Open Journal of Anesthesiology, 2025, 15(4), 115-135
https://www.scirp.org/journal/ojanes
ISSN Online: 2164-5558
ISSN Print: 2164-5531

Factors Associated with Perianesthetic Complications in Pediatric Surgery in Kinshasa Hospitals

Gabriel Makeya Mubobo[1,2,3], Wilfrid Mbombo[1,4*], Vivien Hong Tuan Ha[3], Alphonse Mosolo[1,4], Anatole Kibadi[5], Gibency Mfulani[1], Sylvie Ndjoko[1,6], Jean-Jacques Kalongo[6,7], Patrick Mukuna[1], Martin Mukenga[1], Dénis Mutombo[1], Gilbert Kapiamba[1], Audry Kwamadio[1], Didier Ndjekembo[8], Joseph Nsiala[1], Medard Bula-Bula[1], Berthe Barhayiga[1]

[1]Department of Anesthesia and Intensive Care, University Clinics of Kinshasa, University of Kinshasa, Kinshasa, DR Congo
[2]Faculty of Medicine, University of Kikwit, Kikwit, DR Congo
[3]Medical and Surgical Intensive Care, Grand Hôpital de l'Est Francilien, Meaux, France
[4]Anesthesia and Intensive Care Service, Monkole Hospital Center, Kinshasa, DR Congo
[5]Department of Surgery, University Clinics of Kinshasa, University of Kinshasa, Kinshasa, DR Congo
[6]Anesthesia and Intensive Care Service, Kalembelembe Pediatric Hospital, Kinshasa, DR Congo
[7]Anesthesia and Intensive Care Service, Biamba Marie Mutombo Hospital, Kinshasa, DR Congo
[8]Department of Anesthesia and Intensive Care, Wallonie-Picarde Hospital Center, Tournai, Belgium

Email: gabsmakey@gmail.com, *pwmbombo@yahoo.fr, alphonsemosolo@yahoo.fr, mnsiala78@gmail.com, drmebula@gmail.com, yamukolo@gmail.com, berthebarhayiga@gmail.com, akibadi@yahoo.fr, ndjokosylvie@gmail.com, jeanjacqueskalongo@gmailcom, vhongtuanha@ghef.fr, patmukunam@gmail.com, mukengamartin@gmail.com, mutombodenis75@gmail.com, kapiamba24@gmail.com, gibencymfulani1990@gmail.com, audrykwamadio@gmail.com

How to cite this paper: Mubobo, G.M., Mbombo, W., Hong Tuan Ha, V., Mosolo, A., Kibadi, A., Mfulani, G., Ndjoko, S., Kalongo, J.-J., Mukuna, P., Mukenga, M., Mutombo, D., Kapiamba, G., Kwamadio, A., Ndjekembo, D., Nsiala, J., Bula-Bula, M. and Barhayiga, B. (2025) Factors Associated with Perianesthetic Complications in Pediatric Surgery in Kinshasa Hospitals. *Open Journal of Anesthesiology*, **15**, 115-135.
https://doi.org/10.4236/ojanes.2025.154009

Received: March 13, 2025
Accepted: April 20, 2025
Published: April 23, 2025

Abstract

Background: Despite advances in anesthesia, the risk of complications in pediatric anesthesia remains a major concern. The objective of this study was to identify factors associated with perianesthetic complications in this specialty. **Methods:** This was a retrospective cohort study from June 1 to December 31, 2024, conducted in four hospitals in Kinshasa, which included children from birth to 15 years of age undergoing anesthesia for emergency or scheduled surgical or diagnostic procedures in compliance with ethical rules. Data were analyzed using the R 4.4.2 programming language (R Foundation for Statistical Computing, Austria) for $p < 0.05$. **Results:** 394 children were registered. They were male (57%, sex ratio 1.3), with a mean age of 4.5 ± 4.6 years (from 2 days to 15 years), mostly infants (33.5%) and classified ASA I (60%). Anesthesia conducted by a senior (89%) was general (82.7%) with tracheal intubation (76%), for a scheduled intervention (60%) performed by a senior surgeon (87%) with the predominance of digestive (47%), orthopedic (13%) and urological (10%) surgery. Complications occurred in 28.4%, in per-anesthetic (25.4%) mainly respiratory (14.5%), and in post-operative (16%) often cardiorespiratory cardiac arrest (5.8%) and desaturation (5.6%). Mortality was 7.1% at 3 days and 10.4% at 30 days. ASA score ≥ 3, urgent nature of the intervention, prolonged duration of surgery and reinterventions were major risk factors for morbidity and mortality. **Conclusion:** Compared to previous years, the practice of pediatric anesthesia in our country is improving both in terms of personnel and anesthetic products, with a reduction in the frequency of complications. It seems imperative to optimize the condition of patients and improve intraoperative monitoring for even safer anesthesia. And promote the construction of pediatric hospitals with critical care or resuscitation units and adapted operating theaters, equipped with advanced monitoring equipment for better care of children.

Keywords

Morbidity and Mortality, Pediatric Anesthesia, Retrospective Cohort

1. Introduction

Pediatric anesthesia presents unique challenges due to the physiological and anatomical specificities of children, as well as the variability of responses to anesthetic agents that can underlie a high risk of complications [1]. Two groups of patients are distinguished: those in good health, with a high capacity for recovery, and those whose condition is more precarious due to immaturity or severe acquired or constitutional pathologies [2]. Numerous studies reveal that morbidity and mortality in pediatric anesthesia remain high, particularly in children under three years of age and especially those under one year of age, particularly in low-income countries due to difficulties in care [3]. Although technical and pharmacological advances have improved the safety of anesthesia in children, perianesthetic complications persist and remain frequent. They can cause discomfort, prolong the length of stay in the post-procedural care room, and require unplanned hospitalizations or even admission to intensive care, thus increasing the costs of care and the risk of re-hospitalization [4]. Minor complications, although frequent, have a significant impact on the experience of children and families. Conversely, serious complications, although rarer, can have major consequences. Complications can be respiratory (laryngospasm, bronchospasm, desaturation), cardiovascular (hypotension, bradycardia, arrhythmias) or metabolic (hypoglycemia, hyperkalemia, hypothermia). Several factors influence the occurrence of these complications, including the child's age, ASA (American Society of Anesthesiologists) status, the type of anesthesia used, the anesthesiologist's experience, the type of surgery as well as the pre- and intraoperative conditions [1]. The identification and analysis of these factors are essential to improve anesthetic safety in pediatrics and reduce perioperative morbidity. Studies have identified several risk factors such as comorbidities, ASA score, prematurity and young age [5]. For example, the APRICOT study conducted in Europe reported a rate of critical intraoperative events of 5.2%, with a predominance of respiratory and cardiovascular complications, highlighting the role of young age and medical history as major risk factors [6].

In developing countries, pediatric anesthesia is often performed in unsuitable environments, without specialized personnel and with limited equipment, which increases the risk of complications [7]. Studies conducted in Africa show a higher incidence of complications and postoperative mortality, with a predominance of infectious complications and risk factors such as urgency of surgery and ASA scores 1 and 2 [8] [9]. In Togo, respiratory and cardiovascular complications were reported in 9.03% and 3.28% of patients, respectively, with a perioperative mortality rate of 1.03% [10]. In Kenya, the seven-day postoperative mortality was 1.7%, 17 times higher than in high-income countries [11]. In Cameroon, a study found that 33.1% of patients had at least one complication, with a mortality rate of 7.9% [12].

