ADDISS ABABA UNIVERSITY,COLLEGE OF HEALTHY SCIENCE

SCHOOL OF MEDICINE,DEPARTMENT OF SURGERY

NEUROSURGERY UNIT

RESEARCH PROPOSAL ON

Outcome of pediatric patients treated for ventriculitis at ZMH ,A hospital-based prospective Study

Principal Investigator :Abdisamed Abdi Ali {MD,neurosurgery resident }

Advisor and Mentor:Dr.Yemisirach Bizuneh{MD, Ass prof of neurosurgery}

:Dr.BethelehemYesehak {MD, Ass prof of neurosurgery}

A thesis submitted to Addis Ababa University, College of Health Sciences, Department of neurosurgery in preparation for partial fulfillment of the requirement for a Specialty certificate in neurosurgery

Addis Ababa university

School of medicine ,College of Health Sciences

Department of surgery Neurosurgery unit

RESEARCH PROPOSAL ON

Outcome of pediatric patients treated for ventriculitis at ZMH ,A hospital-based prospective Study

Principal Investigator :Abdisamed Abdi Ali {MD,neurosurgery resident }

Advisor and Mentor:Dr.Yemisirach Bizuneh {MD, Ass prof of neurosurgery}

:Dr.BethelehemYesehak {MD, Ass prof of neurosurgery}

A thesis submitted to Addis Ababa University, College of Health Sciences, Department of neurosurgery in preparation for partial fulfillment of the requirement for a Specialty certificate in neurosurgery

Acknowledgment

First of all, I would like to thank the Almighty Allah, who gave me the commitment and tolerance to pass various obstacles and come up to the accomplishment of this research proposal. I am deeply indebted to my advisors, Dr.YemisrachBizuneh (MD, Ass Prof of Neurosurgery) and Dr.BethelehemYesehak (MD, Asst Prof of Neurosurgery) from Addis Ababa University, College of Health Sciences, Department of Neurosurgery for their understanding, answering my frequent questions without any hesitation, for their countless suggestions, assistance, kindness and invaluable advice.

Table of Contents

Acronym and abbreviation VI

Summery ..... **Error! Bookmark not defined.**

1. Introduction 1

1.1 Background 1

1.2 Statement of the problem 3

1.3 Significance of the study 4

2. Literature review 5

3. Objective 7

3.1 General objective 7

3.2 Specific objective 7

4 Methods 8

4.1 Study design and period 8

4.2 Population 8

4.2.1 Source population 8

4.2.2 Study population 8

4.3 Eligibility criteria 8

4.3.1 Inclusion criteria 8

4.3.2 Exclusion criteria 8

4.4 Sample size determination 9

4.5 Sampling procedure 9

4.6 Study variables 9

4.6.1 Dependent variable: 9

4.6.2 Independent variable: 9

4.7 Data collection technique 10

4.8 Data Processing, Management and Analysis 10

4.9 Operational definitions 10

4.10 Ethical consideration 11

5.Result 12

5.1 Sociodemographic characteristics of the participants 12

5.2 Previous surgery related characteristics of the study participants 14

5.3 Isolated organism related characteristics of the study participants 14

5.4 Cerebrospinal fluid parameter and concomitant infection characteristics 15
5.5 The participants sensitive antibiotic related characteristics 15
5.6 Types of surgery performed after antibiotic 16
5.7 The status of patient at discharge 16
5.8 Third month evolution of the patient after discharge 17
6. Discussion 19
7. Conclusion 21
8. Recommendation 22
Reference 23

Acronym and abbreviation

CNS: Central Nervous System

CSF : Cerebral Spinal Fluid

EVD :External Ventricular Drains

IVT : Intravenous therapy

MDRO: Multidrug-Resistant Organisms.

MRS :Modified Rankin Scale

OR :Odd Ratio

VP :Ventriculo peritoneal

ZMH :Zewditu memorial Hospital

SPSS: Statistical Package for Social Sciences

Abstract

Background: -Ventriculitis is associated with high mortality and negatively affects the prognosis of neurosurgical patients. Procedures that can lead to post-neurosurgical ventriculitis include craniotomy, EVD, ventriculostomy, lumbar puncture, and VP shunt insertion.The management of ventriculitis can be lengthy and expensive and ventriculitis can lead to serious long-term sequelae and even result in death.Therefore, early diagnosis, identification of the pathogen, and time to initiation of adequate antibiotic therapy are important variables that can improve the clinical outcomes of ventriculitis in children.

Objective: -Assessment of the outcome of pediatric patients treated for ventriculitis at Zewditu memorial hospital.

Methods: -All children managed with diagnosis of ventriculitis and fulfill the inclusion criteria were participatein the study. The data was entered into Epi-Data version 4.2 and exported to SPSS version 26 for analysis. Descriptive statistics such as mean and standard deviation (SD) was computed for continuous and percentages for categorical variables. The determinant factor of the outcome variable were measured by odd ratio and 95%CI. A p-value <0.05 stated as statistically significant.

Result: -In this study 53 participants having ventriculitis were involved and from those 81% were improved during discharge of ventriculitis management, 11% died and 4% were deteriorated. the higher mortality was seen the lower in time duration of antibiotic duration. The finding also found that the mortality and the morbidity of ventriculitis were 19%. In this study 41.5% (22/52) of the study participants were received meropenem and from those 18.2% (4/22) had poor outcome during discharge. The finding of the study also showed that 17.1% (8/47) of the child has adverse clinical outcomes at the third month follow up. From those having adverse outcome 4patients had ABM, 3 patients had change in behaviors and 1 case had both ABM and change behavior.

Key word: - ventriculitis, children, outcome, ZMH.

1. Introduction

1.1 Background

Ventriculitis refers to inflammation or infection of the ventricles within the brain. In pediatrics, ventriculitis is often associated with inflammation or infection of the cerebral spinal fluid (CSF) within the ventricles. This condition is a serious and potentially life-threatening neurological complication. Ventriculitis can occur in children for various reasons, and it is commonly associated with ventricular shunt procedures.(1)

Ventriculitis, or infection of the cerebrospinal fluid, in the presence of external ventricular drains (EVD), is an important complication and associated with substantial mortality, morbidity, and healthcare costs.(2) Furthermore , the conditions that require the insertion of an EVD, such as neurotrauma and subarachnoid hemorrhage, are themselves associated with inflammation of the cerebrospinal fluid. Phenotypically, patients with inflammation of the cerebrospinal fluid can present with very similar symptoms, signs, and laboratory findings to those with infection.(3)

It is a dreaded complication of meningitis, brain abscess, and various neurosurgical procedures, including ventricular catheter-related infections.(4-5) So, among central nervous system (CNS) infections, ventriculitis has attracted limited attention in the medical literature to date, most of which is restricted to healthcare-associated ventriculitis.(6-7)

Identified risk factors for ventriculitis include presence of an EVD, duration of EVD placement exceeding, frequency of EVD manipulation for CSF sampling, drain irrigation, presence of intraventricular or subarachnoid hemorrhage, presence of cranial fracture with CSF leak, craniotomy, perioperative steroid use, and poor surgical technique.(8-10)Multiloculated hydrocephalus is usually associated with neonatal age and the presence of intraventricular hemorrhage due to premature birth or neonatal meningitis.(11)In the case of ventriculitis, multiloculated hydrocephalus perpetuates infection because the formation of septate cavities makes it impossible for systemic or intraventricular antibiotics to circulate freely. For this reason, it is essential to communicate with all septate cavities to treat infection and hydrocephalus with the fewest ventricular systems. (12)

