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Outcome of Children under Five Years Old Operated on for Hydrocephalus in University Hospital Centers in Togo

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Abstract

Introduction: Infant hydrocephalus remains a major public health problem in sub-Saharan Africa, where the prognosis is still marked by high mortality and significant sequelae, despite advances in neurosurgery. In Togo, data on the medium- and long-term outcomes of operated children are still scarce. The objective of this study was to assess the vital, neurodevelopmental, and social outcomes of children under five years old who underwent surgery for hydrocephalus in Togo. **Study Setting and Methodology**: This was a descriptive and analytical, retrospective study with prospective data collection, conducted from January 1, 2011, to December 31, 2021, in the university hospital centers (CHU) of Togo. All children aged ≤ 5 years who underwent surgery for hydrocephalus exclusively by ventriculoperitoneal shunt (VPS) were included. Sociodemographic, clinical, diagnostic, therapeutic, and outcome data were analyzed. **Results**: Seventy-one children were included. The mean age was 8 ± 0.95 months, with a male predominance (56.34%). Congenital malformations were the main etiology (47.89%). All patients had undergone ventriculoperitoneal shunting (VPS). Immediate postoperative mortality was zero (0%), but with a follow-up of 5 to 15 years, it reached 43.66%. Among the survivors, 52.11% showed improvement in psychomotor development, 32.39% had stable development, and 15.49% experienced regression. Surgery

performed at ≤ 5 months of age was significantly associated with better survival (OR = 3.10; p = 0.022) and fewer sequelae. A management delay of ≤ 14 days was significantly associated with better survival (OR = 3.29; p = 0.0375). **Conclusion**: Operated infantile hydrocephalus in Togo remains associated with high mortality and major sequelae, mainly due to delayed diagnosis and insufficient postoperative follow-up. Enhanced early screening, multidisciplinary follow-up, and better access to specialized care would improve the prognosis.

Keywords

Hydrocephalus, Child, Ventriculoperitoneal Shunt, Prognosis, Togo

1. Introduction

Hydrocephalus is defined as a pathological dilation of the cerebral ventricles related to an excessive accumulation of cerebrospinal fluid (CSF), secondary to an imbalance between its production, circulation, and absorption [1]. It is one of the most common pediatric neurosurgical conditions worldwide, with a particularly heavy burden in low- and middle-income countries [2].

In sub-Saharan Africa, infantile hydrocephalus is often diagnosed late due to limited access to imaging, insufficient prenatal care, and significant socio-economic constraints. Ventriculoperitoneal shunting remains the main therapeutic approach, despite a considerable risk of complications and long-term sequelae [3] [4].

In Togo, some studies have described the etiological and therapeutic aspects of hydrocephalus in children, but data concerning the vital, psychomotor, and school outcomes of operated children remain limited [4].

The aim of this study was to analyze in detail the outcomes of children under five years old who underwent surgery for hydrocephalus in the university hospitals of Togo over a period of ten years.

2. Study Framework and Method

This was a descriptive and analytical study, retrospective with prospective data collection, conducted in the neurosurgery departments of the University Hospital Centers of Kara and Sylvanus Olympio in Lomé, focusing on patients admitted and treated between January 1, 2011, and December 31, 2021, for hydrocephalus exclusively. All children aged five years or younger who underwent surgery for hydrocephalus with a VP shunt were included. Children with incomplete records or lost to follow-up immediately after surgery were excluded, as were all children with other associated pathologies.

Retrospective data were collected using a data collection form based on neurosurgery department records, patient medical records and operating theatre records.

Prospective data were collected using a survey form. To collect prospective data,

children and their parents or guardians were invited for a clinical check-up at the neurosurgery clinic. Any information missing at the appointment was obtained by telephone in order to validate the form. Only children who had undergone surgery and for whom prospective data was available were included.

Children lost to follow-up were those whose whereabouts could not be traced since their discharge from the hospital. These were children who could not be reached by telephone or whose home address could not be located to complete the investigation form. Conversely, all children declared deceased were those whose parents or guardians had been located and had reported the death. Children lost to follow-up are not considered deceased. The deaths included were those that occurred more than one month after hydrocephalus surgery.