In the Democratic Republic of Congo (DRC), there is only one hospital specifically for pediatric patients, with university hospitals having all anesthetic specialties. Physicians who practice pediatric anesthesia do not have a pediatric anesthesia specialist diploma, but many anesthetize at least one hundred children per year. Some hospitals have multiparameter monitors (NIBP, SpO_2, ECG, temperature, and capnography), while others do not and monitor children with SpO_2 and a precordial stethoscope. Invasive blood pressure monitoring is exceptional due to a lack of equipment. Similarly, pediatric ventilators (with alveolar gas monitoring) are present in some operating rooms, and others ventilate with the Mapelson system (child system). All anesthetic techniques are practiced, especially general anesthesia with orotracheal intubation or with a laryngeal mask or face mask.

Pediatric perianesthetic complications remain poorly documented. Studies conducted in Kinshasa in 2012 and Lubumbashi in 2023 showed a high incidence of respiratory and cardiovascular complications, with mortality rates of 14% in Kinshasa and 19.8% in Lubumbashi [13] [14].

However, with the evolution of the practice of anesthesia and the demographics of anesthesiologists in Kinshasa, it seems necessary to undertake research to better understand the current factors of morbidity and mortality in pediatric anesthesia and this is the objective of this study.

2. Methods

2.1. Type, Period and Framework of the Study

This is a retrospective cohort study covering the period from June 1 to December 31, 2024. It took place in four hospitals in the city of Kinshasa where pediatric anesthesia is practiced by anesthesiologists and resuscitators who agreed to participate in the study: The University Clinics of Kinshasa, the Monkole Hospital Center, the Biamba Marie Mutombo Hospital and the Kalembelembe Pediatric Hospital.

2.2. Study Population and Sampling

The population consisted of all children from birth to fifteen years of age anesthetized for emergency or scheduled surgical or diagnostic procedures in the relevant hospitals, followed from induction to the thirtieth postoperative day. Patients were grouped into two: those who had experienced complications and those who had not. We used non-probability sampling with consecutive recruitment of children. The sample size was calculated according to the Keyes formula.

$$n = z^2 \times p \times q / a^2$$

- ✓ n = sample size
- ✓ z = confidence coefficient (1.96)
- ✓ p = probability of intraoperative complications taken from the study of Amengle *et al.* [12] is 33.1%
- ✓ $q = (1 - p)$ = complement of p (76%)
- ✓ a = standard error (0.05)

$$\text{n} = (1.96)^2 \times 0.331 \times 0.669/0.0025$$
$$\text{n} = 340.2$$

Our minimum sample size is calculated to be 340.

2.3. Patient Selection Criteria

Included were, any child aged zero to fifteen years who was anesthetized for an urgent or scheduled surgical or diagnostic procedure in the relevant hospitals.

Patients operated on under local anesthesia administered by the operator and those whose records missed an important study variable were excluded.

2.4. Data Collection Process

Data were collected from patient records, operating room records, and hospitalization records by the principal investigator and previously trained investigators. A data collection form was developed for this purpose and completed retrospectively. Patient follow-up was ensured until Thirtieth day. The variables sought were:

- Sociodemographic: age (day, month or year), sex and weight (kg).
- Preanesthetics: the operative indication, the urgent or scheduled nature of the surgery, the surgical specialty, the comorbidities and the ASA (American Society of Anesthesiologists) class.
- Per-anesthetics: anesthetic technique and products (induction and maintenance), intubation difficulties (difficult intubation understood as the need for more than two laryngoscopies or more than ten minutes or the implementation of an alternative technique by a senior physician), per-anesthetic monitoring used, the duration of surgery and the qualification of the anesthesia practitioners and the surgeon (senior or junior).
- Evolving: peri- and postoperative complications and vital outcome. The complication was understood as an adverse respiratory event (respiratory depression, desaturation (saturation < 90% with or without oxygen), laryngospasm, bronchospasm), cardiac (bradycardia, tachycardia, arterial hypotension, arte-

rial hypertension, shock, cardiac arrest), neurological (agitation, convulsion, death, delayed awakening), allergic or other (nausea, vomiting, hemorrhage, etc.) with or without life-threatening and/or functional prognosis.

Respiratory depression was defined as a respiratory rate of less than 10 cycles per minute and a pulse oxygen saturation of less than 90%. Bradycardia was defined as a heart rate below the physiological limits for age. Hypotension was defined as blood pressure readings below the physiological limits for age, and hypertension as blood pressure readings above the physiological limits for age. Delayed awakening was defined as failure to open the eyes more than 15 minutes after the cessation of anesthesia.

2.5. Statistical Analysis

Quality control of the collected data was carried out to ensure the completeness, accuracy, reliability and consistency of the data. All data were collected and entered using an Excel 2016 spreadsheet, coded and analyzed using the R 4.4.2 programming language (R Foundation for Statistical Computing, Austria). There was no missing data other than biological data that had not been analyzed. Qualitative data were presented as frequency and percentage, and quantitative data were used to measure central tendency, mean with standard deviation, and median with IQR. Quantitative variables were tested for normal distribution. Frequency comparisons were performed using the Chi-square test or Fisher's exact test and comparisons of quantitative variables were performed using the Student's t-test or ANOVA. The search for factors associated with complications and mortality was performed by multivariate binary logistic regression, including the variables of significant interest in univariate analysis. Univariate and multivariate analyses were performed on the complete case. The null hypothesis was rejected only for a p-value < 0.05 and for odds ratios (OR) whose 95% confidence interval (95% CI) did not include 1. A p-value less than 0.05 was considered a significance threshold.

2.6. Ethical and Regulatory Aspects

The heads of the hospitals involved gave their consent. The study protocol was approved by the Ethics Committee of the School of Public Health under number ESP/CE/236/2024. Given the retrospective nature of the study, based on patient records, we were unable to obtain informed consent from the children's parents or guardians. However, the hospitals involved inform all their patients that the data may be used for research. Ethical principles, including respect for the individual, beneficence, and justice, were respected. We have no conflict of interest in this work.

3. Results

3.1. Patient Flow Diagram

Figure 1 shows the patient flow diagram.

A total of 424 children were operated on during the study period, of which 30 were excluded (21 operated under local anesthesia, 9 with incomplete data), and we retained 394 children. The 394 children came from the University Clinics of Kinshasa (143 or 36%), the Kalembelembe Children's Hospital (121 or 31%), the Monkole Hospital Center (91 or 23%) and the Biamba Marie Mutombo Hospital (37 or 9.4%). Of the 394, 112 (28.4%) children had complications and 282 (71.6%) had no complications.

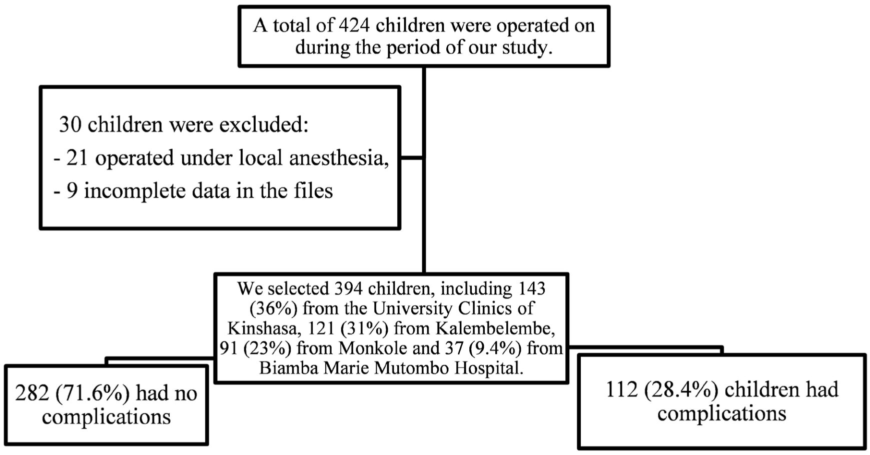


Figure 1. The patient flow diagram.

