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Anesthetic safety in pediatric urology: frequency, profile and factors associated with complication in Kinshasa

L. Kukamba[1], A. Makembi Bunkete[2], W. Mbombo[1,3], A. Mosolo[1,3], D. Moningo[4], K. Anga[1], F. Mbuyi[1], T. Mampangula[1], T. Mbala[4,5], P. Kambala[5], R. Kashala[6], J. Nsiala[1], M. BulaBula[1], B. Barhayiga[1]

[1]Department of Anesthesia and Intensive Care, University Clinics of Kinshasa, University of Kinshasa, Kinshasa, Democratic Republic of Congo
[2]Department of Internal Medicine, University Clinics of Kinshasa, University of Kinshasa, Kinshasa, Democratic Republic of Congo
[3]Anesthesia and Intensive Care Service, Monkole Hospital Center, Kinshasa, Democratic Republic of Congo
[4]Department of Surgery, University Clinics of Kinshasa, University of Kinshasa, Kinshasa, Democratic Republic of Congo
[5]Surgery Service, Monkole Hospital Center, Kinshasa, Democratic Republic of Congo
[6]Medical Directorate, Monkole Hospital Center, Kinshasa, Democratic Republic of Congo

Corresponding author: Arriel Makembi Bunkete, Department of Internal Medicine, University Clinics of Kinshasa, University of Kinshasa, Kinshasa, Democratic Republic of Congo. Email: docteur.makarriel2017@gmail.com.

Keypoints

Identification of high-risk patients, tailored anesthetic management, and enhanced perioperative monitoring can improve safety. These findings provide practical guidance to optimize anesthetic care for children in resource-limited settings.

Abstract

Introduction

Pediatric urological surgery poses unique anesthetic challenges due to patients' age, comorbidities, and procedural complexity. Limited data exist in sub-Saharan Africa regarding anesthetic complications in this population.

Objective: To describe the frequency, profile, and factors associated with anesthetic complications in pediatric urological surgery at a reference center in Kinshasa.

Methods

A retrospective and analytical study was conducted from January 2011 to December 2024 at Monkole Mother and Child Hospital Center. Pediatric patients aged 0–15 years who underwent urological procedures under anesthesia were included. Data on demographics, clinical and surgical characteristics, anesthetic management, and postoperative complications were extracted. Statistical analyses included univariate and multivariate logistic regression to identify factors associated with complications.

Results

Among 292 children, postoperative anesthetic complications occurred in a subset of patients. Multivariate analysis identified significant predictors: presence of intraoperative incident, difficult extubation, difficult awakening, general anesthesia with propofol, ASA 3 classification, difficult airways, higher body weight, and prior anesthetic history. Most patients were managed safely with low overall complication rates.

Conclusion

Anesthetic complications in pediatric urology are multifactorial. Identification of high-risk patients, tailored anesthetic management, and enhanced perioperative monitoring can improve safety. These findings provide practical guidance to optimize anesthetic care for children in resource-limited settings.

Keywords
Anesthesia, Kinshasa, Pediatric, Perioperative complications, Risk factors, Urological surgery.

Introduction

Pediatric anesthesia is a highly specialized field due to the unique anatomical, physiological, and pharmacological characteristics of children. In pediatric urological surgery, the challenges are even greater: a wide variety of procedures (inguinoscrotal surgery, urethrotomies, pyeloplasties, robotic or minimally invasive surgery), often early patient age, and associated comorbidities [1–3]. These characteristics make anesthetic safety central to preventing perioperative complications [4].

Globally, the rise of minimally invasive and robotic techniques has introduced specific anesthetic challenges: pneumoperitoneum, prolonged positioning, risk of hypothermia, and hemodynamic variations [3][4]. Regional anesthesia techniques improve postoperative analgesia quality and reduce opioid use but require expertise and appropriate equipment [5][6].

In sub-Saharan Africa, anesthetic safety remains a challenge due to limited human and material resources and a high frequency of urgent procedures [7]. A study conducted in Libreville showed that nearly 46% of pediatric anesthesias involved urology, with almost exclusive use of general anesthesia and an anesthetic incident rate of 0.9% [7].

