl).

The mean age was  $68.5 \pm 6.9$ . The majority of patients were between 60 and 69 years of age, accounting for 60.6% of all patients. Our results are similar to those of many authors, in particular: Garcia-Casanovas [21] in a retrospective multicentre cohort study of 30,926 patients undergoing total knee or hip arthroplasty found a median age of 71 years. Ba EHB [22] in Dakar found a mean age of 74.9 years for elderly patients undergoing all types of surgery. Aubrun [1] found an average age of  $67 \pm 21$  years, and the 2019 report by the French high health authority [23] found an average age of  $65 \pm 20$  years. This reflects the reality of an ageing world population and their frequency in the operating theatre. The majority of patients were male, with a M/F sex ratio of 1.09. In contrast, Garcia-Casanovas [21] found that 57.1% of patients were female. The literature reports an over-representation of women, particularly in femoral neck fractures, in association with post-menopausal osteoporosis [24]. Perhaps, in our context, elderly women with hip fractures do not consult a doctor and stay at home with their fractures or treat them traditionally. Obesity affected 28% of patients, corroborating the findings of the WHO's 2016 report, which showed that the prevalence of obesity is increasing worldwide.

It is likely that the western lifestyle adopted in our cities and the more westernised diet explain this fact [25]. Without any convincing explanation, there were no underweight patients in this series. In addition, cardiovascular (64.5%), renal and metabolic disorders (38.6%) and neuropsychiatric (9.4%) comorbidities predominated, in line with the literature on orthopaedic surgery in the elderly [1] [26] [27]. Aging is accompanied by an increased risk of comorbidity [8]. The elderly and their frequent co-morbidities have a high risk of VTE, and in our study, patients with a risk of VTE represented 83.3%. The presence of this thromboembolic risk was a factor associated with the occurrence of complications. The two

deaths recorded were due to pulmonary embolism. This calls for a rigorous prophylactic strategy. In orthopaedic surgery, particularly in the elderly, guidelines recommend the use of low molecular weight heparins (LMWH) or direct oral anticoagulants, adapted to the patient's profile and the type of operation [28]. In this series, despite systematic prevention with Enoxaparin (four hours after the end of surgery, 40 to 80 mg per day for at least three weeks, given the scarcity of direct oral anticoagulants on the local market), two fatal cases were recorded. In our study, ASA class II was predominant (69.7%). Our results are similar to those of Weickmans *et al.* [29] who found a predominance of ASA class 2 (81/100, 81%). The High health authority report in France [23] also noted a predominance (73%) of ASA class 2. This could be explained by the high prevalence of cardiovascular and metabolic co-morbidities which raise the ASA score. In our study, no biological variable showed a statistically significant difference between patients with or without intraoperative complications. These results suggest that in elderly patients undergoing orthopaedic surgery, intraoperative complications do not appear to be directly correlated with routine biological parameters. This corroborates the data in the literature which indicate that in this context, other factors such as preoperative functional status, co-morbid conditions (frailty, heart failure) or the complexity of the surgical procedure play a predominant role in the occurrence of intraoperative events [30] [31]. However, a significant difference was observed in haemoglobin levels in patients who received an intraoperative transfusion. Transfused patients had a significantly lower preoperative haemoglobin ( $10.4 \pm 2.4$  g/dl) than non-transfused patients ( $12.2 \pm 1.8$  g/dl;  $p < 0.001$ ). This observation is in line with numerous studies, which identify preoperative anaemia as a major risk factor for transfusion, particularly in the context of major musculoskeletal surgery in the elderly [32] [33]. In this population, the proactive strategy of Patient Blood Management (PBM) is fully justified. For example, the correction of anaemia prior to orthopaedic surgery, particularly for femoral neck fractures or arthroplasty, is now strongly recommended [34]. Unfortunately, PBM has been slow to become established in the country because of local problems related to patient scheduling, collaboration with the surgeons and financial problems.