3.2. Sociodemographic Data of Children

Table 1 presents the sociodemographic characteristics of the children.

Table 1. Sociodemographic characteristics of children.

Variables	Value n = 394	Complications		p	Issue on the 30th day		p
		No n = 282	Yes n = 112		Survivor n = 353	Deceased n = 41	
Sex, n (%)				0.4			<0.9
Female	168 (43%)	119 (42%)	49 (44%)		151 (43%)	17 (41%)	
Male	226 (57%)	163 (58%)	63 (56%)		202 (57%)	24 (59%)	
Sex Ratio	1.3						
Age (in years)							
X ± SD	4.5 ± 4.6 years						
Minimum	2 days						
Maximum	15 years						
Age group				**<0.001**			**<0.001**
Newborn	62 (16%)	26 (9.2%)	36 (32%)		42 (12%)	20 (49%)	
Infant	134 (34%)	104 (37%)	30 (27%)		121 (34%)	13 (32%)	
Little child	56 (14%)	45 (16%)	11 (9.8%)		54 (10.5%)	2 (4.9%)	
Big kid	78 (20%)	63 (22%)	15 (13%)		74 (21%)	4 (9.8%)	
Teenager	64 (16%	44 (16%)	20 (18%)		62 (18%)	2 (4.9%)	
Weight	15 [8 - 29]	16 [11 - 29]	10 [4 - 22]	**<0.001**	16 [10 - 30]	5 [3 - 11]	**<0.001**

Legend: X = mean, SD = standard deviation.

Of the 394 children included, 226 (57%) were male and 168 (41%) were female, with a sex ratio (M/F) of 1.3. The mean age was 4.5 ± 4.6 years with extreme ages of 2 days and 15 years. Most of the children were infants, with 33.5% of cases followed by older children, with 20%. The newborns presented more complications (32%) with a high mortality rate (49%), followed by infants with complications at 27% and mortality at 32% ($p < 0.001$).

3.3. Anesthetic Characteristics of Children

Table 2(a) presents the anesthetic data.

Children with sepsis represented 18%. The majority of children were classified as ASA 1 (60%) while 28% were ASA 3. All children were monitored with a pulse oximeter combined with non-invasive blood pressure in 76% of cases, and with a precordial stethoscope in 64% of cases. General anesthesia was administered to 327 children (82.7% of cases) and orotracheal intubation to 299 children (76% of cases) followed by spinal anesthesia with sedation in 7.4% of cases and peripheral nerve block was administered to 6 children (1.6%) and 4 cases of caudal anesthesia (1%). Most children were ventilated with the Mapelson system (Child System) (58% of cases). Anesthesia was performed by a senior anesthesiologist and resuscitator in 349 cases (89%). Children classified as ASA 3 had more complications (57%) with a high mortality rate (59%) ($p < 0.001$). Children who received general anesthesia with intubation had more complications (96%) and all those who died belonged to this group ($p < 0.001$). Children ventilated with the Mapelson system had more complications (75%) and a high mortality rate (88%) ($p < 0.001$).

Table 2(b) shows the anesthetic drugs.

Table 2. (a) Distribution of patients according to anesthetic data; (b) Distribution of patients according to anesthetic drugs.

Variables	Value n = 394	Complications		p	Issue on the 30th day		p
		No n = 282	Yes n = 112		Survivor n = 353	Deceased n = 41	
				(a)			
Comorbidity							
Sepsis	69 (18%)	27 (9.6%)	42 (38%)	**<0.001**	55 (16%)	14 (34%)	**0.003**
AAS, n (%)				**<0.001**			**<0.001**
One	236 (60%)	206 (73%)	30 (27%)		229 (65%)	7 (17.1%)	
Two	41 (10.4%)	30 (11%)	11 (9.8%)		37 (10.5%)	4 (9.6%)	
Three	110 (28%)	46 (16%)	64 (57%)		86 (24.4%)	24 (59%)	
Four	7 (1.8%)	0 (0%)	7 (6.3%)		1 (0.3%)	6 (15%)	
General anesthesia							
AG + IOT	299 (76%)	191 (68%)	108 (96%)	**<0.001**	258 (73%)	41 (100%)	**<0.001**
Per-op monitoring							
Precordial stethoscope	253 (64%)	176 (62%)	77 (69%)	**0.2**	218 (62%)	35 (85%)	**0.003**
Pulse oximeter	394 (100%)	282 (100%)	112 (100%)		353 (100%)	41 (100%)	-
PNI	298 (76%)	216 (77%)	82 (73%)	**0.5**	278 (79%)	20 (49%)	**<0.001**

Continued

Ventilation							
Mapelson System	228 (58%)	144 (51%)	84 (75%)	**<0.001**	192 (54%)	36 (88%)	**<0.001**
Respirator	99 (25%)	74 (26%)	25 (22%)	0.4	94 (27%)	5 (12%)	**0.04**
Anesthetist				**<0.001**			**<0.001**
Junior	45 (11%)	19 (42%)	26 (57%)		31 (69%)	14 (31%)	
Senior	349 (89%)	263 (75%)	86 (25%)		322 (92%)	27 (7.7%)	
			(b)				
General anesthesia							
Induction							
Sequence, n (%)				**<0.001**			**<0.001**
Crash induction	151 (38%)	69 (23%)	82 (82%)		112 (32%)	39 (95%)	
Classic	176 (45%)	158 (54%)	18 (18%)		174 (49%)	2 (4.9%)	
Type, n (%)				**<0.001**			**0.004**
Intravenous	205 (52%)	130 (46%)	75 (67%)		180 (51%)	25 (61%)	
Inhalation	19 (4.8%)	16 (5.7%)	3 (2.7%)		17 (4.8%)	2 (4.9%)	
Both	103 (26%)	72 (26%)	31 (28%)		89 (25%)	14 (34%)	
Drugs							
Hypnotic				**<0.001**			**<0.001**
Propofol alone	166 (42%)	115 (41%)	51 (44%)		144 (41%)	22 (54%)	
Propofol + Sevoflurane	77 (20%)	56 (20%)	21 (19%)		77 (19.4%)	10 (24%)	
Curare				**<0.001**			**0.002**
Suxamethonium	173 (44%)	117 (41%)	56 (50%)		128 (36%)	23 (56%)	
Without curare	151 (38%)	99 (35%)	52 (46%)		225 (64%)	18 (44%)	
Morphine				**<0.001**			**0.001**
Fentanyl	321 (81%)	212 (75%)	109 (97%)		280 (79%)	41 (100%)	
Without morphine	6 (1.5%)	6 (2.1%)	0 (0%)		6 (2.0%)	0 (0%)	
In Interview:							
Hypnotic, n (%)				**<0.001**			**0.2**
Sevoflurane	242 (61%)	171 (61%)	71 (63%)		212(60%)	30 (73%)	
Isoflurane	85 (22%)	51 (18%)	34 (30%)		75 (21%)	9 (22%)	
Curare, n (%)				**<0.001**			**0.009**
Atracurium	54 (14%)	27 (9.6%)	27 (24%)		48 (14%)	6 (15%)	
Without curare	273 (69%)	198 (70%)	75 (75%)		238 (67%)	35 (85%)	
Morphine, n (%)				**<0.001**			**0.008**
Fentanyl	102 (26%)	65 (23%)	37 (33%)		91 (26%)	11 (27%)	
Without morphine	225 (57%)	153 (54%)	72 (64%)		195 (55%)	30 (73%)	

Legend: ASA = American Society of Anesthesiologists, AG = general anesthesia, OTI = orotracheal intubation, NIBP = non-invasive blood pressure.