A meta-analysis has demonstrated that antibiotic-impregnated EVDs result in a significant decrease in positive CSF cultures.(13)However, whether there is a true reduction in ventriculitis or a reduction in culture positivity rate is a matter of debate.(14) recent large, high-quality randomized trial of antibiotic a significant reduction in infection rate over a median 22-month follow-up with antibiotic-impregnated catheters.(15)

A combination of symptoms, laboratory findings, imaging findings and clinical judgement are used to make a diagnosis and management for better outcome.(16) The management of ventriculitis can be lengthy and expensive and ventriculitis can lead to serious long-term sequelae and even result in death.(17-18)

Different factors were associated with poor outcomes of ventriculitis patients like the duration of disease, age, immune status of the patient, timing of antibiotic initiation, type of microorganism, rapid diagnosis and an early treatment.(19-20) Even though the diagnosis of the disease is a difficult task in pediatrics, it is considered a medical, emergency.(21) Any delay in the initiation of treatment could be fatal and, in most resource, limited settings the mortality of untreated bacterial meningitis/ventriculitis approaches 100%.(22) Therefore, early diagnosis, identification of the pathogen, and time to initiation of adequate antibiotic therapy are important variables that can improve the clinical outcomes of ventriculitis in children.(23)

1.2 Statement of the problem

Ventriculitis is associated with high mortality and negatively affects the prognosis of neurosurgical patients. Procedures that can lead to post-neurosurgical ventriculitis include craniotomy, EVD, ventriculostomy, lumbar puncture, and VP shunt insertion.(24) Although prophylactic antibiotic therapy is commonly used before neurosurgical procedures, its effectiveness is uncertain.(25) In recent years, the extensive use of antibiotics for the treatment of pneumonia and the increasing incidence of neurosurgery may have altered the epidemiology and clinical spectrum of ventriculitis.(26-27)

From the study of 99ventriculitis cases in UKhad antimicrobial treatment given and from those the mortality rate was estimated at 14% of cases.(28) On other study also revealed thatfrom the total of 215 positive cerebrospinal fluid culture an adverse clinical outcome was seen in 167 patients (77.7%) and was defined as death in 20 patients (9.3%), persistent vegetative state in 31 patients (14.4%), severe disability in 77 patients (35.8%), or moderate disability in 39 patients (18.1%). (29-30)

Pediatric ventriculitis, characterized by inflammation or infection of the ventricles within the brain, is a complex medical condition associated with significant morbidity and mortality. Despite advancements in medical care and neurosurgical interventions, the outcomes of pediatric patients treated for ventriculitis remain variable.Assessing the diversity of treatment modalities, including antibiotic regimens, surgical interventions, and adjunctive therapies, employed in the management of pediatric ventriculitis.Identifying patient-specific factors such as age, underlying medical conditions, and the presence of comorbidities that may impact the efficacy of treatment and overall outcomes.

Evaluating the impact of ventriculitis on the quality of life and functional outcomes of pediatric patients, including their ability to perform daily activities and engage in age-appropriate social and academic pursuits.By addressing these issues, this research aims to contribute valuable insights into the complex landscape of pediatric ventriculitis, providing a foundation for evidence-based on outcomes of management in Pediatric ventriculitis in ZMH.

1.3 Significance of the study

The significance of a study on the outcome of pediatric patients treated for ventriculitis lies in its potential to contribute valuable knowledge that can inform clinical practice, enhance patient care, and guide future research. So, the main aspects of the studies were

I. To provide insights into the factors influencing treatment success and failure in pediatric ventriculitis. This information can guide clinicians in making informed decisions regarding treatment modalities, antibiotic selection, and surgical interventions.

II. Understanding the variability in treatment approaches and their outcomes can lead to the development of optimized treatment protocols. This can help standardize care practices, leading to more consistent and effective management of pediatric ventriculitis across healthcare settings.

III. Identification of factors associated with positive outcomes can contribute to the development of targeted interventions to enhance the overall well-being of pediatric patients treated for ventriculitis.

IV. The study can provide valuable prognostic information, enabling healthcare providers to engage in meaningful discussions with families about the potential outcomes of pediatric ventriculitis treatment.

V. Insights into the spectrum of microbial pathogens and antimicrobial resistance patterns can inform antimicrobial stewardship practices.

VI. Understanding healthcare utilization patterns and the economic burden associated with pediatric ventriculitis treatment can guide resource allocation, potentially reducing hospital readmissions, optimizing rehabilitation services, and minimizing the economic impact on families and healthcare systems.

VII. Knowledge of long-term neurological and developmental sequelae can inform the design of rehabilitation programs and support services tailored to the specific needs of pediatric patients post-ventriculitis treatment.

VIII. The study adds to the existing body of scientific knowledge on pediatric ventriculitis. It serves as a reference for future research, facilitating a deeper understanding of the condition, its underlying mechanisms, and potential avenues for further exploration.

2. Literature review

Ventriculitis is a potentially life-threatening infection, and an early diagnosis is essential for the appropriate treatment of ventriculitis. With the available literature, it is difficult to document the frequency with which ventriculitis exists, and also failure to recognize this entity might account for the scant literature. Amulticenter prospective study is needed to establish the true treatment outcome of ventriculitis and its impact on outcome. In this article, we review the available literature and current concepts in the management and outcome of ventriculitis.

A systematic review and meta-analysis done in Military School Hospital, Managua, Nicaragua about intraventricular antibiotics for neonatal meningitis and Ventriculitis revealed that in the pediatric studies, no significant differences in mortality were found between intraventricular antibiotics and only systemic antibiotic [25.4% vs 16.1%, OR=0.96 (0.42–2.24), P=0.93]. However, when analyzing the minimum administered doses, it found a lower mortality when a minimum duration of 3 days for intraventricular antibiotics was used compared to only systemic antibiotic [4.3% vs 17%, OR=0.22 (0.07–0.72), P=0.01]. In the neurosurgical studies, the use of intraventricular antibiotics in ventriculitis generally results in a mortality of 5% and a morbidity of 25%, which is lower than that in cases where intraventricular antibiotics were not used, with an average mortality of 37.3% and a morbidity of 50% .(30)

The finding of the study in university Medicine Greifswald university department of Neurosurgery revealed that the mean age of the study population was 5.98 ± 7.02 years. The mean follow-up duration was 7.6 ± 3.2 months in the conventional group and 5.7 ± 3.4 months in the lavage group. The mortality rate was 25% (4/16) in the lavage group and 52.9% (9/17) in the non-lavage group ($p = 0.1$). The mRS score was less than 3 (good outcome) in 68.8% (11/16) of the lavage group cases and in 23.5% (4/17) of the conventional group ($p < 0.05$). The mean hospital stay duration was 20.5 ± 14.2 days in the lavage group, whereas it was 39.7 ± 16.9 days in the conventional group ($p < 0.05$). (31)

