MAGNITUDE OF SURGICAL SITE INFECTION (SSI) AND ITS ASSOCIATED FACTORS AMONG PEDIATRIC CNS TUMOR PATIENTS AT TERTIARY REFERRAL HOSPITALS IN ETHIOPIA

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Magnitude of Surgical Site Infection (SSI) and its Associated factors Among Pediatric CNS tumor patients at Tertiary Referral Hospitals in Ethiopia

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Contents

List of acronyms

AOR: Adjusted odds ratio

CDC: Center of disease control and prevention

CNS: Central Nerves system

CSF: Cerebrospinal fluid

HAIs: Healthcare-associated infections

LMICs: Low- and middle-income countries

PI: Principal Investigator

SPSS: Statistical Package for Social Sciences version 26

SSI: Surgical site infection

SD: Standard deviation

TASH: Tikur Anbessa Specialized Hospital

WHO: World Health Organization

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Abstract

Background: Surgical site infection SSI is defined as an infection occurring at or near the surgical incision within 30 days of the operation or within one year if an implant is present. The incidence of SSIs in neurosurgical procedures ranges between 1% and 10%. Despite the recognized burden of SSIs in neurosurgery, there is a scarcity of data regarding their prevalence and risk factors among pediatric CNS tumor patients in Ethiopia Addressing SSIs in pediatric neurosurgery is essential for improving surgical outcomes, reducing healthcare costs, and enhancing the quality of life for affected children.

Objective: This study aimed to determine magnitude of Surgical Site Infection (SSI) and its associated factors among pediatric CNS tumor patients at Tertiary Referral Hospitals in Ethiopia

Methods: A retrospective Hospital-based cross-sectional study design was employed. A total of 250 patient records kept in TASH from April 23, 2019 to January 23, 2024. Data were collected by using a checklist through google form and analyzed using SPSS version 27 software package. Mean, and standard deviation were used to describe Continuous data; and frequency and percentage were used to describe categorical data To identify factors associated with the SSI, both bivariable and multivariable binary logistic regression analyses were performed. Statistical significance was set at a 5% level, and adjusted odds ratios (AOR) with 95% confidence intervals (CI) were calculated to present the strength of the associated factors.

Result: The study found that the magnitude of surgical site infection (SSI) in the study population was 51% (95% CI: 44.8-57.5). Several factors were identified as significantly associated with an increased risk of SSI. These included male sex (AOR = 6.4, 95% CI: 2.00 - 20.34), maternal age greater than 35 years (AOR = 3.4, 95% CI: 1.09 - 10.93), severe acute malnutrition (SAM) (AOR = 6.6, 95% CI: 1.39 - 30.99), tumor size greater than 6 cm (AOR = 1.7, 95% CI: 1.08 - 3.65), and being admitted to the Pediatric Intensive Care Unit (PICU) after surgery (AOR = 18.8, 95% CI: 1.08 - 78.28).

Conclusion: The findings suggest that the magnitude of SSI in this study is higher than previously reported in the literature. Key determinants of SSI included male sex, larger tumor size, severe malnutrition, and post-surgical admission to the PICU.

Key words: Magnitude, SSI, pediatrics, Factros TASH, Ethiopia

1. Introduction

1.1. Background

Surgical site infection (SSI) is a post-operative complication that change a patient outcomes, prolongs hospital stays, and increases healthcare costs worldwide (1). SSI is defined as an infection occurring at or near the surgical incision within 30 days of the operation or within one year if an implant is present (2).

Even though there are progress in surgical methods, infection control methods and the use of antimicrobial prophylaxis, it still ranks among the most frequent healthcare-associated infections (HAIs) (3). Among pediatric patients undergoing neurosurgical procedures, SSIs pose a severe threat due to the delicate nature of the central nervous system (CNS) and the potential for catastrophic events such as meningitis, ventriculitis, or abscess formation (4).

Neurosurgical procedures for pediatric CNS tumors are among the most complex and high-risk operations performed in tertiary hospitals. Neurosurgeries typically involve length operative durations, utilization of implants, and extended stays in ICU stay are collectively elevate the incidence of post-operative infections (5).low immune system of pediatric patients further exacerbates their susceptibility to complication , making SSIs a significant cause of increase hospitalization, permanent neurological deficits, or high risk of death in this population. SSIs can cause cerebrospinal fluid (CSF) leaks, brain abscesses, and the need for additional surgical interventions, which leads to increase hospital costs and resource utilization (6). Moreover in resource limited set ups, the impact of SSIs is high, resulting in unfavorable surgical outcomes and a higher incidence of disability infected pediatric patients (7).

Globally, the magnitude of SSIs varies widely depending on factors such as healthcare infrastructure, infection control practices, and patient comorbidities. According to Studies, the prevalence of SSIs during neurosurgical procedures varies from 1 % to 10 % and in low – resource settings, rates might reach to 20 % (8). According to a US study, SSIs account for over 20 % of all HAIs with neurosurgery patients being particularly vulnerable (9). In a European multicenter study, SSI rates after neurosurgery ranged from 3% to 8%, depending on hospital infection control methods (10). In India, a study shows that pediatric neurosurgical patients had an SSI rate of 12%, primarily due to inadequate perioperative prophylaxis (11). In Sub-Saharan Africa, including

Ethiopia, limited access for sterile operation room, inadequate perioperative prophylaxis, and poor postoperative service can elevate SSI (12).

A Brazilian systematic analysis found that the presence of CSF shunts and extended operating times are factors for SSIs, which occurred in 9% of pediatric neurosurgery patients (13). Another study from China, extended hospital stays and poor wound care were major factors for SSIs incidence in pediatric neurosurgery cases (14). Compare to elective neurosurgery procedures, pediatric patients receiving emergency neuosurgerical procedures had a threefold increase in chance of SSIs, according to study done at South Africa (15). Furthermore, research in Egypt identified the improper use of prophylactic antibiotics as a major factor for higher prevalence of SSIs in neurosurgical patients (16).

SSIs are influenced by hospital, surgical and patient related factors. Age, dietary status, coexisting medical problems and immunological suppression bought on by chemotherapy or radiotherapy are patient related factors (17). Surgical factors includes extended operative time, emergency procedures, uses of cerebrospinal fluid (CSF) diversion devices, and sophistication of the surgical techniques (18). Lack of resources for post-operative management such as poor sterilization practices, inappropriate perioperative antibiotic treatment and insufficiency infection control measure are all hospital related problems (19). In pediatric neurosurgery patients around the world the combination of these factors influences the frequency and severity of SSIs.

Ethiopia, like many LMICs, faces significant challenges in healthcare delivery, particularly in tertiary referral hospitals where resource constraints impact surgical outcomes. Post-operative infections can result in serious consequences, such as increased morbidity, mortality and long term neurological impairments and Pediatric CNS tumors malignancies necessitate sophisticated surgical management (20). Despite the growing burden of pediatric CNS tumors in Ethiopia, there is a lack of comprehensive data on the prevalence of SSIs and their associated risk factors in this patient population (21). The absence of reliable data prevents healthcare providers from implementing targeted infection prevention strategies and hinders policymaking aimed at improving surgical care standards.

1.2 Statement of the problem

Surgical site is a major concern in neurosurgery, among pediatric patients undergoing CNS tumor surgeries (1). Extended hospital stays, more surgeries, heightened antibiotic resistance and substantial financial strains on families and healthcare system are all consequences of SSIs in this population (2). Global studies report SSI rates in neurosurgery ranging from 1% to 10%, but data from low-resource settings such as Ethiopia are scarce (3). In high-income countries like the United Kingdom and Germany, rigorous infection control measures have helped reduce SSI rates to below 5% in pediatric neurosurgical procedures (6). However, studies from Latin America have reported SSI rates as high as 15% in pediatric neurosurgery due to inconsistent antibiotic prophylaxis and prolonged surgical durations (7). The burden in Sub-Saharan Africa is expected to be even higher due to suboptimal perioperative infection control, inadequate infrastructure, and limited access to advanced surgical and postoperative care (8).

There are modifiable and non-modifiable factors for the incidence of SSIs. Modifiable factors include inadequate hand hygiene practices, delayed wound closure techniques, improper administration of prophylactic antibiotics, and substandard environmental cleanliness in operating rooms (10). Non-modifiable factors such as patient age, pre-existing comorbidities, and tumor location also play a crucial role in determining SSI risk (11). Understanding these factors is essential for designing effective prevention strategies.

In Ethiopia, tertiary referral hospitals are the main centers for pediatric neurosurgical care, yet infection control measures remain inconsistent, and data on SSI prevalence are limited (5).A major research gap is created by the lack of local epidemiological investigations and the absence of a national surveillance system of SSIs (9). This gap hinders evidence-based decision-making, leaving healthcare providers with limited data to guide SSI prevention strategies (7).

There is no way to overestimate the severity of SSIs in children with CNS tumor patients. Meningitis, ventriculitis, and brain abscesses are among the potentially fatal consequences that can result from infections after neurosurgical treatments and seriously hinder neurological rehabilitation (3). Furthermore, recurrent infections necessitate additional surgical interventions, escalating the risk of permanent disability or death (2).

