VENTRICULO-PERITONEAL SHUNT REVISIONS IN CHILDREN WITH HYDROCEPHALUS AT THE UNIVERSITY TEACHING HOSPITAL, LUSAKA.

By

Dr. Daliso Makani BSc (HB), MBChB

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School of Medicine

University of Zambia

Lusaka.

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I hereby declare that the work presented in this study for the Degree of Masters of Medicine (General Surgery) represents my work and has not been presented either wholly or in part for any other degree and is not currently submitted for any other degree at the University of Zambia or any other university.

Signature of candidate: Date:

Signature of supervisor: Date:

Signature of co-supervisor: Date:

CERTIFICATE OF APPROVAL

This is to certify that this dissertation entitled Causes and Rates of Ventriculo-peritoneal Shunt revisions in children with hydrocephalus at the University Teaching Hospital, Lusaka by Dr Daliso Makani is now ready for examination.

Signature HoD Surgery: Date:

Signature of supervisor. Date

Signature of co-supervisor. Date

ABSTRACT

Insertions and revisions of ventriculo-peritoneal shunts (VPS) are common procedures done at the University Teaching Hospital (UTH) in Lusaka, Zambia. However, the actual incidence rate of revisions and the causes were not properly documented. A retrospective study of the Incidence and Causes of Ventriculo-peritoneal Shunt revisions in children with hydrocephalus at the UTH was carried out over a period of one year (September 2009 to August 2010).

Its specific objectives was to determine the rate of revisions of the VPS inserted at UTH, to identify the causes of VPS revisions and the common infections present in the children undergoing these VPS revisions. Data was obtained from the medical records of patients who underwent initial VPS insertion, and subsequent revisions of these shunts during the study period, after approval from the University of Zambia Research Ethics Committee and hospital authorities.

One hundred and fifty patients were recruited who required an initial VPS inserted. Of these patients, twenty-nine had shunt revisions done, with an incidence of 19.3%. Two patients had two revisions while one had three revisions done. Ninety-four (62.7%) were male and fifty-five (36.7%) were female. The age range of patients was one week to fourteen years, with 50% (75) being below 6 months.

The causes of revision of VPS were surgical wound infections (28.0%), blocked or dislodged shunts, cerebrospinal fluid infections (8.0%), and outgrowing of the VPS (4.0%). Bacteriological studies confirmed *Staphylococcus aureus*, *Enterobacter*, *Citrobacter* and yeast cells in CSF in only four patients, while it was noted that eighty-seven patients had a positive history of either a febrile illness or convulsions. One hundred and sixteen patients (77.3%) had a negative serology for HIV, and fourteen (9.3%) had a positive reaction. The remaining twenty patients did not have an HIV test done.

The rate of revision in this study is comparable to other countries in the developing world i.e.23.3% in Kenya, 20% in Libya[12], and 22% in India[17].

DEDICATION

To the child with hydrocephalus,

May we all try to make this world a better place for you too.

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ABBREVIATIONS

CSF: cerebrospinal fluid

ETV: endoscopic third ventriculostomy

HIV: human immunodeficiency virus

UTH: University Teaching Hospital

VPS: ventriculo-peritoneal shunt

Key words: *hydrocephalus, revision, ventriculo-peritoneal shunt*

1.0 INTRODUCTION

Hydrocephalus is the most frequent neurosurgical problem encountered in the paediatric age group with an incidence of 1 per 2,000 live births[1] worldwide. Observations in Zambia show that more cases are being seen at health facilities either due to increased awareness of the disease in the general population, or favourable outcomes of the treated children noted by the communities where these patients are coming from[2].

In Zambia, the primary treatment used for all causes of hydrocephalus is the insertion of a Ventriculo-peritoneal shunt (VPS) [2]. The other option offered is the endoscopic third ventriculostomy (ETV), which is only done at the Beit Trust/Cure Hospital in Lusaka. Thus, most patients suffering from hydrocephalus for various reasons end up with a ventriculo-peritoneal shunt. Most of the ventriculo-peritoneal shunting is done at the University Teaching Hospital (UTH) in Lusaka. This has a lot of cost implications for both individuals and the state as the patients most times have to travel long distances to get treatment. The rate of revisions, cause for these revisions, and the infections present in these patients had not been explored in Zambia. This study undertook to look at these aspects.