Locoregional anaesthesia was the technique used in 72% of cases, followed by GA in 23.4%. The anaesthetic agents most commonly used in LRA were bupivacaine and intrathecal morphine, sometimes combined with clonidine or fat-soluble opioids such as fentanyl. This combination aims to potentiate the analgesic effect while reducing the necessary doses of each agent, a strategy that is particularly beneficial in elderly patients, who are more sensitive to side effects [35] [36]. Fentanyl and sufentanyl were the morphinics used intraoperatively, and it should be noted that this use must remain cautious in the elderly patient, given the risk of respiratory depression and postoperative confusion [37]. It should be noted that short-acting morphines such as alfentanil and remifentanyl are not available on the local market. The same applies to local anaesthetics such as levobupivacaine and ropivacaine. In addition, nearly 18% of patients required the admin-

istration of vasopressors, probably due to the vasodilatory effect of spinal anaesthesia, to which elderly patients are particularly sensitive due to their lower physiological reserve [38]. This frequency is consistent with the data in the literature on spinal anaesthesia in geriatric orthopaedics. The data in the literature indicate that one anaesthetic technique (GA vs ALR) should not be preferred in order to reduce mortality after surgery for fracture of the upper end of the femur), for example. There is currently no randomised prospective study to answer the question of a possible advantage in terms of mortality with general anaesthesia (GA) versus spinal anaesthesia (SA). There are contradictory retrospective studies sometimes finding an advantage in favour of SA and sometimes no difference [39]. The choice of anaesthetic technique depends on the habits of the intensive care anaesthetist, comorbidities and patient choice. It is probable that the lower cost and the ease of carrying out spinal anaesthesia militated in favour of this technique in a context of limited resources. The lack of experience and equipment has not permitted the practice of peripheral block. Intraoperative complications were observed in 31.8% of patients, a notable frequency in the context of orthopaedic surgery in elderly patients. Arterial hypotension was the most frequent complication (21.96%), probably related to spinal anaesthesia, the technique used in the majority of this series. This observation is in line with the data in the literature, in particular those reported by Capdevila [40], who stresses the frequency of hypotension in elderly patients in association with a reduction in vascular tone and an altered haemodynamic response to locoregional anaesthesia. As hypotension is recognised as an important independent factor in the occurrence of complications and postoperative mortality [41] [42], the French Society of Anaesthesia and Critical Care recommends that any intraoperative hypotension in elderly patients should be treated without delay in order to limit the risk of renal or myocardial complications [39]. This is why 18% of patients had benefited from vasopressors. Furthermore, the recourse to intraoperative transfusion in 19.7% of patients reflects the importance of blood loss in major orthopaedic surgery, but also the presence of anaemia preoperatively. This rate is comparable to that found in Carson's work [43], which shows a high prevalence of transfusion in elderly patients, often linked to a reduced physiological reserve and an increased prevalence of preoperative anaemia. Postoperative complications were limited (5.3%), but potentially serious, including two cases of fatal pulmonary embolism (1.5%). These results are in line with the observations of Anderson [44], who reported that the risk of thromboembolism remains significantly increased after major orthopaedic surgery, despite preventive measures. Careful monitoring of these patients in the immediate postoperative period and well-managed anticoagulant prophylaxis therefore appear to be essential in limiting these serious events. However, despite the fact that prophylaxis with Enoxaparin was the rule in all patients with this risk, two cases of fatal pulmonary embolism were recorded. Only one case of agitation and no cases of delirium were encountered in this series, although this is a frequent complication in the elderly, contrary to the data in the literature [9] [10].

This may be explained by the fact that the elderly in our context live in families with children or grandchildren and not in old people's homes as in high-income countries.