A study done on Treatment of severe ventriculitis in Shanghai Tenth People's Hospital revealed that from 20 male and 5 female, were enrolled in this study. All patients underwent neurosurgery before infection, and all A. baumannii cultures from CSF showed extensive resistance to the tested antibiotics except for tigecycline and colistin. All the patients underwent IVT lavage

followed by daily administration of colistin after surgery; 24 patients received a daily colistin dose of 100,000 IU, while one received 50,000 IU. The patients also received tigecycline-based systemic antibiotic treatment. The mean duration of IVT colistin was 13.4±2.8 days. The time required to obtain a negative CSF culture was 8.9±4.0 days. Of the 20 patients who were cured, eight underwent shunt surgery due to hydrocephalus before they were discharged to a rehabilitation center. Five patients died, including one who was re-admitted due to recurrence 1 month after discharge. (32)

The study done in Texas university on outcome of Healthcare-Associated Ventriculitis and Meningitis revealed that from a total of 215 patients an adverse clinical outcome was seen in 167 patients (77.7%) and death in 20 patients (9.3%), persistent vegetative state in 31 patients (14.4%), severe disability in 77 patients (35.8%), or moderate disability in 39 patients (18.1%). On logistic regression analysis, abnormal neurological exam (adjusted OR, 3.04; 95% CI, 1.27–7.29; P = .013), and mechanical ventilation (adjusted OR, 5.34; 95% CI, 1.51–18.92; P = .01) were associated with an adverse outcome.(33)

A study done for neurodevelopment Outcome of Neonates treated with intraventricular Colistin for Ventriculitis revealed that all neonates received IVT colistin and concomitant intravenous meropenem, and five of them also received intravenous colistin. One neonate died. At the 18-month assessment, only one neonate had cerebral palsy and hydrocephaly and 50% had seizure disorders.(34)

A study done about intraventricular antimicrobial therapy in children with multi-drug resistant ventriculitis revealed that the median age was 1 year (range 1 month to 17 years old, mean: 4.4 years). Fifty-seven (57) percent of the patients were females. The isolated pathogens were Acinetobacter baumannii MDRO (n = 3), Klebsiella pneumoniae MDRO (n = 2), Methicillin-resistant Staphylococcus aureus (n = 1), and Methicillin-resistant Staphylococcus epidermidis (n = 2). One patient had mixed isolates on CSF culture (Acinetobacter baumannii and MRSE). The antimicrobial agents for IVT used were colistin (n = 4), vancomycin (n = 2), and gentamicin (n = 1). The mean time to initiation of intraventricular therapy from the diagnosis of ventriculitis was 19 days. The mean duration of IVT therapy was 15 days. The survival rate was 57% (35).

3. Objective

3.1 General objective

Assessment of the outcome of pediatric patients treated for ventriculitis at Zewditu memorial hospital

3.2 Specific objective

- ✓ Determine the successfuleradicationof ventriculitis through each management system.{I.e Systemic vs intraventricular antibiotics vs lavage}
- ✓ Assess neurological outcome after ventriculitis and its treatment
- ✓ Evaluate the overall morbidity and mortality rates associated with pediatric ventriculitis
- ✓ Measure the patient's ability to perform daily activities and participate in age-appropriate activities at follow up {3months}.

4 Methods

4.1 Study design and period

- An Institution based prospective study was carried out forone year.

4.2 Population

4.2.1 Source population

Source of population includes all children who were managed for ventriculitis in Zewditu memorial hospital.

4.2.2 Study population

- ✓ All children who were managed with the diagnosis of ventriculitis

4.3 Eligibility criteria

4.3.1 Inclusion criteria

- ✓ Pediatric Age Group: Patients within a specific age range,{12yrs}, depending on the study's focus.
- ✓ Diagnosis of Ventriculitis: Patients with a confirmed diagnosis of ventriculitis based on clinical presentation, and/or cerebrospinal fluid (CSF) analysis.
- ✓ Treatment Received: Patients who have received treatment for ventriculitis, which may include antibiotic therapy, surgical intervention (e.g., placement or management of ventricular drains), or a combination of both.
- ✓ Availability of Clinical Data: Patients for whom comprehensive clinical data, including baseline characteristics, treatment modalities, follow-up assessments, and outcomes, are available for analysis.
- ✓ Follow-Up Period: Patients who have been followed up for three months duration post-treatment to assess outcomes and potential complications.

4.3.2 Exclusion criteria

- ✓ Age Outside the Defined Range: Patients outside the specified pediatric age group, such as adults depending on the study's focus.

- ✓ Incomplete Data: Patients with incomplete or insufficient clinical data necessary for outcome assessment, including missing baseline characteristics, treatment details, or follow-up information.
- ✓ Non-Compliance: Patients who did not adhere to the prescribed treatment regimen or follow-up protocol, leading to unreliable outcome assessment.
- ✓ Prior Treatment: Patients who received treatment for ventriculitis before the study period or outside the predefined treatment protocol, potentially influencing outcome measures.

4.4 Sample size determination

All patients who fulfill the inclusion criteria during the study period were considered as a sample.

4.5 Sampling procedure

All the study participants who fulfill the inclusion criteria was using census method during the study period.

4.6 Study variables

4.6.1 Dependent variable:

- Complication with in3 months
- Length of hospital stay
- Mortality

4.6.2 Independent variable:

- Socio-demographic variables**:** Age, Sex
- Antibiotic Therapy: antibiotic regimens, dosages, or durations of treatment
- Surgical Interventions: placement of ventricular drains, ventriculoperitoneal shunt insertion, or surgical debridement.

- Adjunctive Therapies: placement of EVD, intraventricular antibiotics, ventriculosubgaleal shunt or Omaya insertion, on the outcome of ventriculitis management.

- Timing of Treatment Initiation: The timing of initiating treatment relative to symptom onset or diagnosis could be investigated as an independent variable to assess its influence on patient outcomes.
- Multimodal Treatment Approaches: combinations of antibiotics, surgical interventions, and adjunctive therapies.

4.7 Data collection technique

Data was collected through interviewed and chart review using standard questionnaire methods. A child must have types of ventriculitis management and its outcome.Access patient medical records, including electronic health recordsor paper charts, and interview for eligible study participants.Systematically review each patient's medical history, progress notes, laboratory results, surgical reports, and discharge summaries.Extract pertinent data related to the management of ventriculitis, including initial presentation, diagnostic evaluation, treatment interventions (e.g., antibiotics, surgery), complications, and follow-up outcomes.

4.8 Data Processing, Management and Analysis

The questionnaire was checked manually for completeness and was entered into Epi-Data version 4.2 and exported to SPSS version 26 for analysis. Descriptive statistics such as mean and standard deviation (SD) were computed for continuous and percentages for categorical variables. The determinant factor was measured using chi-square test, odd ratio and 95%CI. Then statistical significancy were assured using p-value <0.05.

4.9 Operational definitions

- **Pediatric Patients**: Individuals aged up to 12 years at the time of diagnosis or treatment initiation.
- **Ventriculitis:** Inflammation or infection of the ventricles, confirmed by clinical symptoms, and/or cerebrospinal fluid (CSF) analysis showing evidence of infection. Cell count more than 50cells/Mm3, glucose less than 50mg/dl and protein more than 25mg/dl.
- **Management:** The medical and/or surgical interventions administered to treat ventriculitis in pediatric patients, including antibiotic therapy, surgical procedures (e.g., ventricular drain

placement, shunt revision), and adjunctive therapies (e.g., systemic or intraventricular antibiotics).