The prevalence of serious side effects like extended hospital stays, irreversible brain damage, or elevated mortality rates linked to SSIs highlights the urgent need for targeted studies on their scope (1).

Despite the recognized burden of SSIs in neurosurgery, there is a scarcity of data regarding their prevalence and risk factors among pediatric CNS tumor patients in Ethiopia. The epidemiological data from this study will be useful in improving perioperative treatment, informing hospital infection control policy, and adding to the body of knowledge on pediatric neurosurgery infections worldwide.

1.3 Significance of the study

The study will provide crucial data which can guide policies and clinical practices in managing CNS tumor patients. It will help in identifying risk factors, improving surgical protocols, and establishing effective preventive measures, ultimately contributing to better outcomes for pediatric CNS tumor patients. Additionally, it will serve as a valuable baseline for future studies and measures aimed at decreasing SSI incidence, similar health services, helping to enhance the standard of care in Ethiopia and other similar contexts.

2. Literature Review

2.1. Definitions

Surgical Site Infection (SSI) take place after surgery in the body where the surgery took place. SSIs can be categorized into superficial, deep, and organ/space infections based on depth and severity. The Centers for Disease Control and Prevention (CDC) provides standard criteria for defining SSIs, which contain localized edema, erythema, purulent secretion, and systemic symptom of infection such as fever (22). The World Health Organization (WHO) also classifies SSIs and highlights importance of preventive measures like good hand hygiene, aseptic techniques, and antibacterial prophylaxis (23).

Several definitions exist in the literature regarding SSIs. Based on European Centre for Disease Prevention and Control (ECDC), an SSI is an infection manifesting in 30 days of operation (or with one year if an implant is placed) and is classified based on severity and anatomical involvement (24).

2.2 Magnitude of SSI

The magnitude of SSIs varies depending on the type of surgery, patient population, and hospital setting. In pediatric patients undergoing neurosurgical procedures, particularly those with CNS tumors, the risk of SSI can be significant due to prolonged operative times, the need for implants, and underlying immunosuppression (25, 26).

A global review of SSIs in neurosurgery found infection rates ranging from 1% to 10%, with higher rates observed in low-resource settings (27). A study in the United States reported SSI rates in neurosurgery between 2% and 6%, with absolute following to perioperative antiseptic guidelines significantly reducing contamination rates (28). Similarly, research in the United Kingdom indicated SSI rates ranging from 1.5% to 5% in pediatric neurosurgical procedures, depending on surgical complexity and following infection control practices (29).

In middle-income countries, research from Brazil documented SSI of 7% to 12% in pediatric neurosurgery, with an underlying contributors being lengthen hospital stays and insufficient postoperative wound care (25). Studies in India showed a relatively higher burden, with SSI rates reaching up to 14% due to inconsistent antibiotic prophylaxis and insufficient sterility practices (26).

A study in Pakistan, also mentioned SSI of 12.5% among pediatric neurosurgical patients, with a higher occurrence in those undergoing spinal operation. This study highlighted the effect of surgical approach and the role of perioperative antibiotic prophylaxis in reducing infection rates (33).

In sub-Saharan Africa, specifically in Nigeria, reported SSI rates as high as 20% in pediatric neurosurgical procedures, with contributing factors including poor sanitation, prolonged operative times, and a lack of advanced surgical facilities (30). In Ethiopia, limited research has been conducted on SSIs among pediatric CNS tumor patients, but hospital-based studies at Tikur Anbessa Specialized Hospital and Ayder Comprehensive Specialized Hospital indicate a significant burden, with rates estimated between 10% and 18% (31). Factors such as limited availability of prophylaxis antibiotics, insufficient infection preventive strategy, and a shortage of trained healthcare professionals contribute to these high rates.

Further research from Jordan found that SSI rates in pediatric neurosurgery ranged from 5% to 8%, influenced by factors such as surgical complexity and preoperative nutritional status. These findings align with the global trend that resource availability and hospital settings play a significant role in SSI prevalence (34)

Globally, the burden of SSIs in neurosurgical procedures has prompted health service provider to develop strict infection prevention technique. The WHO’s standard on SSIs emphasize evidence-based strategies such as preoperative antisepsis, timely antibiotic prophylaxis, and stringent intraoperative sterile procedures (23). Hospitals in high-income countries such as Germany and Canada have successfully reduced SSI rates through multidisciplinary approaches (32). Ethiopia continue to struggle with high infection rates due to infrastructural and systemic challenges (31).

2.3. Associated factors

Several factors contribute to the development of SSIs, including:

2.3.1 Patient-related factors:

- **Age**: Younger patients, especially neonates and infants, are more susceptible to infections due to immature immune responses (OR = 2.1, study conducted in Nigeria (30). In a study conducted in Australia, neonates undergoing neurosurgery had an elevated risk of SSIs, particularly those with prematurity or low birth weight. (35).

- **Malnutrition**: Poor nutritional status weakens immune function, increasing the risk of postoperative infections (OR = 3.5, study conducted in Ethiopia in 2019) (31). Another study found that malnourished children undergoing neurosurgery had an increased incidence of infections, further emphasizing the importance of addressing nutritional deficiencies in perioperative care (36).

- **Immunosuppression**: Conditions such as congenital immunodeficiencies, chemotherapy, or steroid use can impair wound healing and increase SSI susceptibility (OR = 4.2, study conducted in the United States (28). In a study conducted in Iraq, immunocompromised children undergoing neurosurgical procedures had a significantly higher rate of SSIs compared to non-immunocompromised patients (37).

- **Pre-existing infections**: Patients with concurrent infections, such as respiratory or urinary tract infections, have an increased risk of postoperative wound infections (OR = 2.8, study conducted in the United Kingdom (29). A study in Egypt also highlighted that child with systemic infections had an elevated risk of developing SSIs after neurosurgery, especially those with infections localized to the central nervous system (38).

- **Prolonged hospitalization**: Extended hospital stays expose patients to multidrug-resistant organisms, increasing SSI risk (OR = 3.1, study conducted in Germany by Wurtz et al., 2012) (32). Similarly, a study in Canada demonstrated that prolonged hospitalizations significantly correlate with an increased rate of SSI development in pediatric neurosurgical patients (39).

2.3.2 Surgical factors:

- **Duration of surgery**: Longer operative times are associated with a higher risk of bacterial contamination and subsequent SSIs (OR = 3.9, study conducted in Ethiopia (31). In a study conducted in China, longer surgeries were significantly correlated with higher infection rates, particularly for spinal and cranial procedures (40).
- **Intraoperative contamination**: Breaks in sterile technique, improper handling of surgical instruments, and contaminated surgical environments contribute to infections (OR = 4.5, study conducted in Nigeria (30). A study by in Brazil found that breaches in aseptic techniques were among the leading causes of SSIs, particularly in pediatric spinal surgeries (41).
- **Presence of foreign implants**: The use of shunts, catheters, or other implants in neurosurgical procedures increases the likelihood of biofilm formation, making infections more difficult to treat (OR = 5.2, study conducted in the United States (28). Another study also demonstrated that pediatric neurosurgical patients with implanted devices had a significantly higher risk of developing SSIs, with biofilm formation on implants serving as a key contributing factor (42).
- **Type of surgical procedure**: Complex surgeries involving multiple tissue layers or cerebrospinal fluid exposure pose a higher risk for SSIs (OR = 3.7, study conducted in the United Kingdom (29). A study in India highlighted that the complexity of the neurosurgical procedure directly impacted SSI rates, especially in surgeries involving brain or spinal cord tumors (43).

2.3.3 Hospital factors:

- **Sterility protocols**: Adherence to proper hand hygiene, sterilization techniques, and aseptic protocols significantly impacts SSI rates (OR = 2.9, study conducted in Germany (32). Another study in Australia confirmed that hospitals with strict infection control protocols had significantly lower SSI rates, underscoring the importance of institutional commitment to infection prevention (44).

- **Antibiotic prophylaxis adherence**: Timely administration of appropriate antibiotics before surgery can reduce the risk of SSIs, but compliance is often inconsistent in resource-limited settings (OR = 4.1, study conducted in Ethiopia (31). A study conducted in Taiwan showed that patients receiving adequate perioperative antibiotic prophylaxis had reduced infection rates compared to those who did not receive it (45) .
- **Postoperative wound care**: Proper postoperative management, including regular dressing changes and wound monitoring, is crucial for preventing SSIs (OR = 3.3, study conducted in Nigeria (30). Another study found that patients who received close postoperative monitoring and wound care had lower SSI rates, highlighting the importance of vigilant post-surgical care (34).
- **Availability of infection control resources**: Limited access to sterile surgical supplies, antibiotics, and well-trained infection control personnel can exacerbate the SSI burden (OR = 5.0, study conducted in Ethiopia (31). Similarly, studies from Kenya (46) and Nigeria (30) have indicated that a lack of infection control resources in hospitals is a major contributing factor to high SSI rates.