In the Democratic Republic of Congo, and specifically in Kinshasa, data on the frequency, profile, and risk factors for anesthetic complications in pediatric urological surgery are scarce. Knowledge of these parameters is essential to improve safety, anesthetic protocols, and continuing education.

Study Objective: To describe the frequency, profile, and factors associated with anesthetic complications in pediatric urological surgery at a reference center in Kinshasa.

Materials and Methods

2.0 Methods

2.1 Study Design, Period, and Setting

This was a retrospective and analytical study conducted from January 1, 2011, to December 31, 2024, at the Monkole Mother and Child Hospital Center, Kinshasa, Democratic Republic of Congo. This center is a reference facility for health zone Mont-Ngafula 1 in Kinshasa, with a permanent anesthesia-intensive care service and standardized follow-up of operated patients.

2.2. Study Population, Sampling, and Selection Criteria

The study included all pediatric patients aged 0 to 15 years who received anesthesia for a diagnostic or therapeutic urological procedure during the study period.

Inclusion Criteria:

- Children aged 0–15 years undergoing surgery for a urological condition under anesthesia.
- Anesthesia is performed by a physician anesthesiologist or under their direct supervision.
- Complete medical records containing the main study variables.

Exclusion Criteria:

- Incomplete records (missing major data).
- Patients with disorders of sexual differentiation.
- Procedures performed exclusively under local anesthesia by the surgeon, without anesthesiologist involvement.

Sampling was exhaustive and consecutive, based on operative and anesthesia registers.

2.3. Data Collection and Study Variables

Data were extracted from anesthesia registers, operative records, and hospitalization reports using a pre-established data collection form. Data covered the preoperative, intraoperative, and immediate postoperative periods until hospital discharge.

Variables:

- Sociodemographic: age (<1 year; 1–5 years; 6–10 years; 11–15 years), sex, residence.
- Clinical: medical history, comorbidities, nutritional status mesured by body mass index (BMI).
- Biological (if available): complete blood count, prothrombin time, aPTT, blood glucose, serum creatinine.
- Surgical procedures can be classified as major, such as those involving the opening of the abdominal cavity or urethroplasty, or minor for other types; they can also be categorized by urgency (emergency or elective), operative duration, and the qualifications of the surgeon.
- Anesthetic details include ASA status (2020 version), premedication, the anesthetic technique used (general, regional, or combined), agents administered, postoperative opioid use, duration of anesthesia, and the qualifications of the anesthesiologist.
- Outcome: perioperative and postoperative complications (type, severity, timing), vital outcome.

2.4. Statistical Analysis

Data were entered in Excel 2016 and transferred to SPSS version 26.0 for analysis.

- Quantitative variables : expressed as mean ± standard deviation or median (IQR).
- Qualitative variables : presented as counts and percentages.
- Comparisons: Student's t-test or Mann-Whitney U test for means/medians ; Pearson Chi² or Fisher's exact test for proportions.
- Multivariate logistic regression was used to identify factors associated with anesthetic complications. Results are presented as adjusted odds ratios (ORa) with 95% confidence intervals.
- Incomplete records were excluded to ensure data consistency.
- Significance threshold: $p < 0.05$.
- Subgroup analyses were performed according to procedure urgency and ASA status.

2.5. Ethical Considerations

Institutional authorization was obtained from the Monkole Mother and Child Hospital Center. The protocol was approved by the Scientific Committee of the Department of Anesthesia and Intensive Care, University Clinics of Kinshasa, and the Ethics Committee of the School of Public Health (ESP/CE/86/2025). The principles of the Declaration of Helsinki were respected. No conflicts of interest were declared.

Results

- **Age Group Distribution of Pediatric Urology Patients**

The study included a total of 292 pediatric patients undergoing urological procedures. The distribution across age groups was as follows: 23 patients were under 1 year, 171 patients were aged 1–5 years, 68 patients were aged 6–10 years, and 30 patients were aged 11–15 years (Figure 1).