2.0 LITERATURE REVIEW

Hydrocephalus is an enlargement of the ventricles, which are normal spaces in the brain, due to excess cerebrospinal fluid (CSF) [3]. This can be either congenital or acquired. Congenital hydrocephalus is often associated with other abnormalities of the neuraxis, such as spina bifida or myelomeningocoele[4]. The commonest cause of congenital hydrocephalus is failure of development of the CSF pathways in the basal cisterns or at the tentorial hiatus[4]. Hydrocephalus is mostly acquired after an inadequately treated CSF infection of bacterial origin i.e. post meningitis. One form of classification is communicating and non-communicating hydrocephalus. Non-communicating hydrocephalus is produced by obstruction within the CSF pathways, either by a tumour or a previous inflammatory process. Communicating hydrocephalus may be due to the faulty absorption of CSF by the arachnoid villi, usually as a complication of chronic inflammation or subarachnoid haemorrhage or trauma[5, 6].

The clinical features of hydrocephalus include progressive enlargement of the head or bulging fontanelles in children with open skull sutures, mental retardation, spasticity, vomiting, dehydration, headache, drowsiness, irritability, seizures, visual disturbances, personality changes and difficulties in waking up or staying awake[7]. Magnetic Resonance Imaging (MRI), ultrasound and computer tomography (CT) scanning are some of the investigations used to aid in the diagnosis of hydrocephalus[4].

The cause of the CSF flow obstruction may be treatable in some cases e.g. tumour. However, providing of an alternative path for the CSF to maintain normal pressures within the brain is the mainstay of treatment in many cases[3]. Thus, objective placement of a ventriculo-peritoneal shunt (VPS) has been the long-standing treatment of choice for hydrocephalus[8] in Zambia and worldwide. The advantages of the VPS system are straight forward implantation, a self-lengthening catheter to accommodate for patient growth, and a lower complication rate compared to other shunt systems. The shunt is placed either in the anterior or posterior horns of the ventricles in the brain and runs under the skin from the head to the abdominal cavity[3]. Occasionally the shunt is channeled to some other site e.g. atrium, pleura or ureter[8]. The shunt contains a one-way valve that allows fluid to leave the ventricle if the pressure becomes high with regards to the respective valve present. The valves are low, medium or high pressure valves.

Endoscopic drainage is a recent innovation and has now taken trend in some centres in the West. This is called endoscopic third ventriculostomy (ETV). This procedure is now being done in Zambia at the Beit Trust Cure Hospital. The

patients in whom ETV may be performed should be well selected if the outcome is to be successful[9, 10] . Although there is successful outcome of about 80% with the VPS, the shunt may have to be revised if it malfunctions[11]. Research has shown that the risk factors most closely associated with repeat shunt surgeries were the patients' age at the time of their initial shunt surgery, the cause of the patient's hydrocephalus and the time from the previous shunt surgery. The immunity in the younger children is not well developed and thus the insertion of a foreign body may predispose to inflammation and infection. This in turn will result in shunt failure and revision of the shunt[1,7]. There is also reduced immunity in children with malnutrition and HIV infection. It can be postulated then that the children who have poor or reduced immunity will have more revisions due to infection.

The longer the time from previous initial shunt surgery, the more likely one will have revision. This is usually due to blockage of the shunt, migration of the shunt or infection[10]. Other causes of shunt revision include dislodging or disconnecting of the tubes[8]. The most common pathogen isolated in Libya was *Pseudomonas aeroginosum* (50%) compared with 18.2% of *Staphylococcus epidermidis*[12]*.* Other complications of shunt insertion are bowel or organ perforation, intraperitoneal infection, ascites, and abdominal pseudocysts.