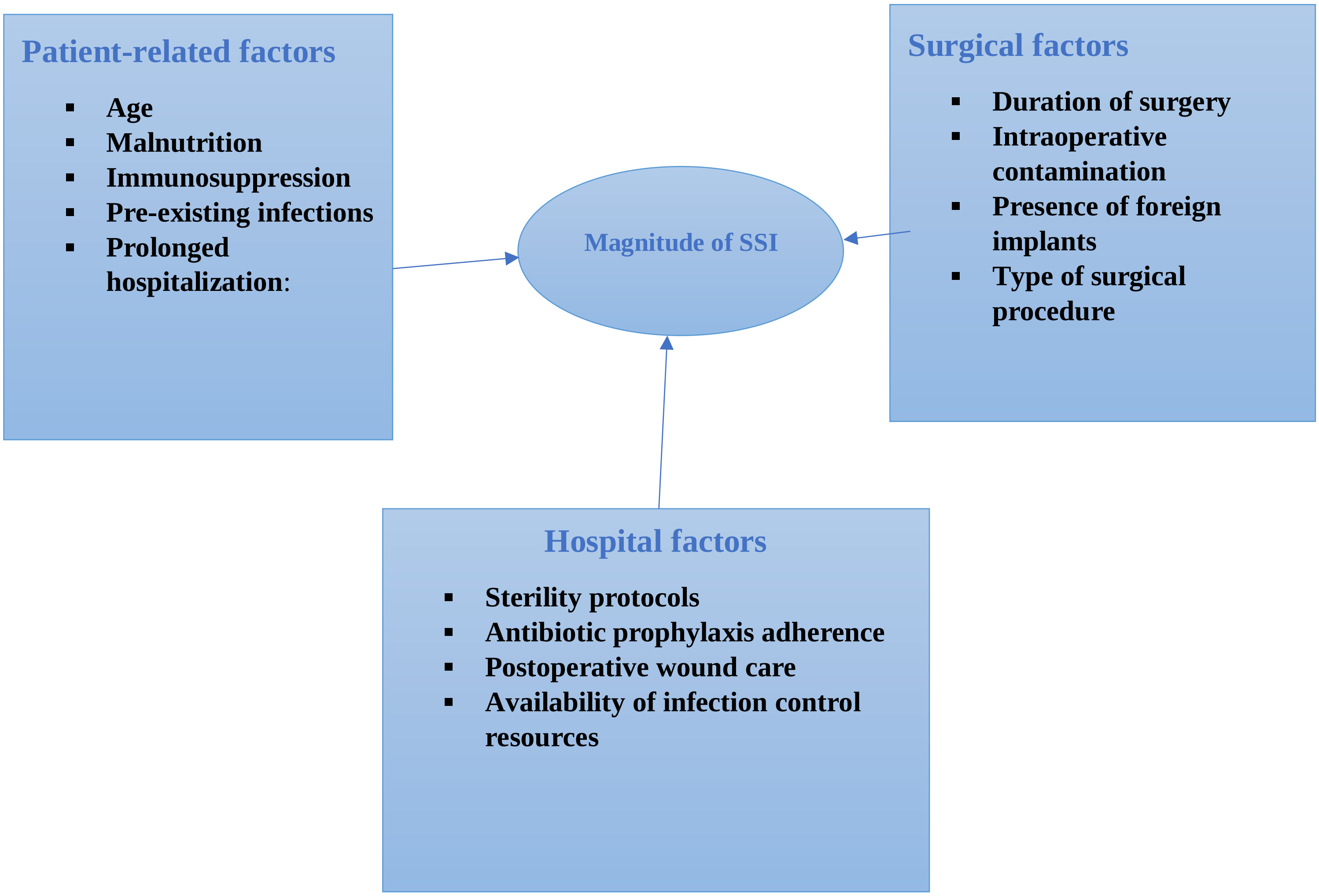

Fig 1: - A conceptual framework derived from the reviewed literature.

3. Objective

3.1. General objective

- To determine magnitude of Surgical Site Infection (SSI) and its associated factors among pediatric CNS tumor patients at Tertiary Referral Hospitals in Ethiopia

3.2. Specific objectives

- To determine the Magnitude of Surgical Site Infection (SSI)
- To identify factors affecting surgical site infection

4. Method and Materials

4.1. Study area and period

The study was carried out at Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital from September 1 to 30, 2024.

Tikur Anbessa Specialized Hospital is the biggest tertiary treatment center in Ethiopia. Administered by Addis Ababa University, it is the oldest academic medical center in the country, training approximately 300 medical students and 350 residents each year. The hospital diagnoses and treats around 400,000 patients annually and has a capacity of 800 beds, employing 130 specialists and 50 non-teaching doctors.

Zewditu Memorial Hospital, also located in Addis Ababa and developed in 1976, is managed by the Ministry of Health (MOH). It holds the largest ART clinic in country, currently caring for 14,000 patients. In addition it offers a wide range of endure , including supportive care, HIV counseling, testing, STI services, and expert care for conditions such as spina bifida and hydrocephalus through its Centers of Excellence program. The hospital employs a total of 1,176 healthcare professionals.

4.2. Study design

- ❖ A Hospital based retrospective cross-sectional study was carried out.

4.3. Population

4.3.1. Source population

- ❖ All pediatric patients who had surgery for CNS tumor Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital

4.3.2. Study population

- ❖ All pediatric patients who had surgery for CNS tumor Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital From September 1, 2018, to September 1, 2024

4.4. Eligibility

4.4.1 Inclusion

- All children <15 years and who had an intervention for CNS tumor at TASH and Zewditu during the study period.

4.4.2 Exclusion criteria

- Those who have been operating outside TASH and Zewditu
- Patient who had an infection before the surgery
- Incomplete data

4.5. Sample size determination

4.5.1. Sample size determination

The sample size was determined using a single population proportion formula, with a confidence level of 95%, a marginal error of 5%, and a proportion of 50% was used.

$$\text{Sample size: } N=\frac{Z^2P\ (1-P)}{d^2} = \frac{(1.96)^2*0.5*(1-0.5)}{(0.05)^2} = 384$$

Where: N= the minimum sample size

p=the expected prevalence of SSI 50 % (was used since no comparable research could be located. Within the comparable)

d= the level of precision (margin of error)

z= the value at 95% confidence level

The total study population is below 10,000, We used the following correction formula for the sample size determination:

$S = n/ (1 + n/N)$

n = sample size for population size

N = number of nurses in hospital

The final sample size calculated using the above formula and adding non-response rate of 10% becomes 279

4.6 Data Collection Tool and Procedures

Once the study cases were selected, a Structured Checklist assessment tool was employed to gather a range of information. This included not only socio-demographic data showcasing the diverse backgrounds of the participants but also clinical characteristics that painted a clearer picture of their health status and potential influencing factors affecting the study's outcomes.

The principal investigator embarked on an extensive journey of data collection, delving into the intricate details of medical charts to extract relevant information. To streamline this process, a user-friendly Google Form was created to facilitate the gathering of data. The information collected was then securely stored on the Gmail server, ensuring it would remain organized and accessible for future analysis.

4.7 Data Quality control and management

To guarantee the utmost quality of our data, we employed Google Forms as our primary tool. Each question was meticulously crafted and coded to capture precise responses. Throughout the data gathering process, the principal investigator conducted thorough daily checks to ensure all collected data was complete and consistent of making every effort to achieve precision.

4.8. Variables

4.8.1 Outcome variable

- Magnitude of SSI

4.8.2 Explanatory variables

- Sociodemographic
- Anthropometry
- Type of brain tumor
- Size of the tumor
- Types of surgery
- Types of resections
- Time of surgery
- Place of admission after surgery

4.9. Operational Definition

- **Surgical site infection SSI** : happens at or near the surgical incision within 30 days of the operation or within one year if an implant is present
- **Delay post operation treatment** not being received chemotherapy or radiation after surgery in 4 weeks (30 days)
- **Subtotal resection** -removal of large portion of the tumor but a noticeable amount remains
- **Gross total resection**-removal of the entire visible tumor mass
- **Near total resection** - removal of more than 95 % of the tumor
- **Partial resection** – removal of 50 % of the tumor
- **Biopsy** -a operation that removes tissue or cells from the body for examination

4.10. Data processing and Analysis

After data collection with google form, each completed form was checked for completeness and exported to SPSS version 26 for analysis. Continuous data were summarized using average and standard deviation .whereas categorical data were represented by counts and proportions. Finally, the results were presented though text, table, and charts.

4.11. Ethical consideration

Ethical clearance was obtained from the Department of Research and Ethical Review Committee (DRERC). Then an official letter of support and ethical clearance was submitted to the Record office of Black lion Hospital and Zewditu Memorial Hospital. Confidentiality was maintained at all levels of the study, besides only the MRN number of study participants were used without mentioning the name and the collected information was kept in a secured place.

