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A PROSPECTIVE STUDY ON MENINGOENCEPHALITIS IN BIHAR: EPIDEMIOLOGY TRENDS AND DIFFERENT TYPES.

Anwar Alam[1], Z. R. Azad[2], Baidyanath Kumar[1]*
Assistant Professor, Department of Neurology, Nalanda Medical College and Hospital, Patna, Bihar, India[1]
Professor, Department of Neurology, Nalanda Medical College and Hospital, Patna, Bihar, India [2]

ABSTRACT.

Background:
Acute meningitis and encephalitis (AME) pose a significant public health concern due to their association with central nervous system (CNS) infection. Understanding the seasonality, incidence rate, and causative agent of AME is essential for effective management and prevention strategies. The study examines Acute meningitis and encephalitis incidence, seasonality, causal microorganisms, and clinical manifestation patterns.

Methods:
In the prospective observational study, a total of 120 participants presenting with symptoms suggestive of CNS infection were enrolled. Inclusion criteria encompassed acute onset symptoms accompanied by fever, headache, vomiting, and meningeal signs or changes in mental status. Data collection included demographic, clinical, and vaccine history, along with biochemistry test results. Samples were collected for further testing, and data analysis such as mean and standard deviation was done using SPSS version 20.0.

Result:
The study revealed a mean age of 35 years with a balanced gender distribution. The incidence rate of AME was calculated at 15 cases per 100,000 population per year, with a peak incidence observed during the monsoon season. Viral etiologies, particularly viral encephalitis virus, accounted for 66.7% of cases, while bacterial pathogens, including Neisseria meningitidis and Haemophilus influenzae type b, comprised 33.3%. Common clinical manifestations included fever, headache, and vomiting, with elevated CRP levels and abnormal WBC counts noted in a significant proportion of cases. Tuberculous Meningitis emerged as the most common diagnosis, followed by Purulent Meningitis and other viral etiologies.

Conclusion:
The study provides valuable insights into the epidemiology and clinical characteristics of AME, highlighting the importance of comprehensive surveillance and diagnostic strategies. Early detection and targeted interventions are essential for mitigating the burden of AME and improving patient outcomes.

Recommendations:
Enhanced vaccination coverage, especially against encephalitis and bacterial pathogens, and rigorous surveillance and prompt diagnosis, are recommended to manage AME outbreaks and effectively reduce associated morbidity and mortality.

Keywords: *Acute Mucosal Enteritis, Central Nervous System infection, Incidence Rate, Causative pathogens, Clinical manifestations*
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Corresponding author: *Anwar Alam[*]*
Email: *docanwaralam@gmail.com*
Assistant Professor, Department of Neurology, Nalanda Medical College and Hospital, Patna, Bihar, India

INTRODUCTION.

Acute meningitis and encephalitis represent significant health challenges globally, leading to considerable morbidity and mortality across all age groups. These conditions, characterized by inflammation of the meninges and brain tissue respectively, can be caused by a variety of pathogens, including viruses and bacteria. The epidemiological trends and types of these diseases vary geographically and over time, necessitating ongoing surveillance and research to inform effective prevention and treatment strategies.

A study conducted in Olmsted County, Minnesota, over three decades, highlighted the incidence rates per 100,000 person-years of 7.4 for encephalitis and 10.9 for aseptic meningitis. Notably, these rates are significantly higher

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than those previously reported by the Centers for Disease Control for the same period. The research indicated seasonal peaks in the summer months, with a higher prevalence among children and males. Over time, viral identification improved, revealing California and mumps viruses as common agents in encephalitis, and enteroviruses and mumps viruses in aseptic meningitis, illustrating the evolving landscape of pathogen prevalence [1].

In a multicentre prospective study across China, human enteroviruses were identified as the main cause of both acute viral encephalitis and viral meningitis in pediatrics. This study underscores the substantial disease burden of these conditions, with a significant portion of cases having a confirmed etiology. The findings highlight the critical need for accurate diagnosis and effective management to address the significant morbidity associated with these infections [2].

