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PATTERNS OF CENTRAL NERVOUS SYSTEM INFECTIONS IN PAKISTAN: A CROSS-SECTIONAL MULTICENTER STUDY

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ABSTRACT

Background and Objective:

In low- and middle-income countries, central nervous system infections are amongst the neurological entities associated with significant disability. Despite the availability of both preventative and antimicrobial treatment, management of CNS infections continues to be a great challenge. The objective of this study was to assess the pattern of CNS infections across multiple urban and rural centers in Pakistan.

Methods:

A cross-sectional observational study was conducted across 39 outpatient neurology centers in Pakistan, including both public and private setups from August 2017 to December 2019. Data on demographics, comorbidities, and categorization of CNS infections were obtained from the hospital records. Disability as a measure of outcome was classified using the Modified Rankin Scale (mRS). SPSS 19.0 was used for statistical analysis of the data.

Results:

A total of 455 patients with CNS infections were analyzed. Tuberculous meningitis (38%) was the most prevalent, followed by bacterial meningitis (27.9%) and viral meningitis (22.9%). Fungal infections (2.9%), brain abscesses (2.4%), and rare cases of amoebic encephalomyelitis (0.4%) were also observed. The mean age was 38.8 years, with 40.2% of cases occurring in young adults (18–30 years). Males (53.4%) were slightly more affected than females. Hypertension (16.3%) and diabetes (10.1%) were the most common comorbidities. Post-infection disability was seen in 15.7% of cases, with 4.6% being bedridden.

Conclusion:

The findings indicate that tuberculosis meningitis and bacterial meningitis constitute the majority of CNS infections. Early diagnosis, improved vaccination coverage, and better antimicrobial stewardship play a key role in long-term outcomes.

Keywords: CNS infection, Tuberculosis meningitis, Bacterial meningitis, Vaccination.

INTRODUCTION

Amongst neurological emergencies, central nervous system infections (CNSI) remain a major cause of morbidity and mortality worldwide.[1] Although rare in developed countries, central nervous system infections still serve as a diagnostic and therapeutic challenge and impose significant burden on public health care in developing countries.[2]

Infections of the central nervous system can be broadly classified based on several factors. This mainly includes the clinical features on presentation, the pathogenic organisms involved and also on the site where they occur.[3] The causative organisms include bacteria, mycobacterium, viruses, fungi, protozoa and even prions.[4] The tendency to acquire a certain microbe is also associated with certain human-related factors i.e. age, vaccination status, geographical location, immune

status or other co-morbid conditions including history of any neurosurgical procedures.[5]

In general, CNSI encompasses three main entities; meningitis, encephalitis, and abscesses.[1] Meningitis and encephalitis signify inflammation of meningeal lining and brain parenchyma respectively. There is remarkable overlap between the two, with the latter resulting in impairment in cerebral function leading to alteration in sensorium. Brain abscess is a localized area of necrosis enclosed within a membrane in the brain parenchyma. The route of transmission common to all is hematogenous seeding of microorganisms, however brain abscesses may also result from contiguous infection of head and neck (e.g. sinusitis, otitis media, mastoiditis).[6]

The clinical presentation of CNS infections is quite variable and so is the value of physical findings in a patient. The typical symptomatology i.e. fever, headache, neck rigidity and/or altered mental status is seen in a handful of patients only.[7] Additional features include seizures, nausea and vomiting, focal neurological deficits and behavioral abnormalities, depending on the type and severity of central nervous system infection. Given the natural history of CNSI, high clinical suspicion has paramount significance in early recognition and treatment.[8]

Central nervous infection is primarily a diagnosis to be established in the emergency department. Lumbar puncture for CSF analysis is the gold standard for diagnosis. An important consideration in clinical practice is not delaying initiation of empiric antimicrobial treatment, if the lumbar puncture is delayed for any reason.[9] CNSI is therefore considered as a time-sensitive clinical entity, where immediate treatment is associated with reduced risk of neurological sequel. As per the guidelines of Infectious Disease Society of America (IDSA), history of immunocompromised status, prior background of CNS disease, seizure within one week of presentation and certain physical examination findings suggestive of raised intracranial pressure or focal neurological signs mandates doing a CT head prior to lumbar puncture.[10]