4.12. Dissemination and utilization of results

The finding of this research will be submitted to Addis Ababa university health science and medical college,departement of pediatrics and child health and will be presented during the final defense for partial fulfillment of speciality. The finding of the study will also be shared other concerned bodies. Subsequently an attempt will be made to present the findings on different review meetings, seminars, and workshops Furthermore, the manuscript will be published on peer reviewed journals.

5 Result

5.1 Sociodemographic characteristics of the study participant

A total of 250 patients were included in the study and majority of the participants were in the age group of 5-9 years, and 54.7% were female with a female to male ratio of 1.2:1. Two-thirds of the patients; 66.8% (n=167) were from outside Addis Ababa, and about 65.6% of the care given mothers were under 35 years old. About 32.4% and 18.8% of the patients had moderate and severe acute malnutrition respectively.

Table 1, The sociodemographic characteristics of the study participants among Pediatric CNS Tumor Patients at Tertiary Referral Hospitals in Ethiopia, 2025.

Variable	**Category**	**frequency**	**Percent**
Age of the children	<1	11	4.4
	1-4	73	29.2
	5-9	84	33.6
	10-15	82	32.8
Sex of the study participants	Male	113	45.2
	Female	137	54.8
Address	Addis Ababa	83	33.2
	Out of Addis Ababa	167	66.8
Residency	Urban	153	61.2
	Rural	97	38.8
Maternal age	<35	164	65.6
	>=35	86	34.4

5.2 Magnitude of SSI

The Magnitude of Surgical Site infection (SSI) in the study population was found to be 51% (95% CI: 95% CI: 44.8- 57.5). Surgical site infections accounted for 87.1% of all postoperative complications and 92.1% of all infectious complications.

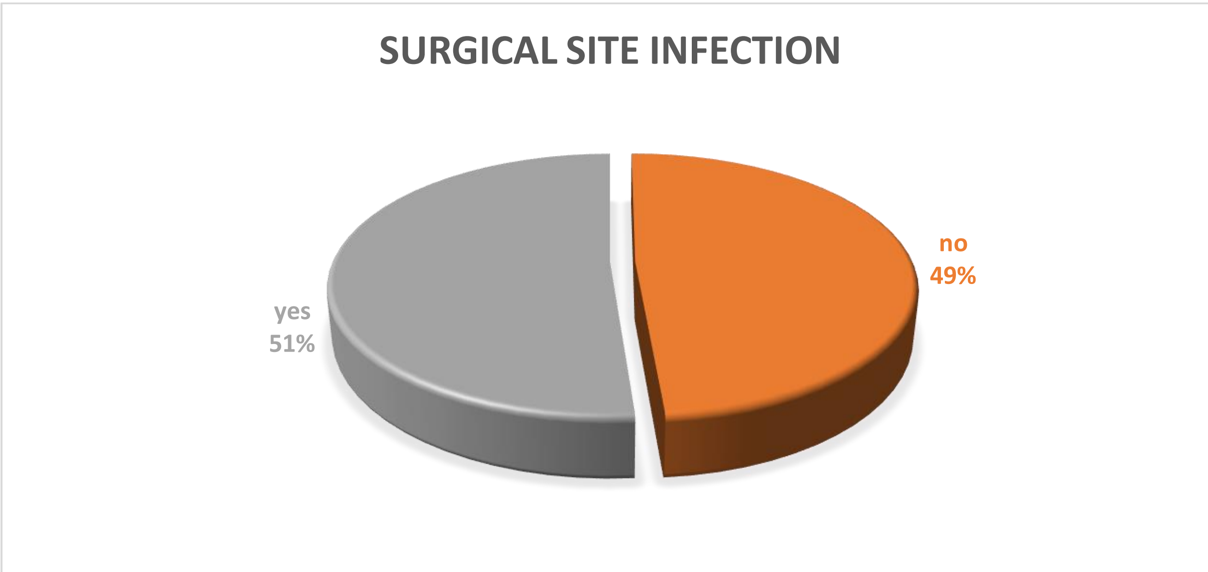

Figure 2.The Magnitude of the surgical site infection.

Among those who developed surgical site infections, 60.9% were readmitted, and 79.7% had deep infections. Nine percent of the study participants had Staphylococcus aureus, and 7.1% of them were sensitive to treatment. Forty-four percent of the study participants were treated with both Vancomycin and Ceftriaxone.

Table 2. Surgical site infection related characteristics of the study participants

Variable	Category	frequency	Percent
Infection type	Deep	102	79.7
	Superficial	26	20.3
Infective organism	k. pneumonia	13	10.1
	Cons	15	11.7
	Staphylococci aures	11	8.6
	No organism	81	63.3
	Unknown	8	6.3
Sensitivity	Cefepime	3	2.3
	Ceftriaxone	5	3.9
	Meropenem	6	4.7
	Vancomycin	9	7.1
	Not done	105	82
Infection type **Infective organism**	Ceftriaxone and vancomycin	77	60.1
	Cefepime and vancomycin	30	23.4
	Meropenem and vancomycin	15	11.7
	Meropenem and amikacin	6	4.5
Delay in postresection management because of surgical complication	Yes	57	79.7
	No	71	20.3
duration of delay treatment in day (n=128)	<30	26	66.2
	>30	102	60.1
Chemotherapy received	Yes	63	49.2
	No	65	50.8
Time of chemotherapy(n=63)	After one month	46	74.6
	With in one month	17	25.4
Radiation ray	Yes	28	24.8
	No	85	75.2
Time of radiotherapy (n=28)	After one month	28	100

5.3 Nutritional status of the study participants

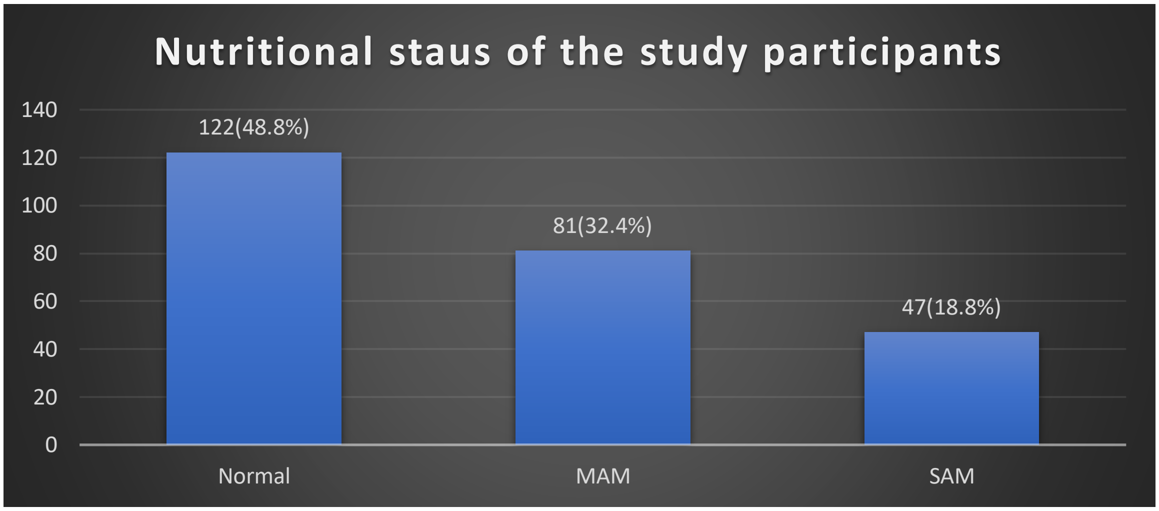

Figure 3. Nutritional status of the study participants

5.4 Disease related characteristics of the study participants

Forty percent (n=101) of the patients had a duration of 1–3 months from the onset of symptoms to diagnosis. Forty percent of the participants had tumors located in the fourth ventricle, and 7.1% of the tumors were metastasized, with 83.3% of those metastasized tumors located in the brain. Almost fifty-six percent of the tumors measured 3-6 cm in their largest diameter. Seventy-seven percent of the patients (n=192) had hydrocephalus, and 75.2% underwent a CSF diversion procedure. Forty-one percent of the participants had a hemoglobin level of less than 12 mg/dL prior to surgery.

Table 3. Disease related characteristics of the study participants

Variable	Category	Frequency	Percent
Duration between onset of symptoms and diagnosis in month	<1	56	22.4
	1-3	101	40.4
	3-6	40	16
	>6	53	21.2
Site of tumor	Fourth ventricle	100	40
	cerebellum	66	26.4
	Seller/suprasellar	38	15.2
	Cerebral	29	11.6
	Brain stem	16	6.4
	Penile gland	1	0.4
Metastasis present	Yes	18	7.2
	No	232	92.8
Site of metastasis	brain	15	83.3
	spine	3	16.7
Tumor size in cm (using largest diameter)	<3	58	23.2
	3-6	139	55.6
	>6	53	21.2
hydrocephalus	Yes	192	76.8
	No	58	23.2
CSF diversion procedure	Yes	188	75.2
	No	62	24.8
Types of CSF diversion procedure (n=188)	ETV	19	10.1
	EVD	7	3.7
	VP shunt	162	86.2
Pre-surgery hemoglobin	<12	102	40.8
	≥12	148	59.2

5.5 Management related characteristics of the disease

Half of patients waited less than 15 days for surgery after the decision was made by MDT, and 76% underwent elective surgery. Eighty-eight percent of the surgeries were craniotomies, with 52.4% of the procedures site were supratentorial and 60.4% being gross total resections and 41.6% of the tumor were in the fourth stage.

