



## Postoperative Central Nervous System Infections in Neurosurgical Patients: An Account of a Teaching Hospital in Bauchi, Nigeria

**Olabisi O Ogunleye\***

Senior Lecturer/Consultant Neurosurgeon, Abubakar Tafawa Balewa University  
Bauchi

**\*Corresponding Author:** Olabisi O Ogunleye, Senior Lecturer/Consultant  
Neurosurgeon, Abubakar Tafawa Balewa University Bauchi.

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### Abstract

**Introduction:** Postoperative central nervous system infection (PCNSI) poses a significant threat to life after neurosurgical procedure and require urgent intervention to avoid prolonged morbidity and avoid mortality. PCNSI presents as cases of meningitis, wound infection, empyema and abscess. We aimed to look at the incidence and factors associated with PCNSI in our hospital.

**Materials and Method:** Retrospective analysis of 119 patients who had elective neurosurgical procedures in our hospital between August 2018 and July 2022. Incidence of PCNSI recorded, pathogen offended identified and factors related to the development of PCNSI were also reviewed.

**Results:** One hundred and nineteen patients that elective neurosurgical procedures with median age group of 38.6 years, out of which 6 developed PCNSI and this represent 5% incidence rate of PCNSI. Cranial (73%) and spinal (27%) procedures has 3 cases of PCNSI each. The *Staphylococcus aureus* was the most offending organism isolated from culture representing over 66%. Age and male sex were associated with PCNSI in our study ( $p < 0.05$ ).

**Conclusions:** The incidence of PCNSI in our center is 5% which comparable with findings from many researchers, though higher to some reports. Commodities like hypertension and diabetes were seeing not to be associated with PCNSI. Prophylactic usage of antibiotics is of utmost important.

**Keywords:** CNS Infection; Neurosurgery; Incidence Rate

### Introduction

The development of postoperative central nervous system infection (PCNSI) after neurosurgical procedures poses a significant threat to life after and it requires urgent intervention, both medical/or surgical, to curtail or cure the infection. The most common presentation of PCNSI are meningitis, encephalitis, subdural empyema, epidural abscess and intracerebral abscess [1-3]. Worldwide, prolonged hospital stay, increased cost of care, increased mortality and poorer outcome are some of the resulting effect of PCNSI [3-5]. Choroid plexus is the first site of inflammation with approximately 100.000 bacteria in 1g of tissue that form the prerequisite for PCNSI [6].

Bacterial, fungi, virus and parasites are among the over 100 pathogens documented to be causing PCNSI [7]. The most common bacterial pathogens are *Neisseria meningitidis*, *Streptococcus pneumoniae*, Coagulase-negative *Staphylococci* (CoNS), *Staphylococcus aureus* and *Acinetobacter baumannii* [8]. Isolation of these pathogens causing PCNSI is from cerebrospinal fluid (CSF) culture which is not feasible within 48hrs especially the antimicrobial susceptibility [9]. Gram staining and Agglutination test will only help preliminarily in differentiating among Gram-positive, Gram-negative and Fungi. Therefore, empirical antibiotics therapy becomes necessary while awaiting pending pathogenic identification and antibiotics susceptibility test.

The Centers for Disease Control and Prevention (CDC) defines central nervous system infection as follows: {1} isolation of pathogens from CSF; {2} patient presented with at least one of the following signs with no other recognized cause: fever ( $> 38^{\circ}\text{C}$ ), headache, stiff neck, meningeal signs, cranial nerve signs, changing level of consciousness, or confusion; {3} increased white cells, elevated protein, and/or decreased glucose in CSF [10]. Multidrug resistant (MDR) is defined as non-susceptibility to three or more classes of antibiotics, and extensively drug resistant (XDR) is defined as non-susceptibility to at least one agent in all but two or fewer antimicrobial categories [11,12].

The incidence of PCNSI after neurosurgical procedure has been reported to be 5-7% with a high incidence of up to 10% when prophylactic antibiotics was not used [13]. The aim of this study was to identify potential risk factors and incidence of PCNSI following neurosurgical procedures in a tertiary facility.

## Materials and Method

### Study population

Retrospective study involving 119 patients that had elective neurosurgical procedures between August 2018 and July 2022 in Abubakar Tafawa Balewa University Teaching Hospital Bauchi, Nigeria.

### Pre and intra-operation preparation

All operations were preceded by prophylactic antibiotics of 1g Ceftriazone as our operation protocol. In each of the intracranial procedure, the head, on the operation site was shaved on table before application of savlon and betadine scrub. Surgical site was draped in a sterile fashion before knife on skin.

### Data collection and statistical analysis

Patient age and sex, development of PCNSI and isolated organisms were obtained from patient's folder for each operation and were recorded. Statistical analysis was performed using SPSS IBM Statistics Version 22 and data were expressed in mean, standard deviation, frequency and percentage. To compare the difference between two groups of patients (PCNSI and without PCNSI), categorical variables were analyzed by a Chi-square test and independent samples t-test was used for continuous variables. A  $P$  value  $< 0.05$  was considered statistically significant.

## Results

One hundred and nineteen patients were operated as elective cases with mean age of 38.6 years at the time of operation. Out of those operated, six (6) of the neurosurgical procedures were diagnosed to have PCNSI, accounting for 5% incidence rate of PCNSI. The Clinical characteristics of the study population are show below in table 1.

Characteristics	Value
Age (years)	38.6 $\pm$ 13.4
Age >40years	69 (58)
Sex	
Male	97 (81.5)
Female	22 (17.5)
Hospital stay (days)	~13 (5-35)
Comorbidities	
Hypertension	30 (25)
Diabetic	12 (7.5)
Steroid therapy	2 (1.6)
Surgery	
Cranial	107 (90)
Spinal	12 (10)

**Table 1:** Clinical characteristics of the study population (N = 119).

Cranial procedures were the majority accounting for 73% of all procedures with PCNSI rate of 3.5%. Higher PCNCI rate was seen in ventriculo-peritoneal procedures compared to burr hole procedures (Table 2).

