

# Paediatric Neurosurgical emergency operations: Clinical spectrum, Presentation- Intervention Interval and Early operative outcome in Regional Neurosurgical center, Nigeria

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**BACKGROUND:** Pediatric neurosurgical emergencies are prevalent worldwide, often triggered by acute, life-threatening conditions that necessitate immediate surgery to prevent disability and death. Managing these conditions perioperatively poses significant challenges for neurosurgeons and anesthetists due to potential complications like anemia, seizures, electrolyte imbalances, intracranial hypertension, and vision threats, alongside the primary neurosurgical issues. Proper correction and optimization of these physiological derangements before surgery are crucial for favorable postoperative outcomes.

**PATIENTS AND METHODS:** This retrospective study analyzes emergency neurosurgical operations performed on children aged sixteen and under at a neurosurgical center in Sokoto, Nigeria, from January 2018 to December 2021. The center caters to a population of approximately twenty million people from three north-western and one north-central Nigerian states, as well as neighboring Niger and Benin republics. The area features a mostly arid climate with limited seasonal rainfall and experiences the Sahara's harmattan winds.

**RESULTS** A total of 131 children underwent emergency neurosurgical procedures during the study period. The majority were males (71%), with an average age of 5.6 years. Hydrocephalus was the most frequent emergency condition, leading to 44.3% of surgeries, primarily through ventriculoperitoneal shunt procedures, which accounted for 42.7% of interventions. Anemia was the most common comorbid condition. The mean time from presentation to intervention was 10 days. Postoperatively, 17.9% of patients suffered from surgical site infections, yet 67.9% had favorable outcomes with a mortality rate of 7.1%.

**CONCLUSION:** This study underscores the importance of timely surgical interventions and highlights the predominance of ventriculoperitoneal shunts in treating pediatric hydrocephalus in the region, with generally positive outcomes despite delays

**Keywords:** emergency paediatric neurosurgery, paediatric surgical operations, hydrocephalus, paediatric brain injury, ventriculoperitoneal shunt

## INTRODUCTION

Generally, pediatric surgical conditions are common in developing countries, and timely referral of patients for surgical treatment is essential in order to reduce morbidity and possible mortality[1]. Congenital surgical emergencies predominate in the neonatal period, while acquired conditions are more prevalent with advancing age[2,3]. Pediatric neurosurgery in particular, has one of the highest morbidity and mortality rates among pediatric subspecialties [4,5]. It is well known, that these patients may have preoperative co-morbidities that may influence the outcome of surgical procedures [6]. Correction and optimization of preoperative physiological derangements is not always achievable in emergency situations further adding to the morbidity and mortality in these patients. As costs of health care rise, attention is now focused on

improving surgical outcomes through quality improvement (QI) initiatives [7]. Therefore, this study was designed to determine the clinical spectrum and early outcome of emergency pediatric neurosurgical operations done in our centre, as this may help in improving the quality of care given to these patients in the future.

## MATERIALS AND METHODS

This was a retrospective study that recruited all pediatric patients age 16 years and below who had emergency neurosurgical operation from January 2018 to December 2021 at Usmanu Danfodiyo University Teaching Hospital (UDUTH) Sokoto. The neurosurgical center serves three north-western states and one north-central state of Nigeria as well as neighbouring Niger and Benin republics, an estimated twenty million population is served by the center,



located in Sokoto, Sokoto, state, northwestern Nigeria. Bordering the Republic of Niger to the north, it also shares boundaries with Kebbi state to the west and south, and Zamfara to the south and east. Sokoto state occupies an area of short-grass savanna vegetation in the south and thorn scrub in the north. A generally arid region that gradually merges into the desert across the border in the Niger republic, it has limited rainfall from mid-May to mid-September and is subjected to the Sahara's harmattan (dry, dust-laden wind) from November to March. Data was extracted from the patients' case notes, operation notes, and operation register and admission-discharge records. Details of clinical diagnosis, pre-operative comorbidity, presentation-intervention interval (PII), surgical operation and early post-operative outcome (admission to discharge) were noted and analyzed using statistical package for social sciences (SPSS) version 22. Chi-square test was used for categorical variables. Results were presented in tables. P value was set at 0.05.