Table 4. Management related characteristics of the disease

Variable	**Category**	**frequency**	**Percent**
Duration of waiting form admission to surgery in days after MDT decision	<2weeks	126	50.4
	2-4weeks	98	39.2
	>4weeks	26	10.4
Duration of waiting after AMDT for admission	<1week	71	28.4
	1-4week	32	12.8
	>4weeks	147	58.8
Timing of surgery	Emergency	60	24
	Elective	190	76
Types of surgery	Craniectomy	30	12
	Craniotomy	220	88
Site of procedure	Infratentorial	119	47.6
	Supratentorial	131	52.4
Types of resections	Gross total resection	151	60.4
	Near total resection	43	17.2
	biopsy	27	10.8
	Subtotal resection	22	8.8
	Partial resection	7	2.8
Grade of tumor	Stage I	37	14.8
	Stage II	56	22.4
	Stage III	53	21.2
	Stage IV	104	41.6

5.6 The pathological type of the tumor

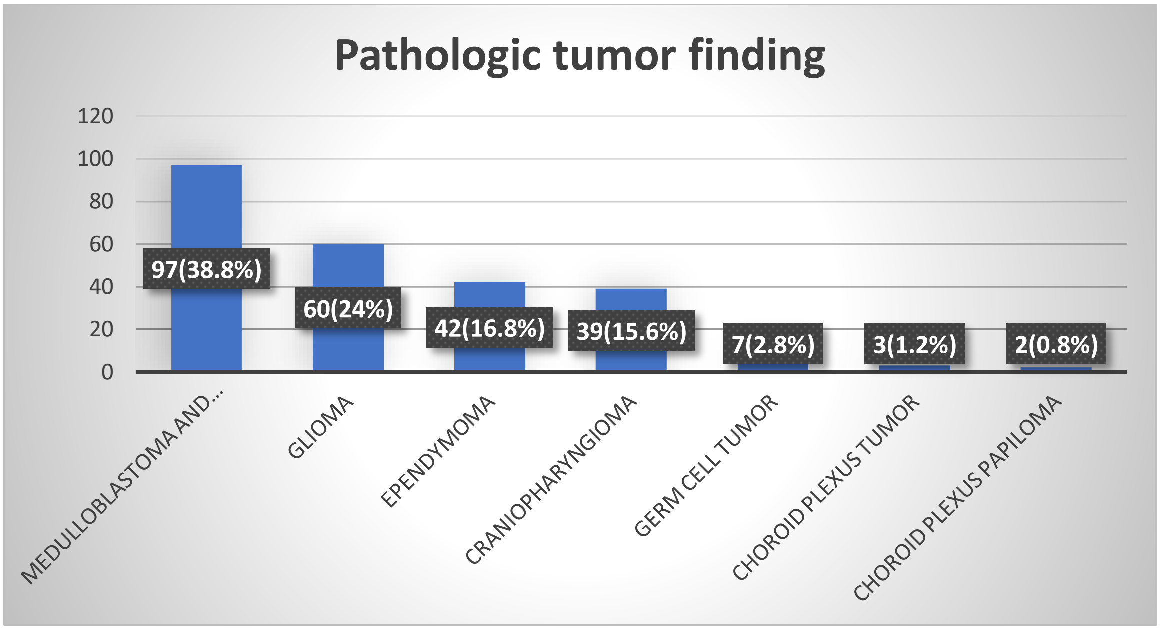

Figure 4. The pathological type of the tumor

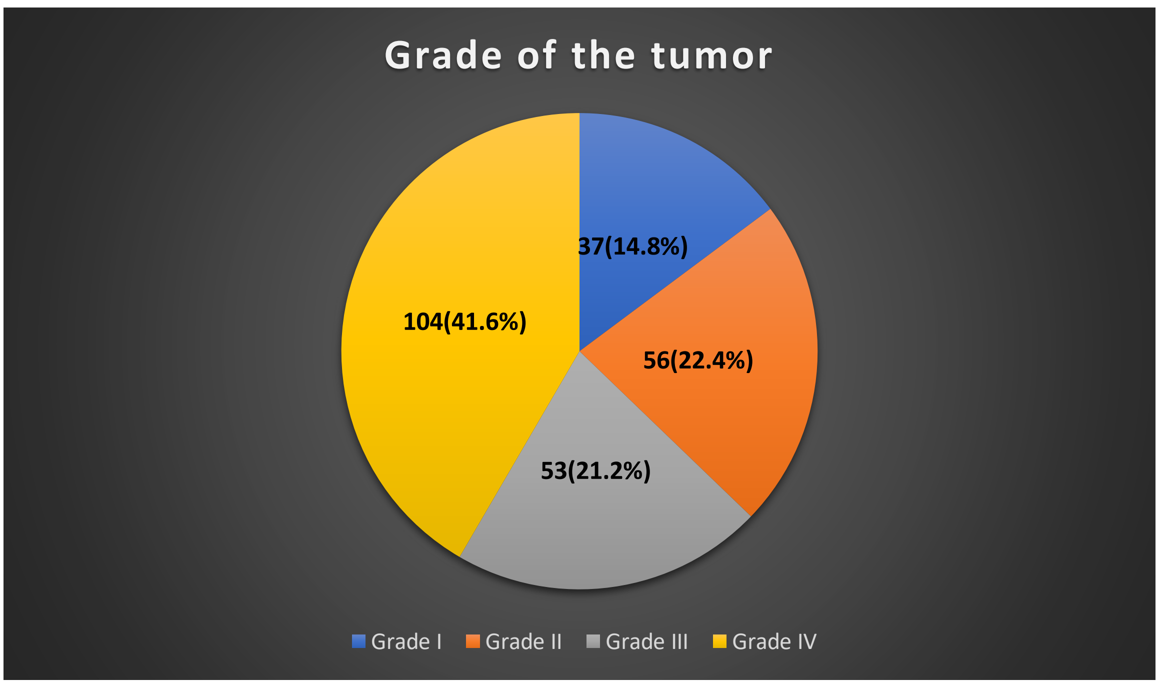

Figure 5 Grade of Tumor

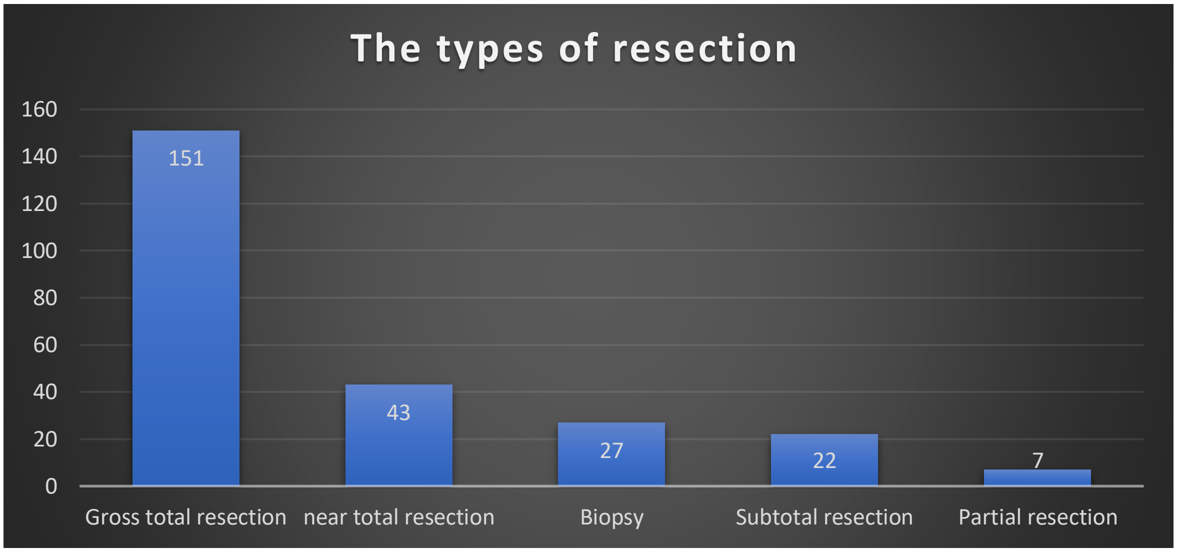

Figure 5 Types of resections

5.7 Postoperative related characteristics of the study participants

Forty-four percent (n=109) of the participants were transferred to the PICU after surgery, and among those, 36.7% waited in the PICU for 24-48 hours. Sixty-four percent (n=161) of the patients developed complications, with 84.5% of those being infectious complications, followed by neurological complications. Most (90.4%) of the participants received prophylactic treatment. The mean duration of stay in the hospital before surgery and after surgery 19.03 and 24.82 days respectively.