In contrast to meningitis, encephalitis or meningoencephalitis, recognition of brain abscess requires neuroimaging as the primary modality of investigation. CSF is sterile in most cases, unless concomitant meningitis is suspected. MRI with gadolinium is the study of choice, to define the extent of pathology.[11] The clinical course of brain abscess is distinguishable, because of a subacute presentation often ranging from days to weeks, with the classic triad of fever, headache and focal neurological deficits being found in only 20% of patients.[12]

Antimicrobial treatment is tailored, based on the identification of causative microorganism. Familiarity with the local resistance patterns is helpful. The role of steroids in bacterial meningitis specifically is essential in preventing long term neurological complications. Untreated bacterial meningitis has a mortality rate approaching 100% and with proper treatment, it is reduced to 4.2%.[13] Of note, fatality associated with CNS infections is unlike any other infection.[14] The purpose of this study is to identify the patterns of central nervous system infections across multiple centers in Pakistan.

Existing studies are often limited to single centers or specific subpopulations, restricting generalizability. This study aims to address this gap by providing a comprehensive overview of CNS infection patterns across urban and rural centers, including both public and private healthcare facilities. Furthermore, it evaluates demographic characteristics, comorbidities, and functional outcomes, thereby offering clinically relevant insights to inform early diagnosis, management strategies, and public health planning.

METHODS

This was a cross-sectional observational study conducted across 39 neurology centers in Pakistan, representing both urban and rural regions, and including public and private healthcare sectors. A standardized data collection proforma was developed and pre-tested prior to study initiation. The proforma included structured variables on patient demographics, clinical diagnoses, comorbidities, and functional outcomes. Functional outcome was assessed using the Modified Rankin Scale (mRS), which was recorded at the time of outpatient evaluation by the treating neurologist.

The proforma was distributed to participating neurologists at each center, who were responsible for data collection. Adult patients (≥18 years) presenting to outpatient neurology clinics with a diagnosis of CNS infection were included, encompassing both newly diagnosed cases and those under follow-up or ongoing

management.

Diagnoses were made by consultant neurologists at each center based on clinical presentation, supported by cerebrospinal fluid (CSF) analysis and neuroimaging findings where available, in accordance with established clinical practice guidelines. Tuberculous meningitis, bacterial meningitis, and viral encephalitis were diagnosed using standard clinical and laboratory criteria, including CSF parameters and microbiological testing where available. Neuroimaging (CT/MRI) was used particularly in cases of encephalitis and brain abscess.

Due to variability in diagnostic resources across centers, cases were classified based on the best available clinical and laboratory evidence, and distinction between microbiologically confirmed and clinically diagnosed cases was not uniformly feasible.
Continuous variables were reported as mean ± SD and number (percentage) for categorical variables. The number (%) of demographic as well as clinical factors was assessed and divided by patient gender. Continuous variables with normal distribution were analyzed using independent samples t-test, while those with categorical variable were analyzed using chi-square test. The analysis was performed using SPSS (Statistical Package of Social Sciences) version 19. All p-values were based on two-sided tests and significance was set at a p-value <0.05.

The study was approved by the Ethical Review Committees and they waived the requirement of informed consent from the participants.

RESULTS

A total of 455 patients with CNS infections were seen during the study period. The mean age of the study population was 38.8 ± 16.0, 243 (53.4%) were men, while 212 (46.6%) were women. Most of the patients fell into the age category of 18-30 years (n: 183 – 40.2%), while only 16 patients (3.5%) were of age greater than 70 years (Figure 1). As far as the status of education is concerned, it was found that CNS infection was more common in patients who had either received secondary education only (27%) or those who did not even receive any primary education (25.9%). Interestingly, only 10 patients who developed CNS infections had received post graduate education. The two common medical co-morbid conditions were hypertension (n: 74, 16.3 %) followed by diabetes (n: 46, 10.1%). Twenty-two patients (4.8% of the study population) had active exposure to tobacco.

