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Challenges of Neonatal Anaesthesia in a Tertiary Institution in Nigeria: A Ten-year Retrospective Review

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Abstract

Background: Successful management of neonatal problems is faced with numerous anaesthetic challenges especially in a low resource country like Nigeria with significant morbidity and mortality. The study examined the challenges encountered during neonatal anaesthesia and its association with mortality in a tertiary institution.

Method: This is a 10 - year retrospective study from January 2008 and December 2017 at the University College Hospital, Ibadan, Nigeria. Neonates anaesthesized for neonatal surgery were recruited.

Demographic data, American Society of Anesthesiologist's (ASA) status, type of surgery, duration of surgery, intraoperative critical events and mortality were subjected to statistical analysis using SPSS version 23.

The association between intraoperative critical events and the type of surgery, ASA status, duration of surgery and mortality was determined with chi square and the level of significance was set at p less than or equal to 0.05.

Results: A total of 356 neonatal data were retrieved with 215 (60.4%) males and 141 (39.6%) females. Overall, 35 (9.8%) neonates had intraoperative critical events (ICE) (hypotension 2.8%, hypothermia 14.4%, difficult intubation 17.1%, desaturation 20%, cardiac arrest 17.1% and delayed recovery from anaesthesia28.6%).

Emergency surgery (p=0.004), ASA status (p=0.16) and duration of surgery (p=0.03) were factors affecting the ICE, 10 patients out of 35 patients with ICE died hence ICE was associated with mortality (p=0.002).

Conclusion: Intraoperative critical events pose a challenge during neonatal anaesthesia and risk factors for critical events are emergency surgery and longer duration of surgery are associated with mortality. Efforts should be made to reduce these critical events to obtain a better outcome.

Keywords*: Anaesthesia, Challenges and Surgical neonate*

Abstrait

Contexte: Une prise en charge réussie des problèmes néonatals est confrontée à de nombreux défis anesthésiques, en particulier dans un pays à faibles ressources comme le Nigeria avec une morbidité et une mortalité importantes. L'étude a examiné les défis rencontrés lors de l'anesthésie néonatale et son association avec la mortalité dans un établissement tertiaire.

Méthode: Il s'agit d'une étude rétrospective de 10 ans, de janvier 2008 à décembre 2017, à l'University College Hospital d'Ibadan, au Nigeria. Des nouveau-nés anesthésiés pour une chirurgie néonatale ont été recrutés.

Les données démographiques, le statut de l'American Society of Anesthesiologist (ASA), le type de chirurgie, la durée de la chirurgie, les événements critiques peropératoires et la mortalité ont été soumis à une analyse statistique à l'aide de SPSS version 23.

L'association entre les événements critiques peropératoires et le type de chirurgie, le statut ASA, la durée de la chirurgie et la mortalité a été déterminée avec le chi carré et le niveau de signification a été fixé à p inférieur ou égal à 0.05.

Résultats: Un total de 356 données néonatales ont été récupérées, avec 215 (60.4 %) hommes et 141 (39.6%) femmes. Au total, 35 (9.8%) nouveau-nés ont présenté des événements critiques peropératoires (ICE) (hypotension 2.8%, hypothermie 14.4%, intubation difficile 17.1%, désaturation 20%, arrêt cardiaque 17.1% et récupération retardée après l'anesthésie 28.6%).

La chirurgie d'urgence (p = 0.004), le statut ASA (p = 0.16) et la durée de la chirurgie (p = 0.03) étaient des facteurs affectant l'ICE, 10 patients sur 35 atteints d'ICE sont décédés, l'ICE était donc associée à la mortalité (p = 0.002). .

Conclusion: Les événements critiques peropératoires posent un défi pendant l'anesthésie néonatale et les facteurs de risque d'événements critiques sont la chirurgie d'urgence et une durée plus longue de la chirurgie est associée à la mortalité. Des efforts doivent être faits pour réduire ces événements critiques afin d'obtenir de meilleurs résultats.