Table 5. Postoperative management related characteristics of the study participants

Variable	**category**	**Frequency**	**Percent**
Duration of waiting for surgery in the hospital	<1weeks	65	26
	1-4weeks	41	16.4
	>4weeks	144	57.6
Transfer unit after surgery	PICU	109	43.6
	Ward	141	56.4
If transfer in PICU length of stay in hrs.	<24	35	32.1
	24-48	40	36.7
	>48	34	31.2
Post surgical complication	Yes	161	64.4
	No	89	35.6
Types of complication (n=161)	infection	136	84.5
	neurological	21	13
	endocrinological	4	2.5
Prophylactic antibiotic	Yes	226	90.4
	No	24	9.6

5.8 The determinant factors of surgical site infection

In this study, residency, duration between symptom and diagnosis in month, metastasis, types of surgery, site of the procedure and child transferred unit were associated with surgical site infections (SSI). The multivariate logistic regression found that the odds of SSI were 14.9 times higher in rural compared to urban (AOR=14.9, 95% CI=2.37, 95.01). The odds of SSI were 4.8 and 13.4 times higher in participants MAM and SAM compared to normal nutritional status (AOR=4.8, 95% CI=1.02, 22.99 &AOR=13.4, 95%CI=2.52, 44.23). The odds of SSI were 2.9 times higher in participants metastasis cancer compared to non-metastasis (AOR=2.9, 95% CI=1.19, 46.12). The odds of SSI were 7.2 times higher in participants with tumor size >6 cm compared to those with tumor size <3 cm (AOR=7.2, 95% CI=2.97, 77.76). Participants who were admitted to the PICU after surgery had 4.6 times higher odds of developing SSI compared to those transferred to the ward (AOR=18.8, 95% CI=1.74, 19.24) and the odds waiting in the PICU more than 48 hours were 4.3 times increase its SSI compared to those of waiting <24 hours (AOR=4.6, 95%CI=1.74, 19.24).

Table 6. The bivariate and multivariate association between SSI and independent variable among Pediatric CNS Tumor Patients at Tertiary Referral Hospitals in Ethiopia, 2025.

variable	**SSI**		**P-value**	**COR with 95%CI**	**P-value**	**AOR with 95%CI**
	Yes	No				
Age in years						
<1	3	8	0.069	0.29(0.07, 1.10)	0.894	0.80(0.03, 21.26)
1-4	36	37	0.947	1.0(0.54, 1.92)	0.778	1.3(0.20, 8.36)
5-9	49	35	0.217	1.5(0.79, 2.71)	0.690	1.5(0.21, 10.58)
10-15	40	42	1		1	
Residency						
Urban	66	87	1		1	
rural	62	35	0.001	2.4(1.43, 4.07)	0.004	**14.9(2.37, 95.01)**
Nutritional status						
Normal	40	82	1		1	
MAM	52	29	0.108	0.45(0.17, 1.19)	0.047	**4.8(1.02, 22.99)**
SAM	36	11	0.092	2.3(0.87, 6.01)	0.008	**13.4(2.52, 44.23)**
Duration between symptom and diagnosis in month						
<1	22	34	1		1	
1-3	51	50	0.107	1.7(0.89, 3.31)	0.215	3.5(0.48, 25.13)
3-6	26	14	0.008	3.1(1.35, 7.21)	0.696	1.7(0.13, 20.65)
>6	29	24	0.066	2.0(0.96, 4.33)	0.497	2.4(0.19, 30.74)
Metastasis						
Yes	15	3	0.000	5.5(2.44, 12.43)	0.039	**2.9(1.19, 46.12)**
no	113	119	1			
Tumor size in cm						
<3	28	30	1		1	
3-6	68	71	0.694	1.1(0.62, 2.06)	0.217	3.6(0.47, 27.32)
>6	32	21	0.124	1.8(0.85, 3.79)	0.009	**7.2(2.97, 77.76)**
Duration of waiting form decision to surgery in days						
<15	71	55	1		1	
15-30	40	58	0.034	0.56(0.33, 0.96)	0.115	0.47(0.14, 8.32)
>30	17	9	0.334	1.5(0.64, 3.72)	0.324	0.13(0.01, 2.35)
Types of surgery						
Craniectomy	6	24	1		1	
craniotomy	122	98	0.001	4.9(1.96, 12.66)	0.095	4.8(0.51, 45.79)
Site of the procedure						
Infratentorial	68	51	0.074	1.6(0.96, 2.60)	0.085	5.1(0.79, 33.68)
supratentorial	60	71	1		1	
After surgery child transferred unit						
PICU	77	33	0.000	3.9(2.29, 6.58)	0.024	**4.6(1.74, 19.24)**
Ward	51	90	1		1	
PACU waiting duration in days						
≤24	25	10	1		1	
24-48	23	17	0.212	0.54(0.21, 1.42)	0.575	0.58(0.08, 3.95)
>48	29	5	0.169	2.3(0.69, 7.69)	0.012	**4.3(2.31, 83.01)**

5.9 Outcome of related characteristics of the study participants

The study found that 16% of the participants died on the time of from surgical procedure up to the first follow up.

Figure 6. Final patient status during the follow-up period

5.10 Status of the patient in the first year of follow up

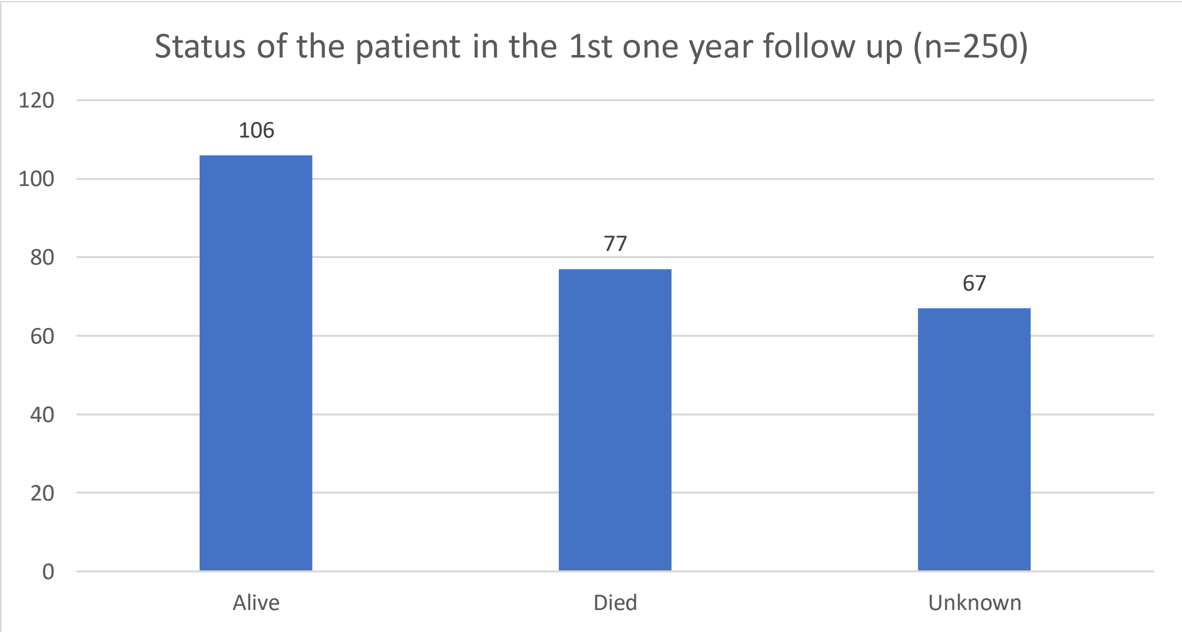

Figure 7 status of the Patient in the 1st one year follow up

6. Discussion

The study was five-year retrospective cross-sectional study conducted in Tikur Anbessa Specialized Hospital and Zewditu Memorial Hospital from September 1 to 30, 2024.

In this study, the magnitude of surgical site infection (SSI) in the study population was found to be 51% (95% CI: 44.8-57.5). This rate is notably high compared to global figures for pediatric neurosurgery, which typically range from 1% to 10% in high-resource settings (United States, UK, Germany) (28, 29). However, the high rate is consistent with studies conducted in low-resource settings such as Ethiopia, Brazil, India, and Nigeria, where SSI rates in pediatric neurosurgery have been reported to range from 7% to 20% due to factors like inadequate infection control, longer hospital stays, and poor nutritional support (30, 31). The higher SSI rate in this study may be attributed to similar infrastructural and systemic challenges in the healthcare environment, including limited access to antibiotics, improper wound care, and compromised hygiene practices.