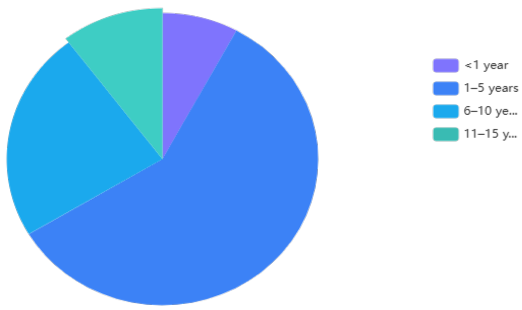

Figure 1. Age Group Distribution
The pie chart shows the proportion of patients in each age group. The 1–5 years group forms the largest segment, representing the majority of the population, while the <1 year group forms the smallest segment.

- **General Characteristics of the Population**

Table 1 presents the general anthropometric characteristics of pediatric patients undergoing urological procedures, stratified by age group.

The analysis of the study population shows clear growth trends across age groups. Both mean weight and height increase consistently with age, as expected in a developing pediatric population.

Children under 1 year of age had a mean weight of 8.00 kg and a mean height of 68.70 cm, whereas those aged 11–15 years reached a mean weight of 38.33 kg and a mean height of 146.60 cm.

Despite these increases in weight and height, the mean BMI remained relatively stable across all age groups, ranging from 16.16 to 17.61.

Most children, between 76.67% and 80.70% depending on the age group, fell within the normal weight category, while the proportions of underweight and overweight children showed only minor fluctuations.

In terms of demographic characteristics, most children lived outside the health zone served by the hospital (approximately 70–73%), while 27–30% resided within the areas covered by Monkole Hospital.

The sex distribution was nearly balanced across age groups, with a slight increase in female representation in the older age group, rising from 47.83% in children under 1 year to 53.33% in those aged 11–15 years (Table 1).

Parameter	<1 year	1–5 years	6–10 years	11–15 years
Weight (kg), mean ± SD	8.00 ± 2.15	14.32 ± 3.87	27.31 ± 8.50	38.33 ± 10.47
Height (cm), mean ± SD	68.70 ± 12.49	93.96 ± 12.78	128.16 ± 11.55	146.60 ± 10.44
BMI, mean ± SD	17.33 ± 2.00	16.16 ± 1.92	16.34 ± 2.50	17.61 ± 3.01
BMI category Normal weight (%)	78.26	80.70	79.41	76.67
BMI category Overweight (%)	13.04	10.53	11.76	13.33
BMI category Underweight (%)	8.70	8.77	8.82	10.00
Sex – Female (%)	47.83	49.12	50.00	53.33
Sex – Male (%)	52.17	50.88	50.00	46.67

Table 1. General Characteristics of the Population by Age Group

- **Pre-Anesthetic Characteristics of the population**

Table 2 summarizes the pre-anesthetic characteristics of pediatric patients undergoing urological procedures, stratified by age group. The pre-anesthetic evaluation showed clear age-related trends in both laboratory and clinical parameters. Hemoglobin and platelet counts increased with age, while white blood cell counts slightly decreased; prothrombin time remained stable. Younger children (<1 year) more frequently exhibited minor respiratory symptoms such as cough, cold, and fever, whereas airway assessments and consciousness were favorable across all age groups Successful venous access was common, but most patients did not receive venous thromboembolism (VTE) or antibiotic prophylaxis. The proportion of ASA 1 patients increased with age, indicating better overall preoperative health in older children. Overall, the table highlights how pre-anesthetic status improves with age, while minor symptoms are more prevalent in the youngest patients.

Parameter	<1 year	1–5 years	6–10 years	11–15 years
Laboratory Values (Mean ± SD)				
Hemoglobin (g/dL)	11.23 ± 1.56	11.89 ± 1.09	12.51 ± 1.08	13.06 ± 1.02
WBC (×10³/µL)	10.66 ± 3.89	9.24 ± 3.01	8.42 ± 2.54	8.07 ± 2.35
Platelets (×10³/µL)	389.16 ± 100.27	360.87 ± 95.12	334.69 ± 87.27	319.25 ± 80.59
Symptoms (%)				
Cough	21.74	18.75	16.67	15.00
Cold	26.09	25.00	20.00	17.50
Fever	13.04	10.00	8.33	7.50
Consciousness & Airway (%)				
Conscious	95.65	97.50	98.33	100.00
Mallampati Score 1	65.22	68.75	70.00	72.50
Cormack-Lehane Grade 1	73.91	77 .50	80.00	82.50
Venous Status & Prophylaxis (%)				
Good venous status	86.96	90.00	91.67	92.50
No VTE prophylaxis	86.96	87.50	88.33	90.00
No antibioprophylaxis	86.96	87.50	88.33	90.00
ASA Classification (%)				
ASA 1	65.22	68.75	70.00	72.50