Classical sequence induction was the most commonly used, 176 (45%). Induction was intravenous, 205 (52%), mixed intravenous and inhalation, 103 (26%). Propofol was the most commonly used hypnotic in anesthetic induction, alone in 166 children (42%) and associated with sevoflurane in 77 children (19.5%). Suxamethonium was the most commonly used curare in anesthetic induction, *i.e.*, 173 children (44%) and 151 (38%) had not received curare in induction. Fentanyl was the only morphine used in anesthetic induction, *i.e.*, 321 children (81%). Sevoflurane was the most commonly used hypnotic in anesthetic maintenance, *i.e.*, 242 children (61%). Most children did not receive curare or morphine for maintenance anesthesia, *i.e.*, 70% for curare and 57% for morphine, respectively. Complications were more frequent in children who received rapid sequence induction (82%) and a high mortality rate (95% of all deaths) ($p < 0.001$) and those who received intravenous induction had more complications (67%) and a high mortality rate (61% of all deaths) ($p < 0.001$ and 0.004).

3.4. Surgical Data

Table 3 summarizes the surgical data of the children.

Table 3. Distribution of patients according to surgical data.

Variables	Value n = 394	Complications		p	Issue on the 30th day		p
		No n = 282	Yes n = 112		Survivor n = 353	Deceased n = 41	
Character, n (%)				**<0.001**			**<0.001**
Program	238 (60%)	217 (77%)	21 (19%)		236 (67%)	2 (4.9%)	
Urgent	156 (40%)	65 (23%)	91 (81%)		117 (33%)	39 (95%)	
Type, n (%)							
Digestive/General	184 (47%)	114 (40%)	70 (63%)	**<0.001**	157 (44%)	27 (66%)	**<0.001**
Gynecological	1 (0.3%)	0 (0%)	1 (0.9%)		1 (0.3%)	0 (0%)	
Malformative	33 (8.4%)	13 (4.6%)	20 (18%)	**<0.001**	22 (6.2%)	11 (27%)	**<0.001**
Maxillofacial	1 (0.3%)	1 (0.4%)	0 (0%)		1 (0.3%)	0 (0%)	
Neurosurgery	10 (2.5%)	7 (2.5%)	3 (2.7%)		9 (2.5%)	1 (2%)	
Ophthalmology	28 (7.1%)	26 (9.2%)	2 (1.8%)		28 (7.9%)	0 (0%)	
ENT	20 (5.1%)	16 (5.7%)	4 (3.6%)		20 (5.7%)	0 (0%)	
Orthopedic	53 (13%)	49 (17%)	4 (3.6%)		52 (15%)	1 (2%)	
Plastic	21 (5.3%)	18 (6.4%)	3 (2.7%)		20 (5.7%)	1 (2%)	
Urological	40 (10%)	36 (13%)	4 (3.6%)		42(11%)	0 (0%)	
Thoracic	2 (0.5%)	1 (0.4%)	1 (0.9%)		2 (0%)	0 (0%)	
Imaging	1 (0.3%)	1 (0.4%)	0 (0%)		1 (0%)	0 (0%)	
Time, n (%)				**<0.001**			**<0.001**
Day	326 (83%)	261 (93%)	65 (58%)		309 (88%)	17 (41%)	
Night	68 (17%)	21 (7.4%)	47 (42%)		44 (12%)	24 (59%)	

Continued

Duration of the interv.	80 [55 - 120]	65 [45 - 105]	118 [90 - 150]	**<0.001**	120 [95 - 150]	70 [50 - 115]	**<0.001**
Minimum/Maximum	10/320						
Median [IQR]	80 [55 - 120]						
Mean (SD)	91 (51.69)						
≤1 h	153 (39%)	139 (49%)	14 (13%)	**<0.001**	150 (42%)	3 (7.3%)	**<0.001**
>1 h	241 (61%)	143 (51%)	98 (88%)	**<0.001**	203 (58%)	38 (93%)	**<0.001**
New operation				**<0.001**			**<0.001**
Yes	25 (6.3%)	4 (1.4%)	21 (19%)		16 (4%)	9 (22%)	
No	369 (94%)	278 (99%)	91 (81%)		337 (95%)	32 (78%)	
Surgeon quality				0.3			0.6
Junior	50 (12.8%)	40 (14.4%)	10 (8.9%)		47 (12%)	3 (7.3%)	
Senior	344 (87%)	242 (86%)	102 (91%)		306 (87%)	38 (93%)	

Legend: Duration of the interv.: Duration of the intervention SD = standard deviation, ENT = Ear, Nose, and Throat.

The majority of interventions were scheduled (60%) and performed during the day (83%) and by a senior surgeon (87%). Digestive surgery predominated in 47% of cases. The median duration was 80 minutes and the extremes were 10 minutes and 320 minutes and 25 children (6.3%) underwent surgical revision. Children operated on urgently had more complications (82%) and a high mortality rate (95%) ($p < 0.001$). Those operated on in digestive and general surgery had more complications (63%) and a high mortality rate (66%) followed by surgery for malformations with 18% complications and a mortality rate of 27% ($p < 0.001$). Interventions that lasted more than one hour were accompanied by more complications (88%) and a high mortality rate (93%) ($p < 0.001$) and children who were reoperated had a mortality rate of 22% ($p < 0.001$).

3.5. Children's Evolving Data

3.5.1. Peri-Anesthetic Complications

Table 4(a) summarizes children's data according to complications at induction and maintenance.

Intra-anesthetic complications found in 100 children (25%) were respiratory (14.5%) and cardiac (13.7%). Complications at induction were desaturation (10 children (2.5%), tachycardia (8 children (2%)); at maintenance, hemorrhage/anemia (3 cases (7.9%), bradycardia 21 cases (5.3%) and unrecovered cardiac arrest). Mortality was higher in children who had experienced intra-anesthetic complications (93%), both neurological, respiratory and cardiac ($p < 0.001$); also higher in children who had experienced bradycardia (29%) than desaturation (20%) at maintenance ($p < 0.001$).

Table 4(b) summarizes the complications upon awakening

Complications on awakening were: delayed awakening (44 or 11.2%), and desaturation (42 or 10.7%). The majority of children were referred to the post-anesthetic care unit (86%). Mortality was higher in children who had desaturation on awakening (66%) or delayed awakening (59%) ($p < 0.001$).

Table 4. (a) Distribution of children according to complications at induction and maintenance; (b) Distribution of children according to complications upon awakening.