Studies conducted in the USA and Spain showed that the revision rates for the VPS was between 15 and 25%[13, 14] , respectively. Other studies conducted by the Dutch, however, indicate that revision rates of VPS may be as high as 50% [15] . This has mainly been shown in resource-limited countries. The other reason why a shunt may malfunction and occasion the process of shunt revision or replacement is the technique of insertion i.e. inadequate skin preparation, poor suturing technique, or inexperienced surgeon operating. Thus, the lack of surgical skill and inexperience of the operating surgeon may result in revisions of the VPS[14].

Out of the 542 major paediatric surgical operations performed at UTH, 210 were on hydrocephalus patients from January to December 2007[2] . This has major cost implications on the parents or guardians, who usually travel from distant towns and villages. The government and hospital administration can also use the findings of the study to plan for the long-term management of the patients as well as assist set up an appropriate program for the children with hydrocephalus.

3.0 STATEMENT OF THE PROBLEM

Hydrocephalus is a major problem to the child as well as to the parents or guardians of the patients. The medical personnel also face challenges in managing these patients as they either lack the expertise of inserting the VPS or the shunts are unavailable. In Zambia, we do not know what the revision rates of VPS are, and what factors determine if a child who has had a shunt inserted will have a revision. We do not know the local risk factors associated with VPS revision.

4.0 HYPOTHESIS

The research question is: “What is the rate and main cause of VPS revisions in children with hydrocephalus?”

Alternate hypothesis: CNS infections in a child who has had a shunt inserted is the main cause of shunt revisions.

5.0 STUDY JUSTIFICATION

This study will enable us to identify the major causes of VPS revisions at the UTH. It will also enable us to evaluate the rate of revisions in children who have shunts inserted at the same institution. The study was best done at UTH since it is the only tertiary referral hospital in Zambia and almost all the hydrocephalus cases are treated at the same health facility. It will also assist authorities to plan in view of the limited health resources available.

6.0 OBJECTIVE OF THE STUDY

The main objective of the study was:

> To determine the rate of revisions of VPS inserted in children with hydrocephalus at the University Teaching Hospital in Lusaka.

The specific objectives were:-

i. To determine the causes of the revision of the VP shunts.
ii. To determine the common infections present in the patients undergoing revision of shunt.

7.0 METHODOLOGY

Study design

A descriptive, retrospective hospital-based study of children with hydrocephalus was conducted over a one year period commencing September 2009 to August 2010. This was at the University Teaching Hospital in Lusaka, Zambia.

.Study population and data collection

The study population included all children who were admitted to the paediatric surgical ward (D01) of the UTH for ventriculo-peritoneal shunting for hydrocephalus during the period of study.

Inclusion criteria

(i) All patients admitted to the paediatric surgical ward (D01) with hydrocephalus for initial VPS insertion.

(ii) Children aged 0 months to ≤ 15years.

(iii) Only children admitted and treated during the study period.

Exclusion criteria

All patients who presented to D01 for revision of VPS whose shunt were not inserted during the study period.

At initial VPS insertion

A standardized questionnaire form was used to collect basic demographic data.

An abstraction form was used to collect clinical data, including signs and symptoms, result of the routine HIV test done, and CSF results collected. The type of shunt used and site of placement were also noted.

At revision of VPS

- A standardized abstraction form was used to collect clinical data of the child i.e. signs, symptoms, CSF results.
- The same type of standardized abstraction form was used for children who have more than one revision during the study period.

Data was obtained from the patients' medical records after approval from the University of Zambia Bio-medical Research Ethics Committee (UNZAREC) to have information extracted from the patients' files. Thus, a waiver was made for consent not to be obtained from the parents or guardians. Permission was also obtained from the UTH neurosurgical and paediatric surgical units to have information from the patients' medical records