Mots-clés : Anesthésie, défis et nouveau-né chirurgical

Introduction

Neonates belong to a high - risk surgical population group and neonatal anaesthesia is the most challenging aspect of paediatricanaesthesia as evident by the fact that anaesthesia related perioperative morbidity and mortality are relatively higher in neonates in comparison with infants and older children [1,2].

In a multi-centred study in Thailand of 25,098 paediatric patients, neonates were found to have more significant adverse events compared to older children and desaturation was found to be the commonest adverse events encountered. Other adverse events found were multiple intubation attempts, oesophageal intubation, bradycardia, drug error, cardiac arrest and death [2].

Congenital abnormalities occurred in 80% of all neonatal surgical conditions in many African hospitals compared to older children who present more with acquired condition as the commonest indication for surgery [3]. Neonatal perioperative outcome in the developed countries is better when compared with sub-Saharan Africa and this may be attributed to advances in diagnosis of these anomalies, and provision of safe anaesthesia [3,4].

Administration of safe paediatricanaesthesia in the developing world has been a source of concern to the World Federation of Societies of Anaesthesiologist (WFSA). They express concern about anaesthetist skill, knowledge, drug and anaesthetic equipment [5].

The aim of this study was to examine the incidence of intraoperative critical events and deaths and to find the association of intraoperative critical events with neonatal death in a typical paediatric unit of a tertiary institution in Nigeria.

Methodology

After ethical approval by the Institution Ethics Committee (UI/EC/18/0461), a retrospective study was conducted at the University College Hospital, Ibadan, Nigeria over a ten-year period from January, 2008 to December, 2017. Data were extracted from the surgical and anaesthetic records. All children aged between 0 and 28 days who had both elective andemergency non-cardiac surgery were included. Patients with incomplete or missing data were excluded.

General anaesthesia was administered by Consultant Anaesthetists and by the most senior trainee anaesthetists (Registrars) with the Consultant inattendance. The Senior registrars usually have spent four years in the residency training and Consultant Anaesthetists are Physicians who were formally trained in paediatricanaesthesia.

Data was collected from anaesthetic record and files. The parameters studied were; Demographic data (age and weight), Preoperative data (Indication for surgery, urgency of surgery and American Society ofAnesthesiologist (ASA) Physical Status), Intraoperative data (type of anaesthesia, induction mode, muscle relaxants, the type of surgicalprocedures performed, duration of the surgery and anaesthesia, intra-operativecritical events, the cadre of the anaesthetist and outcome (mortality or survival).

Critical events were defined as any event that affected or could have affected the safety of the patient while under the care of anaesthetist from the induction of anaesthesia until discharge from the post-anaesthesia care unit. Hypotension was defined as a decrease of systolic blood pressure by 20% from the baseline and below normal for age while hypertension as an increase of systolic blood pressure by 20% from the baseline and above normal for age.

Tachycardia as an increase in heart rate by 20% from the baseline and above normal for age whereas bradycardia as a decrease heart rate by 20% and below normal for age.

Hypoxia defined as oxygen saturation SpO_2< 95%.

Hypothermia as defined by temperature less than 36.5^0C

Difficult intubation defined as required more than three attempts for endotracheal intubation.

Delayed recovery from anaesthesia was defined as delayed return of consciousness within 40-60 minutes after the last administration of anaesthetic agent.

The recorded data was entered into a proforma and analyzed. The procedures for data collection and reporting were in accordance with the ethical standards of Helsinki declaration of 1975 as revised in 2000.

Data analysis was performed using IBM Statistical Package for Social SciencesSoftware Version 23.0 for Windows (SPSS Inc., Chicago, IL, USA). Categorical datawas summarized as absolute values (percentage) whereas continuous data was expressed as mean ± SD. Chi-square analysis was conducted to check forassociation between categorical variables and independent sample t-test was usedto compare continuous variables. P values < 0.05 were regarded as significant.

Results

During the study period, data of 356 neonates were retrieved comprising of 215 (60.4 %) males and 141 (39.6 %) females with a male to femaleratio of 1.5:1.The mean age was 7.91 (SD ± 6.6) days with age range of 1 and 28 days while the mean weight was 2.69 (SD ± 1.13) kg with range of 1.9 and 4.6kg.