- **Outcome:** The overall result or status of pediatric patients following management for ventriculitis, encompassing various dimensions such as infection resolution, neurological function, complications, morbidity, mortality, and quality of life.
- **Infection Resolution**: Absence of clinical symptoms and signs of ventriculitis, supported by negative cultures, indicating resolution of inflammation or infection within the cerebral ventricles.
- **Neurological Function:** The functional status of the central nervous system, including cognitive abilities, motor function, sensory perception, and speech/language skills, assessed through standardized neurological examinations or validated assessment tools.
- **Complications**: Adverse events or sequelae arising during or after the management of ventriculitis, such as hydrocephalus, intracranial hemorrhage, seizures, or neurological deficits.
- **Morbidity:** Any adverse health outcomes or complications resulting from ventriculitis or its management, including physical, cognitive, or psychological impairments affecting the patient's overall well-being.
- **Mortality**: Death occurring during the course of ventriculitis management or within a three months follow-up period, attributable to complications of the infection or its treatment.

4.10 Ethical consideration

Ethical clearance was received from Addis Ababa university, health science collage, department of neurosurgery research team prior to data collection. A formal letter was written by the department to Zewditu memorial hospital. Permission was asked from the responsible body of the unit. The data was extracted from the patient chart without writing their names to ensure confidentiality.

4.11 Dissemination of the study findings

The findings of this study will be submitted to the Neurosurgical Unit of the Department of Surgery of College of Health Sciences, Addis Ababa University as a partial fulfillment of the specialty certificate in Neurosurgery. The findings will also be presented and disseminated to other concerned stakeholders through presentation in different workshops and seminars.

Finally, the manuscript will be submitted to a peer-reviewed scientific journal for possible publication

5.Result

5.1 Sociodemographic characteristics of the participants

This study included data derived from 53 patients with ventriculitis who was admitted to Zewditu memorial hospital during the study period. Majority (32;60.4%) were males, and the remaining (21;39.6) were females. Sixty-percent of the patients were in the age group of 1-6 months for whom majority (41;77.4%) were from Addis Ababa and the remaining (12;22.6%) were from outside Addis Ababa .

Sixty percent of 1-6 months of age from those 84.4% were improved at discharge. Sixty-percent (n=32) of the patients were male and from those 12.5% (n=4) were unimproved/died. Seventy-seven percent of the participants were from Addis Ababa and from those 17.1% were unimproved/died. Participant from Addis Ababa had 17.1% of unimproved/died while 25% were unimproved died for those of from outside Addis Ababa. Almost fifty-five percent of the participants had prior hospitalization and from those 27.6% had unimproved/died during discharge.

Table 1.The sociodemographic characteristics of the pediatric patients treated for ventriculitis at Zewuditu memorial hospital

variable	Status at discharge		Percent
	Unimproved/died	improved	
Age in month			
<1	3(23.1)	10(76.9)	13(24.5)
1-6	5(15.6)	27(84.4)	32(60.4)
7-12	2(25)	6(75)	8(15.1)
Sex of the children			
Male	4(12.5)	28(87.5)	32(60.4)
female	6(28.6)	15(71.4)	21(39.6)
Residency			
AA	7(17.1)	34(82.9)	41(77.4)
Out of AA	3(25)	9(75)	12(22.6)
Prior hospitalizing			
Yes	8(27.6)	21(72.4)	29(54.7)
no	2(8.3)	43(81.1)	24(45.3)

5.2 Clinical presentation of the pediatric patients having ventriculitis

Further more, more than half (34; 64.2%) of the patients had fever clinical presentation . followed by CSF leak which occurred in (8; 15.0%) of the patients. Further 6(11.3%) and 5(9.4%) of the patients had vomitting and altered level of conciousness respectivelly.

Sixty-four percent of the participants had fever clinical presentation and from those only 5.9% (n=2) were unimproved/died. Vomiting were the major presentation having unimproved/ died outcome during discharge. 5 participants having altered level of consciousness were unimproved/died.

Table 2. Clinical presentation of the pediatric patients having ventriculitis

variable	Status at discharge		Percent
	Unimproved/died (%)	Improved (%)	
Fever	2(5.9)	32(94.1)	34(64.2)
Vomiting	2(33.3)	4(66.7)	6(11.3)
ABM	1(50)	1(50)	2(3.8)
CSF leak	0	8(100)	8(15.1)
Altered level of consciousness	5(100)	0	5(9.4)

5.2 Previous surgery related characteristics of the study participants

Almost seventy-two percent of the participants had history of previous surgery and from those 21.1% had unimproved/died status during discharge. From those having surgical history, 43.4% were performed for ETV followed by MMC repair (31.6%, n=12), EVD (21.2%, n=8) and encephalocele repair (10.5%, n=4).

Table 3. Previous surgery related characteristics of the study participants

variable	Status at discharge		Percent
	Unimproved/died (%)	Improved (%)	
History of previous surgery			
Yes	8(21.1)	30(78.9)	38(71.7)
no	2(13.3)	13(86.7)	15(28.3)
Types of previous surgery performed (n=38)			
MMC repair	2(16.7)	10(83.3)	12(31.6)
EVD	4(50)	4(50)	8(21.1)
VPS	0	1(100)	1(2.6)
Encephalocele repair	2(50)	2(50)	4(10.5)
ETV	0	13(100)	23(43.4)

5.3 Isolated organism related characteristics of the study participants

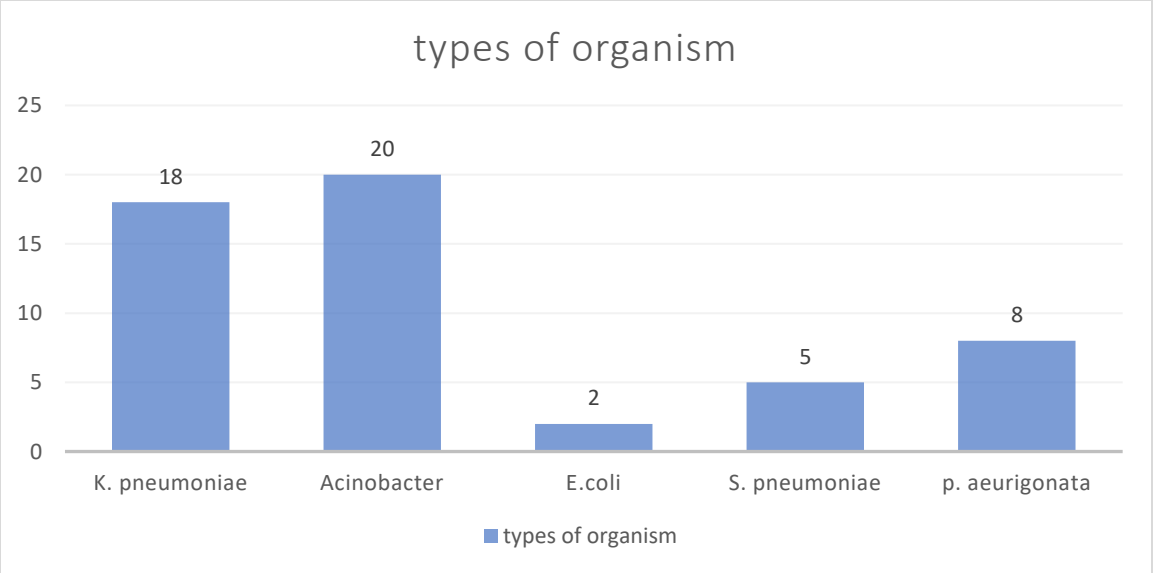


Figure 1.Isolated organism related characteristics of the study participants

5.4 Cerebrospinal fluid parameter and concomitant infection characteristics

Twenty-eight percent of the participants had a cell count of >1000 and from those having cell count >1000, forty percent of them were unimproved /died. Almost fifty-seven percent of the participants had low glucose level and from those 26.7% were unimproved/died during discharge. Fifty-six percent of the participants had >400mg/dl protein level and from those 33.3% had unimproved/died status at discharge time. only three patients had concomitant infection and from those, two of them had chest focus and one case had GI focus.