The variables studied included sociodemographic, clinical, etiological, therapeutic, and developmental data. Neurodevelopmental outcomes were assessed based on motor skills, language, schooling, and the quality of life reported by parents. The DENVER Developmental Screening Test and the child and adolescent development observation grid from 0 to 18 years, CISS of Monteregie-Est, were used. Data were entered and analyzed using Excel 2021 and SPSS 16.0. Chi-square and Fisher's exact tests, as well as the calculation of odds ratios, were used to analyze associations. The significance threshold was set at $p < 0.05$. The study was conducted after obtaining administrative authorizations from the relevant university hospitals, in compliance with data anonymity and confidentiality.

3. Results

This study included 71 children aged 0 to 60 months who underwent surgery for hydrocephalus with ventriculoperitoneal shunting (VPS) in the university hospitals of Togo between 2011 and 2021. They accounted for 0.29% of neurosurgery admissions during the study period. The average age at the time of surgical management was 8 months, with extremes ranging from 1 to 48 months, and a male predominance (56.34%), corresponding to a sex ratio of 1.29. This distribution shows a predominance of infants in the management of hydrocephalus, a critical period for brain development.

All these children had been seen for the reason of macrocephaly (100%), which could be associated with lumbar-sacral swelling (18.30%), vomiting (38.03%), refusal to eat (66.19%), or other signs as shown in Table 1. This macrocephaly was therefore the only constant physical sign, with a median head circumference of 47 cm, ranging between 38 and 55 cm. The other clinical signs, shown in Table 2, were dominated by the sunset gaze (87.32%), thin skin (76.05%), and bulging of the fontanelles (64.79%), These clinical signs made it possible to recognize hydrocephalus in 64.79% of cases postnatally, while hydrocephalus had been identified prenatally through obstetric ultrasound in 35.21% of children. In this confirmed diagnosis of hydrocephalus, imaging played a major role. Fifty-eight patients (81.69%) underwent a cranial CT scan; fifteen patients (21.13%) underwent a transfontanellar ultrasound, and five patients (7.04%) underwent Magnetic Resonance

Imaging (MRI), which revealed triventricular hydrocephalus in 56.34% of children and biventricular hydrocephalus in 28.17%. This information was missing for 15.49% of children. The type of spina bifida found in 18.30% of children was all myelomeningocele.

Table 1. Distribution of children by reason for consultation.

	Frequency	Percentage
Vomiting	27	38.03
Macrocranai	**71**	**100**
Seizures	7	9.86
Headaches	1	1.41
Crying	**38**	**53.52**
Refusal to eat	**47**	**66.19**
Weight loss	5	7.04
Visual disturbance	2	2.82
Walking disorder	2	2.82
Fever	4	5.63

Table 2. Association between age at surgery and complications.

	≤ 5 mois	> 5 mois	OR (IC 95%)	P-value
None	47.50 (19)	22.60 (7)	3.10 (1.15 – 8.38)	0.022
Epilepsy (alone or with TL)	7.50 (3)	16.10 (5)	0.43 (0.09 - 1.96)	0.288
PMP (alone or in partnership)	25.00 (10)	9.7 (3)	3.07 (0.75 - 12.58)	0.112
Inexplicable	35.00 (14)	54.80 (17)	0.46 (0.18 - 1.18)	0.104
Cortical blindess	2.50 (1)	0.00 (0)	-	1.000

From an etiological standpoint, hydrocephalus of malformative origin represented the main cause, accounting for 47.89% of cases (n = 34), followed by infectious causes at 28.17% (n = 20), tumors at 8.45% (n = 6), while 15.49% (n = 11) remained of unspecified etiology (Figure 1). All children underwent a ventriculoperitoneal shunt (100%), and 18.30% also had corrective surgery for spina bifida. Immediate postoperative outcomes were uncomplicated for all patients. However, with a follow-up of 5 to 15 years post-surgery, the long-term evolution was marked by significant morbidity and mortality. Of the 71 children operated on, 40 (56.34%) are alive with regular follow-up, while 31 (43.66%) deaths were recorded, including all children with myelomeningocele.

Among the 40 surviving children, 36 (90.00%) had made progress in motor skills; 32 (80.00%) had progressed in language, 34 (85.00%) can follow simple commands, 38 (95.00%) can recognize their surroundings, 33 (82.50%) can interact with their surroundings, and 39 (97.50%) can respond to emotions and facial expressions.