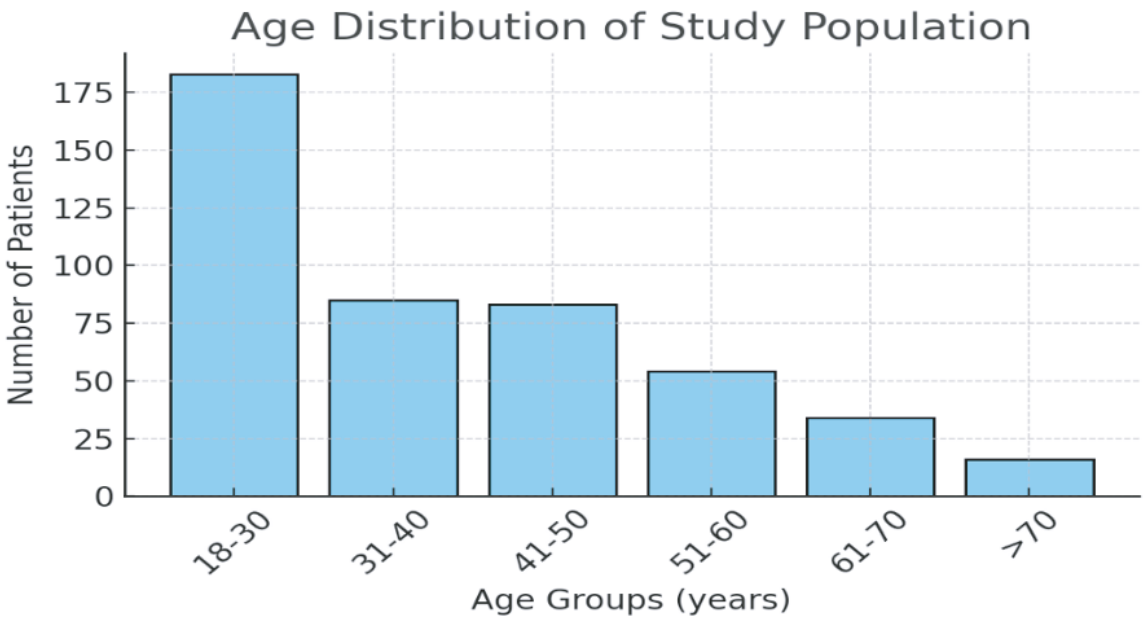


Figure 1: Age distribution of the study population

The frequency of clinically diagnosed CNS infection categories as shown in Table 1 demonstrated that tuberculous meningitis (n: 173, 38%) was the most common type of CNS infection in our study population followed by bacterial meningitis (n: 127, 27.9%) and viral meningitis/encephalitis (n: 104, 22.9%). Rare forms of CNS infection in our study participants included herpes zoster ophthalmicus, fungal meningitis including the one caused by aspergillus, brain abscess and amoebic encephalitis. These categories reflect clinically assigned diagnoses based on treating neurologists' assessments, rather than a strictly etiological or hierarchical classification. Disability as a measure of outcome was quantified using the Modified Rankin Scale (mRS). The outcome was variable, with majority of the patients having either no disability (n: 200, 44%) or minimal deficits without disability (n: 102, 22.4%). The level of education and comorbid conditions of the study participants are given in Table 2 and Table 3. Less than five percent of our study population ended up having severe disability, causing them to be bedridden and requiring complete assistance for activities of daily living – refer to Table 4.