Variables	Value n = 394	Complications	Issue on the 30th day		p
		Yes n = 112	Survivor n = 353	Deceased n = 41	
		(a)			
Intraoper. complications	100 (25%)	100 (89%)	62 (18%)	38 (93%)	**<0.001**
Cardiac	54 (13.7%)	54 (48%)	33 (9%)	21 (51%)	**<0.001**
Respiratory	57 (14.5%)	57 (51%)	26 (7%)	31 (76%)	**<0.001**
Neurological	45 (11%)	45 (40%)	21 (5%)	24 (59%)	**0.14**
Others	33 (8.4%)	33 (29%)	27 (7%)	6 (15%)	
On induction:					
Cardiac, n (%)					**0.007**
Bradycardia	6 (1.5%)	6 (5%)	3 (0%)	3 (7%)	
Tachycardia	8 (2.0%)	8 (7%)	6 (1%)	2 (4%)	
Respiratory, n (%)					**0.002**
Desaturation	10 (2.5%)	10 (8%)	8 (2%)	2 (4%)	
Difficult intubation	6 (1.5%)	6 (5%)	2 (0%)	4 (9%)	
Laryngospasm	2 (0.5%)	2 (1%)	2 (0%)	0 (0%)	
At the interview:					
Cardiac, n (%)					**<0.001**
Cardiac arrest	1 (0.3%)	1 (0%)	0 (0%)	1 (2%)	
Bradycardia	21 (5.3%)	21 (19%)	9 (2%)	12 (29%)	
Shock	2 (0%)	2 (1%)	2 (0%)	0 (0%)	
Tachycardia	21 (5%)	21 (19%)	16 (4%)	5 (12%)	
Respiratory, n (%)					**<0.001**
Desaturation	11 (2%)	11 (9%)	3 (0%)	8 (20%)	
Others, n (%)					**0.2**
Anemia/hemorrhage	31 (7 %)	31 (28%)	25 (7 %)	6 (15%)	
Hyperthermia	4 (1%)	4 (3%)	4 (1%)	0 (0%)	
		(b)			
Upon waking:					
Neurological					**<0.001**
Mushroom effect	1 (0.3%)	1 (0.9%)	1 (0.3%)	0 (0%)	
Delayed awakening	44 (11.2%)	44 (39%)	20 (5.7%)	24 (59%)	
Cardiac, n (%)					**<0.001**
Bradycardia	7 (1.8%)	7 (6.3%)	2 (0.6%)	5 (12%)	
Shock	4 (1.0%)	4 (3.6%)	2 (0.6%)	2 (4.9%)	
Tachycardia	5 (1.3%)	5 (4.5%)	3 (0.8%)	2 (4.9%)	

Continued

Respiratory, n (%)					**<0.001**
Desaturation	42 (10.7%)	42 (38%)	15 (4.2%)	27 (66%)	
Difficult extubation	4 (1.0%)	4 (3.6%)	2 (0.6%)	2 (4.9%)	
Others, n (%)					**<0.001**
Anaphylaxis	1 (0.3%)	1 (0.9%)	0 (0%)	1 (2.4%)	
Anemia/hemorrhage	3 (0.8%)	3 (2.7%)	2 (0.6%)	1 (2.4%)	
Hyperthermia	2 (0.5%)	2 (1.8%)	0 (0%)	2 (4.9%)	
Hypothermia	1 (0.3%)	1 (0.9%)	1 (0.3%)	0 (0%)	
Hypoglycemia	2 (0.5%)	2 (1.8%)	2 (0.6%)	0 (0%)	
Vomiting	2 (0.5%)	2 (1.8%)	2 (0.6%)	0 (0%)	
Orientation					**<0.001**
Recovery room	338 (86%)	56 (50%)	332 (94%)	6 (15%)	
Intensive Care Unit	27 (6.9%)	27 (24%)	15 (4.2)	12 (29%)	
Resuscitation/ Neonat	28 (7.1%)	28 (25%)	6 (7.1)	22 (54%)	
Morgue	1 (0.3%)	1 (0.9%)	0 (0%)	1 (2.4)	

(a) Legend: Intraoper. Complications = Intraoperative complications. (b) Legend: Neonat = Neonatology.

3.5.2. Postoperative Complications

Table 5 summarizes children's data according to postoperative complications.

Table 5. Distribution of patients according to postoperative complications.

Variables	Value n = 394	Complications	Issue on the 30th day		p
		Yes n = 112	Survivor n = 353	Deceased n = 41	
Post-op complication	62 (16%)	62 (55%)	23 (6.5%)	39 (95%)	**<0.001**
Neurological					**<0.001**
Delayed awakening	12 (3.0%)	12 (11%)	2 (0.6%)	10 (24%)	
Cardiac, n (%)					**<0.001**
Cardiac arrest	23 (5.8%)	23 (21%)	0 (0%)	23 (56%)	
Bradycardia	2 (0.5%)	2 (1.8%)	0 (0%)	2 (4.9%)	
Shock	2 (0.5%)	2 (1.8%)	1 (0.3%)	1 (2.4%)	
Tachycardia	1 (0.3%)	1 (0.9%)	0 (0%)	1 (2.4%)	
Respiratory					**<0.001**
Desaturation	22 (5.6%)	22 (20%)	5 (1.4%)	17 (41%)	
Others, n (%)					**<0.001**
Anemia	5 (1.3%)	5 (4.5%)	3 (0.8%)	2 (4.9%)	
Post-SA headaches	1 (0.3%)	1 (0.9%)	1 (0.3%)	0 (0%)	
Multiple organ failure	7 (1.8%)	7 (6.3%)	0 (0%)	7 (17%)	
POP	10 (2.5%)	10 (8.9%)	8 (2.3%)	2 (4.9%)	
Sepsis	5 (1.3%)	5 (4.5%)	5 (1.4%)	0 (0%)	

Legend: post-op = postoperative, SA = spinal anesthesia, POP = postoperative peritonitis.

Postoperative complications found in 62 children (16%) were cardiorespiratory arrest (23 or 5.8%), and desaturation (22 children or 5.6%). Mortality was higher in children who had cardiac arrest (56%) and desaturation (41%) (p < 0.001).

3.5.3. Distribution of Children According to Vital Outcome

Table 6 summarizes the children's data according to their vital outcomes.

Table 6. Distribution of children according to their vital outcome.

Variables	Value n = 394	Complications		P	Issue on the 30th day		p
		No n = 282	Yes n = 112		Survivor n = 353	Deceased n = 41	
Number of days	6 [3 - 10]	5 [3 - 9]	8 [2 - 13]	<0.001	6 [4-10]	2 [1 - 5]	**<0.001**
Min/Max	0/30						
Average [IQR]	6 [3 - 10]						
Mean (SD)	7.4 (6.4)						
Vital question							
≤1 day					379 (96.2%)	15 (3.8%)	
≤2 days					368 (93.4%)	26 (6.6%)	
≤3 days					366 (92.9%)	28 (7.1%)	
≤7 days					359 (91.1%)	35 (8.9%)	
The 30th day					353 (89.6%)	41 (10.4)	

Legend: SD = Standard deviation.

The median survival time was 6 days [3 - 10] with a standard deviation of 7.4 days (6.44) and minimum and maximum duration of 0 and 30 days. Children who died had a much shorter survival time with a median survival of 2 days, suggesting that the majority of deaths occur very quickly after surgery, *i.e.*, within the first 3 days. The mortality rate was 7.1% on the third day, 8.9% on the seventh day, and 10.4% on the 30th day.

3.5.4. Survival Curve

Figure 2 shows a survival curve.