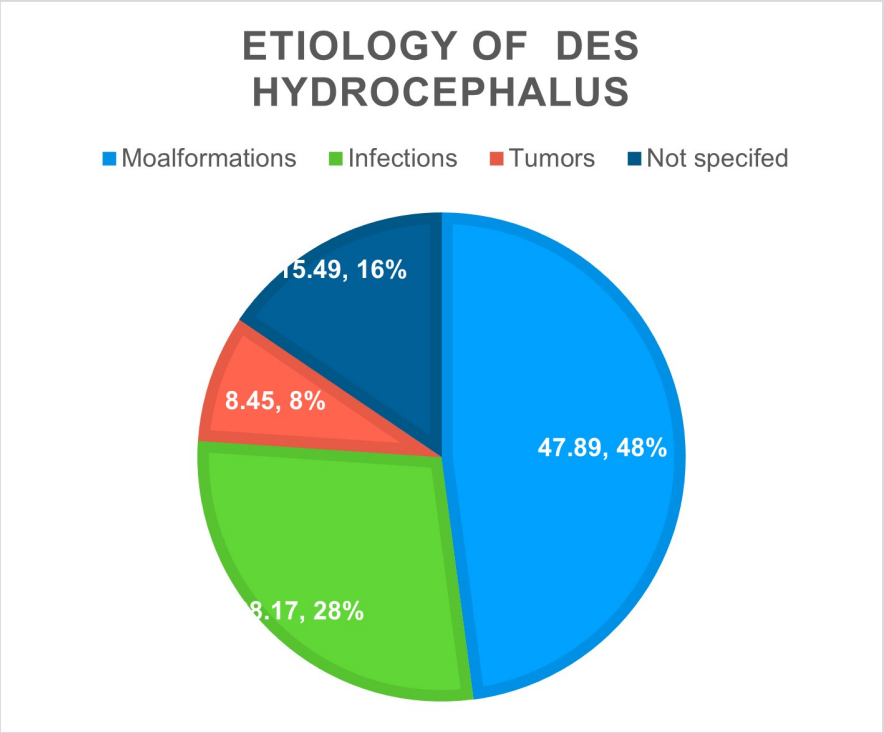

Figure 1. Distribution of the causes of hydrocephalus.

Still among these surviving children, the assessment of psychomotor development showed improvement in 52.11% (n = 37), a stationary evolution in 32.39% (n = 23), and regression in 15.49% (n = 11).

Postoperative sequelae were observed in 32.39% of children. Major neurological sequelae (epilepsy, cortical blindness, language disorders) accounted for 22.54%, motor sequelae 16.90% (paralysis of the lower limbs, mental retardation, sphincter disorders), while 28.17% of children had no identifiable sequelae.

In terms of socio-educational outcomes, 65.00% of surviving children were enrolled in school, and 60.00% had age-appropriate play development. Academic performance was not significantly influenced by age at the time of surgery (p = 0.828). There was no correlation between age at surgery alone and later school performance. Regarding quality of life, 72.50% of parents rated it as good (35.00%) or very good (37.50%).

Analysis of prognostic factors highlighted the important role of the time to treatment, which in this case is the time taken between the positive diagnosis of hydrocephalus and the performance of the ventriculoperitoneal shunt. Children who underwent surgery after a delay of more than 14 days had a significantly higher risk of death (OR = 3.29; 95% CI [1.15 - 9.41]; p = 0.0375). In contrast, no statistically significant association was found between time to treatment and psychomotor regression (p = 0.49). Age at diagnosis (≤ 5 months versus > 5 months) was not significantly associated with mortality (OR = 1.04; p = 1.000). The ≤ 5 months group had significantly more cases without sequelae than the > 5 months group (47.5% vs 22.6%, p = 0.022). Other sequelae, including epilepsy, PMP, and

unexplained cases, showed no statistically significant differences between the age groups.

The odds ratio for "no sequelae" suggests that children operated on earlier are about three times more likely not to have postoperative sequelae (Table 3).

Finally, the type of drain used (low, medium, or high pressure) was not significantly associated with mortality (p = 0.824) or psychomotor regression, although some clinical trends were observed for low- and high-pressure drains.

Table 3. Distribution of children by physical signs.

