

Practice of Pediatric Anesthesia in Sub-Saharan Africa: Experience of Two Referral Hospitals in Benin

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Abstract: Introduction: The practice of pediatric anesthesia present particular risks and requires specifically trained staff. We describe here the practice of pediatric anesthesia in two referral hospitals of Cotonou. Method: This was an observational study conducted over a period of 05 months from August 4 to December 31, 2020. All children who had undergone an anesthetic procedure in these reference hospitals of Cotonou during the study period and who met the inclusion criteria were recruited. Data collection was carried out by filling out an individual physical form for each child on whom a surgery was performed. Children who underwent surgery were followed up until their discharge from hospital and called back 30 days later. Results: A total of 345 patients were registered. Among them, 224 (64.9%) were male, for a sex ratio of 1.85. The average age was 55 months \pm 4 months with extremes of one day and 190 months. Medical history was found in 9.56% of cases, and in 80.90% of cases, most interventions were scheduled. Digestive surgery was the most common (30.1%). The ASA1 class was the most represented (73.04%). The practice of pediatric anesthesia was medicalized in 17.39% of cases. All children were monitored. General anaesthesia was the most commonly used anaesthesia technique (89.85%). Loco-regional anaesthesia techniques were less used (27.53%). Spinal anesthesia (11.90%) and caudal anesthesia (11.30%) were the most commonly used local anesthesia techniques. The prevalence of anesthetic incidents and/or accidents during our study was 23.7% with a rate of 29 cardiac arrests per 10,000 anesthetics and an intraoperative mortality rate of 29 per 10,000 anesthetics. Perioperative complications were dominated by respiratory complications (11.57%), followed by cardiovascular complications (8.68%) and neurological complications (6.95%). A total of 84.35% of our patients were referred to an immediate post-interventional monitoring unit. I recorded 13 deaths in the postoperative period, representing a mortality rate of 3.7%. Conclusion: This work shows that the practice of pediatric anesthesia in Benin compared to previous years is becoming more and more satisfactory, even if the anesthetic safety is not yet optimal. It seems imperative to favor the specialization of practitioners, to promote loco-regional anaesthesia and to create pediatric hospitals with adapted resuscitation rooms and operating theaters.

Keywords: Pediatric Anesthesia, Referral Hospitals, Child, Cotonou - Bénin

1. Introduction

The practice of anesthesia in sub-Saharan Africa suffers from lack of trained personnel, drugs, monitoring equipment, and high morbidity and mortality rates [1]. In children, it is aggravated by lack of adequate infrastructures, and high mortality and morbidity rates from conditions like congenital anomalies, and typhoid fever with intestinal perforation and

generalized peritonitis in older children [2, 3].

The improvement of anesthesia quality and perioperative security has become the must for anesthetists taking care of children. In developed countries, health policies have been put in place to improve quality indicators and reduce risks linked with occasional pediatric anesthesia practice [4].

In Maghreb, Benkhalifa and co. [5], in 2010, have addressed pediatric anesthesia practice with focus on training, practices and obstacles. It was then shown that pediatric

anesthesia in that region was practiced by unspecialized personnel. Moreover, it was practiced without restriction of age or pathology in general health facilities.

In sub-Saharan Africa, Zoumenou and co. showed in 2015 that most children operated in that region were managed by anesthetic nurses and the latter were not trained and given enough competences and experience to provide optimal anesthesia security. Thus, morbidity and mortality incidences increased to unacceptable limits when compared with developed countries standards. Many researches realized in different countries of the region showed proof. In line with that, in Congo, Otiobanda and co. [7] reported in 2011, 55 cardiac arrests incidence in 10000 anesthesia, and a perioperative mortality of 270 in 10000 anesthesia; all at the Brazzaville Teaching Hospital Center. Kaboré and co. [8] in Burkina Faso in 2009 found a perioperative mortality rate of 624 in 10000 anesthesia in Ouagadougou Teaching Hospital Center. Zoumenou and co. [9] observed in Benin in 2010, a frequency of perioperative cardiac arrests of 156 in 10000 anesthesia with a mortality of 97 in 10000 anesthesia.

The present research addresses actual aspects of pediatric anesthesia practice at Cotonou, in a way to sort out propositions for management quality improvement.