Table 4. Cerebrospinal fluid parameter and concomitant infection characteristics

variable	Status at discharge		Percent
	Unimproved/died (%)	Improved (%)	
Cell count			
100-500	3(15.8)	16(84.2)	19(35.8)
500-1000	1(5.3)	18(94.7)	19(35.8)
>1000	6(40)	9(60)	15(28.4)
Glucose level			
Normal	2(8.7)	21(91.3)	23(43.2)
Low	8(26.7)	22(73.3)	30(56.6)
Protein level in mg/ml			
200-400	0	23(100)	23(43.2)
>400	10(33.3)	20(66.7)	30(56.6)
Concomitant infection			
Chest focus	1(50)	1(50)	2(3.8)
GI focus	0	1(100)	1(1.9)

5.5 The participants sensitive antibiotic related characteristics

41.5% of the participants were received meropenem, from those 18.2% (n=4) had unimproved/died status. Next to meropenem, are amikacin (28.3%), gentamycin (22.6%) and ceftazidime were the sensitive antibiotics. Ninety-two percent of the participants were waiting in antibiotic for 21 days 81.1% used systemic antibiotics.

Table 5. The participants sensitive antibiotic related characteristics

variable	Status at discharge		Percent
	Unimproved/died (%)	Improved (%)	
Amikacin	4(26.7)	11(73.3)	15(28.3)
meropenem	4(18.2)	18(81.8)	22(41.5)
ceftazidime	1(20)	4(80)	5(9.4)
gentamycin	1(8.3)	11(91.7)	12(22.6)
Duration of antibiotic in days			
10	4(100)	0	4(7.5)
14	0	1(100)	1(1.9)
21	6(12.5)	43(81.1)	48(92.3)
Route of antibiotic			
Systemic	5(11.6)	38(88.4)	43(81.1)
Intrathecal	0	1(100)	1(1.9)
Both intrathecal and systemic	5(55.6)	4(44.4)	9(17)

5.6 Types of surgery performed after antibiotic

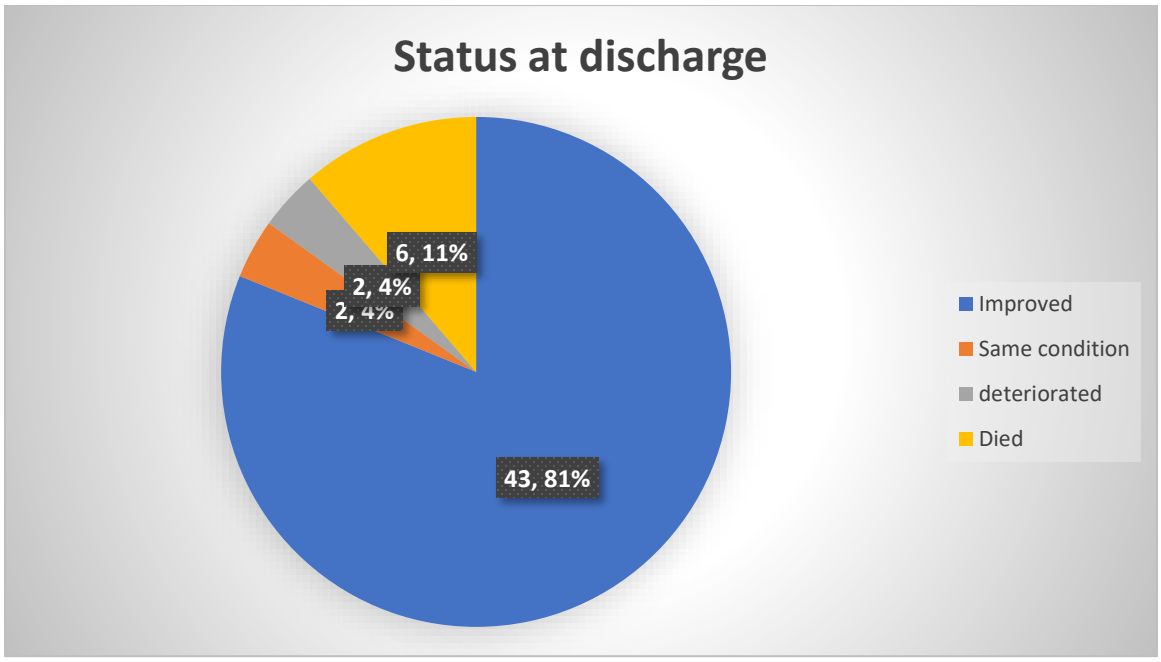
Surgery was performed for 84.9% of the child after antibiotic. Unimproved/died outcome were higher from those of surgery didn't do after antibiotic compared to those of surgery done after antibiotic. EVD, VPS and Omaya insertion were the main procedure performed after antibiotics.

Table 6. Types of surgery performed after antibiotic usage

variable	Status at discharge		Percent
	Unimproved/died (%)	Improved (%)	
Surgery performed after antibiotic			
Yes	5(11.1)	40(88.9)	45(84.9)
No	5(62.5)	3(37.5)	8(15.1)
Types of surgery performed (n=45)			
EVD	2(100)	0	2(4.4)
VPS	3(7.3)	38(92.7)	41(91.2)
Omaya insertion	0	2(100)	2(4.4)

5.7 The status of patient at discharge

Eighty-one percent of the participants had Improved outcome during discharge, while 11% were died and 4% each were same condition to preoperative and deteriorated respectively.



5.8 Third month evaluation of the patient after discharge

During third evaluation assessment of the 47 cases who were discharged a lively, 83% had no complaint and 2.1% had ABM and change behavior and 8.5% had compliant of ABM alone. 12.8% were managed surgically and from those 66.7% were died.

variable	Status at discharge		Percent
	Unimproved/died (%)	Improved (%)	
Main compliant (n=47)			
ABM			4(8.5)
Change behavior			3(6.4)
ABM and change behavior			1(2.1)
No compliant			39(83)
Any surgery performed (n=47)			
Yes	4(66.7)	2(33.3)	6(12.8)
no	0	41(100)	41(87.2)
Types of surgery (n=6)			
EVD	1(100)	0	1(25)
Shunt removal	3(100)	0	3(75)
EVD and shunt removal	0	2(100)	2(33.3)

5.9 The determinant factor of child ventriculitis management outcome

The fisher exact test found that prior hospital admission was a statistically significant for unimproved /died of ventriculitis management outcome (p-value=0.019) and presence of fever and altered consciousness of clinical presentation were the significant factor of unimproved/died outcome ($p<0.05$). study participants having CSF protein level of >400mg/ml had significant unimproved/died ventriculitis management outcome (p-value =0.003) and participant having surgical procedure of EVD had significant impact on unimproved/died ventriculitis management outcome (P-value=0.044).