## RESULTS

A total of 131 children with emergency neurosurgical conditions were operated over the study period. Majority (71.0%) were males, with M: F of 2.4: 1. Out of the 131 patients recruited in this study, 68(51.9%) were 0-5 years at presentation, 44(33.6%) were 6-11 years and 19(14.5%) were 12-16 years of age. The mean age at presentation was 5.6 years ( $\pm 5.0$ ) (table 1). The most common indication for emergency operation was hydrocephalus (44.3%), followed by traumatic brain injury (TBI) (32.8%), cranial infections (brain abscess, ventricular empyema, pott's puffy tumor and implants infection)-11.4%, shunt malfunction (6.9%) and chronic subdural haematoma (3.1%) (table 2). Patients aged 0-5 years more likely to present with hydrocephalus ( $p=0.001$ ) and have longer hospital stay ( $p=0.049$ ). While TBI in children aged 6-11 years ( $p=0.001$ ), pott's puffy tumor in age group 12-16 ( $p=0.003$ ). Anaemia was the most common comorbid condition (15.4%), 65.4% had no comorbidity (table 3). The mean haemoglobin was 10.2g/dl  $\pm 1.4$ , hypokalaemia was the only electrolytes derangement found (7.7%). Males more likely to have comorbidity ( $p=0.003$ ). The mean presentation-intervention interval was 10.0 days  $\pm 9$ . Emergency surgical operations done include: ventriculoperitoneal shunt (vps) (42.7%), debridement and duroplasty (19.1%), elevation of depressed skull fracture (9.9%), craniotomy (6.9%), burr hole (5.3%), external ventricular drainage (5.3%), craniectomy (5.3%), shunt revision (4.6%) and implant removal and flap cover (1.5%) (table 4). The mean duration of hospital stay was 27 days  $\pm 22$ . The early postoperative outcome was good in 69.5%, surgical site infection (17.6%), anemia (3.6%) and 6.9% mortality recorded (table 5).

Table 1: Demographic profile of patients

Variables	Number	Frequency (%)
<b>SEX</b>		
Male	93	71
Female	38	29
Total	131	100
<b>AGE(years)</b>		
0-5	68	51.9
6-11	44	33.6
12-16	19	14.5
Total	131	100

Table 2: Distribution of pathology

Pathology	Number	Frequency (%)
Hydrocephalus	58	44.3
Traumatic brain injury	43	32.8
Cranial infections	15	11.4
Shunt malfunction	9	6.9
CSDH	4	3.1
Others	2	1.5
Total	131	100

Table 3: Preoperative Co-morbidities

Co-morbidity	Number	Frequency (%)
None	101	76.9
Anemia	20	15.4
Hypokalemia	10	7.7
Total	131	100

Table 4: pattern of neurosurgical interventions

Intervention	Number	Frequency (%)
VP Shunt	56	42.7
Debridement and duroplasty	25	19.1
Elevation of depressed skull fracture	13	9.9
Craniotomy	9	6.9
Burr hole drainage	7	5.3
EVD Insertion	7	5.3
Craniectomy	7	5.3
Shunt revision	5	3.8
Implant removal and flap cover	2	1.5
Total	100	100

Table 5: Early postoperative outcome

Outcome	Number	Frequency (%)
Anemia	20	15.4
Hypokalemia	10	7.7
Total	131	100
Absence of any complication	91	69.5
SSI	23	17.6
Post op Anemia	5	3.8
Recurrence of CSH	3	2.3
Death	9	6.9
Total	131	100

## DISCUSSION

Pediatric surgical emergencies require proper and timely perioperative supportive care and surgery than elective cases in order to reduce morbidity and mortality [8,9]. Limited human resources and poor infrastructure negatively affect the outcome, especially in low resource setting. Other factors that influence the outcome of surgical interventions even when trained personnel and facilities are available, include delayed presentation and delayed surgical intervention due to poverty, especially in low income countries [2,3,10]. Operating on a child that has a neurosurgical condition remains a challenge for the neurosurgeon [11], more so in emergency setting in which child may have preoperative co morbidities, that condition may not allow for adequate correction/optimization before surgery. Anesthetic challenges of pediatric patients are numerous, ranging from difficult intubation, short apnea period during general anesthesia that may lead to rapid desaturation, bronchospasm and laryngospasm during extubation among others [11]. These challenges may increase morbidity and mortality of neurosurgical interventions, especially in centers like ours that lack dedicated pediatric anesthetists for all the pediatric neurosurgical cases. Therefore, a specialized pediatric neurosurgical care is needed to avert morbidity and mortality in emergency pediatric neurosurgical cases.

From this study, majority of the patients were males (71%) with M: F of 2.4: 1. This finding was similar to that of Acharya et al and Petsas et al in India and Greece respectively [11,12]. It was also similar to the finding of Abebe et al in Addis Ababa, Ethiopia [13]. However, it was in variance to the finding of Rana et al in Pakistan who reported female preponderance among patients that had neurosurgical operative interventions [14]. Most of our patients (51.9%) were 0-5 years at presentation which was contrary to the finding of 0-6 months reported by Petsas et al [12].