2. Patients and Methods

This was a transversal observational study that took place in two reference teaching hospitals of Cotonou (South Benin) named: Hubert Koutoukou Maga National Teaching Hospital Center (CNHU-HKM) and Lagoon Mother and Child Teaching Hospital Center (CHU-MEL), for a period of five months from August 4th to December 31st 2020 (period of data collection). All children having benefited from anesthesia care in any of the above hospitals during the period of data collection, were recruited according to the following criteria:

Inclusion of all children aged 0 to 15 years that benefited from elective or emergency anesthesia care in then above cited reference hospitals during the period of study irrespective of the indication or type of surgery.

Exclusion of any child aged 0 to 15 years admitted to the theater for surgery either elective or emergency that died before any anesthesia care.

We proceeded to an exhaustive recruitment of all children matching with the above criteria during the period of study. The following variables were studied: sociodemographic data, patient's past-history, ASA grade, type of surgery, anesthesia technique, perioperative accidents/incidents, postoperative evolution and surveillance. Data was collected from admission files, anesthesia files, and preanesthetic evaluation files and transcribed in a pre-established form. It is to note that operated patients were followed till discharged from hospital and called back 30 days later.

Data entry involved EPI Data software version 3.1. Data treatment involved R software version 3.5. (with RStudio environment) and Excel 2013 software. Qualitative variables were estimated in terms of proportions while qualitative

variables were described in terms of median.

The study was conducted after approval and ethical clearance obtained from the local Ethic Committee, in the same line we obtained informed consent from each parent of all participants.

3. Results

During the study period 345 children benefited from surgery at CNHU-HKM (231/345; 66.96%) and CHU-MEL (114/345; 33.04%).

3.1. Sociodemographic Data

3.1.1. Age

60 months old and above was the most represented age range. Mean age was 55 months 16 days \pm 4 months 21 days, ranging from 1 day to 190 months. Table 1 presents repartition of children according to their age.

Table 1. Repartition of children according to age.

Age in months	Effectives	Frequencies
≤ 1	27	7.82
[1-30]	123	35.66
[30-60]	56	16.23
[60 and above]	139	40.29
Total	345	100

3.1.2. Sex

In our series, 121 (35.1%) were females and 224 (64.9%) were males, this is a sex ratio of 1.85.

3.2. Past-history

Medical past-history was found in 9.56% of our participants (33 patients). Asthma (2.3%) and Chronic Obstructive Pulmonary Disease (1.7%) were the most represented. Surgical past-history was found in 18.55% of participants with digestive surgery being the most represented (8.7%).

3.3. ASA Grade

ASA 1 and ASA 2 were the most represented, respectively 73.04% and 21.45% in our study.

Modality of surgical intervention

Surgeries were elective in 80.90% of cases. Digestive surgery was first in order (30.1%) followed by urologic surgery (20.9%), traumatology (16.8%) and ENT (15.1%). Time of surgery varied from 2 minutes to 540 minutes with a mean of 104 minutes \pm 11.

3.4. Anesthesia Care

No participant had premedication. Only 17.39% of pediatric anesthesia practice was done by specialized doctors. Anesthesia nurses were present in the theater for all interventions. All children were monitored during surgeries. SpO₂ (100%) and BP (97.97%) were the most monitored parameters. Table 2 shows repartition of children according to the monitored parameter.

Table 2. Repartition of children according to the monitored parameter.

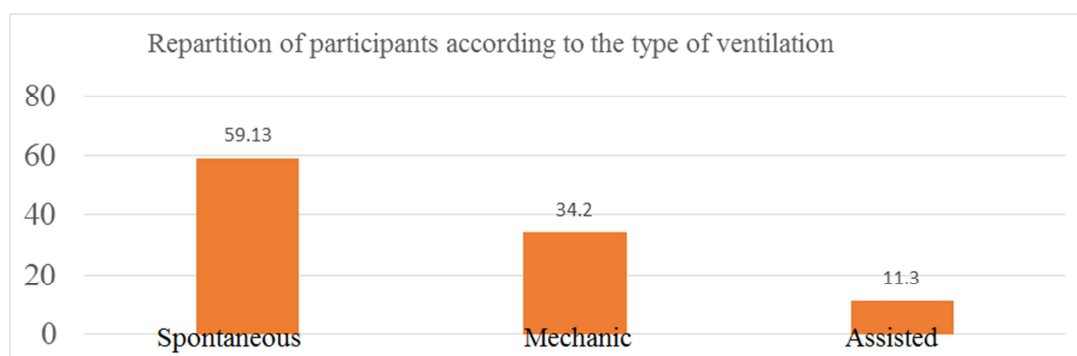
Parameters	Effectives	Frequencies
SpO ₂	345	100
TA	338	97.97
ECG	104	30.14
Capnography	51	14.78

General anesthesia was the most practiced technique (310/345; 89.85%) with predominance of general anesthesia and orotracheal intubation (270/345; 78.26%) followed by general anesthesia and facial mask (30/345; 8.70%) and general anesthesia and laryngeal mask (10/345; 2.90%). Locoregional anesthesia techniques were less practiced (27.53%) and involved spinal anesthesia (41/345; 11.90%), caudal block (39/345; 11.30%) and peripheral blocks (15/345;

4.35%).