Table 7. the determinant factor of child ventriculitis management outcome using fisher's exact test

Variable	Status at discharge		p-value using fishers exact test
	Unimproved/died (%)	Improved (%)	
Prior hospitalizing			0.019
Yes	8(27.6)	21(72.4)	
no	2(8.3)	22(91.7)	
Presence of fever			0.002
Yes	2(5.9)	32(94.1)	
No	8(42.1)	11(57.9)	
Altered consciousness			0.000
Yes	5(100)	0	
no	5(10.4)	43(89.6)	
EVD			0.044
Yes	4(50)	4(50)	
no	4(13.3)	26986.7)	
Protein level in mg/ml			0.003
200-400	0	23(100)	
>400	10(33.3)	20(66.7)	
Surgery performed after antibiotic			0.004
Yes	5(11.1)	40(88.9)	
No	5(62.5)	3(37.5)	

6. Discussion

In this study 53 participants having ventriculitis were involved and from those 81% were improved during discharge of ventriculitis management, 11% died and 4% were developed complication. The mortality of this finding was higher than the study done by Fumei et al (32) and the study done on systematic review done by Doraim P et al (30). This difference was may be due to especially low-resource ones, diagnostic tools like MRI or CSF cultures might be limited, leading to delays in diagnosis. Early intervention is crucial in ventriculitis to prevent complications.Effective management of ventriculitis often requires a multidisciplinary team, including neurologists, neurosurgeons, and infectious disease specialists. In settings with limited access like the current setting to these specialists, comprehensive care may be harder to provide, leading to lower recovery rates. This was also particularly in hospitals with high patient turnover or limited antibiotic stewardship, resistance to antibiotics can be a challenge.

In this study the higher mortality was seen the lower time duration of antibiotic duration. This finding was in opposed to the systematic review done by Doraim P et al (30). This was may be due to ventriculitis, especially bacterial, often requires a prolonged course of antibiotics to fully eradicate the infection, given the difficulty of penetrating the CSF and the brain's protective barriers. Shorter antibiotic durations may leave residual bacteria, leading to recurrence or persistence of infection, which can increase mortality. Infections with more resistant or aggressive bacteria often require extended antibiotic courses. A shorter duration may not be effective enough to manage these infections, allowing the pathogen to thrive and potentially cause more severe complications

The finding also found that the mortality and the morbidity of ventriculitis were 19%. This finding was in line with the study done by systematic review done by Doraim P et al (30). In this study the improved treatment of male was 87.5% and improved treatment of female were 71.4%. this implies that there was a treatment outcome difference between male and female. This finding was supported by the study done by Fumeichen et al (32). This was may be due to neonates have underdeveloped immune systems, but sex-based differences in immune responses are present even at birth. Female neonates may mount a stronger inflammatory response to infection, which could lead to more significant inflammation in the CNS. The permeability of the blood-brain barrier can vary between male and female neonates due to subtle hormonal and genetic factors.

This could theoretically influence the degree to which inflammatory agents, pathogens, or even medications cross into the CNS. If female neonates have slightly higher blood-brain barrier permeability, it may increase susceptibility to more severe CNS inflammation or infection spread, affecting outcomes.

The finding of the study also showed that 17.1% (8/47) of the child has adverse clinical outcomes at the third month follow up. From those having adverse outcome 4 patients had ABM, 3 patients had change in behaviors and 1 case had both ABM and change behavior. This finding was lower compared to the study done in Texas university (33). This was may be due to difference in mode of management, skill of the provider and even difference in operational definition to say adverse clinical outcome. In this study 41.5%(22/52) of the study participants received meropenem and from those 18.2% (4/22) had poor outcome during discharge. This finding was in line was the study done by Hussain K et al (34).

The finding of the study also showed that the proportion of ventriculitis classified as EVD-related is low (15.0%). This finding is with a line with David Luque, Matthieu Revest with their retrospective studies of 98 patients, their EVD-related ventriculitis was (12.2%). This may differ from one site to another, due to case mix. Indeed, the risk of ventriculitis after EVD implantation was recently estimated between 4.8 to 12.7% cases per 1000 EVD(17).

Regarding microbiology, previous studies identified Gram-negative bacilli and staphylococci as the main categories of pathogens responsible for ventriculitis. similarly this study the main pathogen was Klebsiella pneumonia(34.0%) and Acitenobacter(37%). but study done by David Luque, Matthieu Revest, with their retrospective studies of 98 patients, streptococci were the leading causative species(44.9%), with S.pneumonia as leading causative organism but in this study S.pneumonia accounts only (10.0%).

In this study we found that factors associated with mortality were as follows: (1) prior hospitalization (2) altered level of consciousness (3)positive CSF culture

These prognostic factors are in line with those that have been associated with other CNS infections.

This study also found that CSF culture yielding Pseudomonos aeruginosa was risk factor for death, one study found that CSF culture positive for Pseudomonos aeruginosa was associated with higher mortality in EVD infection(34).

To conclude, the author believes that the outcomes of ventriculitis obtained in this study can be substantially influenced by the familiarity of the physician with ventriculitis and availability of the appropriate antibiotics.

7 Strengths and Limitations

7.1 Strenghts

- ✓ *The study is done in single center which is* a large-volume tertiary health institution of the country where the highest number of pediatric patients with varying background characteristics are expected to be represented. This is believed to allow the findings to be generalized to other populations with comparable sociodemographic characteristics.

7.2 Limitations

- ✓ *Small number of patients which become difficult for analysis*
- ✓ Single center study
- ✓ our finding my not be generalizable: the proportion and characteristics of healthy care associated ventriculitis may differ according to case mix.

8. Conclusion

In this study 53 participants having ventriculitis were involved and from those 81% were improved during discharge of ventriculitis management, 11% died and 4% were having complications . the higher mortality was seen the lower in time duration of antibiotic duration.

The finding also found that the mortality and the morbidity of ventriculitis were 19%. In this study 41.5% (22/52) of the study participants were received meropenem and from those 18.2% (4/22) had poor outcome during discharge. The finding of the study also showed that 17.1% (8/47) of the child has adverse clinical outcomes at the third month follow up. From those having adverse outcome 4 patients had ABM, 3 patients had change in behaviors and 1 case had both ABM and change behavior. The fisher exact test found that prior hospital admission , presence of fever, altered consciousness of clinical presentation , CSF protein level of >400mg/ml and participant having surgical procedure of EVD had significant impact on unimproved/died ventriculitis management outcome (P-value<0.05).

9 . Recommendation

To improve the treatment outcomes of ventriculitis, the following recommendations may be beneficial:

I. Its needed prospective multicenter studies
II. Concerned stakeholders including local policy makers should consider capacity building interventions for familiarizing practitioners for ventriculitis
III. Develop patient registries for ventriculitis cases to monitor long-term outcomes, track treatment efficacy, and guide future care improvements based on real-world data.