Table 2. Pre-Anesthetic Characteristics by Age Group. Continuous variables are presented as mean ± standard deviation, and categorical variables as percentages. WBC = White Blood Cells; ASA = American Society of Anesthesiologists classification; VTE = Venous Thromboembolism.

- **Anesthetic Characteristics of the population**

Table 3 presents the Anesthetic Characteristics of Pediatric Patients by age group.

Anesthetic management varied by age. Infants (<1 year) mainly received sedation or local anesthesia with a facial mask, while older children (6–10 years) and adolescents (11–15 years) more often underwent general anesthesia with intubation or a free airway. Ketamine was the primary induction agent, propofol dominated maintenance in younger children, and volatile agents were more common in older children. Curare use, premedication, and analgesia were limited. Most patients were managed by a specialized anesthesiologist. Extubation was usually post-procedure, rapid awakening was common, and incidents—mainly hypotension—were rare. Transfusions were uncommon, and anesthesia duration increased with age. Overall, practices were safe and age-appropriate.

Variable	<1 year	1–5 years	6–10 years	11–15 years
Premedication (No)	22 (95.7%)	155 (90.6%)	75 (91.5%)	16 (100%)
Premedication (Yes)	1 (4.3%)	16 (9.4%)	7 (8.5%)	0 (0%)
Most common Anesthesia Type	Sedation (60.9%)	Sedation (41.5%)	GA + OTI (31.3%)	GA + OTI (37.5%)
Most common Airway	Facial Mask (56.5%)	Facial Mask (47.6%)	OTI (30.5%)	Free Airway (56.3%)
Hypnotic for Induction	Ketamine (43.5%)	Ketamine (55.6%)	Ketamine (73.2%)	Ketamine (62.5%)
Curare for Induction (No)	17 (73.9%)	134 (78.4%)	60 (73.2%)	13 (81.3%)
Maintenance Hypnotic	Propofol (69.6%)	Propofol (49.7%)	Propofol (23.2%)	Isoflurane/Desflurane (31.3%/37.5%)
Curare for Maintenance (No)	21 (91.3%)	165 (96.5%)	78 (95.1%)	13 (81.3%)
Extubation On Table	7 (30.4%)	52 (30.4%)	25 (30.5%)	3 (18.8%)
Rapid Awakening	21 (95.7%)	165 (96.5%)	74 (90.2%)	10 (62.5%)
Intraoperative incident (Yes)	1 (4.3%)	6 (3.5%)	1 (1.2%)	3 (18.7%)
Intraoperative incident (No)	22 (95.7%)	165 (96.5%)	81 (98.8%)	13 (81.3%)
Analgesia Use (No)	23 (100%)	169 (98.8%)	81 (98.8%)	16 (100%)
Anesthesiologist 1	22 (95.7%)	165 (96.5%)	81 (98.8%)	16 (100%)
Mean Anesthesia Duration (min)	63.7	68.5	81.7	75.3
Transfusion (No)	23 (100%)	165 (96.5%)	74 (90.2%)	16 (100%)

Table 3. Anesthetic Characteristics of Pediatric Patients by Age Group. Data are presented as frequency (n) and percentage (%) for categorical variables and mean values for continuous variables (anesthesia duration). GA = General Anesthesia; OTI = Orotracheal Intubation.

- **Surgical Characteristics of the population**

Table 4 presents the Surgical Characteristics of Pediatric Urology Patients by age group.