Surgical conditions are summarized in Table 1. Gastrointestinal anomalies were the most frequent diagnoses (46.7%) and the least frequent diagnoses were in the head and neck region accounting for 7.9% of cases.

There were 85 (23.9%) neonates in ASA Class 1, 138 (38.8%) in ASA Class 2, 107 (30%) in ASA Class 3 and 26 (7.3%) neonates in ASA Class 4.

All surgical procedures were performed under general anaesthesia and endotrachealintubation and induction agents were either with intravenous ketamine or inhalational agent halothane and maintenance of anaesthesia was achieved using halothane.

The mean duration of surgery was 92.3 minutes and the range was between 30 to 240 minutes while the mean duration of anesthesia was 123.0 minutes and the range was between 45 to 300 minutes.

The mean systolic blood pressure ranges from 88.4 mmHg to 104.3 mmHg, the mean temperature ranges between 36.2 and 37.8^{0}C whereas the mean oxygen saturation ranges between 93.7 to 100%.

Table 1: Neonatalclinical diagnosis

Diagnosis	Frequency	Percentage
Head and Neck		
Encephalocoele	15	4.2
Maxillary Alveolar Polyp	2	0.6
Cystic Hygroma	5	1.4
Congenital Hydrocephalus	6	1.7
Anterior Abdominal Wall		
Exomphalos	45	12.6
Gastroschisis	21	5.9
Gastrointestinal tract		
Oesophageal Atresia with TOF	26	7.3
Hypertrophic pyloric stenosis	10	2.8
Duodenal Atresia	23	6.5
Intestinal malrotation	1	0.3
Intestinal atresia	34	9.6
Pneumoperitoneum	3	0.8
Colonic perforation	2	0.6
Hirschsprung's disease	17	4.8
Meconium plug syndrome	3	0.8
Genitourinary system		
Inguinal hernia	25	7.0
Post circumcision cicatrization	1	0.3
Bladder Exstrophy	17	4.8
Posterior urethral valve	6	1.7
Musculoskeletal system		
Myelomeningocoele	41	11.2
Polydactyly	3	0.8
Fibroma	3	0.8

TOF – Tracheo-oeseophageal fistula

Table 2: Intraoperative critical events

Intraoperative critical events	N=35	%
Delayed recovery	10	28.6
Desaturation	7	20.0
Difficult intubation	6	17.2
Cardiac arrest	6	17.2
Hypothermia	5	14.4
Hypotension	1	2.8

There were five (5.9%) intraoperative critical events among neonates in ASA Class 1 physical status in comparison with 30 (11.1%) intraoperative critical events among neonates in ASA greater than Class 1 physical status. (p=0.16).

There was a significant association between intraoperative critical events and duration of anaesthesia (p=0.03)

Of the 35 patients that developed intraoperative critical events, 10 (23.3%) patients died, this was statistically significant p=0.002. (Table 3)

Table 3: Risk factors affecting intraoperative critical events

Parameter	Intraoperative critical events N=35	No intraoperative critical events N=321	P value
Type of surgery			
Emergency			
n=168	23(13.7%)	145(86.3%)	0.02
Elective n=188	12(6.4%)	176(93.6%)	
ASA status			
ASA 1 (n=85)	5(5.9%)	80(94.1%)	0.16
ASA>1 (n=271)	30(11.1%)	241(88.9%)	
Duration of surgery			
< 1 hour (n=141)	8(5.7%)	133(94.3%)	0.03
> 1 hour (n=215)	27(12.6%)	188(87.4%)	
Outcome			
Mortality (n=43)	10(23.3%)	33(76.7%)	0.002
Survival (n=313)	25(8%)	288(92%)	

One hundred and sixty-eight (47.2%) neonates had emergency procedures whereas 188 (52.8%) neonates had elective operations performed on them. Anaesthesia was administered on 192 (54%) neonates by Consultant Anaesthetists and 164 (46%) neonates by the most senior trainee anaesthetists (Registrars) with the Consultant inattendance.