Hydrocephalus (44.3%) was the commonest indication for emergency operative intervention, followed by traumatic brain injury. This correlates with the findings in sub-Saharan Africa by Abebe et al, Afolabi et al, Udoh et al and Abebe et al in Addis Ababa Ethiopia, Ife Nigeria, and Benin Nigeria respectively [13,15,16]. It was also similar to the findings of authors in other part of the world [12, 17, 18]. However, our observation was contrary to that of other authors that reported craniocerebral trauma as the commonest indication for pediatric neurosurgical interventions [19-21].

The predominant neurosurgical operative intervention during our study period was ventriculoperitoneal shunt (42.7%), followed by debridement of open traumatic brain injury and elevation of depressed skull fracture. Our finding correlates with that of Petsas et al in Greece, Abebe et al in Addis Ababa Ethiopia, Rana et al in Pakistan and Afolabi et al in Ife Nigeria [12-15]. All the patients with hydrocephalus were treated by ventriculoperitoneal shunt and external ventricular drain (EVD) for patients with infected cerebrospinal fluid. None of these patients had endoscopic third ventriculostomy (ETV) due to lack of functioning facility for the procedure. Our finding was in keeping with that of Rana et al in Pakistan [14]. Procedures that were performed very few included, craniectomy for comminuted skull fracture (n=5), shunt revision for shunt malfunction (n=5) and removal of exposed methyl acrylate and wound cover (n=2). Surgical interventions were delayed in most patients due to lack of funds and occasional non-availability of shunt devices. The mean presentation-intervention interval was 10.0 days  $\pm$ 9.

Twenty three percent (30 patients) had preoperative comorbidities. The common preoperative comorbidities were anemia (15.4%) and hypokalemia (7.7%), more common in males, probably because they were the majority. This was in variance with the 70.7% preoperative comorbidities that included prematurity, anemia, infectious disease and respiratory problems reported by Petsas et al. [12]. The mean duration of hospital stay was 27 days  $\pm$ 22. Patients aged 0-5 years had longer duration of hospital stay (p=0.049). This stresses the need for a proper pediatric intensive care unit, as this age group requires special perioperative care to avert morbidity and mortality.

Most of our patients had good outcome despite our challenges, 69.5% had no complication postoperatively. The commonest postoperative complication was infection (17.6%). This emphasizes the need for strict adherence to aseptic measures. Our finding agrees with that of Acharya et al in India and Petsas et al in Greece [11,12]. We recorded a mortality rate of 6.9% which correlates with the 5.6% reported by Udoh et al in Benin, Nigeria and 4% reported by Martins et al in Iraq [16,19]. However, our mortality rate was higher than that of less than 0.1% and 0.2% reported by Acharya et al and Rana et al, despite their larger sample sizes of 236 and 725 patients respectively [11,14]. This could be

attributed to the delay in presentation intervention interval observed in most patients in our study. Some technical nuances of operating pediatric patients that were shown to reduce morbidity by Acharya et al included, appropriate selection of pediatric-specific set of instruments, use of small size sutures, minimal skin incision, meticulous hemostasis, detailed knowledge of operative anatomy and utmost asepsis [11].

Overall, our findings were like that of other authors in Nigeria and other parts of the world. However, the retrospective, single centre and hospital-based nature are some of the limitations of this study.

From this study, we noticed that most of the emergency cases were done like elective cases as the surgical interventions were delayed. We therefore, recommend establishment of a protocol in our center that would permit all emergency pediatric neurosurgical cases to be taken as at when due, and also adherence to operative nuances that were shown to improve outcome by other authors. So also, the need for Provision of functioning ETV facilities and further training of personnel cannot be overemphasized.

## CONCLUSION

Ventriculoperitoneal shunt for hydrocephalus was the most common emergency neurosurgical operation in our environment. Males majorly affected; emergency operations were delayed, but majority had good postoperative outcome. A robust emergency pediatric neurosurgical care is needed in order to reduce morbidity and mortality.

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## DISCLOSURES

### Ethical approval

This study was performed in line with the principles of the Declaration of Helsinki. Since it is a retrospective study in which the participants were not identified in any way, submission for ethical committee approval was not applicable in our setting.

### Consent to participate

The patients gave consent to use their information and images for research purposes. *Consent for publication*

### Conflict of interest

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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## CONTRIBUTIONS

**-Aliyu Muhammad Koko:** Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

**-Ali Lasseini:** Conceptualization, Resources, Supervision, Validation, Writing – review & editing

**-Usman Daibu:** Formal Analysis, Investigation, Methodology, Software, Supervision, Writing – review & editing

**-Muhammad Mansur Idris:** Data curation, Formal Analysis, Methodology, Resources, Supervision, Validation, Writing – review & editing

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