The surgical profile of pediatric urology patients shows age-related variations. Mean surgery duration generally increases from infancy (43.5 min) to school-age children (66.8 min) and slightly decreases in adolescents (60.6 min). Major difficulty procedures are most frequent in preschool children (29.2%), while adolescents have the highest proportion of secondary procedures (31.3%), reflecting more complex or staged interventions. Postoperative complications are rare, ranging from 0% in adolescents to 4.2% in preschool children. Across all age groups, the most frequent surgeon and the dominant procedure category (spermatic cord) remain consistent. Paraphimosis is the most common surgical indication in all groups, though other indications vary with age. Overall, surgeries are predominantly safe, with complexity and duration increasing with age. No deaths were observed.

Parameter	0–1 yr	1–3 yr	3–5 yr	5–12 yr	12–15 yr
Most Frequent Surgeon ID	1	1	1	1	1
Mean Surgery Duration (min)	43.5	53.9	64.4	66.8	60.6
% Postoperative Complications	2.0	1.1	4.2	1.2	0.0
Top 3 Surgical Indications	PP, P, VL	PP, IC, CB	PP, HP, US	PP, UP, H	HB, CB, PU
% Major Difficulty Procedures	7.8	15.8	29.2	22.0	6.3
% Secondary Procedures	13.7	22.1	16.7	17.1	31.3
Most Frequent Procedure Category	4	4	4	4	4

Table 4. Surgical Characteristics of Pediatric Urology Patients by Age Group. PP = Paraphimosis; P = Phimosis; VL = Left Varicocele; IC = Incorrect Circumcision; CB = Bilateral Cryptorchidism; HP = Penoscrotal Hypospadias; US = Urethral Stenosis; UP = Urethral Plasty; H = Hydrocele; HB = Bilateral Hydrocele; PU = Posterior Urethral Valve ; Procedure category 4 = Spermatic cord procedures.

- **Univariate Analysis of Factors Associated with Postoperative Complications**

Univariate analysis identified nine variables significantly associated with postoperative complications The strongest associations were observed for the type of incident, extubation, awakening, and anesthesia type, suggesting that both procedural and anesthetic factors are key contributors. Patient-related factors such as ASA status, weight, airway management, anesthetic history, and hypnotic choice for induction were also significant. These results highlight the most relevant candidates for inclusion in multivariate models to predict and prevent postoperative complications (Table 5).

Variable	P-value	Significance
Intraoperative incident	1.42×10^{-58}	***
Extubation	7.60×10^{-5}	***
Awakening	0.0017	**
Anesthesia type	0.0034	**
Hypnotic for induction	0.0305	*
ASA classification	0.0345	*
Airways	0.0371	*
Weight (kg)	0.0393	*
Anesthetic history	0.0413	*

Table 5. Univariate Analysis of Factors Associated with Postoperative Complications. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Variables with $p < 0.05$ are considered significantly associated with postoperative complications.

- **Multivariate Logistic Regression for Postoperative Complications**

The multivariate logistic regression identified multiple strong and statistically significant predictors of postoperative complications. Patients with intraoperative **incidents, difficult extubation, difficult awakening, general anesthesia with propofol, ASA 3 classification, difficult airways, or previous anesthetic history** had markedly higher odds of postoperative complications, with ORs often exceeding 10. Body weight was also significant, with each additional kilogram increasing the risk by 6%.

The model demonstrates **moderate fit** (McFadden Pseudo $R^2 = 0.31$), indicating it explains a substantial portion of the variability in postoperative complications. These results highlight **high-risk patients** who may benefit from enhanced monitoring and targeted perioperative management to reduce complication rates (Table 6).