Inhalatory induction combined with intravenous induction was the most frequent (69.3%). According to inhalatory agents, halothane was used in 124/345 (34.95%) and sevoflurane in 112/345 (32.50%) of patients. The most frequently used intravenous anesthetics were: propofol (78.6%) as hypnotic, sufentanil (76.5%) as the morphinic and suxamethonium (40.9%) as the neuromuscular blocker. Maintenance of anesthesia involved use of halothane or sevoflurane, propofol or ketamine, sufentanil and vecuronium.

Spontaneous ventilation (59.13%) was the principal mode of ventilation of the operated patients. Figure 1 shows repartition of participants according to the type of ventilation.

**Figure 1.** Repartition of participants according to the type of ventilation.

Bupivacaine was the most frequently used local anesthetic (12.8%) followed by ropivacaine (7.8%); when lidocaine and levobupivacaine were used in the same proportions (1.4%). Adjuvants for local anesthetics involved morphine (10.14%) clonidine (5.50%) and sufentanil (1.15%).

Paracetamol was the most frequently administered post-operative analgesic. Table 3 shows repartition of participants according to the administered analgesics.

Table 3. Repartition of children according to administered analgesics.

Analgesics	Effectives	Frequencies
Paracetamol	300	87.0
NSAID	43	12.5
Tramadol	21	6.1
Nefopam	13	3.8
Nalbuphine	2	0.6
Morphine	1	0.3
None	14	4.1

3.4.1. Anesthetic Incidents and Accidents

Prevalence of anesthetic incidents and accidents was 23.7% during the period of study, and they mostly happened during wakening period (9.57%), induction (8.99%), and, maintenance (7.83%).

(i). Complications at Induction of Anaesthesia

The most frequent here were: systemic hypotension (3.20%), respiratory difficulties (1.70%) and difficult intubations (1.70%) and we registered one case of death after cardiac arrest.

(ii). Complications at Maintenance of Anaesthesia

We noted cardiovascular (4.34%) and respiratory (3.18%) complications.

(iii). Complications at Wakening from Anaesthesia

Wakening period was essentially marked by neurologic (6.95%) then respiratory (3.47%) complications.

3.4.2. Place of Post-anaesthetic Wakening

In our study, 15.65% of participants were not sent to the post interventional care unit for immediate surveillance. Table 4 shows repartition of participants according to the place of postanesthetic wakening.

Table 4. Repartition of participants according to the place of wakening.

	Effectives	Frequencies
Post anesthesia care unit	173	50.1
Critical care	104	30.1
Hospitalization room	54	15.65
Intensive care unit	8	2.31
Neonatology	4	1.2
Pediatric emergency	1	0.3
Total	345	100

3.5. Evolution

We noted favourable evolution in 95.9% of cases. Unfavourable evolutions are linked to the death cases registered during the period of study (4.1%).

4. Discussion

4.1. Sociodemographic Characteristics

4.1.1. Sex

Males were the most represented in our survey (64.9%), with a sex ratio of 1.85. In 2010, Zoumenou and co. [9] reported a sex ratio of 2/1 in Benin. This male predominance has been observed in many other studies. Amengle and co. in Cameroun 2019, Nze Obiang and co. 2019 in Gabon, Mouzou and co. 2016 in Togo, respectively reported male predominance of 70.9%, 76.09%, 58.5% [10-12]. This tendency could be explained by the fact that operated affections were mostly of male type. In our survey these involved abdominal wall hernia, urologic malformative conditions, uncircumcised penis and orthopaedic surgery.

4.1.2. Age

The mean age in our survey was 55 months +/- 4 months (4.5 years +/- 4 months). Zoumenou and co. [9], Amengle and co. [10], Niandou and co. [13] respectively found mean ages of 5 +/- 3.9 years, 4.4 +/- 4.5 years, and 4.37 years. Compared to Zoumanou and co. in 2010 [9], proportion of participants aged one month or less was surperimposable. It was 8% with 512 participants in 2010, then 7.82% with 345 participants in 2020.