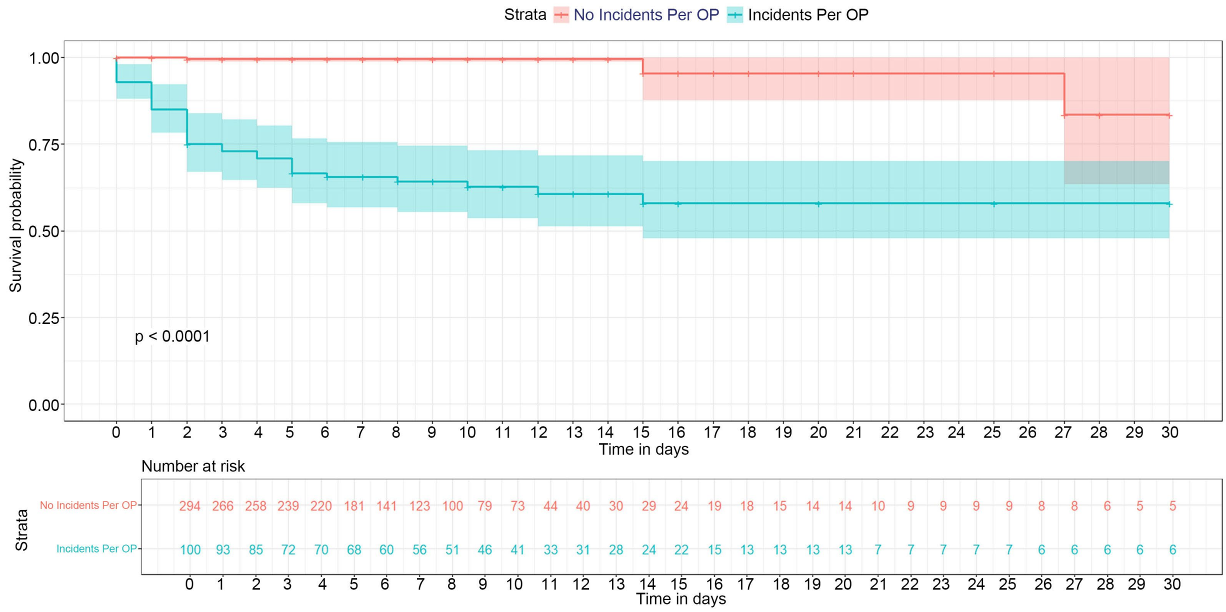
Survival was poor in children with complications.

3.6. Factors Associated with Morbidity and Mortality

3.6.1. Factors Associated with Perianesthetic Complications in Children

Table 7 summarizes factors associated with perianesthetic complications in children.

In multivariate analysis, an ASA score ≥ 3 multiplied by 3 the risk of perianesthetic complications (ORa = 3.28 (1.36 - 8.06), p = 0.008), an emergency intervention multiplied by 8.6 this risk (ORa = 8.61 (3.38 - 23.4), p < 0.001), the duration of the intervention greater than one hour multiplied this risk by 3 (ORa = 3.31 (1.54 - 7.59), p = 0.002).



Legend: Per Op = intraoperative.

Figure 2. Survival curve.

Table 7. Factors associated with perianesthetic complications in children.

Determinants	Univariate analysis		Multivariate analysis	
	p	OR (95% CI)	p	ORa (95% CI)
Age	**<0.001**		**0.4**	
Infant		1		1
Newborn		3.96 (2.07 - 7.68)		1.17 (0.44 - 3.11)
Little child		0.97 (0.43 - 2.08)		2.49 (0.86 - 7.27)
Big child and teenager		1.11 (0.62 - 1.99)		1.42 (0.40 - 4.96)
Sepsis	**<0.001**		**0.6**	
No		1		1
Yes		6.09 (3.52 - 10.7)		1.25 (0.57 - 2.77)
ASA	**<0.001**		**0.008**	
≤2		1		1
≥3		8.64 (5.24 - 14.5)		3.28 (1.36 - 8.06)
Surgery for malformations	**<0.001**		**0.2**	
No		1		1
Yes		3.56 (1.72 - 7.41)		2.58 (0.67 - 9.49)
Digestive surgery	**<0.001**		**0.12**	
No		1		1
Yes		2.50 (1.58 - 4.03)		0.46 (0.16 - 1.21)
Intervention	**<0.001**		**<0.001**	
Program		1		1
Urgent		13.5 (7.79 - 24.7)		8.61 (3.38 - 23.4)
Duration of intervention > 1 hour	**<0.001**		**0.002**	
No		1		1
Yes		7.56 (4.04 - 15.5)		3.31 (1.54 - 7.59)

Legend: ASA = American Society of Anesthesiologists.

3.6.2. Factors Associated with Child Mortality

Table 8 summarizes the factors associated with child mortality.

In multivariate analysis, factors associated with death were: ASA score ≥ 3, ORa = 4.97 (1.24 - 26.3), (p = 0.023), emergency, ORa = 14.2 (2.90 - 74), (p < 0.001), duration of intervention greater than one hour, ORa = 3.82 (1.01 - 19.4), (p = 0.048) and new intervention, ORa = 6.97 (1.94 - 27.7), (p = 0.003).

Table 8. Factors associated with child mortality.

Determinants	Univariate analysis		Multivariate analysis	
	p	OR (95% CI)	p	ORa (95% CI)
Age	**<0.001**		>0.9	
Infant		1		1
Newborn		4.43 (2.05 - 9.89)		1.15 (0.35 - 3.41)
Little child		0.34 (0.05 - 1.30)		1.01 (0.11 - 6.39)
Big child and teenager		0.41 (0.14 - 1.07)		0.55 (0.05 - 4.47)
Sepsis	**0.006**		0.077	
No		1		1
Yes		2.81 (1.36 - 5.63)		0.41 (0.15 - 1.10)
ASA	**<0.001**		**0.023**	
≤2		1		1
≥3		8.34 (4.12 - 18.1)		4.97 (1.24 - 26.3)
Surgery for malformations	**<0.001**		0.14	
No		1		1
Yes		5.52 (2.38 - 12.3)		4.81 (0.62 - 6.3)
Digestive surgery	**0.07**		0.9	
No		1		1
Yes		2.46 (1.27 - 4.98)		0.89 (0.18 - 5.23)
Intervention	**<0.001**		**<0.001**	
Program		1		1
Urgent		39.3 (11.8 - 100)		14.2 (2.90 - 74)
Duration of intervention > 1 hour	**<0.001**		**0.048**	
No		1		1
Yes		9.36 (3.31 - 39.3)		3.82 (1.01 - 19.4)
New intervention	**<0.001**		**0.003**	
No		1		1
Yes		5.92 (2.34 - 14.3)		6.97 (1.94 - 27.7)

Legend: ASA = American Society of Anesthesiologists.

4. Discussion

This study was conducted to investigate the factors associated with perianesthetic complications in pediatric surgery in hospitals in the city of Kinshasa. Of the 394 children, 112 (28.4%) had complications, 100 (25.4%) in perianesthesia dominated by respiratory complications (57 or 14.5%), cardiac complications (54 or 13.7%) and 62 children or 16% had postoperative complications represented more by cardiac complications. Mortality was 10.4% and more marked in the first three days. A high ASA score, emergency, surgical revision, and surgery duration greater than one hour were factors that contributed to complications and mortality.