Spinal procedures were 32 constituted 27% with PCNSI rate of 9.3% with neural tube defect repair has two cases of PCNSI and Laminectomy procedures recorded only one (1) PCNSI.

The isolated pathogens from culture were mainly two organisms; *Staphylococcus aureus* and *Pseudomonas aeruginosa* with 66.6% and 33.7% spread respectively. Out of the six (6) PCNSI cases, pathogens were isolated in 5 cases and with only one yielded negative growth (Table 3).

Neurosurgical procedures	Volume of procedure	PCNSI cases	PCNSI rates
Cranial			
Craniotomy	14	0	0
Burr hole	40	1	2.5
Ventriculo-peritoneal shunting	30	2	6.7
Others	3	0	0
Subtotal	87	3	3.5
Spinal			
Laminectomy ± Discectomy/instrumentation	8	1	12.5
Neural tube defect repair	24	2	8.3
Subtotal	32	3	9.3

**Table 2:** Neurosurgical cases distribution.

Pathogen	Number	Procedure	Percentage
<i>Staphylococcus aureus</i>	4	Ventricul-peritoneal shunting (2) Neural tube defect repair (1) Laminectomy (1)	66.6
<i>Pseudomonas aeruginosa</i>	1	Neural tube defect repair (1)	16.7
Negative culture	1	Burr hole (1)	16.7
Total	6		

**Table 3:** Isolated pathogens and associated procedures.

We recorded only one mortality from PCNSI representing 16.7% among the 6 cases with PCNSI and 0.8% mortality rate among the patients who has elective neurosurgical procedures.

Clinical characteristics between patients with PCNSI and those without PCNSI showed a strong correlation in age, male sex and duration of stay on admission, with p value <0.05 as shown in table 4.

## Discussion

The beginning of germ theory by Louis Pasteur and its subsequent application in surgical sterilization by Joseph Lister in the late 19<sup>th</sup> century has resulted into a marked reduction in the rates of postoperative sepsis, with resultant expansion of the depth and breadth of operative neurosurgical procedures that could be performed safely [14,15]. PCNSI has brought a dare but life-threatening challenges to the practice of neurosurgery. The safety of neurosurgical operations has been further improved by the clinical application of Alexander Fleming's original penicillin mold extract in the 1940s in the operating room through the work of Howard Florey

and Ernst Chain, allowing for elective lesions in neurosurgery to be treated with a previously unattainable level of postoperative safety, thereby opening the door for elective neurosurgery [16].

Our study reported 3.5% incidence rate of PCNSI for intracranial procedures whereas other earlier studies done in various part of the world have reported PCNSI for intracranial procedures, that were defined as meningitis, epidural abscess, subdural empyema, brain abscess, bone-flap infection, and/or wound infection, of incidence rate varying but ranges between <1% to >8% [13,17-19]. This finding showed our reported incidence was still in consonant with other reported incidences so far, despite our small study population.

The incidence of PCNSI after spinal neurosurgical procedure was 9.3% which is very high compared to 0.4% reported by McClelland and Hall [20]. Though there are other studies that reported similar and even higher incidence rates [21,22].

Clinical Characteristics	Total(N)	PCNSI	No PCNSI	p value
Age (years)	38.6 ± 13.4	45.2 ± 9	33.7 ± 10	0.004
Age > 40years	69 (58)	6	63	0.017
Sex				
Male	97 (81.5)	6 (100)	92 (81)	0.005
Female	22 (17.5)	0 (0)	22 (19)	0.213
Hospital stays (days)	-13 (5-35)	20 (15-35)	10 (5-14)	0.011
Comorbidities				
Hypertension	30 (25)	3 (10)	27 (90)	0.222
Diabetic	12 (7.5)	0 (0)	12 (100)	0.351
Steroid therapy	2 (1.6)	0 (0)	0 (100)	0.82
Surgery				
Cranial	107 (90)	3 (2.8)	104 (97.2)	0.662
Spinal	12 (10)	3 (25)	9 (75)	0.411

**Table 4:** Comparison of clinical characteristics between patients with and without PCNSI.

*Staphylococcus aureus* is the most common offending organism in our study accounting for about 66.6% of all the infections, which is in tandem with previous studies [17,18]. *Pseudomonas* accounted for 16.7% of the infections, which has also been reported as one of the common offending organisms [18,23]. Differing from the findings of previous studies was that finding in our series revealed *Enterobacter*, *Acinetobacter*, *Proteus*, or *Candida* species were not causes of PCNSI.

Earlier studies have evaluated cerebrospinal fluid leakage, male sex, operating surgeon, previous neurosurgical operation and absence of prophylactic antibiotics as the risk factors for PCNSI (18, 24). All the patients in our study were operated by the only neurosurgeon in our hospital and all the patients as well received prophylactic antibiotics prior to each procedure. So operating surgeon and prophylactic antibiotics have been eliminated as possible risk factors in our study.

## Conclusion

The results from our series indicate that the PCNSI is real and life threatening with overall incidence rate of 5% which is comparable to other studies in other region of the world. Risk factors like Age, Sex and comorbidity should be taken into consideration in PCNSI. The limitations of our study must be acknowledged. This

was a single-center study with a small sample size, which may restrict the applicability of the findings to patients with PCNSI in other centers and regions.

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## Conflict of Interest

The author has no conflict of interest to declare

## Author Contribution

The Author conceived and designed the study, conducted research, provided research materials, collected, organised the data, analysed the data, interpreted the data, wrote and reviewed the whole text.

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