Reference

1. Luque-Paz, D.; Revest, M.; Eugène, F.; Boukthir, S.; Dejoies, L.; Tattevin, P.; Le Reste, P.-J. Ventriculitis: A Severe Complication of Central Nervous System Infections. Open Forum Infect. Dis. 2021, 8, ofab216.
2. Tunkel, A.R.; Hasbun, R.; Bhimraj, A.; Byers, K.; Kaplan, S.L.; Scheld, W.M.; van de Beek, D.; Bleck, T.P.; Garton, H.J.L.; Zunt, J.R. 2017 Infectious Diseases Society of America's Clinical Practice Guidelines for Healthcare-Associated Ventriculitis and Meningitis. Clin. Infect. Dis. 2017, 64, e34–e65.
3. Citerio, G.; Signorini, L.; Bronco, A.; Vargiolu, A.; Rota, M.; Latronico, N. External ventricular and lumbar drain device infections in icu patients: A prospective multicenter Italian study. Crit. Care Med. 2015, 43, 1630–1637.
4. Hazany S, Go JL, Law M. Magnetic resonance imaging of infectious meningitis and ventriculitis in adults. Top Magn Reson Imaging 2014; 23:315–25.
5. Harris L, Munakomi S. Ventriculitis. StatPearls. Treasure Island, FL: StatPearls Publishing; 2020.
6. Tunkel AR, Hasbun R, Bhimraj A, et al. 2017 Infectious Diseases Society of America's Clinical Practice Guidelines for Healthcare-Associated Ventriculitis and Meningitis. Clin Infect Dis 2017; 64:e34–65.
7. Bijlsma MW, Brouwer MC, Kasanmoentalib ES, et al. Community-acquired bacterial meningitis in adults in the Netherlands, 2006–14: a prospective cohort study. Lancet Infect Dis 2016; 16:339–47.

8. ((Humphreys H, Jenks PJ. Surveillance and management of ventriculitis following neurosurgery. Journal of Hospital Infection. 2015. Available from: https://www.journalofhospitalinfection.com/article/ S0195-6701(15)00051-1/fulltext DOI: 10.1016/j.jhin.2014.12.019..
9. Tunkel AR, Hasbun R, Bhimraj A, Byers K, Kaplan SL, Scheld WM, et al. 2017 Infectious Diseases Society of Infectious Diseases. 2017; 64(6): p. e34-e65. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/P MC5848239/pdf/ciw861.pdf DOI:10.1093/cid/ciw861.
10. Beer R, Lackner P, Pfausler B, Schmutzhard E. Nosocomial ventriculitis and meningitis in neurocritical care patients. Journal of Neurology. 2008; 255. Available from:https://link.springer.com/article/10.1007%2Fs 00415-008-0059-8 DOI: 10.1007/s00415-008-0059-8.
11. Spennato P, Mirone G, Cicala D, Ruggiero C, Di Martino G, De Caro ML, et al. Pathophysiology and treatment of multiloculated hydrocephalus. In: Cinalli G, editor. Pediatric hydrocephalus. Milan, Italy: Springer, 2019. p. 855-905.
12. . Zuccaro G, Ramos JG. Multiloculated hydrocephalus. Childs Nerv Syst 2011;27:1609-19.
13. Wang, X.; Dong, Y.; Qi, X.Q.; Li, Y.M.; Huang, C.G.; Hou, L.J. Clinical review: Efficacy of antimicrobial-impregnated catheters in external ventricular drainage—A systematic review and meta-analysis. Crit. Care 2013, 17, 6–10.
14. Harris, L.; Munakomi, S. Ventriculitis. StatPearls 2021, 1–8. Available online: https://www.ncbi.nlm.nih.gov/books/NBK544332/ (accessed on 4 August 2021.
15. Mallucci, C.L.; Jenkinson, M.D.; Conroy, E.J.; Hartley, J.C.; Brown, M.; Dalton, J.; Kearns, T.; Moitt, T.; Griffiths, M.J.;Culeddu, G.; et al. Antibiotic or silver versus standard ventriculoperitoneal shunts (BASICS): A multicentre, single-blinded,randomised trial and economic evaluation. Lancet 2019, 394, 1530–1539.
16. Tunkel AR, Hasbun R, Bhimraj A, Byers K, Kaplan S, Scheld M,et al. 2017 Infectious Diseases Society of America's ClinicalPractice Guidelines for Healthcare-Associated Ventriculitis and Meningitis. Clin Infect Dis 2017;64:e34.
17. Phan K, Schultz K, Huang C, Halcrow S, Fuller J, McDowell D,et al. External ventricular drain infections at the Canberra Hospital: A retrospective study. J Clin Neurosci2016;32:95e8.

18. Patwardhan RV. Nanda A Implanted ventricular shunts in the United States: the billion-dollar-a-year cost of hydrocephalus treatment. Neurosurgery 2005;56:139e45.
19. Gudina EK, Tesfaye M, Adane A, Lemma K, Shibiru T, Wieser A, et al. Adjunctive dexamethasone therapy in unconfirmed bacterial meningitis in resource limited settings: is it a risk worth taking? BMC Neurol. 2016;16(1):1–8. https://doi.org/10.1186/s12883-016-0678-0.
20. Wall EC, Cartwright K, Scarborough M, Ajdukiewicz KM, Goodson P, Mwambene J, et al. High mortality amongst adolescents and adults with bacterial meningitis in sub-Saharan Africa: an analysis of 715 cases from Malawi. PLoS One. 2013;8(7):e69783. https://doi.org/10.1371/journal.pone.0069783.
21. Teixeira DC, Diniz LMO, Guimarães NS, Moreira HMdAS, Teixeira CC,RomanelliRMdC. Risk factors associated with the outcomes of pediatric bacterial meningitis: a systematic review. J Pediatr 2020;96(2):159–167, DOI:https://doi.org/10.1016/j.jped.2019.07.003.
22. Acho H. Childhood bacterial meningitis: antimicrobial use pattern and treatment outcomes in Jimma university specialized hospital, Southwest Ethiopia; 2015.
23. Tewabe T, Fenta A, Tegen A, Mezgebu M, Fentie T, Zeleke T. Clinical outcomes and risk factors of meningitis among children in referral hospital, Ethiopia, 2016: a retrospective chart review. Ethiopian J Health Sci. 2018; 28(5).
24. Martin C, Thomachot L, Albanèse J. Iatrogenic and traumatic cerebro-meningeal infections. Rev Prat. 1994;44(16):2207–2212.
25. Eljamel MS. Antibiotic prophylaxis in unrepaired CSF fistulae. Br J Neurosurg. 1993;7(5):501–505.
26. Buckwold FJ, Hand R, Hansebout RR. Hospital-acquired bacterial meningitis in neurosurgical patients. J Neurosurg. 1977;46(4):494–500.
27. Lai WA, Lu CH, Chang WN. Mixed infection in adult post-neurosurgical bacterial meningitis: a hospital-based study. Biomed J. 2013;36(6):295–303
28. Daniel Lilley, Peter Munthali. Analysis of the management of ventriculitis cases at a UK neurosurgery center. Infection Prevention in Practice 4 (2022) 100240.
29. ChanunyaSrihawan, Rodrigo Lopez Castelblanco, Lucrecia Salazar, Susan H. Wootton,Elizabeth Aguilera, Luis Ostrosky-Zeichner, David I. Sandberg, HuiMahn A. Choi,Kiwon Lee, Ryan Kitigawa, Nitin Tandon, and Rodrigo Hasbun. Clinical

Characteristics and Predictors of Adverse Outcome in Adult and Pediatric Patients with Healthcare-Associated Ventriculitis and Meningitis.2016. infectious disease society of America. DOI: 10.1093/ofid/ofw077.