The mean age of the children was 4.5 ± 4.6 years, with most ranging from 1 month to 3 years (33.5%) as some have reported by other studies [2] [12] [15]-[17] in the ranges of 2 to 8 years. Variations in mean age may be explained by variations in the type of pathologies (congenital or others), organization of care (late or early surgery for certain malformations) and sample size. The male sex predominated with 57% corroborating data from the literature [12] [14] [15] [17] [18] due to urological surgery including hypospadias and ritual circumcision in Africa. Sociocultural factors and pathologies treated may also influence sex. ASA class I was the majority (60%) in accordance with literature data [2] [12] [14] [15] [19] children do not often present comorbidities apart from malformations. The dominant surgical specialties were digestive surgery (47%), orthopedics 13% and urology (10%) as Nicolas [20] in Europe, Amengle [12] in Cameroon, Obiang [19] in Gabon and Akodjenou [15] in Benin. Unlike Mulewa [14] in Lubumbashi DRC who found that urology (35.9%) came before digestive surgery (27%). These data are consistent with the prevalence of general digestive and urological pathologies in pediatrics (hernias, appendicitis, congenital malformations), but variations exist depending on local specificities (the distribution of surgical specialties depends on the available infrastructure, team skills and service orientations) and the difference access to care (certain hospital structures may be reference centers for certain specialties). The duration of the surgical procedure showed significant variations, an average of 91.33 minutes (10 to 320 minutes) because it depends on the type of surgery, the complexity of the procedure and the experience of the teams. Thus, Akodjenou [15] reported an average of 101 minutes and extremes of 2 to 540 minutes. In our study, anesthesia was often performed by an anesthesiologist and resuscitator, as in European studies [21], although they are not specialists in pediatric anesthesia. This is due to the increase in the number of anesthesiologists and resuscitators in Kinshasa, unlike in the provinces and other African countries where anesthesia is performed by anesthesiologist technicians: 83.8% in Togo [10] and only 17.39% by doctors in Benin [15]. Intraoperative monitoring was poor due to a lack of equipment except SpO_2 which was monitored in all children as in other low-income countries [10] [15] but different from practices in Europe (Nicolas Disma) [20], a situation that could be the basis of high morbidity and mortality, because monitoring allows rapid detection of abnormalities and therefore their correction. Intravenous induction alone or associated with inhalation predominated as reported by other studies [10] [12] [15] [16] [19]. It should be noted however that the availability of anesthesia products and devices, as well as the team's habits and the type of surgery and emergency, influence the induction technique. General anesthesia, often with tracheal intubation, was widely used due to surgical requirements (visceral such as intestinal obstruction, peritonitis, appendicitis, adenotonsillectomy, malformations, etc.) corroborating data from the literature [10] [15] [19] [20]. The frequent use of manual ventilation with the Mapelson system is due to the lack of pediatric respirators as is the case in other low-income African countries [15]. However, this manual ventilation without adequate monitoring can be the basis of respiratory and circulatory complications, especially in very young children. Locoregional anesthesia (LRA) was less used due to the lack of suitable equipment and expertise in this technique. However, it must be recognized that the use of LRA depends on the type of surgery and explains the very significant variations in the use of this technique from 2.3% to 35.9% [10] [12] [14] [15] [19] [20]. Propofol, reported by other authors [10] [14] [15] and sevolflurane were the most used hypnotics due to their good kinetics marking an evolution in the practice of pediatric anesthesia in Kinshasa. Indeed, these anesthetic agents, quite rare on the market 20 years ago, have become relatively accessible. In our study, curare at induction used succinylcholine in 44% of cases, while 38% of patients were not curarized. These results are in agreement with those obtained in Benin by Akodjenou *et al.* [15], where succinylcholine was used in 40.9% of cases. Our results diverge from data reported in Togo (Mouzou T *et al.*, [10] and Cameroon (Amengle AL *et al.*) [12], where succinylcholine was rarely used for induction (3.6% and 19% of cases, respectively). This shows that the use of curare for intubation remains a subject of debate in children. Fentanyl was the most used morphine in our series and the choice of morphine and other drugs in our settings is strongly influenced by their availability, explaining the divergence of results [10] [12] [15].

Complications were 25% in our series, including respiratory (14.5%), cardiac: 13.7% and neurological: 11%. This still high rate is reported by other authors and shows the challenges of pediatric anesthesia. Thus, Nicolas Disma [20] (Europe 2021) reports 35.3% of critical events, including 60.7% cardiac and 36% hypoxemic. Amengle [12] reports 33.1%, with a predominance of respiratory complications (40%). Akodjenou [15] reports 23.7% of complications, including 11.57% respiratory. In contrast, the APRICOT study (Walid H. 2017) [6] conducted in 33 European countries (standardized care, adequate equipment and expert hands) found an overall incidence of critical perioperative events of only 5.2%, which is much lower than our rate. Delayed awakening (11.2%) and desaturation (10.7%) predominated upon awakening, results close to the Cameroonian study which found 33.3% of cases of delayed awakening [12]. This delayed awakening would probably be due to hypothermia, especially since temperature monitoring was rare, but perhaps also due to the drugs used such as halothane and an overdose of narcotics, especially since monitoring of the depth of anesthesia was non-existent. It should be noted that while the frequency of complications varies according to the studies, the nature remains the same: respiratory, cardiac and neurological

[12] [13] [15]. Thus, the postoperative complications present in 16% were mainly cardiovascular in agreement with the work of Amengle [12] 22.2% of which 40% were cardiovascular. The European study had reported only 5.2% of postoperative complications. Mortality varies between studies: 10.4% in this study, 3 to 14% in sub-Saharan Africa [12]-[15] [18] [20] and 0% to 1% in Europe [6]. The gap between African and European studies suggests a major influence of the health context (poverty, late consultation), in particular technical resources (insufficient technical platforms), the quality of peri- and post-operative care, and accessibility to intensive care or resuscitation. The study found that the patient's general condition (ASA ≥ 3), the urgency of the intervention, the prolonged duration of surgery and reinterventions are major risk factors for complications and mortality. These results are consistent with several studies conducted in West and Central Africa. The study by Talabi [18] and Mouzou [10] confirms that ASA ≥ 3 and urgency are major determinants of morbidity and mortality. Amengle [12] also identifies urgency as a factor in postoperative complications. Mulapu (DRC, 2012) [13] links these complications to digestive surgeries and multiple reinterventions. Age less than one year found by other authors [10] [12] [18] was not found in our series. Sepsis found by Mulewa, congenital anomalies found by Talabi and anesthetic agents (ketamine and pancuronium) found by Mulapu did not emerge in this study. However, young age, sepsis and congenital malformations were not found as complicating factors probably due to the sample size and the representativeness of each subgroup. Indeed, young age is a known risk factor in pediatric anesthesia [6].

Weaknesses and strengths of the study

The study has the disadvantage of not collecting biological data, which may have an impact on morbidity and mortality due to its retrospective nature. Indeed, anemia, dyskaliemia, dysnatremia, coagulation disorders, and renal and/or hepatic function disorders, to name a few, are important factors for mortality. The study was conducted only in Kinshasa and the results cannot be generalized to the entire country.

Beyond the methodological limitations, the strength of this study is that it is not only multicenter but also one of the few to investigate factors associated with morbidity and mortality at all stages of pediatric anesthesia in our setting up to day 30. It should be noted that the centers involved in this study are among the largest where pediatric surgery is performed.

5. Conclusions

At the end of our study, we found that the severity of the children (ASA ≥ 3), the urgency, and the long duration of the procedures are major factors associated with perianesthetic complications and mortality. Although mortality is decreasing compared to previous studies, it remains high, around 10.4% in our study, particularly in the immediate postoperative period. Perianesthetic complications remain high, reaching 25%, mainly respiratory and cardiac.

This work demonstrates the improvement in the practice of pediatric anesthesia in our country compared to previous years. It appears necessary to improve intra-anesthetic monitoring and optimize perioperative care, especially postoperative, in order to reduce early postoperative mortality. And it seems imperative to promote the construction of pediatric hospitals with critical care or resuscitation units and adapted operating theaters, equipped with advanced monitoring equipment for better care of children.

So we suggest:

- ✓ A reduction in operating times by improving the organization of operating rooms and training teams in the fastest and most effective surgical and anesthetic techniques.
- ✓ Strengthening the capacity of teams to manage early respiratory and cardiovascular complications.
- ✓ Acquisition of advanced monitoring equipment (capnography, continuous oximetry, invasive hemodynamic monitoring) for better care of children during and after surgery.
- ✓ Have local databases to better analyze complication trends and refine protocols.