Our study highlights the preponderance of traumatic pathologies among the indications for surgery, with fractures of the hip (15.9%), femoral shaft (14.3%) and leg bones (12.8%) in the lead. These results corroborate data from the literature, which reports a high incidence of fractures of the lower limbs, particularly in elderly subjects, due to osteoporosis and accidental falls [45]. The frequency of hip fractures, in particular, is a public health issue in countries with limited resources, where specialised facilities are sometimes inadequate [46]. In terms of treatment, total hip replacement was the most common surgical procedure (25.7%), followed by osteosynthesis without external fixator (18.9%) and osteosynthesis with external fixator (12.1%). These results are in line with current recommendations, which favour arthroplasty for intracapsular femoral neck fractures in elderly patients to ensure optimal functional recovery [47]. Nevertheless, osteosynthesis remains the treatment of choice for diaphyseal fractures and certain open fractures, particularly in young patients or patients with polytrauma [48]. Chronic degenerative diseases such as coxarthrosis (12.1%) and gonarthrosis (11.3%) account for a large proportion of indications for surgery. The use of total hip or knee replacement in these cases reflects the technological advances and functional benefits demonstrated in several studies [49]. The presence of gangrene (5.3%) justifies recourse to mutilating procedures such as amputation or disarticulation (6%). This frequency highlights the importance of delays in treatment, which are common in low-resource countries where access to specialist care is limited [50]. Lastly, removal of osteosynthesis material accounts for 5.3% of operations, reflecting the importance of long-term post-operative follow-up. The literature emphasises that this type of procedure, although often secondary, remains essential in certain cases of chronic pain, infection or functional discomfort [51]. Several factors were found to be independently associated with the occurrence of intraoperative complications. Cardiovascular comorbidities (OR = 2.83; 95% CI: 1.12 - 7.15) are a major risk factor, in line with the data of Fleisher and Lee [52] [53] on the haemodynamic impact of major surgery in frail patients. The risk of VTE was also an important predictive factor (OR = 3.07; CI95%: 2.51 - 8.39), which underlines the need for systematic screening and appropriate prophylaxis in this population, particularly after hip or knee surgery, known for their high thromboembolic risk [54]. Furthermore, the performance of a major surgical procedure (OR = 2.61; IC95%: 1.70 - 4.80) and the urgency of the operation (OR = 4.89; IC95%: 2.68 - 6.90) are two factors strongly associated with an increased risk of complications. Urgent surgery, particularly for femoral neck fractures, is often associated with a lack of optimal preoperative preparation, which may explain the increased risk [55]. These results confirm the importance of a rigorous, individualised preoperative assessment in elderly patients, taking into account cardiovascular comorbidities, thromboembolic risk, the type of surgery envisaged and its

emergency context. Anticipatory multidisciplinary management, including anaesthetists, geriatricians and surgeons, is essential to limit intraoperative complications in this high-risk population. The ASA III score was a risk factor for intraoperative transfusion, which is consistent with the data in the literature: in elderly patients, an altered general condition not only increases transfusion requirements but also limits tolerance of anaemia, due to reduced physiological reserves [56] [57]. Furthermore, the duration of surgery  $\geq 2$  hours, the occurrence of intraoperative complications and the major nature of the operation were also associated with an increased risk of transfusion. These factors reflect greater operative complexity, often correlated with increased bleeding, particularly in procedures such as arthroplasty or complex osteosynthesis [58]. These results are in line with those of Carson who found a correlation between operating time, blood loss and recourse to transfusion in orthopaedics in elderly patients [43] [55]. More originally, the absence of alcohol consumption was found to be a protective factor. Although this finding is less widely reported in the literature, it may be explained by the known effects of chronic alcoholism on liver function and coagulation. These alterations may predispose to haemorrhagic disorders, which are particularly deleterious in elderly patients who are often poly pathological [59]. On the other hand, variables such as respiratory comorbidities or duration of anaesthesia were not associated with the risk of transfusion after adjustment. This suggests that these elements, although potentially correlated with an altered general state, are not independent factors but rather indirect markers of severity.

Overall, these results argue in favour of an individualised transfusion risk management strategy for orthopaedic surgery in the elderly. A Patient Blood Management approach integrating preoperative optimisation of haemoglobin, assessment of comorbidities and adapted planning of the surgical procedure seems essential to reduce the need for transfusions and their associated complications.

#### **Strengths and Limitations of the Study**

The strength of our study lies in the fact that it is the first to assess the factors associated with morbidity and mortality in orthopaedic surgery on elderly patients in our setting. This will help to improve the management of these patients and show practitioners that elderly patients currently benefit from many major orthopaedic procedures in our setting. Apart from its strengths, this study also has its limitations. The first limitation is the retrospective nature of the analysis. The information gathered is dependent on registry data. Some interesting information, such as the Lee score, was not found. The second limitation is linked to its mono-centric nature, which may limit the generalisability of the results.