Male Sex (AOR = 6.4, 95% CI: 2.00 - 20.34), The high odds ratio for male sex (AOR = 6.4) aligns with findings in other studies, which have identified males as being at higher risk for SSIs in pediatric neurosurgery (28, 29). This may be due to biological factors, such as differences in immune function or hormonal influences, such as testosterone, which could contribute to a heightened susceptibility to infections. Furthermore, males often undergo more complex neurosurgical procedures, which could increase their exposure to infection. The increased risk in males could be due to both biological factors and the higher likelihood of undergoing complex surgeries, both of which make males more vulnerable to SSIs (28, 29).

Maternal Age Greater Than 35 Years (AOR = 3.4, 95% CI: 1.09 - 10.93), While the association between maternal age and SSI risk is not frequently highlighted in neurosurgical literature, advanced maternal age is linked to higher rates of neonatal complications, such as low birth weight and premature birth, both of which may increase the risk of infection after surgery (35). The risk of malnutrition or compromised immunity in children born to older mothers could further contribute to a higher risk of developing SSIs.

Maternal age may indirectly impact SSI risk by contributing to conditions like low birth weight or other complications that impair the child’s immune function, thus increasing vulnerability to infections (35).

Severe Acute Malnutrition (SAM) (AOR = 6.6, 95% CI: 1.39 - 30.99), SAM was strongly associated with SSIs in this study, with an AOR of 6.6. This finding aligns with literature that consistently identifies malnutrition as a significant risk factor for SSIs in pediatric neurosurgery. Malnutrition compromises immune function, delays wound healing, and makes patients more susceptible to infections (31, 36). Studies from various settings, including Ethiopia and Nigeria, have similarly found high SSI rates in malnourished children, emphasizing the need for nutritional support as part of the perioperative care (31, 36).

SAM weakens the immune system, impairs wound healing, and increases the likelihood of postoperative infections, contributing significantly to the high SSI rate in this study (31, 36).

Tumor Size Greater Than 6 cm (AOR = 1.7, 95% CI: 1.08 - 3.65)**,** The association between larger tumor size and increased SSI risk is consistent with findings in the literature. Larger tumors typically require more complex and prolonged surgeries, which can increase the risk of infection. Studies have demonstrated that longer operative times and more invasive procedures are directly correlated with higher SSI rates, particularly in surgeries involving large brain or spinal tumors (29, 43). This is in line with the finding in this study that tumor size greater than 6 cm significantly increased the risk of SSI.

Larger tumors require more complex and invasive surgeries, which increase the risk of surgical complications, including infections (29, 43).

Admission to Pediatric Intensive Care Unit (PICU) After Surgery (AOR = 18.8, 95% CI: 1.08 - 78.28). The strong association between PICU admission and increased SSI risk (AOR = 18.8) is well-supported by the literature. Studies in both high- and low-resource settings have found that patients who require intensive care are at a higher risk of infections due to their critical condition, prolonged hospital stays, and often complex surgeries (40). PICU patients are generally those with more severe or complicated postoperative courses, which increases their exposure to infection and complicates recovery.

Admission to the PICU often indicates a more complex or prolonged recovery, which places patients at higher risk for infections due to factors like prolonged hospitalization and closer monitoring (40).

7. Strength and Limitations of the study

Limitation

- ❖ Due to incomplete registration of patient information and data management system in the study hospitals, some variables that were not included under the study
- ❖ Finance.
- ❖ The nature of study is retrospective

Strength

- ❖ Large sample size on pediatric CNS tumor and broad age range.
- ❖ The first study to be conducted in our siting

8. Conclusion

The high SSI rate in this study (51%) in line with elevated infection documented in similar settings with limited resources. Factors such as male sex, severe acute malnutrition, large tumor size, maternal age, and PICU admission are well-documented in the studies as key determinant of SSIs. These factors contribute to the increased vulnerability of pediatric neurosurgical patients, especially in resource-limited settings where access to antibiotics, proper wound care, and optimal perioperative management may be constrained.

9. Recommendations

These findings underscore the need for targeted interventions to improve patient care, such as enhancing nutritional support, optimizing surgical protocols, and improving infection control measures to reduce the incidence of SSIs. Based on the findings of the study, the following recommendations are forwarded

For Parents:

- ❖ Parents should receive counseling on the importance of nutritional rehabilitation for malnourished children, emphasizing its role in recovery, immunity, and overall well-being.
- ❖ Educate parents on proper post-hospitalization care to prevent infections and support long-term health.

For Healthcare Providers:

- ❖ Implement Severe Acute Malnutrition (SAM) rehabilitation for hospitalized children under the supervision of the pediatric and child health department to improve treatment outcomes.
- ❖ Enforce strict aseptic techniques among surgeons and nurses to minimize the risk of surgical site infections (SSI) and other hospital-acquired infections.
- ❖ Apply and monitor adherence to the WHO Infection Prevention and Control (IPC) protocol to ensure a safe hospital environment and reduce infection rates.

For Researchers:

- ❖ Conduct a large-scale prospective study to determine the incidence, risk factors, and outcomes of surgical site infections (SSI) in pediatric brain tumor patients.
- ❖ Explore the effectiveness of various infection prevention strategies and their impact on reducing SSI in pediatric neurosurgical patients.
- ❖ Investigate nutritional status as a potential risk factor for SSI in pediatric brain tumor cases.

10. Reference

1. World Health Organization. Global guidelines for the prevention of surgical site infection. Geneva: WHO; 2016.

2. Mangram AJ, Horan TC, Pearson ML, et al. Guideline for prevention of surgical site infection. Infect Control Hosp Epidemiol. 1999;20(4):247-78.

3. Mertz D, Faucheux S, Givens N, et al. Risk factors for surgical site infections in pediatric neurosurgery. Neurosurgery. 2018;82(4):574-580.

4. Mehta SS, Reddy GS, Goel A. Surgical site infections in pediatric neurosurgery: A retrospective study. J Neurosurg Pediatr. 2015;16(2):245-250.

5. Sharma S, Ghai B, Sabharwal R, et al. Prolonged hospital stay and surgical site infections in pediatric neurosurgical cases. Indian J Surg. 2020;82(2):345-350.

6. Liu J, Zhang J, Xie J, et al. Risk factors for surgical site infections in pediatric neurosurgery. Pediatr Infect Dis J. 2017;36(6):508-512.

7. Akinmoladun VI, Oyeneyin K, Akinloye O, et al. Risk factors for surgical site infections in pediatric neurosurgery: A study in Sub-Saharan Africa. Childs Nerv Syst. 2019;35(11):1965-1971.

8. Gosselin RA, Marsden K, Blakeley L, et al. Surgical site infections in pediatric neurosurgery in resource-limited settings. World Neurosurg. 2016;90:55-60.

9. Cavanagh SJ, Pilgram TK, Yu Z, et al. Prevalence of surgical site infections in pediatric neurosurgical procedures in the United States. Pediatr Infect Dis J. 2019;38(6):571-576.

10. Merrer J, Dap L, Desmonts JM, et al. Surgical site infections in neurosurgery: A multicenter study. J Neurosurg. 2014;120(2):375-380.

11. Sinha S, Puri A, Bansal A, et al. Prevalence and risk factors for surgical site infections in pediatric neurosurgical patients. Neurol India. 2013;61(2):137-142.

12. Tsegaye H, Mulugeta G, Desta K, et al. Surgical site infections in pediatric neurosurgical patients in Ethiopia. Ethiopian Med J. 2020;58(4):435-441.

13. Lima AA, Diniz ME, Almeida AF, et al. Risk factors for surgical site infection in pediatric neurosurgery: A systematic review. Braz J Infect Dis. 2019;23(6):435-440.

14. Wang H, Zhou X, Zhang Y, et al. Factors influencing surgical site infection in pediatric neurosurgery in China. J Pediatr Surg. 2018;53(8):1555-1560.

15. Goulder F, Lowry J, Ho S, et al. Emergency pediatric neurosurgery and risk factors for surgical site infections in South Africa. World Neurosurg. 2018;116:e287-e294.

16. Abd El Rahman H, El-Shehaby AM. Factors contributing to surgical site infections in pediatric neurosurgical patients: A study from Egypt. J Infect Public Health. 2020;13(5):764-770.

17. Jeong HS, Lee HJ, Han YJ, et al. Risk factors for surgical site infections in pediatric neurosurgery: A multi-center study. J Korean Neurosurg Soc. 2017;60(2):155-160.

18. Seifi A, Vahidi E, Nasiri S, et al. Factors influencing surgical site infections in pediatric neurosurgical procedures. J Pediatr Neurosci. 2016;11(3):213-218.

19. Hennequin A, Ravel S, Lafargue C, et al. Surgical site infections in pediatric neurosurgery: Role of infection control measures and surgical environment. J Neurosurg Pediatr. 2021;28(3):245-253.

20. Tefera M, Abdu A, Negash M, et al. Pediatric CNS tumors and surgical outcomes in Ethiopia. East Afr Med J. 2018;95(9):345-351.