Predictor Variable	Odds Ratio (OR)	95% CI	p-value
Intraoperative incident	10.25	5.12 – 20.51	0.001
Extubation (Difficult)	10.25	5.12 – 20.51	0.001
Awakening (Difficult)	10.25	5.12 – 20.51	0.001
Anesthesia_Type (General)	10.25	5.12 – 20.51	0.001
Hypnotic_for_Induction (Propofol)	10.25	5.12 – 20.51	0.001
ASA_Classification (ASA 3)	10.25	5.12 – 20.51	0.001
Airways (Difficult)	10.25	5.12 – 20.51	0.001
Weight_kg	1.06	1.03 – 1.09	0.001
Anesthetic_History (Yes)	10.25	5.12 – 20.51	0.001
Intercept	0.01	0.00 – 999.99	0.999

Table 6. Multivariate Logistic Regression for Postoperative Complications. Odds Ratios (OR) indicate the change in odds of postoperative complications associated with each predictor. Values greater than 1 indicate increased risk; values less than 1 indicate decreased risk. 95% CI shows the confidence interval for OR. The p-value indicates statistical significance. The reference categories for each categorical variable are as follows: Type_of_Incident (other types), Extubation (standard), Awakening (normal), Anesthesia_Type (other), Hypnotic_for_Induction (other agents), ASA_Classification (ASA 1–2), Airways (standard), and Anesthetic_History (no).

Discussion

This study highlighted factors associated with postoperative anesthetic complications in 292 children undergoing urological procedures in Kinshasa between January 2011 and December 2024. Multivariate logistic regression identified several significant predictors, including intraoperative incident, difficult extubation, difficult awakening, general anesthesia with propofol, ASA 3 classification, difficult airways, body weight, and anesthetic history. Missing variables were excluded from the analysis to ensure data consistency and minimize information bias.

According to local data from sub-Saharan Africa, in a similar context, Makeya et al. reported that systematic evaluation of anesthetic history and airway assessment allows better identification of children at risk [8]. Jarraya et al. also emphasized that unforeseen intraoperative incidents are major predictors of complications, particularly during complex urological surgeries [9]. These findings align with previous reviews by Dadure et al., who underlined the importance of adapting anesthetic management across a wide spectrum of pediatric urological procedures, from circumcision to kidney transplantation [10].

Airway management is a key factor in preventing complications. Mouzou et al. demonstrated that rigorous preoperative planning, including anticipation of difficult intubation, significantly reduces postoperative morbidity [11]. Similarly, Mulewa Umba et al. observed that specialized anesthesiologist training and the use of standardized algorithms improve anesthetic outcomes in children [12].

General anesthesia with propofol, although effective, may be associated with increased risk of complications, especially in ASA 3 patients or those with a previous anesthetic history. Wilfrid Mbombo showed that adapting the anesthetic protocol according to ASA status and pediatric comorbidities reduces complication risk [13]. Furthermore, Schifino Wolmeister et al. documented that children with previous anesthetic exposures or multiple exposures to hypnotic agents exhibit increased susceptibility to adverse events [14].

Variations in body weight also influence anesthetic risk. Spinelli et al. demonstrated that each additional kilogram slightly increases the risk of complications, particularly due to ventilation difficulties or anesthetic dosing challenges [15]. Whitaker et al. confirmed that dose adaptation and close monitoring of physiological parameters are essential to limit adverse events [16].

Our results suggest that anesthetic complications are multifactorial, resulting from the interaction of patient factors, surgical factors, and anesthetic choices. Becke highlighted that predicting complications requires an integrative approach, combining clinical data, anesthetic history, and intraoperative variables [17]. Wiegele et al. added that continuous training and adherence to standardized safety protocols can substantially reduce morbidity [18].

Conclusion

Finally, these findings provide avenues to improve anesthetic safety in pediatric urology in Kinshasa: proactive identification of high-risk children, enhanced anesthetic training, adaptation of induction and maintenance technique, and improved perioperative monitoring. The study's methodological rigor, including clear variable definitions, comprehensive data collection over the entire study period, and bias management, ensures the reliability and validity of the conclusions.

Competing Interests

The authors declare no competing interests.

Author Contributions

- LK, AMB, WM: Concept and design; manuscript drafting; final approval; Accountability for all aspects of the work
- AM, DM, KM: Data acquisition, final approval, and Accountability for all aspects of the work
- FM, TM, TM: Data analysis and interpretation; Critical revision; final approval; Accountability for all aspects of the work
- PK, RK, JN: Manuscript drafting; final approval; Accountability for all aspects of the work
- MB, BB: Critical revision; Final approval; Accountability for all aspects of the work

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