Table 1: Frequency of various types of CNS infections (n=455)

Type of CNS infection	Frequency (n)	Percentage (%)
Tuberculous Meningitis	173	38.0
Bacterial Meningitis	127	27.9
Viral Meningitis	104	22.9
Herpes Zoster Ophthalmicus	22	4.80
Fungal Meningitis	13	2.90
Brain abscess	11	2.40
Aspergillosis	03	0.70
Amebic Encephalomyelitis	02	0.40

Table 2: Level of Education of Study Participants (n=455)

Level of Education	Number of study participants (n)	Percentage of study participants (%)
Unknown	109	24.0
Illiterate	118	25.9
Matriculation	123	27.0
Intermediate	52	11.4
Graduate	40	8.80
Masters	9	2.00
Doctors	1	0.20
Others	3	0.70

Table 3: Medical Co-morbid Conditions in Study Participants (n=455)		
Medical co-morbid conditions	**Number of study participants (n)**	**Percentage of study participants (%)**
Hypertension	74	16.3
Diabetes Mellitus	46	10.1
Dyslipidemia	8	1.80
Coronary Artery Disease	13	2.90
Exposure to Tobacco	22	4.80
Depression	7	1.50

Table 4: Disability Status on Discharge (Modified Rankin Scale)			
Disability category	**mRS score**	**Frequency (n)**	**Percentage (%)**
Normal	0	200	44.0
Minor symptoms without disability	1	102	22.4
Slight disability	2	60	13.2
Moderate disability	3	26	5.7
Moderately severe disability	4	46	10.1
Severe disability	5	21	4.6
Total		455	100.0

mRS – modified Rankin Scale

DISCUSSION

Infections of the central nervous system remain a leading cause of neurological morbidity and mortality in low and middle-income countries.[15] Our study provides a multicenter overview of CNS infections in Pakistan, highlighting tuberculosis meningitis as the most prevalent etiology, followed by bacterial and viral infections, with important implications for clinical practice and public health planning.

According to the national neurology database, CNS infection was found to be present in 1.6 percent of the population attending neurology outpatient services in Pakistan – overall percentage being comparatively lower than in other neurological illnesses including vascular diseases, epilepsies, headaches, movement disorders, dementias, etc.[16] Similar was the case in pediatric population, where the prevalence of CNS infections was found to be 1.2 percent, with epilepsy (36%), behavioral disorders (16%), cerebral palsy (10.5%) and headache (3.6%) being more common.[17]

The most prevalent central nervous system infection, according to our data, was tuberculous meningitis (38%) followed by bacterial meningitis (27.9%) and viral meningitis (22.9%), causing major health and socio-economic impact. This conclusion is consistent with other observations from South Asia, where the high endemicity of tuberculosis makes tuberculous meningitis a major cause of central nervous system infections. According to Thakur et al. (2018), for example, tuberculosis meningitis (TBM) was the most frequent form of CNS tuberculosis, accounting for around 1% of all cases of tuberculosis.[18] In comparison, data reported from developed nations show a lower prevalence of TBM, with bacterial and viral etiologies being more prominent due to effective utilization of TB control programs.[17] This necessitates the need of early diagnosis and treatment initiation, expansion of BCG vaccination, promoting adherence to treatment and addressing multi-drug resistance, by creating public health awareness and targeting the constraints through a multidimensional approach.

Bacterial meningitis, which accounted for 27.9% of cases in our study, has been reported at similar rates in previous studies conducted in Pakistan, with Streptococcus pneumoniae and Neisseria meningitides being the common pathogens.[19] In contrast, the prevalence of pneumococcal and meningococcal meningitis has exhibited a considerable decline in western nations with the introduction of conjugate vaccines; nonetheless, ongoing high disease burden in our study population points to inadequacies in early diagnosis, timely consideration of treatment and vaccination coverage. The occurrence of fungal CNS infections (2.9%) and brain abscesses (2.4%) in our study cohort aligns with findings from a tertiary care hospital in Karachi, which reported similar rates in immunocompromised patients, emphasizing importance of identification of risk factors in patients with CNS infections.[17] However, compared to Western literature, fungal CNS infections remain underreported in Pakistan, attributable to diagnostic limitations.