4.2. Past-history

A little proportion of our participants presented medical pasthistory during our survey (9.56%). The little found included asthma (2.30%) and chronic obstructive bronchopneumopathy (1.70%). The knowledge of those is important as far as S. Monsel and B. Riou found that, patients with disturbed functional explorations or gazometry are 20 times more at risk of postoperative complications; and the risk of per operative bronchospasm is 7 times more important [11]. Overall, 18.55% of our participants had surgical thus anaesthetic past-history.

4.3. ASA Grading

Most participants were ASA 1 (73.04%). Zoumenou and co. in 2010, Mouzou T and co. in Togo 2016 [12], Nze Obiang and co. in Gabon 2017 [11] and Amengle and co. in Cameroon 2019 [10] also reported predominance of ASA 1 with respective proportions of 93%, 79.7%, 93%, and 60.9%. ASA 1 predominance could be explained here by the fact that 80.90% of interventions were elective.

4.4. Type of Surgery

In our survey, digestive surgeries were most frequent (30.1%), followed by urologic surgery (20.9%) traumatology surgery (16.8%) and ENT (15.1%). Other surgery types had low proportions. Niandou and co. at Niamey 2015 [13] found same ranking with 70.79% of digestive surgeries, 23.16% of urologic surgeries, and 2.92% of orthopaedic surgery. Nze Obiang and co. [11] reported otherwise 85.7% for digestive surgery, 7.31% for gynaecology, 3.9% for ENT and 3.4% for

orthopaedic surgery in Gabon. This difference could be explained by the fact that Nze Obiang and co. had extended their study to participants aged more than 15 years thus included gynaecologic surgery.

4.5. Duration of Intervention

Duration of intervention ranged from 2 minutes to 540 minutes with a mean of 104 minutes +/- 11 minutes in our survey. In Gabon, Nze Obiang and co. [11] instead found a mean duration of 44 minutes +/- 10 minutes.

4.6. Anaesthetic Care

Anaesthesia and critical care High technicians were present in theatres for all interventions during the period of study. The presence of anaesthesia and critical care doctors was effective in only 17.39% of cases. Our results are similar to those of many African authors. In 2016 in Togo, Mouzou and co. reported paediatric anaesthesia practiced exclusively by high technicians, working alone in 83.8%, and supervised by a specialist doctor in only 16.2% of cases [12]. Although in Netherland in 2015, anaesthesia procedures have exclusively been assured by specialist paediatric anaesthesia doctors associated to a nurse specialized in paediatric anaesthesia [14]. This situation could be explained by the very low demography of doctors specialized in anaesthesia and critical care in sub-Saharan Africa in general and Benin in particular.

4.6.1. Peroperative Monitoring

Peroperative monitoring involved monitors during all realized interventions. Monitoring concerned mostly SpO₂ (100%) and non-invasive blood pressure (97.97%) during our study. We had low rates of ECG (30.14%) and capnography (14.78%) monitoring. This difference could be explained by the lack of dedicated equipment for the monitoring of those parameters in theatres of CNHU-HKM of Cotonou.

4.6.2. Anaesthesia Technique

Inhalatory induction combined with intravenous induction was the most frequent (69.3%) during our study. Amengle and co. In Cameroon, Mouzou and co. in Togo reported similar results [10, 12]. The frequency of combined inhalatory and intravenous induction was 45% in Cameroon 2019 and 55% in Togo 2016 [12]. Nze Obiang and co. in Gabon 2017 [11] and Niandou and co. at Niamey 2015 [6] instead reported a far elevated frequency of intravenous induction with respective proportions of 100% and 96.12%. These differences could be explained by local habits of each anaesthesia service and varied availability of drugs in each country.

4.6.3. Ventilation Mode and Airways Management

Airway management technique depends on the type of surgery, its eventual duration and associated risks [15]. Overall, 78.26% of our participants had oro-tracheal intubation as in other African studies [7, 12, 13]. Oro-tracheal intubation was the technique of choice since it offers efficient control of upper airways [4]. Ventilation was spontaneous in 59.13% of cases, mechanic in 34% of cases and manual in 11.03% of

cases. Predominance of spontaneous ventilation could be justified by dysfunctional or unavailable paediatric respirators in some operating rooms.

4.6.4. Anaesthetic Agents Used at Induction

Propofol was the most employed anaesthetic in the class of hypnotics (78.66%) at induction. Propofol choice was justified by its rapid period of action with large volume of distribution in peripheral compartments and fast elimination [16]. Our results are similar to those of Mouzou and co. in Togo, Nze Obiang and co. in Gabon and Niandou and co. at Niamey [11-13]. Indeed the latter found usage of propofol at induction in the respective following proportions: 76.74%, 87.80%, and 98.02%.