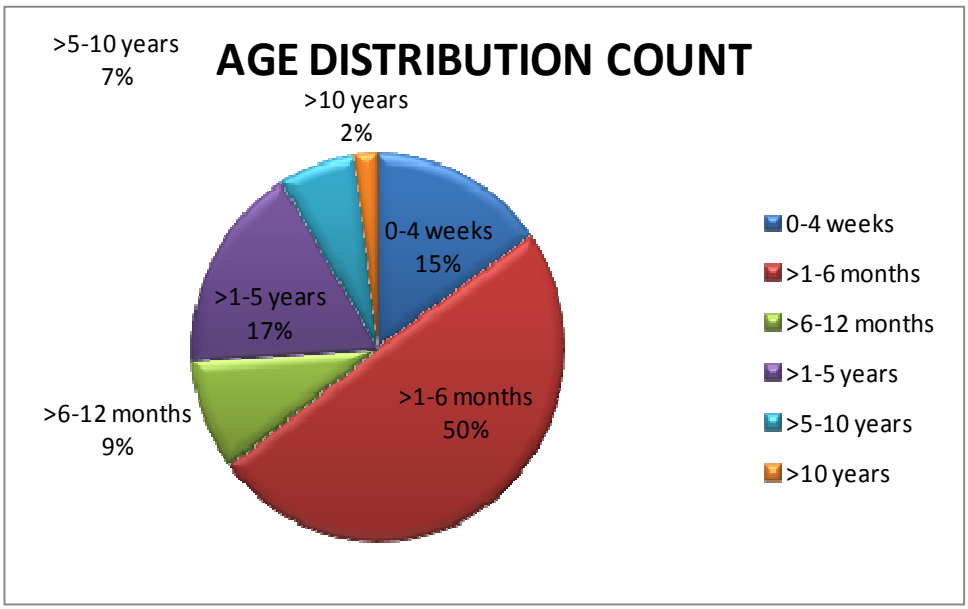
There was no manipulation of the patients or data during the study. The data was collected, cleaned and analysed using the SPSS version17 and Excel statistical packages. Confidentiality of the patients was also maintained.

8.0 RESULTS

During the study period, one hundred and fifty (150) patients had VPS inserted for hydrocephalus and their records were reviewed. The age range was one week to fourteen years. The age distribution was broken down as illustrated in Figure 1.

Figure 1.

Age range of patients



The male to female ratio was 2:1. One (0.7%) patient's file had no detail on their gender (Table1). Fifty-four (36.0%) patients were referred from first-level district hospitals (Table 3). Twenty-three (15.3%) patients were referred by third-level hospitals while seventeen (11.3%) had no referral centres noted. Fifty (33.3%) had their places of residence indicated as rural areas while twenty-one (14.0%) lived in the peri-urban areas (Table 2).

Table1.

Sex distribution

	Frequency	Percent
Male	94	62.7
Female	56	37.3
Total	150	100.0

Table 2.

Place of residence

	Frequency	Percent
Urban	33	22.0
Peri-Urban	21	14.0
Rural	50	33.3
No Results	46	30.7
Total	150	100.0

Table 3.

Type of referring health facility

	Frequency	Percent
Health Centre	25	16.7
Level 1 Hospital	54	36.0
Level 2 Hospital	31	20.7
Level 3 Hospital	23	15.3
No Results	17	11.3
Total	150	100.0

Twenty-nine (19.3%) patients had a revision of the VPS done. Of the twenty-nine (29) patients that required revisions, Surgical Registrars did the majority of initial VPS insertions i.e. twelve (41.4%) while Consultants did eleven (37.9%), Senior registrars did five (17.2%), and one (3.4%) patient was done by a clinical officer (Figure 2). The revisions of the VPS were done mostly by a Senior Registrar i.e. thirteen (44.8%) as illustrated in Figure 3..

Figure 2.