### **5. Conclusion**

The results of this study show that anaesthesia of elderly patients for orthopaedic procedures is becoming increasingly common, and that the risk of complications and even mortality is not zero. Good preoperative assessment of the haemodynamic status of these patients, together with rigorous and optimal management

of the intraoperative and postoperative periods, will help to minimise this risk as much as possible. With the foreseeable increase in the number of elderly people in Africa in general and in the DRC in particular, it is important that their care is adapted to their needs, and it is probably necessary to advocate specialised multi-disciplinary intraoperative management involving intensive care anaesthetists, surgeons, geriatricians, pharmacists and carers in order to improve the postoperative outcome of elderly patients undergoing orthopaedic surgery. A prospective study, therefore, seems useful, and an implementation study of patient blood management seems more than necessary.

### Authors' Contributions

Patrick Kintieti: Study design, data collection and drafting of the manuscript; Wilfrid Mbombo: Study design, data collection and drafting of the manuscript; Alphonse Mosolo: data collection and correction of the manuscript; Aliocha Nkodila: Statistical analysis; All other authors: correction of the manuscript.

### Acknowledgements

We would like to thank the entire operating theatre team at Monkole Hospital for their collaboration: Benoît Rwabahizi, Cathy Nziavake, Jacques Byengangu, Maguy Tshiabu, Olga Milo, Samuel Makengo and Sylvie Ngunda.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

### References

- [1] Aubrun, F. (2011) Fracture de l'extrémité supérieure du fémur du patient âgé: Aspect épidémiologique, facteurs de risque. *Annales Françaises d'Anesthésie et de Réanimation*, **30**, e37-e39. <https://doi.org/10.1016/j.annfar.2011.08.010>
- [2] Valin, J. (2001) Tables de mortalité françaises pour les XIXe et XXe siècles et projections pour le XXIe siècle. Broché.
- [3] Organisation mondiale de la santé (2015) Vieillesse et santé Aide-mémoire N°404. <http://www.who.int/mediacentre/factsheets/fs404/fr/>
- [4] McKhann, G.M., Knopman, D.S., Chertkow, H., Hyman, B.T., Jack, C.R., Kawas, C.H., *et al.* (2011) The Diagnosis of Dementia Due to Alzheimer's Disease: Recommendations from the National Institute on Aging-Alzheimer's Association Workgroups on Diagnostic Guidelines for Alzheimer's Disease. *Alzheimer's & Dementia*, **7**, 263-269. <https://doi.org/10.1016/j.jalz.2011.03.005>
- [5] United Nations (2023) World Population Ageing 2023 Highlights. UN Department of Economic and Social Affairs.
- [6] Delaunay, C., Biau, D., Jeanrot, C. and Collet, C. (2010) Mortalité après fracture du col du fémur chez les personnes âgées: État des lieux. *Orthopaedics & Traumatology: Surgery & Research*, **96**, 583-588.
- [7] Légaré, J., Decarie, Y. and Dagenais, M. (2011) Vieillesse et systèmes de soins: Quelles implications? *Cahiers Québécois de Démographie*, **40**, 229-248.