Halothane (35.7%) and sevoflurane (32.5%) were the most used inhalation agents in association with propofol. Sevoflurane was prioritized in infants and new-borns. It is best tolerated with less cardiorespiratory side effects, low hepatic toxicity and no nephrotoxicity [16]. It all shows that sevoflurane should be the inhalatory agent of choice, but its high cost makes its usage very limited.

Muscle relaxation was done with suxamethonium in 40.9% of cases in our study. In Morocco, in 2014 [17] it was used in 65% of cases. However in Cameroon in 2019 [10] and in Togo in 2016 [12] it was very less used respectively 19% and 16%. This could be explained by the fact that neuromuscular blockade for intubation remains a subject of debate in children [16].

The most used morphinic was sufentanyl (76.5%) during our period of study. These results differ from those obtained in other sub regional countries where fentanyl remained the most used morphinic. Fentanyl is used in Togo at 84%, 67.5% in Cameroon and in all surgery cases in Gabon [10-12]. The observed difference could be explained by the variable availability of those products in each country.

4.6.5. Anaesthetic Agents Used at Maintenance of Anaesthesia

In most cases, maintenance of anaesthesia involves the use of inhalatory anaesthetics. Halothane was used in 53.9% of cases. This result is superimposable to those obtained in Cameroon, Gabon, Togo and Morocco [10-12, 17]. The large usage of halothane in these studies could be explained by its availability despite its numerous cardiovascular and hepatic side effects. Economic accessibility is a reason that justifies its frequent usage in sub-Saharan Africa.

4.6.6. Local Anaesthetics

Bupivacaine was used in 12.8% of cases in association with morphine for spinal anesthesia. Ropivacaine (7.8%), Levobupivacaine (1.4%) and Mepivacaine (2.9%) were instead used for caudal and penile blocks.

4.7. Anaesthetic Incidents and/or Accidents

The prevalence of anaesthetic incidents and/or accidents during our study was 23.7%. They were predominantly represented by respiratory complications (11.57%), cardiovascular complications (8.68%) followed, then neurologic complications (6.95%). These results came to

corroborate those of many authors. APRICOT study realized in 33 European countries by Walid H. and co. in 2017 [4] found a critical perioperative events global incidence of 5.2%. These events involved respiratory complications (3.1%) and cardiovascular instability (1.9%).

However, Samaké B. and co. in Mali 2011, Mouzou and co. in Togo 2016, Amengle and co. in Cameroon 2019 respectively reported: 12%, 31%, 33.1%, of perioperative anesthetic incidents. They involved respiratory complications followed by cardiovascular and neurologic complications [16]. It shows out clearly from the above cited studies that perioperative paediatric anesthetic complications are essentially of neurologic, cardiovascular and respiratory order.

4.8. Post Anaesthetic Awakening Place

During our study, 15.65% of patients were transferred directly to the hospitalisation room at the end of surgery. This could be explained by the unavailability of post interventional care rooms in the units where the participants got operated. It all recalls the importance of reinforcing equipment and infrastructures in our hospitals. From SFAR and ADARPEF recommendations, it is essential to have a specific post interventional care room for a secured post anaesthetic awakening [18].

4.9. Postoperative Outcome

Operated participants in our study were followed till discharge from the hospital and even called back 30 days later. We registered on perioperative death case. Postoperative evolution was favourable in 95.7% of cases. It is to note that 3.1% of participants developed lethal complications of diverse orders. Some were linked with anaesthesia and others to postoperative care. Complications linked with anaesthesia were predominantly respiratory. All deaths registered occurred within 7 days from end of surgery. Complications linked with surgery were not registered. Amengle and co. in Cameroon, Niandou and co. at Niamey found respective mortality rates of 7.9% and 8.51%.

5. Conclusion

I recorded 13 deaths during the postoperative period, this is a mortality rate of 3.7%. Young age (0-1 month), ASA grades 3 and 4, the emergency character of the surgery, and general anaesthesia technique with orotracheal intubation were the principal risk factors found during our study. This work shows that paediatric anaesthesia practice in Benin, comparatively to previous years, becomes more satisfactory despite anaesthetic security is not optimal. It seems imperative to promote specialization of practitioners, locoregional anaesthesia and build paediatric hospitals with critical care units and adapted operating rooms.

Conflicts of Interest

The authors declare that they have no competing interests.

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