Initial VPS insertion of revised shunts

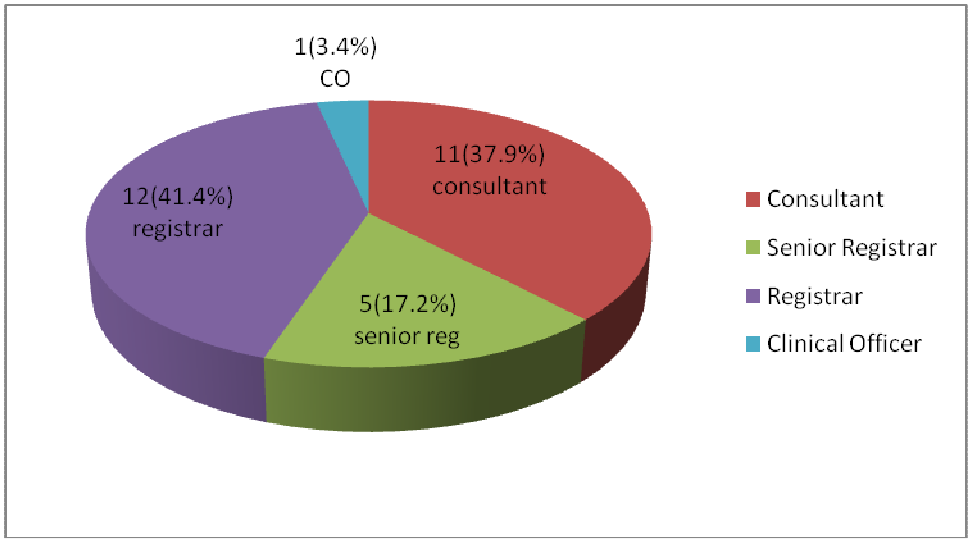


Figure 3.

Revised VPS insertions

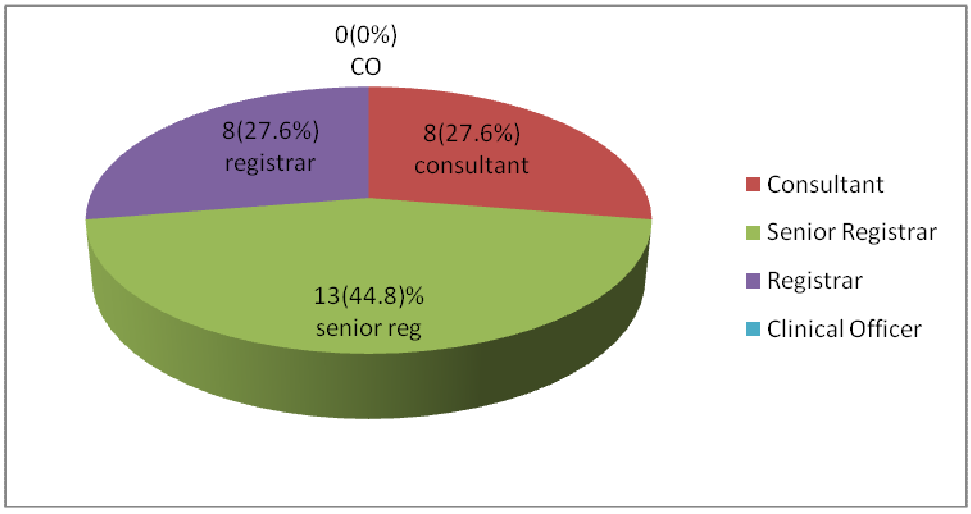


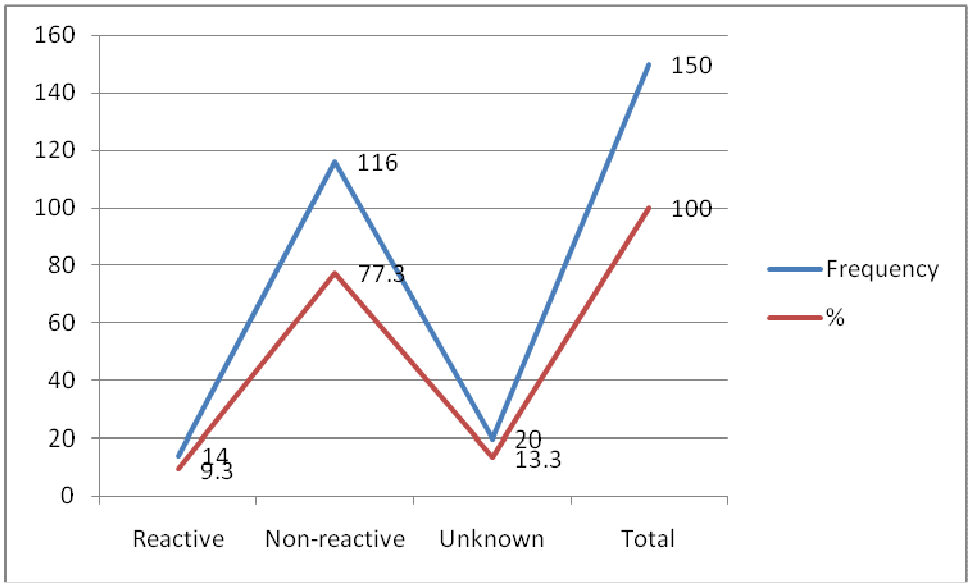
Table 4.