21. Zewdie S, Asfaw A, Fentahun N, et al. Surgical complications in pediatric neurosurgical cases at a referral hospital in Addis Ababa, Ethiopia. BMC Health Serv Res. 2019;19(1):351.

22. Centers for Disease Control and Prevention (CDC). Surgical site infections (SSIs) [Internet]. Atlanta: CDC; 2017 [cited 2025 Mar 20]. Available from: https://www.cdc.gov/infectioncontrol/guidelines/ssi/index.html

23. World Health Organization (WHO). WHO guidelines for the prevention of surgical site infections. Geneva: World Health Organization; 2016.

24. European Centre for Disease Prevention and Control (ECDC). Surveillance of surgical site infections in Europe 2013. Stockholm: ECDC; 2014.

25. Silva CA, de Almeida SM, Freitas C, et al. Surgical site infections in pediatric neurosurgery in Brazil. J Neurosurg Pediatr. 2017;19(2):147-53.

26. Chakraborty A, Garg R, Yadav P, et al. A study of surgical site infections in pediatric neurosurgery in India. J Infect Public Health. 2018;11(2):263-8.

27. Allegranzi B, Bischoff P, de Jonge S, et al. New WHO recommendations on preoperative antisepsis. Lancet Infect Dis. 2011;11(8):533–9.

28. Anderson DJ, Podgorny K, Berríos-Torres SI, et al. Strategies to prevent surgical site infections in acute care settings: 2014 update. Infect Control Hosp Epidemiol. 2014;35(6):605-27.

29. Astagneau P, Caillet C, Ravaud P, et al. Surgical site infections in children: a retrospective study in the UK. J Hosp Infect. 2013;83(2):124-7.

30. Adeolu O, Olayinka A, Taiwo A, et al. A prospective study of surgical site infections in pediatric neurosurgery in Nigeria. Afr J Med Med Sci. 2015;44(4):381-5.

31. Tadesse T, Assefa Y, Nega A, et al. Surgical site infections in pediatric CNS tumor patients in Ethiopia: a hospital-based study. J Infect Dev Ctries. 2019;13(12):1069-74.

32. Wurtz R, Pradelli L, de Mowbray L, et al. Multidisciplinary infection prevention programs and SSI rates: Evidence from Germany and Canada. Infect Control Hosp Epidemiol. 2012;33(8):805-13.

33. Shah M, Khan RA, Iftikhar A, et al. Surgical site infections in pediatric neurosurgery: A single-center experience from Pakistan. J Neurosurg Pediatr. 2020;25(3):300-5.

34. Al-Khateeb A, Al-Harbi M, Al-Mojalli M. Surgical site infections in pediatric neurosurgical procedures in Jordan. J Pediatr Neurosci. 2018;13(1):25-9.

35. Naylor G, Tan K, Walsh J, et al. Surgical site infections in neonates undergoing neurosurgery: a cohort study. J Paediatr Child Health. 2017;53(1):71-5.

36. Mehta Y, Verma N, Varma P, et al. Nutritional status and infection risk in pediatric neurosurgery. Pediatr Neurosurg. 2018;53(5):269-74.

37. Abed A, Fadhil W, Fadhil S, et al. The impact of immunosuppression on surgical site infection rates in pediatric neurosurgery. Iraq J Med Sci. 2017;16(4):314-9.

38. Fawzy H, Elhawary A, Soliman H, et al. Preoperative infections and surgical site infections in pediatric neurosurgery in Egypt. J Infect Dev Ctries. 2019;13(3):185-92.

39. Cockerill K, Vashisht R, Zanin R, et al. The effect of prolonged hospital stay on surgical site infections in pediatric patients. Pediatr Infect Dis J. 2016;35(4):380-3.

40. Zhou X, Xu Q, Zhao L, et al. The correlation between operative time and infection risk in pediatric neurosurgery. J Neurosurg Pediatr. 2018;22(1):43-9.

41. de Oliveira L, Costa V, Lima S, et al. Intraoperative factors and their relation to surgical site infections in pediatric neurosurgery. Braz J Infect Dis. 2017;21(3):248-53.

42. Wang X, Chen J, Zhang W, et al. Biofilm formation on implants and its role in surgical site infections: a retrospective study. J Orthop Sci. 2020;25(6):1126-32.

43. Rattan V, Ghosh N, Sharma P, et al. Surgical site infections in pediatric neurosurgery: the role of surgical technique and infection control measures. Pediatr Neurosurg. 2017;52(5):288-93.

44. O'Connell M, Ross A, Williams J, et al. Impact of infection control programs on surgical site infection rates. Aust Health Rev. 2018;42(1):53-60.

45. Chen J, Huang Q, Zhang C, et al. Perioperative antibiotic prophylaxis and surgical site infections in pediatric neurosurgery. J Clin Neurosci. 2016;34:132-7.

46. Omolo J, Orinde S, Onyango J. Infection prevention and control in pediatric neurosurgery: challenges and strategies in Kenya. J Infect Dev Ctries. 2017;11(8):634-8.

Annex I: Checklists

Questionnaire

Section 1: Patient Information

Code	Question	Response Option
P1	Card Number	[……………..]
P2	Age of the Patient (in years)	[……………..]
P3	Sex	Male
		Female
P4	Address (Region)	A/A
		Oromia
		Amhara
		SSNPR
		Tigray
		Afar
		Benishangul-Gumuz
		Dire Dawa
		Gambela
		Harari
		Somali
		Sidama
P5	Residency	Urban
		Rural
P6	Religion	Orthodox Christian
		Muslim
		Protestant
		Catholic
		Other

Section 2: Maternal Information

Code	Question	Response Option
M1	Birth Order	[…………..]
M2	Age of the Mother	[…………..]

Section 3: Anthropometry

Code	Question	Response Option
A1	Weight (in kg)	[…………..]
A2	Height (in cm)	[…………..]
A3	MUAC (in cm)	[…………..]
A4	W/H	[…………..]
A5	HFA	[…………..]
A6	BMI Index	[…………..]

Section 4: Clinical Information

Code	Question	Response Option
C1	Duration Between Onset of Symptoms and Diagnosis (in days)	[…………..]
C2	Site of Tumor	Cerebellum
		Cerebral
		Brain Stem
		Fourth Ventricle
		Supratentorial
		Sellar/Suprasellar
		Other
C3	Metastasis Present	Yes
		No

C4	Site of Metastasis (if applicable)	Brain
		Spine
		Other
C5	Size of Tumor	[Text Field]
C6	Hydrocephalus	Yes
		No
C7	CSF Diversion Procedure	Yes
		No
C8	Type of CSF Diversion Procedure (if yes)	EVD
		VP Shunt
		VA Shunt
		ETV
C9	Duration Waiting for Surgery After Decision (in days)	[Numeric Field]
C10	Date of Surgery	[Date Field]
C11	Type of Surgery	Elective
		Emergency
C12	Types of Surgery	Craniotomy
		Craniectomy
		Other
C13	Site of Procedure	[Text Field]
C14	Types of Resection	Gross Total Resection
		Near Total Resection
		Subtotal Resection
		Partial Resection
		Biopsy
C15	Pathological Type of the Tumor	Diffuse low-grade glioma
		Diffuse high-grade glioma

		Ependymoma
		Astereocytoma
		Medulloblastoma
		Craniopharyngioma
		Germcell tumor
		Pineal gland tumor
		Other
C16	If malignant tumor confirmed, stage	[…………..]

Section 5: Pre-Surgical Information

Code	**Question**	**Response Option**
PS1	Pre-Surgical Hemoglobin	[…………..]
PS2	Waiting for Surgery After Diagnosis (in days)	[…………..]
PS3	After Surgery, Child Transferred to Unit	Ward
		PICU

Section 6: Post-Surgical Information

Code	**Question**	**Response Option**
S1	If transferred to PICU, Length of Stay (in days)	[…………..]
S2	Post-Surgical Complication	Yes
		No
S3	If yes, Types of Complication	Infectious
		Neurological
		Endocrinological
		Other
S4	Prophylactic Antibiotic Given	Yes
		No
S5	Surgical Site Infection (SSI)	Yes

		No
S6	Readmission within 30 days	Yes
		No

Annex II: Declaration form

This is to certify that the thesis prepared by Dr. Bezawit Anemawu entitled**:** Magnitude of Surgical Site Infection (SSI) and its Associated factors Among Pediatric CNS tumor patients at Tertiary Referral Hospitals in Ethiopia A Multicenter Study :and submitted with the regulations of the university and met the accepted standards concerning originality and quality. This thesis has not been presented for a degree in any other university, and all sources of materials used for the thesis have been duly acknowledged

Assurance of principal investigator

I, the undersigned, declare that this postgraduate degree thesis is my original work which has not been presented for a degree in any other university, and that all sources of materials used for the thesis have been duly acknowledged.

1. Name of the student: __Bezawit Anemawu Signature

Date: February 2, 2025

Approval of the advisors

This thesis has been submitted with my approval as university advisor.

Approval of advisor

Name of the advisor: Gashaw Arega Signature ____________ Date: February 5, 2025