30. Doriam Perera MD; Edgar Herrera MD; Luis Zapata MD; José Hurtado MD; Karen Herrera PhD. Systematic review and meta-analysis of intraventricular antibiotics for neonatal meningitis and ventriculitis.2023. doi: https://doi.org/10.1101/2023.09.07.23295218.
31. Ahmed Al Menabbawy, MBBCh, Ehab El Refaee, Mohamed A. R. Soliman, Mohamed A. Elborady, Mohamed A. Katri, Steffen Fleck, Henry W. S. Schroeder, and Ahmed Zohdi. Outcome improvement in cerebral ventriculitis after ventricular irrigation: a prospective controlled study. J NeurosurgPediatr 26:682–690, 2020.
32. FuMei Chen1, Xianyu Deng, Zhanpeng Wang, Li Wang, Ke Wang and Liang Gao. Treatment of severe ventriculitis caused by extensively drug-resistant Acinetobacter baumannii by intraventricular lavage and administration of colistin. Infection and Drug Resistance 2019:12 241–247.
33. ChanunyaSrihawan, Rodrigo Lopez Castelblanco, Lucrecia Salazar, Susan H. Wootton, Elizabeth Aguilera, Luis Ostrosky-Zeichner, David I. Sandberg, HuiMahn A. Choi, Kiwon Lee, Ryan Kitigawa, Nitin Tandon, and Rodrigo Hasbun. Clinical Characteristics and Predictors of Adverse Outcome in Adult and Pediatric Patients With Healthcare-Associated Ventriculitis and Meningitis. 2016. Infectious disease society of America. DOI: 10.1093/ofid/ofw077.
34. Hussain K, Sohail Salat M, Ambreen G and Iqbal J (2021) Neurodevelopment Outcome of Neonates Treated With Intraventricular Colistin for Ventriculitis Caused by Multiple Drug-Resistant Pathogens—A Case Series. Front. Pediatr. 8:582375.doi: 10.3389/fped.2020.582375.
35. Francesca Mae T. Pantig, MD, Anna Lisa T. Ong-Lim, MD. intraventricular antimicrobial therapy in children with multi-drug resistant ventriculitis: a tertiary hospital experience and literature review. Pediatric Infectious Disease Society of the Philippines Journal. Vol 20 No 2 pp.47-56 July-December 2019.

5 Annex

Annex I: Information sheet for the study

This sheet will be read for medical director of the hospital before collecting any information from the registries. Greetings. My name is Dr. Abdisamed Abdi Ali , and I am a postgraduate student in Neurosurgery Unit, of Department of Surgery of Addis Ababa University, This hospital was selected to conduct the proposed study "Outcomes of pediatric patients treated for ventriculitis . one year prospective study " as it has been one of the health institutions providing neurosurgical care in the country, and providing treatment of pediatric patients diagnosed with ventriculitis . I am humbly requesting your esteemed office to give me permission to conduct the stated study in this hospital. Please read the following information for further understanding.

What the study is about: The purpose of this study is to know the outcome of pediatric patients treated with ventriculitis , The study is designed to study the pediatric patients who were diagnosed to have ventriculitis .

What I will ask you to do: If you agree to facilitate the undertaking of this study; I will be using a checklist to collect necessary data from the medical records of patients. The checklist will include questions items regarding socio-demographic, clinical data and post operative follow up data. I would appreciate very much for your cooperation in this study.

Risks and benefits: The result of the study is believed to help responsible body to advance neurosurgical care offered to patients with Ventriculitis .

Confidentiality: All information gathered from the log book and patient medical record will be kept confidential. Any of patients' personal information will not be registered. The records of this study will be kept private. In any sort of public report, any information that will be making it possible to identify the patient will not be included. Research records will be kept in a locked file; only the researcher will have access to the records.

Contact Address of the principal investigator: Abdisamedd@gmail.com

Name: Dr.Abdisamed Abdi Ali

Addis Ababa University

School of medicine, surgery department

Neurosurgery unit

001. Data collector: code ____/___/___ Name _____

002. Date of data collection ____/___/____ Time _____

003. Checked by supervisor: Signature _____day _____month _____ year____

004. Serial number_____

Section 1: Demographic data		
S.N	***Question item***	***Possible answer***
101	***Age {in days, months or years}***	
102	***Sex***	***A.:Male B.: Female***
103	***Residence***	***A.: Addiss Ababa B.:Out sideAddissAbaba:mention:***
104	***Prior hospitalizing***	***A.:Yes B:No***

Section 2: Clinical presentation		
201	A:Fever	
202	B:Vomiting	
203	C:Convulsion	
204	D:CSF leak	
205	E:Altered consciousness	

Section 3: was there previous surgery performed?		
S.N		
301	A:Yes	B: No

Section 4: If yes in question 3 what type of surgery performed ?		
S.N	Type of surgery	
401	A:MMC repair B:EVD	C:VPS D:Encephalocele repair E: ETV

Section 5: Isolated organism

S.N	Organism	
501	A..K.Pneumoniae	
502	B..Acinobacter	
503	C..E.coli	
504	D.S.pnemoniae	
505	E.PseudomonosAuriginosa	

Section 6: CSF parameters

A:Cell count	
A:0-100cells	C: 500-1000cells
B:100-500cells	D:>1000cells

Section 6: CSF parameters

B:Glucose	
A: Normal	
B:Low	

Section 6: CSF parameters

C:Protein	
A:50-100mg/dl	C: 200-400mg/dl
B:100-200mg/dl	D: >400mg/dl

Section 7: Concomitant infection		
S.N	Type of infection	
601	A.chest focus {Pneumonia}	

602	B.UTI	
603	C:GI focus {AGE} D:none	

Section 8: Type of sensitive antibiotic

S.N	Type of S.antibiotic	
701	A.Amikicin	
702	B.Meropenem	
703	C.Chloramaphenicol	
704	D.Ceftazidine	
705	E.Gentamycin	
706	F.Ceftraxione	

Section 9: How long was taking antibiotic

S.N	How long taking antibiotics		
801	***A:10days***		
802	***B:14days***		
803	***C:21days***		

Section 10: route of antibiotic		
S.N	Route of antibiotic	
901	A.Systemic	
902	B.intrathecal	
903	C.both	

Section 11: What type of surgery performed after antibiotics

S.N	TYPE OF SURGERY	
1001	A.EVD	
1002	B.VPS	
1003	C.MMC repair	
1004	D.Encephalocele repair	

1005	E.V.lavage	
1006	F.Omaya insertion	

Section 12: status of discharge

S.N	***status of discharge***	
1001	A:Improved	C:deteriorated
1002	B:same condition	D:died

After Three months

Section 13: main complaint

S.N	***Main complaint***	
1001	A:ABM	D:no complaint
1002	B:change in behavior	

Section 14: any surgery performed

S.N	***Main complaint***	
1001	A:EVD	D:both
1002	B:Shunt removal	E:No