Past medical history frequencies

	Responses	
	N	%
Past medical history (febrile illness)	58	66.7%
Past medical history (convulsions)	29	33.3%
Total	87	100.0%

Figure 4.

HIV status of patients



The causes of the VPS revisions (Table 5) were seven (28.0%) surgical wound infections, five (20.0%) blocked shunts on distal aspect, four (16.0%) blocked shunts on proximal aspect, four (16.0%) dislodged or disconnected shunts, two (8.0%) migrated shunts, two (8.0%) CSF infections and one (4.0%) had a short VPS. The most common symptom at revision was vomitting in fifteen patients

(34.1%), while the least noted was headache alone in two patients (4.5%) as shown in Table 6.

One hundred and sixteen patients (77.3%) had a negative serology for HIV (Fig. 4). Fourteen (9.3%) had a positive reaction for HIV while twenty (13.3%) had no HIV test done (Figure 4). Three patients had positive HIV status and VPS revision done i.e. 21.4% of the patients with a positive HIV test. Only four patients had CSF bacteriology results with *Staphylococcus aureus, Enterobacter, Citrobacter*, and yeast cells species isolated with sensitivity patterns. Eighty-seven patients (58.0%) had a positive history of either febrile illness or convulsions noted indicating a previous infection at initial insertion (Table 4). However, bacteriology for CSF and surgical wound infections had no growth or specimen collected as illustrated in Table 9.

Table 5.

Causes for shunt revisions

	Frequency	%
Block shunt proximal	5	3.3
Block shunt Distal	5	3.3
infection CSF	4	2.7
Short VPS	1	.7
Migrated	2	1.3
Dislodged/disconnected	5	3.3
Wound	7	4.7

Table 6.

Symptoms of patients at revision

Symptoms	Responses	
	N	Percent (%)
Vomiting	15	34.1
Fever	16	36.4
Lethargy	6	13.6
Convulsions	4	9.1
Headache	2	4.5
NIL	1	2.3
	44	100.0

Table 7.

Types of shunt used during study

	Frequency	Percent
Chharbra Low Pressure	14	9.3
Chhabra Medium Pressure	118	78.7
Chharbra High Pressure	1	.7
UNZA Shunt	5	3.3
Integra	1	.7
No Results	11	7.3
Total	150	100.0

Table 8.

Site of VPS placement

		Responses	
		N	%
	Site of Shunt placement Left temporal	11	9.2%
	Site of Shunt placement Right temporal	109	90.8%
Total		120	100.0%

Table 9.

CSF bacteriology results

Pathogen	Sensitivity	Frequency
Staphylococcus aureus	Cloxacillin, ciprofloxacin	1
Citrobacter	Ciprofloxacin, gentamycin, chloramphenicol	1
Enterobacter	Imipenum	1
Yeast cells		1
No growth		25

9.0 DISCUSSION

The revision rate of 19.3% for VPS in patients with hydrocephalus is quite remarkably low in our resource limited tertiary hospital. It is much less than the more developed countries such as Spain[14] where the revision rate for VPS is 25% where a retrospective study over a ten-year period was conducted. This low revision rate of 19.3% could be because the period and numbers under review were less, and some of the patients were treated at the BEIT Cure Hospital which specializes in neurosurgical care only. Another finding from the study is the incidence of HIV infection in the children undergoing shunt placement. Only 9.3% had a positive serology, either on Elisa or PCR testing. The prevalence rate of HIV in the general paediatric block of the UTH is almost 20% where the routine screening of the children is at 98%. It can then perhaps be inferred that the patients undergoing the VPS procedure are due to post-meningitic or congenital hydrocephalus. This is in view of the past medical history where 38.7% of these patients had a febrile illness prior to their hydrocephalus.