A total of 35 (9.8%) neonates had intra-operative critical events, these events were hypotension 1 (2.8%), hypothermia (14.4%), difficult intubation (17.1%), desaturation (20%), cardiac arrest (17.1%) and delayed recovery from anaesthesia (28.6%). Table 2.

None of these intraoperative events resulted in death on the operating table.

There were twenty-three (13.7%) intraoperative critical events among neonates who had emergency surgicalprocedures in comparison with 12 (6.4%) in the elective group (p = 0.02).

There was an overall neonatal mortality of 12.1% (43/356).

Discussion

Neonatal anaesthesia is a very challenging aspect of paediatricanaesthesia andbeing a neonate is a widely recognized risk factor for perioperative morbidity and mortality across low, middle - and high - income countries of the world. Neonatal anaesthesia requires an in-depth knowledge of the physiologic, pharmacologic and anatomic peculiarities of the newborn in relation to older children and the adult surgical population [1,2].

The observed incidence of intra-operative critical events of 9.8% in our study falls within the reported range of 0.42% to 30.8% in a review by Carter et al, where they suggested that the incidence depends on the methodology and the definition of adverse events used[6]. However, recent advances in surgery, monitoring and anaesthetic techniques may

influence the incidences of adverse events observed in different studies.

There were more intraoperative critical events among neonates who had emergency surgical procedures compared to neonates who had elective surgical procedures in this study. This finding is in keeping with previous studies that identified emergency procedures as risk factor for perioperative morbidity and mortality [8,9]. Thus, emergency neonatal surgical procedure is a significant risk factor for perioperative adverse events [9].

ASA Physical Status classification is a useful tool for preoperative risk stratification and is believed to be an independentrisk factor for perioperative mortality. ASA physical status greater than 1 is not a significant risk factor for developing intraoperative critical events in this study although majority of the patients were with anaesthetic risk of ASA 2 and ASA 3 but meticulous efforts were also put in place for these group of neonates to produce better outcome. Neonates with higher ASA status greater than 1 were shown to be 25.5 times likely to develop perioperative adverse events as reported by Mendee et al [9].

Duration of surgery and anaesthesia were observed to be significant risk factors for developing intraoperative critical event in this study. Duration of surgery and anaethesia are important determinants of surgical stress especially in neonates and increase the chances of intraoperative events like hypothermia[10]. Mandee et al also found duration of surgery as a significant risk factor for developing intraoperative critical event [10].

Delayed recovery from anaesthesia was the most frequent critical adverse event observed in this study, numerous factors have been implicated in delayed awakening from general anaesthesia, this can be attributed to residual effect of one or more anaesthetic agents, hypothermia or hypoxia.

General anaesthesia was with either intravenous ketamine or halothane induction. Both drugs have been found to cause prolonged unconsciousness after surgery due to their pharmacokinetics [10]. Halothane has a high blood gas partition coefficient leading to slow emergence from anaesthesia, however, newer inhalational agent like sevoflurane and desflurane have superior emergence time which is due to their low blood gas partition coefficient but were not available for use during the data collection. These drugs have been reported in some studies to have reduced delayed emergence from anaesthesia[10]. Intravenous induction method was preferred because most neonates arrived in the theatre with intravenous cannula. Ketamine is usually used in neonates with hemodynamic instability.

Hypothermia, a common intraoperative critical event in neonates as observed in this study can lead to hypoxia, apnea, myocardial depression and prolonged the duration of action of anaesthetic drugs resulting in a delayed awakening [11,12]. Although warming devices were used for these neonates, they were often not adequate due to factors like surgical exposure of the neonates, use of cold irrigation fluid, cold theatre environment and length of time of surgery amongst other factors.

Other intraoperative critical events observed were mainly respiratory and cardiovascular. This corroborates previous reports alluding to the frequency of these complications in neonates and infants [1,2,9].