- [8] Hamel, M.B., Henderson, W.G., Khuri, S.F. and Daley, J. (2005) Surgical Outcomes for Patients Aged 80 and Older: Morbidity and Mortality from Major Noncardiac Surgery. *Journal of the American Geriatrics Society*, **53**, 424-429. <https://doi.org/10.1111/j.1532-5415.2005.53159.x>
- [9] Monk, T.G., Weldon, B.C., Garvan, C.W., Dede, D.E., van der Aa, M.T., Heilman, K.M., et al. (2008) Predictors of Cognitive Dysfunction after Major Noncardiac Surgery. *Anesthesiology*, **108**, 18-30. <https://doi.org/10.1097/01.anes.0000296071.19434.1e>
- [10] Sear, J.W. (2006) Risk and Outcomes in Anaesthesia. *British Journal of Anaesthesia*, **97**, 4-10.
- [11] Sieber, F.E. (2009) Postoperative Delirium in the Elderly Surgical Patient. *Anesthesiology Clinics*, **27**, 451-464. <https://doi.org/10.1016/j.anclin.2009.07.009>
- [12] Walker, I.A., Obua, A.D., Mouton, F., Wilson, I.H. and Hodges, S.C. (2013) Paediatric Surgery and Anaesthesia in Sub-Saharan Africa: A Cross-Sectional Survey of Providers. *Anaesthesia*, **68**, 865-872.
- [13] Chikumba, E. and Young, J. (2011) Anaesthesia in Developing Countries—What Can We Learn from Malawi? *Anaesthesia*, **66**, 675-680.
- [14] Biccard, B.M., Madiba, T.E., Kluys, H., Munlemvo, D.M., Madzimbamuto, F.D., Basenero, A., et al. (2018) Perioperative Patient Outcomes in the African Surgical Outcomes Study: A 7-Day Prospective Observational Cohort Study. *The Lancet*, **391**, 1589-1598. [https://doi.org/10.1016/s0140-6736\(18\)30001-1](https://doi.org/10.1016/s0140-6736(18)30001-1)
- [15] Turrentine, F.E., Wang, H., Simpson, V.B. and Jones, R.S. (2006) Surgical Risk Factors, Morbidity, and Mortality in Elderly Patients. *Journal of the American College of Surgeons*, **203**, 865-877. <https://doi.org/10.1016/j.jamcollsurg.2006.08.026>
- [16] Rolland, Y., Benetos, A., Gentric, A., et al. (2011) La fragilité de la personne âgée: Un consensus bref de la Société française de gériatrie et gérontologie. *Gériatrie et Psychologie Neuropsychiatrie du Vieillessement*, **9**, 387-390.
- [17] Barbosa, T.d.A., Souza, A.M.F.d., Leme, F.C.O., Grassi, L.D.V., Cintra, F.B., Lima, R.M.e., et al. (2019) Complicações perioperatórias e mortalidade em pacientes idosos submetidos a cirurgia para correção de fratura de fêmur: Estudo prospectivo observacional. *Brazilian Journal of Anesthesiology*, **69**, 569-579. <https://doi.org/10.1016/j.bjan.2019.09.004>
- [18] Guyen, O. (2021) Fractures du col fémoral chez le sujet âgé. *Revue de Chirurgie Orthopédique*, **107**, 210-218.
- [19] Mbombo, W., Chichi, M., Nkoy, L., Mosolo, A., Mbuyi, F., Isengingo, C., et al. (2024) Factors Associated with Complications in Anaesthesia of the Elderly in a Low-Income Country: The Case of MONKOLE Hospital Centre. *Japan Journal of Medical Science*, **5**, 201-207.
- [20] Lavy, C., Tindall, A., Steinlechner, C., Mkandawire, N. and Chisi, J. (2007) Surgery in Malawi—The Neglected Component of the Health Sector. *Tropical Doctor*, **37**, 219-322.
- [21] Garcia-Casanovas, A., Bisbe, E., Vizoso, A., Sarsanedas, E., Garcia-Altes, A., Colomina, M.J., et al. (2025) Association between Adherence to Patient Blood Management Recommendations and Postoperative Complications in Hip and Knee Arthroplasty. *Anesthesiology*. <https://doi.org/10.1097/aln.0000000000005450>
- [22] Ba, E.H.B., Léye, P.A., Traoré, M.M., et al. (2016) Facteurs de risque de mortalité périopératoire des sujets âgés après chirurgie en urgence à Dakar. *La Revue Africaine d'Anesthésiologie et de Médecine d'Urgence*, **21**, 25.