Generally, most of the children who were admitted to the neurosurgical paediatric ward (DO1) via the general paediatric units had a more comprehensive history taken and examination done than those who were admitted directly to DO1. This could have influenced the results with regards to the past obstetric and medical history of the various records reviewed. The age range for the patients undergoing initial VPS insertion was as noted in the Mukhida et al study in Kathmandu, Nepal where 42% of the patients who received a VPS were younger than five years[18]. In this study at UTH, 50% of the patients were aged six months and younger as they had a shunt inserted. The birth and past medical history of the patients need to be clearly outlined if the management is to be optimal for the patients having initial insertion of the VPS. Thus, a standardized form or format in the patients' records would greatly improve in the treatment and follow-up of these hydrocephalic children. Furthermore, none of the medical records reviewed had post operative head circumferences done or indicated in the files. This is of paramount importance to ensure that the treatment instituted, i.e. VPS insertion, is effective. Although head circumference charts were present, very few have records.

Almost all patients had a primary cranial ultrasound done before insertion of a VPS. Some other patients had a CT scan done which indicated various pathologies including aqueduct stenosis and cerebral tumors. There was no record of any of the mothers having had an antenatal ultrasound scan done to rule out any developmental abnormalities. This would have forewarned the birth

attendants of any potential birth trauma which may arise because of congenital hydrocephalus. It would also assist determine how many patients have congenital hydrocephalus from the onset and treatment instituted early. The diagnostic cranial ultrasound reports mostly indicated “massively or grossly dilated ventricles with minimal brain tissue.” This is very subjective as none indicated the amount of dilatation present or the amount of brain tissue noted. It would be more informative if figures were attached to these parameters.

One hundred and nine of the patients had proximal shunt insertion done on the right parieto-occipital area i.e. 72.7%. The rationale being that most patients were right handed and the dominant side of the brain would be on the opposite side i.e. left. There was, however, no note in the records to indicate whether patients were right or left handed. Eleven of the patients (less than 1%) had shunts inserted on the left parieto-occipital area with only six patients having the reasons noted. These include infected shunt site on the right parieto-occipital area, septate hydrocephalus on the left and post cannula scalp infection on the right parietal area. 20% of the patients did not have the site of shunt insertion noted in their files. This lapse can be overcome if there is a standard form to be used in theatre at the time of shunt insertion. A similar form can also be used when the patient has a revision done, whatever the cause for the revision.

Only 4 patients (2.7%) had positive CSF bacteriology results. Twenty-five patients (16.7%) had no growth recorded on CSF culture. *Staphylococcus aureus* was isolated in one patient which was sensitive to cloxacillin. This is in conformity with a study by A.H. Fried et al on childhood hydrocephalus which indicated that the majority of infections were due to *Staphylococcus*[19,21]. The *Staphylococcus aureus* infections are usually acute and fulminant while those with *Staphylococcus epidermidis* are indolent[20]. Other agents noted in that study that may contaminate VPS included gram positive bacilli and enterobacilli. *Citrobacter spp.* sensitive to ciprofloxacin, gentamycin and chloramphenicol was isolated from one patient whose ultrasound scan showed dilated lateral ventricles with septations. Another patient had *Enterobacter spp.* isolated which was sensitive only to imipenum. This was on CSF culture at revision and CT scan done showed severe hydrocephalus secondary to aqueduct stenosis without brain abscess. The most remarkable CSF result was of yeast cells from an HIV negative six month-old patient whose had a third revision of VPS done. CT and ultrasound scans done suggested congenital atresia of the aqueduct of Sylvius. This could have been due to the recurrent infections and antibiotic use. The patient may also have other malformations or immune deficiencies not yet established due to our limited laboratory facilities and resources.