	Frequency	Percentage
Macrocrania	**71**	**100**
Scalp vein dilatation	**46**	**64.79**
Diplopia	0	0.00
Exophtalmos	2	2.82
Craniofacial dysmorphia	38	53.52
Sutures separation	42	59.15
Sunset gaze	**62**	**87.32**
Bulging fontanelle	**46**	**64.79**
Hypotonia	10	14.08
Thin skin	**54**	**76.05**
Psychomotrice regression	10	14.08
Developemental delay	31	43.66
Strabismus	9	12.68
Oculomotor paralysis	1	1.41
Motor deficit	3	4.22

4. Discussion

According to several authors, hydrocephalus is a complex brain disorder with multiple causes, such as folic acid deficiency, meningeal hemorrhage, obstetric and perinatal trauma, viral, bacterial, or fungal infections, environmental factors, developmental anomalies, and a genetic predisposition, often associated with structural brain abnormalities and neuronal dysfunctions [5] [6].

Young age (before birth or at the newborn or infant stage) and male predominance found in our series is also an observation made by several authors [4] [7]. While the young age can be explained by the significant number of malformative hydrocephalies, the male predominance has not yet been clearly explained by science. Although genetic factors contribute to nearly 40% of cases of congenital hydrocephalus (CH), the precise genetic causes have only been identified in less than 5% of human cases [8] [9]. Specific genetic factors may potentially be linked to the X chromosome. Boys would therefore be predisposed to certain malformative hydrocephalies because they have only one X chromosome [10].

The postoperative mortality observed in this study (43.66%) remains high compared to data reported in high-income countries, where it is generally below 10% [2] [11]. In contrast, comparable rates are described in several African series, reflecting the specific challenges related to the African context [4] [10]-[13]. This high mortality cannot be attributed to the surgical procedure, as the immediate postoperative course was uncomplicated in all patients, but rather to a combination of preoperative and postoperative factors, since all deaths occurred beyond the first month after surgery.

The predominance of malformative and infectious etiologies observed in this study is consistent with African and international data [4] [9] [12]. This distribution highlights the impact of congenital anomalies and perinatal infections in Togo. Post-infectious hydrocephalus and severe congenital malformations are often associated with irreversible brain lesions, explaining the high frequency of neurodevelopmental sequelae [9] [11]. Similarly, some complex congenital malformations are accompanied by intrinsic brain damage that limits the potential for neurodevelopmental recovery, even after effective ventriculoperitoneal shunting. The purpose of this shunting is solely to restore cerebrospinal fluid circulation to reduce or normalize intracranial pressure and alleviate the clinical signs resulting from intracranial hypertension, as shown in **Figure 2**.

The time to care appears to be a major prognostic factor. A delay of more than 14 days more than tripled the risk of death, a result consistent with the observations of Warf *et al.* [9]. In this context, the speed of diagnosis and referral to a specialized center seems more decisive than the child's chronological age alone [11], which could explain the lack of a significant association between age at diagnosis and mortality in our series.

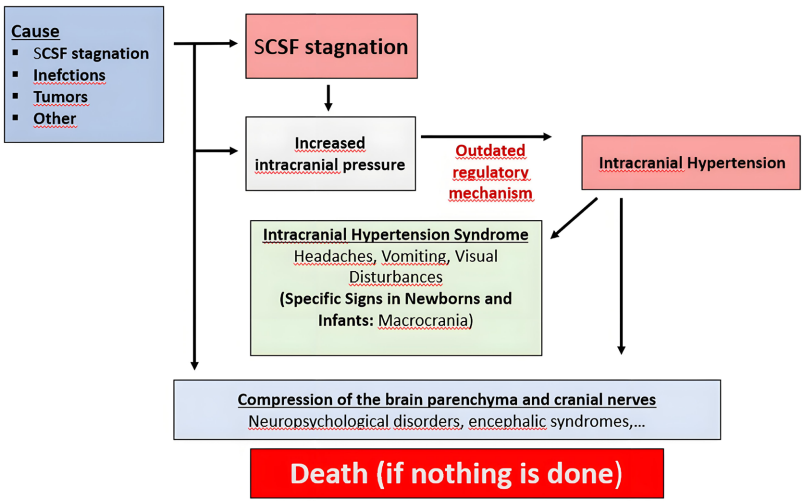

Figure 2. Pathophysiology of hydrocephalus.