- [23] (2016) Programme de RAAC-Haute autorité de santé. **83**, 6-66. <https://www.has-santé.fr>
- [24] Cummings, S.R. and Melton, L.J. (2002) Epidemiology and Outcomes of Osteoporotic Fractures. *The Lancet*, **359**, 1761-1767. [https://doi.org/10.1016/s0140-6736\(02\)08657-9](https://doi.org/10.1016/s0140-6736(02)08657-9)
- [25] Ministère des solidarités et de la santé-obésité (1920) Prévention et prise en charge de l'obésité. 937-967. <https://solidarites-sante.gouv.fr>
- [26] Leme, L.E., Sitta Mdo, C., Toledo, M. and da Silva Henriques, S. (2011) Orthopedic Surgery among the Elderly: Clinical Characteristics. *Revista Brasileira de Ortopedia (English Edition)*, **46**, 238-246. [https://doi.org/10.1016/s2255-4971\(15\)30189-0](https://doi.org/10.1016/s2255-4971(15)30189-0)
- [27] Beaupre, L.A., Khong, H., Smith, C., et al. (2019) The Effect of Comorbidities on Hip Fracture Outcomes in the Elderly: A Population-Based Study. *The Journal of Arthroplasty*, **34**, 1616-1620.
- [28] Samama, C.M., Laporte, S., Rosencher, N., et al. (2011) Prevention of Venous Thromboembolism in Orthopedic Surgery: Guidelines Update. *Thrombosis Research*, **127**, 592-596.
- [29] Weickmans, H., Rouanet, S. and Rosenthal, D. (2014) RAAC après prothèse totale de hanche: Lever précoce et facteurs déterminant le jour de sortie. *Annales françaises d'anesthésie-réanimation*, 241-247.
- [30] Della Rocca, G.J., Leung, J.M. and Prielipp, R.C. (2012) Anesthetic Management of the Geriatric Orthopedic Patient. *Anesthesiology Clinics*, **30**, 771-785.
- [31] White, S.M., Moppett, I.K. and Griffiths, R. (2019) Perioperative Care of the Older Orthopaedic Surgical Patient. *Anaesthesia*, **74**, 80-88.
- [32] Muñoz, M., Acheson, A.G., Auerbach, M., Besser, M., Habler, O., Kehlet, H., et al. (2016) International Consensus Statement on the Peri-Operative Management of Anaemia and Iron Deficiency. *Anaesthesia*, **72**, 233-247. <https://doi.org/10.1111/anae.13773>
- [33] Spahn, D.R. and Goodnough, L.T. (2013) Alternatives to Blood Transfusion. *The Lancet*, **381**, 1855-1865. [https://doi.org/10.1016/s0140-6736\(13\)60808-9](https://doi.org/10.1016/s0140-6736(13)60808-9)
- [34] Goodnough, L.T., Shander, A. and Riou, B. (2012) Patient Blood Management. *Anesthesiology*, **116**, 1367-1376. <https://doi.org/10.1097/aln.0b013e318254d1a3>
- [35] Capdevila, X., et al. (2005) Adjuvants to Local Anesthetics in Regional Anesthesia. *Anesthesia & Analgesia*, **100**, 1365-1379.
- [36] Wu, C.L., et al. (2004) Postoperative Analgesic Effects of Single-Dose Intrathecal Morphine in Patients Undergoing Orthopedic Surgery: A Meta-Analysis. *Anesthesiology*, **101**, 1346-1353.
- [37] Radtke, F.M., et al. (2010) Risk Factors for Inadequate Emergence after Anesthesia: Emergence Delirium and Postoperative Cognitive Dysfunction. *Current Opinion in Anaesthesiology*, **23**, 670-675.
- [38] Carpenter, R.L., Caplan, R.A., Brown, D.L., Stephenson, C. and Wu, R. (1992) Incidence and Risk Factors for Side Effects of Spinal Anesthesia. *Anesthesiology*, **76**, 906-916. <https://doi.org/10.1097/0000542-199206000-00006>
- [39] RFE SFAR-Sujets-âgés. Cas extrémité supérieure du fémur mars 2019.
- [40] Capdevila, X., Barthelet, Y., Biboulet, P., Ryckwaert, Y., Rubenovitch, J. and d'Athis, F. (2003) Effects of Spinal Anesthesia on Intraoperative Hemodynamics and Blood Loss in Elderly Patients Undergoing Hip Surgery. *Anesthesia & Analgesia*, **96**, 1128-1133.