Authors' Contribution

Gabriel Makeya and Wilfrid Mbombo: study design, data collection, and article writing. Vivien Hong Tuan Ha: statistical analyses. All other authors: read and correct the manuscript.

Acknowledgements

We would like to thank the hospital managers who participated in this study, the residents of the anesthesia and intensive care unit who contributed to data collection, as well as Milka Mbombo for proofreading this English version.

Conflicts of Interest

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

References

[1] Coté, C.J., Lerman, J. and Anderson, B.J. (2018) A Practical Guide to Anesthesia for Infants and Children. 6th Edition, Elsevier, 1256 p.

[2] Tsang, M. (2018) A Practice of Anesthesia for Infants and Children, Sixth Edition. *Canadian Journal of Anesthesia*, **65**, 1392-1393. https://doi.org/10.1007/s12630-018-1201-4

[3] Ogondon, B., *et al.* (2014) Practice of Pediatric Anesthesia in Emergency at the Cocody University Hospital (Abidjan-RCI). *Rev. Afr Anesthesia Medicine Emergency*, **19**, 6-9.

[4] Paterson, N. and Waterhouse, P. (2010) Risk in Pediatric Anesthesia. *Pediatric Anesthesia*, **21**, 848-857. https://doi.org/10.1111/j.1460-9592.2010.03366.x

[5] Trotman, G., Foley, C.E., Taylor, J., DeSale, S. and Gomez-Lobo, V. (2017) Postoper-

ative Outcomes among Pediatric and Adolescent Patients Undergoing Minilaparotomy vs Laparoscopy in the Management of Adnexal Lesions. *Journal of Pediatric and Adolescent Gynecology*, **30**, 632-635. https://doi.org/10.1016/j.jpag.2017.06.009

[6] Michel, F. (2018) Indicateurs de complications postopératoires en anesthésie pédiatrique. *Anesthésie & Réanimation*, **4**, 345-353. https://doi.org/10.1016/j.anrea.2018.04.001

[7] Habre, W., Disma, N., Virag, K., Becke, K., Hansen, T.G., Jöhr, M., *et al.* (2017) Incidence of Severe Critical Events in Paediatric Anaesthesia (APRICOT): A Prospective Multicentre Observational Study in 261 Hospitals in Europe. *The Lancet Respiratory Medicine*, **5**, 412-425. https://doi.org/10.1016/s2213-2600(17)30116-9

[8] Brouh, Y. (2013) Pediatric Anesthesia in French-Speaking Black Africa: What Practice? *Ramur*, **18**, 1-2.

[9] Torborg, A., Cronje, L., Thomas, J., Meyer, H., Bhettay, A., Diedericks, J., *et al.* (2019) South African Paediatric Surgical Outcomes Study: A 14-Day Prospective, Observational Cohort Study of Paediatric Surgical Patients. *British Journal of Anaesthesia*, **122**, 224-232. https://doi.org/10.1016/j.bja.2018.11.015

[10] Wood, G., Barayan, G., Sanchez, D.C.J., Inoue, G.N.C., Buchalla, C.A.O., Rossini, G.A., *et al.* (2013) Validation of the Pediatric Surgical Risk Assessment Scoring System. *Journal of Pediatric Surgery*, **48**, 2017-2021. https://doi.org/10.1016/j.jpedsurg.2013.04.017

[11] Mouzou, T., Egbohou, P., Tomta, K., Sama, H., Assenouwe, S., Akala, Y., Assih, P. and Randolph, L. (2016) Pediatric Anesthesia Practice in a Developing Country: Experience of Sylvanus University Hospital Olympio of Lomé in Togo. *Ramur*, **21**, 38-43.

[12] Newton, M.W., Hurt, S.E., McEvoy, M.D., Shi, Y., Shotwell, M.S., Kamau, J., *et al.* (2020) Pediatric Perioperative Mortality in Kenya: A Prospective Cohort Study Conducted in 24 Hospitals. *Anesthesiology*, **132**, 452-460. https://doi.org/10.1097/aln.0000000000003070

[13] Amengle, A.L., Bengono Bengono, R., Metogo Mbengono, J.A., Zambo, A., Esiene, A. and ZeMinkande, J. (2020) Peri- and Postoperative Complications in Pediatric Anesthesia in 2 Reference Hospitals in Cameroon. *Ramur*, **25**, 16-21. https://www.web-saraf.net/Complications-per-et.html

[14] Mulapu, N., Mbala, R., Bula-Bula, M., Ilunga, M., Mbombo, W. and Kilembe, M. (2012) Complications of Awakening in Pediatric Anesthesia: Case of the University Clinics of Kinshasa and the Pediatric Hospital of Kalembe-Lembe. *Ramur*, **17**, 14. https://web-saraf.net/IMG/pdf/saranf_2012_-_an.pdf

[15] Umba, D.M. (2023) Pratique de l'anesthésie pédiatrique dans la Ville de Lubumbashi en RD Congo: Indications, Complications et Facteurs de mortalité. *American Journal of Medical and Clinical Research & Reviews*, **2**, 1-12. https://doi.org/10.58372/2835-6276.1055

[16] Joseph, A., Serge, M., Ernest, A., Yasmine, L., Eugène, Z., Séraphin Antoine, G., *et al.* (2021) Practice of Pediatric Anesthesia in Sub-Saharan Africa: Experience of Two Referral Hospitals in Benin. *American Journal of Pediatrics*, **7**, Article No. 219. https://doi.org/10.11648/j.ajp.20210704.17

[17] Niandou, M., *et al.* (2015) Pediatric Anesthesia Practice at the Lamordé National Hospital in Niamey. *Rev. Afr Anesthesiology Med Urgence* (*Special Congress*), **20**, 1-134.

[18] Samaké, B., Keita, M., Magalie, I. and Diallo, G. (2010) Adverse Events of Anesthesia in Scheduled Pediatric Surgery at Gabriel Touré Hospital. *Mali Medical*, **25**, 1-5.

[19] Talabi, A.O., Ojo, O.O., Aaron, O.I., Sowande, O.A., Faponle, F.A. and Adejuyigbe,

O. (2021) Perioperative Mortality in Children in a Tertiary Teaching Hospital in Nigeria: A Prospective Study. *World Journal of Pediatric Surgery*, **4**, e000237. https://doi.org/10.1136/wjps-2020-000237

[20] Nze Obiang, P.C., Obame, E.R., Edjo Nkilly, G., *et al.* (2023) Analysis of the Practice of Pediatric Anesthesia at the Mother and Child University Hospital of Libreville. *Health Sciences and Diseases*, **24**, 161-165.

[21] Disma, N., Veyckemans, F., Virag, K., Hansen, T.G., Becke, K., *et al.* (2021) Morbidity and Mortality after Early-Life Anesthesia: Results from the European Multicenter Prospective Observational Study, Audit of Anesthesia Practices in Newborns and Children in Europe (Nectarine). *British Journal of Anaesthesia*, **126**, 1157-1172. http://creativecommons.org/licenses/by-nc-nd/4.0/

[22] Graaf, J.C., Sarfo, M.C., Wolfswinkel, L.V., *et al.* (2016) Critical Incidents Related to Anesthesia in the Perioperative Period in Children; Proposal for a System for Reporting Critical Incidents Related to Anesthesia in Children. *Pediatric Anesthesia*, **26**, 7-43.