A critical aspect of managing hydrocephalus is being well informed and staying vigilant about potential life-threatening complications. The majority of patients showed that they suffered from febrile illness or convulsions in their past medical history i.e. 38.7% and 19.3% respectively. This is in keeping with other studies that indicate that infections are among the top cause of hydrocephalus[16, 17]. The guardians brought the patients within five days of their children showing symptoms of shunt complications. This is commendable in view of the far flung areas from which these patients come from, as well as their poor socio-economic status. However, the revision rate could be considered to be much higher because of the same argument i.e. most patients would not manage to make it back to the UTH when the patients shunt required attention, and thus the patients die and are buried in their home villages or towns without knowledge of the attending surgeons.

A national data base could be setup incorporating all provincial hospitals with inputs from the referring health centres to track patients who have hydrocephalus and have had various interventions such as VPS so that more accurate records and hence revision rates are made. Outreach or surgical support programmes for the children with hydrocephalus can then be implemented should such a need arise in future.

10.0 **CONCLUSION**

The revision rate of hydrocephalus ventriculo-peritoneal shunts inserted at the paediatric surgical unit of the University Teaching Hospital, Lusaka, from September 2009 to August 2010 was 19.3%. Infections of the central nervous system in a child post shunt insertion is not the main cause of shunt revisions.

The main causes of shunt revisions were surgical site infections and shunt malfunction such as distal blockage and dislodged shunt. *Staphylococcus. aureus*, *Citrobacter*, *Enterobacter* and yeast cells were the pathogens isolated. The HIV prevalence in the group undergoing VPS insertion during the study period was 9.3%, which is much lower than that noted from the Paediatrics department of the UTH.

This retrospective study of the incidence and causes of VPS revisions at the UTH provides a starting point for future careful long-term follow-up studies.

11.0 RECOMMENDATIONS

A continuous study with input from the referring health centres, where the patients come from and are later discharged back to, would be of great benefit to both the state as it plans for hydrocephalus, and the patients and their guardians.

A standard operating form should be put in place for appropriate data collection and patient care in the D01 ward of the UTH. This will also evaluate the different methods, site placements and levels of surgical competencies. More importantly, patient care would be optimal for our environment.

The surgical site preparation should be re-evaluated in association with the theatre and ward environments to which the patients are nursed post-operatively.

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APPENDIX 1:

QUESTIONAIRE FORM #.....

(a)Vital statistics: Name: ……

Age/sex: ……

DoB: ……

Place of birth: ……

Tribe: ……

(b)Residence: Urban…… Peri-urban…… Rural……..

(c) Recruitment date:……..

(d) Referred from (Health facility):…….

(e) Delivery: Term:……. (premature, term, post dates)

Mode :…….(SVD, C/S, vacuum, forceps)

Birth weight:……..

(f) U/S scan during pregnancy: Yes: → Normal……..Abnormal…….

No:……

(g) Under 5yr record: Vaccinations:……..

Weight gain: normal……. abnormal…….

(h) Past medical history: Febrile illness:……

Convulsions:……..

(i)Examination: HC:…….cm Temp:……^{o}C

Wt:…….Kg Height:……cm

Level of consciousness:……

APPENDIX 2:

ABSTRACTION FORM # ……..

CSF results: 1^0 insertion: ……

Revision:……

HIV results: Reactive:…….. Non-reactive:…….

Surgeon: 1^0 insertion :……(CO, Reg, SR, Con)

Revision :……(CO, Reg, SR, Con)

U/S scan report (indicate 1^o or revision): …… ……..

CT scan report (indicate 1^0 or revision): ……

Revision date: ……..

Symptoms at revision: Vomiting: ……. Fever: …… Lethargy: …….

Convulsions: ……. Headache: …….

CSF results: 1^0 insertion……

Revision…….

CSF infection: Bacterial…….. Fungal…….. TB……..

Others…… No growth…….

Type of Shunt: *Chhabra* – (i) LP……. (ii) MP……. (iii) HP……..

U*NZA*……..

Site of Shunt placement: left temporal…… right temporal ……