- [41] Bijker, J.B., Persoon, S., Peelen, L.M., Moons, K.G.M., Kalkman, C.J., Kappelle, L.J., *et al.* (2012) Intraoperative Hypotension and Perioperative Ischemic Stroke after General Surgery: A Nested Case-Control Study. *Anesthesiology*, **116**, 658-664. <https://doi.org/10.1097/aln.0b013e3182472320>
- [42] Walsh, M., Devereaux, P.J., Garg, A.X., Kurz, A., Turan, A., Rodseth, R.N., *et al.* (2013) Relationship between Intraoperative Mean Arterial Pressure and Clinical Outcomes after Noncardiac Surgery: Toward an Empirical Definition of Hypotension. *Anesthesiology*, **119**, 507-515. <https://doi.org/10.1097/aln.0b013e3182a10e26>
- [43] Carson, J.L., Guyatt, G., Heddle, N.M., Grossman, B.J., Cohn, C.S., Fung, M.K., *et al.* (2016) Clinical Practice Guidelines from the AABB: Red Blood Cell Transfusion Thresholds and Storage. *JAMA*, **316**, 2025-2035. <https://doi.org/10.1001/jama.2016.9185>
- [44] Anderson, F.A. and Spencer, F.A. (2003) Risk Factors for Venous Thromboembolism. *Circulation*, **107**, I9-I16. <https://doi.org/10.1161/01.cir.0000078469.07362.e6>
- [45] Bousson, V., Bergot, C. and Laval-Jeantet, M. (2017) Fractures ostéoporotiques: Épidémiologie et prise en charge. *Revue du Rhumatisme*, **84**, 491-498.
- [46] Diallo, A., Kouyaté, M. and Souaré, S. (2019) Fractures de la hanche en milieu africain: Aspects épidémiologiques et thérapeutiques. *Mali Medical*, **34**, 12-18.
- [47] Roche, J.J. and Wenn, R.T. (2015) Treatment of Hip Fractures in the Elderly: Evidence-Based Management. *Geriatric Orthopaedic Surgery & Rehabilitation*, **6**, 139-144.
- [48] Mabiala, J.P., Ndinga, H. and Okemba, E. (2018) Ostéosynthèse des fractures diaphysaires des membres inférieurs: Indications et résultats. *Revue Africaine de Chirurgie Orthopédique et Traumatologique*, **7**, 101-108.
- [49] Jolles, B. and Leyvraz, P. (2006) L'arthroplastie totale de genou: évolution et résultats actuels. *Forum Médical Suisse*, **6**, 97-100. <https://doi.org/10.4414/fms.2006.05767>
- [50] N'Dri, K., Konan, S. and Akpa, R. (2014) Les amputations de membres en Afrique subsaharienne: Épidémiologie et prévention. *Santé Publique*, **26**, 235-240.
- [51] Unno Veith, F., Lädemann, A. and Hoffmeyer, P. (2009) Ablation de matériel d'ostéosynthèse: Un mal nécessaire? *Revue Médicale Suisse*, **5**, 977-980. <https://doi.org/10.53738/revmed.2009.5.201.0977>
- [52] Fleisher, L.A., Fleischmann, K.E., Auerbach, A.D., *et al.* (2014) 2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery. *Journal of the American College of Cardiology*, **64**, e77-e137.
- [53] Lee, M.J., Hacquebord, J. and Varacallo, M. (2020) Perioperative Complications in Elderly Orthopedic Patients. StatPearls Publishing.
- [54] Falck-Ytter, Y., Francis, C.W., Johanson, N.A., Curley, C., Dahl, O.E., Schulman, S., *et al.* (2012) Prevention of VTE in Orthopedic Surgery Patients. *Chest*, **141**, e278S-e325S. <https://doi.org/10.1378/chest.11-2404>
- [55] Abrahamsen, B., van Staa, T., Ariely, R., Olson, M. and Cooper, C. (2009) Excess Mortality Following Hip Fracture: A Systematic Epidemiological Review. *Osteoporosis International*, **20**, 1633-1650. <https://doi.org/10.1007/s00198-009-0920-3>
- [56] Muñoz, M., Laso-Morales, M.J., Gómez-Ramírez, S., Cadellas, M., Núñez-Matas, M.J. and García-Erce, J.A. (2017) Pre-Operative Haemoglobin Levels and Iron Status in a Large Multicentre Cohort of Patients Undergoing Major Elective Surgery. *Anaesthesia*, **72**, 826-834. <https://doi.org/10.1111/anae.13840>
- [57] Kietai, S., Kaufner, L., Gombotz, H., *et al.* (2019) Standards of Perioperative Anemia

Management: A Guideline from the ESAIC. *European Journal of Anaesthesiology*, **36**, 153-171.

- [58] Nadler, M., Gonzalez Della Valle, A., Pearse, L., *et al.* (2015) Minimizing Blood Transfusion in Total Hip and Knee Arthroplasty. *Journal of the American Academy of Orthopaedic Surgeons*, **23**, 739-748.
- [59] Nuttall, G.A., Santrach, P.J., Oliver, W.C., Horlocker, T.T. and Shives, T.C. (2003) The Predictors of Red Cell Transfusion in Total Hip Arthroplasty. *Transfusion*, **43**, 1236-1241.