It is possible that some of the children who were lost to follow-up and who had myelomeningocele are still alive, as only the children who were found were included in the study. This mortality rate may therefore be biased due to our meth-

odology. However, 100% of those with myelomeningocele who underwent surgery for hydrocephalus died. The circumstances of death were not clearly explained by the parents or guardians. This made it impossible to determine the precise causes of death in the context of this study. Both myelomeningocele and hydrocephalus are neural tube defects that occur during foetal development [14]. The combination of hydrocephalus and myelomeningocele is commonly found in Chiari type II [14]. Chiari II malformation involves a brain malformation mainly affecting the cerebellum, spinal cord and midbrain [15]. One hypothesis is that these two malformations are responsible for a comorbidity that could aggravate the clinical picture and gradually lead to the death of patients in a context such as that of Togo. We can also put forward another hypothesis based on the fact that these children could possibly have other malformations that were not diagnosed at the time of treatment because the clinical expression was delayed. For certain types of hydrocephalus, spina bifida causes a displacement of the contents of the posterior fossa, which blocks the circulation of cerebrospinal fluid. This blockage causes hydrocephalus due to circulation problems. It is precisely to prevent these secondary brain lesions and hydrocephalus that foetal surgery has been developed [15] [16]. In a series of 293 deaths of patients with myelomeningocele reported by Szymanski in December 2023 in the United States and Canada, 89% were related to derivative hydrocephalus and 28% of the causes of death were unknown. The causes of death in children with myelomeningocele who had been diverted in this series were dominated by neurological causes (31%) and pulmonary causes (14%). Urological causes accounted for 9% [17].

More than half of the surviving children showed improvement in psychomotor development, confirming the effectiveness of ventriculoperitoneal shunting in controlling hydrocephalus dynamics. However, nearly half of the children remained at a stable developmental level or experienced regression, highlighting that surgery restoring CSF circulation is a necessary but not sufficient condition for normal neurocognitive development, especially in an already malformed brain. These sequelae most likely reflect a combination of preexisting brain injuries, delayed care, and insufficient long-term neurodevelopmental follow-up.

The high frequency of neurological and motor complications observed in this study confirms the chronic and progressive nature of infantile hydrocephalus, even after surgical treatment. In high-income countries, these complications are mitigated by structured multidisciplinary follow-up involving neurosurgeons, pediatric neurologists, physiotherapists, speech therapists, and psychologists. The absence or insufficiency of such arrangements in our context limits the possibilities for rehabilitation and compensation of deficits, contributing to the persistence of sequelae [12] [18].

From a socio-educational perspective, the relatively satisfactory school enrollment rate observed among surviving children (65%) is encouraging, but it should be interpreted with caution. Enrollment does not necessarily indicate academic performance or effective social integration. Furthermore, the assessment of qual-

ity of life, considered good or very good by a majority of parents, may be influenced by family coping mechanisms and limited expectations regarding the child's development, as described in other African contexts [12].

Although ventriculoperitoneal shunting remains the most commonly used technique in our context due to its availability and technical familiarity, endoscopic third ventriculostomy, with or without choroid plexus cauterization, represents an interesting alternative for certain etiologies, particularly obstructive hydrocephalus [9] [18]. However, its accessibility remains limited by cost, technical requirements, and specialized training.

Overall, these results highlight the multifactorial nature of poor prognosis in infantile hydrocephalus in Togo. They emphasize the need for a comprehensive approach that includes prenatal and neonatal screening, reduced delays in care, improved postoperative follow-up, and the development of rehabilitation and socio-educational support programs. Such a strategy would not only improve survival but also the quality of life and social integration of children operated on for hydrocephalus.

Study limitations

The main limitations are the partial retrospective nature of the study, the relatively small sample size, the loss to follow-up, and the lack of standardized neurocognitive assessment tools. These factors should be taken into account when interpreting the results.

5. Conclusion

Infantile hydrocephalus operated on in university hospitals in Togo is associated with high mortality and frequent neurodevelopmental sequelae in the medium and long term. Ventriculoperitoneal shunting can help improve the survival and functional outcomes of these children. Improving prenatal screening, early referral to specialized centers, prompt surgical intervention with structured postoperative follow-up appear essential to sustainably optimize the prognosis.

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Conflicts of Interest

No conflicts of interest.

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