The mean age of our study population was 38.8 years, with a predominance of younger adults (18–30 years: 40.2%). This trend is consistent with studies from other low-income settings, where CNS infections are more prevalent in the similar age group. On the other end, developed countries report a higher incidence of CNS infections in elderly populations, likely due to widespread usage of childhood vaccinations and longer life expectancy.[17] The male predominance (53.4%) in our study has been noted in previous research, which attributes this disparity to healthcare-seeking behavior differences and occupational exposures. However, some studies have reported a higher risk of TBM in females due to differential immune responses and social determinants of health.[19] In our group, diabetes (10.1%) and hypertension (16.3%) were the most prevalent comorbid medical conditions. Nearly 20% of patients with CNS infections had diabetes, according to comparable research from Pakistan, highlighting the importance of diabetes as a predisposing factor, especially for fungal and tuberculous infections. Herpes zoster ophthalmicus (4.8%) and aspergillosis (0.7%) are further indicators of underlying immunosuppression, which may be a sequel of poorly controlled diabetes or even undiagnosed HIV infection.[20] Although comorbid conditions such as diabetes and hypertension were commonly observed in our cohort, their statistical association with specific CNS infection subtypes was not explored and warrants further investigation in future studies.

With regards to functional outcome in terms of disability as denoted by the modified Rankin Scale (mRS), a significant proportion of patients (44%) had no residual disability post-infection, while 22.4% experienced minor symptoms. However, 15.7% were moderately to severely disabled, highlighting the long-term neurological sequelae associated with CNS infections, despite being both a preventable and treatable entity. Studies from South Asian region have documented similar post-infectious disability rates, particularly among survivors of tuberculosis meningitis.[19] Post-infectious disability in the form of both cognitive and motor impairment calls for efforts towards integration of neurorehabilitation services in hospital discharge planning to improve long term outcomes.[20]

This study has several limitations. First, as an outpatient-based study, it may underrepresent more severe cases of CNS infections requiring hospitalization. Second, variability in diagnostic resources across centers may have influenced classification accuracy. Third, detailed data on diagnostic delays, hospitalization duration, and immunocompromised states were not consistently available. Additionally, given the descriptive nature of the study and variability in data completeness, advanced comparative or inferential statistical analyses were not performed, limiting the ability to assess associations or draw causal inferences. Despite these limitations, the multicenter design provides valuable insights into the epidemiology of CNS infections in Pakistan.

The findings of this cross-sectional study, on the whole, underscores the urgent need of strengthening public health strategies to reduce the burden of CNS infections in Pakistan. Measures for intensification of the already existing national tuberculosis control program (NTP) and routine immunization campaigns is one way of doing it. In low or middle-income settings, delayed presentation to the hospital is a major concern. It is mainly due to financial limitations and restricted access to health care.[21] Therefore, facilitation of tertiary care referral systems and ensuring availability of affordable neuroimaging and microbiological testing can help mitigate these challenges.

CONCLUSION

The burden of CNS infections in Pakistan remains substantial. Improved vaccination coverage, rapid diagnostics, enhanced treatment adherence, and

strengthened public health policies can help to reduce the morbidity and mortality associated with CNS infections. Thereafter, longitudinal evaluations of neurological outcomes and extensive, multi-center epidemiological studies should be the main areas of future research.