Seven (20%) of our patients suffered intraoperative arterial oxygen desaturation, although the immediate cause and the exact timing of these events could not be established due to the retrospective nature of this study. de Graff et al in a study on the incidence of intraoperative hypoxemia in children in relation to age reported a higher incidence of intraoperative hypoxemia among neonates compared to other paediatric age groups.[13]

Neonates are generally more difficult to intubate by inexperienced provider. Unexpected difficult intubation was found in three cases in the study by Mandee et al leading to multiple intubation attempts [9]. A potential difficult airway may result from patient's syndrome or anatomic airway abnormalities. It is known that anatomical airway peculiarities of the neonates are sometimes a source of difficult intubation.

Neonates also have a higher metabolic rate and higher oxygen consumption, resulting in a more rapid desaturation during periods of apnea [1,2]. The observed hypoxic events could also have resulted from inability topromptly secure the airway at induction.

There were 6 (17%) cases of cardiac arrests. This could have resulted from desaturation, cardiac depressant effects of the inhalational agents, hypovolaemia, other co- existing medical disease or a combination of these. A lower incidence of 0.03% of cardiac arrest resulting from hypoxia, decreased cardiac output and hypotension was reported from Europe [12]. The difference in the incidence of cardiac arrest may be due to better paediatric health care facilities across Europe compared to sub

Saharan – Africa [14]. Also, lack of availability of newer inhalational agents during the induction and maintenance of anaesthesia may have explained the higher incidence of cardiac arrest observed in this study. Halothane was used frequently in this study due to availability this differs from some institutions where halothane was no more in use because of its concern about its cardiovascular effect such as arrhythmia and cardiac arrest [1].

The prevalence of hypotension was observed to be the lowest in this study (2.8%). Meticulous attention to volume replacement (preload) and maintenance of an optimal heart rate were crucial in ensuring appropriate blood pressure maintenance in these neonates. Haemodynamic parameters were monitored using a multi-parameter monitor and by clinical observation of the neonates but accurate fluid replacement could only be achieved with the aid of the "buretrol" infusion set, since there were no drip counters and syringe pumps in our operating room, similarly, blood transfusion was doneby administering boluses using a 2ml syringe.

Optimal monitoring using the precordial stethoscope, pulse oximeter, capnograph, noninvasive blood pressure, electrocardiogram and temperature probes were key to agood outcome in neonatal anaesthesia in this study. These basic monitors were all available for use in our centre. Availability of standard monitoring could also account for the prompt detection of critical events in our series, but the retrospective nature of this study does not rule out the possibility of under-reporting of these events.

Of the 356 neonates studied, there was an overall in-hospital mortality of 12.1% out of which 0.6% of the patients had anaesthesia related deaths. This comparably good outcome could be attributed to the routine anaesthetic management of neonates andvery ill infants by Consultant paediatricanaesthetists and very senior anaesthetic trainees under the supervision of a Consultant. A mortality of 39.2% was reported by Faponle et al following anaesthesia for neonatal surgical emergencies [15]. This high mortality could have resulted from the fact that besides being emergency procedures more than 95% of cases were done by non-physician anaesthetists. The management of high-risk age groups like neonates by experienced anaesthetists at appropriate levels of care has been shown to decrease anaesthesia-related mortality [16]. This view was also corroborated by Walid et al who in a recent prospective multicentre study identified the management of the youngest and most ill paediatric patients by an inexperienced anaesthetic team as a major risk factor for severe critical events [14].

Limitation of the study was its retrospective nature. The retrospective data collection may leave out some variables due to error in retrieving the record as well as mistake in recording the data in the computer database. Analysis could not be done for these unknown data.

Conclusion

Intraoperative neonatal anaesthetic challenges observed in this retrospective study were hypotension, desaturation, hypoxia, hypothermia, difficult intubation and delayed recovery after surgery. The risk factors for developing these intraoperative challenges were emergency surgery and longer duration of surgery which could lead to mortality. Factors minimizing incidence include vigilance, experienced consultant anaesthestists and well optimized neonates before surgery.

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