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REFERENCES

1. Archibald LK, Quisling RG. Central Nervous System Infections. Textbook of Neurointensive Care. 2013 May 7:427–517. doi: 10.1007/978-1-4471-5226-2_22. PMCID: PMC7122753.
2. Sarrazin J, Bonneville F, Martin-blondel G. Infections cérébrales. J Radiol Diagnostique Interv. 2019;93(6):503–20.
3. Ahmed MM. Clinical presentation and outcome of bacterial Meningitis in University Hospital. Adv Infect Dis. 2014; 4:124–31.
4. Giovane RA. Central nervous system infections. Prim Care Clin Off Pract. 2018.
5. Riddell J, Shuman EK. Epidemiology of central nervous system infection. Neuroimaging Clin N Am. 2012;22(4):543–56.
6. Lange N, Berndt M, Jörger AK, Wagner A, Wantia N, Lummel N, et al. Clinical characteristics and course of primary brain abscess. Acta Neurochir (Wien). 2018 Oct;160(10):2055-2062.
7. Waghdhare S, Kalantri A, Joshi R, kalantri S. Accuracy of physical signs for detecting meningitis: a hospital-based diagnostic accuracy study. Clin Neurol Neurosurg. 2010;112(9):752–7.
8. Robertson FC, Lepard JR, Mekary RA, Davis MC, Yunusa I, Gormley WB, et al. Epidemiology of central nervous system infectious diseases: a meta analysis and systematic review with implications for neurosurgeons worldwide. J Neurosurg. 2018;130(4):1 20.
9. Aronin SI, Peduzzi P, Quagliarello VJ. Community-acquired bacterial meningitis: risk stratification for adverse clinical outcome and effect of antibiotic timing. Ann Intern Med. 1998;129(11):862–9.
10. Tunkel AR, Hartman BJ, Kaplan SL, Kaufman BA, Roos KL, Scheld WM, et al. Practice Guidelines for the Management of Bacterial Meningitis. Clin Infect Dis. 2004;39(9):1267–84.
11. Rath TJ, Hughes M, Arabi M, Shah GV. Imaging of cerebritis, encephalitis, and brain abscess. Neuroimaging Clin N Am. 2012;22(4):585–607.
12. Brouwer MC, Coutinho JM, van de Beek D. Clinical characteristics and outcome of brain abscess: systematic review and meta-analysis. Neurology. 2014;82(9):806–13.
13. Li C, Feng W, Lin A, Zheng G, Wang Y, Han Y, et al. Clinical characteristics and etiology of bacterial meningitis in Chinese children > 28 days of age, January 2014–December 2016: a multicenter retrospective study. Int J Infect Dis. 2018; 74:47–53.
14. Parikh V, Tucci V, Galwankar S. Infections of the nervous system. Int J Crit Illn Inj Sci. 2012;2(2):82.
15. Kumar D, Pannu AK, Dhibar DP, Singh R, Kumari S. The epidemiology and clinical spectrum of infections of the central nervous system in adults in north India. Trop Doct. 2021 Jan;51(1):48-57. doi: 10.1177/0049475520959905.
16. Wasay M, Awan S, Shahbaz N, Khan S, Sher K, Malik A, et al. Neurological disorders and disability in Pakistan: A cross-sectional multicenter study. J Neurol Sci. 2023 Sep 15; 452:120754.
17. Chand P, Sultan T, Kulsoom S, Jan F, Ibrahim S, Mukhtiar K, et al. Spectrum of Common Pediatric Neurological Disorders: A Cross-Sectional Study from Three Tertiary Care Centres Across Pakistan. Pediatr Neurol. 2023 Jan; 138:33-37.
18. Thakur K, Das M, Dooley KE, Gupta A. The Global Neurological Burden of Tuberculosis. Semin Neurol. 2018 Apr;38(2):226-237. doi: 10.1055/s-0038-1651500.
19. Faizi N, Hassan J. Etiology and Epidemiology of Central Nervous System Infections. InViral and Fungal Infections of the Central Nervous System: A Microbiological Perspective 2023 Dec 15 (pp. 3-13). Singapore: Springer Nature Singapore.
20. Shafait S, Alamgir W, Yousaf A, Hashmat A, Nawaz KH, Nizami A. Aetiologies of Central Nervous System Infections: A Study at Tertiary Care Hospital in Northern Punjab. Pak Armed Forces Med J. 2023 Jan. 3 [cited 2025 Mar. 1];72(6):2108-12.
21. Wen L, Li M, Xu T, Yu X, Wang L, Li K. Clinical features, outcomes and prognostic factors of tuberculous meningitis in adults worldwide: systematic review and meta-analysis. J Neurol. 2019 Dec;266(12):3009-3021. doi: 10.1007/s00415-019-09523-6.

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Shafaq Saleem; Data Analysis, Manuscript writing
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Muhammad Arif Nadeem Saqib; data analysis, manuscript revision
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All the authors have approved the final version to be published and agree to be accountable for all aspects of the work.

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