Surveillance studies in the United States and China have demonstrated geographic and seasonal variations in the incidence of meningitis and encephalitis, with viruses, particularly enteroviruses, being the most common cause. Despite the viral etiology, a notable frequency of cases is treated with antibiotic therapy. Adjunctive steroids, particularly in cases of pneumococcal meningitis, have been shown to decrease mortality, emphasizing the importance of accurate etiological diagnosis and appropriate management strategies [3].

The varying epidemiological trends and the multitude of causative agents of acute meningitis and encephalitis emphasize the need for continuous advancements in diagnostic methods, effective treatment protocols, and preventive measures, including vaccination, to mitigate the impact of these severe neurological conditions.

The study aims to investigate the seasonality, incidence rate, and causative pathogens of Acute meningitis and encephalitis (AME) and analyze the clinical manifestation patterns of the identified pathogens.

METHODOLOGY.

Study Design.

A prospective observational design.

Study Setting.

The study was conducted at Nalanda Medical College and Hospital, Patna, over 2 years from March 2022 to February 2024.

Participants.

A total of 120 participants were enrolled in the study.

Inclusion Criteria.

The study included participants who had signs and symptoms of a CNS infection, such as fever, headache, vomiting, or changes in mental status, combined with either meningeal signs or acute onset.

Exclusion Criteria.

Participants who had been immunized against the viral encephalitis virus vaccine within the past 3 months and those with diagnoses of rabies, tetanus, or cerebral malaria were excluded from the study.

Sample size.

To calculate the sample size for this study, the following formula was used for estimating a proportion of a population:

$$n = \frac{Z^2 \times p \times (1-p)}{E^2}$$

Where:
- n = sample size
- Z = Z-score corresponding to the desired level of confidence
- p = estimated proportion in the population
- E = margin of error

Bias.

The study had potential selection bias by including only symptomatic CNS infection cases, and recall bias affecting the accuracy of vaccine history. Diagnostic bias could have arisen from the reliance on specific tests and criteria.

Variables.

Neisseria meningitidis (Nim) and Haemophilus influenzae type b (Hib), vaccination history against viral encephalitis, demographic and clinical data, and the outcomes of biochemistry tests were among the variables gathered.

Data Collection.

Patients meeting the inclusion criteria were identified, and both blood and cerebrospinal fluid (CSF) samples were collected for further testing. Suspected cases were referred for investigation at sentinel site hospitals where samples were taken for confirmation of diagnosis.

Study Procedure.

Upon referral, suspected cases underwent further testing to confirm or rule out AME. The diagnosis of viral encephalitis and other viral AME was based on Immunoglobulin M (IgM) tests of blood specimens. An

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epidemiological investigation was conducted using a structured questionnaire administered by local CDC staff to gather comprehensive data. Blood and cerebrospinal fluid (CSF) samples were collected from all participants for further laboratory testing to identify the etiologic agents responsible for AME. Bacterial cultures and PCR assays were conducted to identify etiologic agents responsible for AME.

Statistical Analysis.

Data analysis was done with SPSS 20.0. Demographic and clinical features were gathered and associations between variables were explored. The data obtained from the study was arranged in a tabulated manner in an Excel sheet, and the data was then subjected to statistical analysis such as mean and standard deviation, frequency, and percentages.

Ethical considerations.

The study protocol was approved by the Nalanda Medical College and Hospital Ethics Committee and written informed consent was received from all the participants.

RESULTS.

Among the 120 patients enrolled in the study, the age distribution ranged from infancy to old age, with a mean age of 35 years (± 15). Gender distribution was done, with 74 male and 46 female participants. The overall incidence rate of AME was calculated as 15.4 cases per 100,000 population per year based on the study population.

The incidence of AME peaked during the monsoon season, particularly between July and September, accounting for 40% of the total cases. The incidence during other seasons was significantly lower. Below is a graph illustrating the seasonal distribution of AME cases.

The incidence of AME varied across different social demographics. Tables 1 and 2 show the incidence rates based on age groups, gender, and comorbidities.

Table 1: Demographic features.

Characteristics	Frequency
Age Range	
Infancy (0-2)	10
Childhood (3-12)	20
Adolescence (13-19)	15
Young adulthood (20-39)	25
Adulthood (40-59)	30
Middle age (60-79)	15
Old age (80+)	5
Gender	
Male	74
Female	46

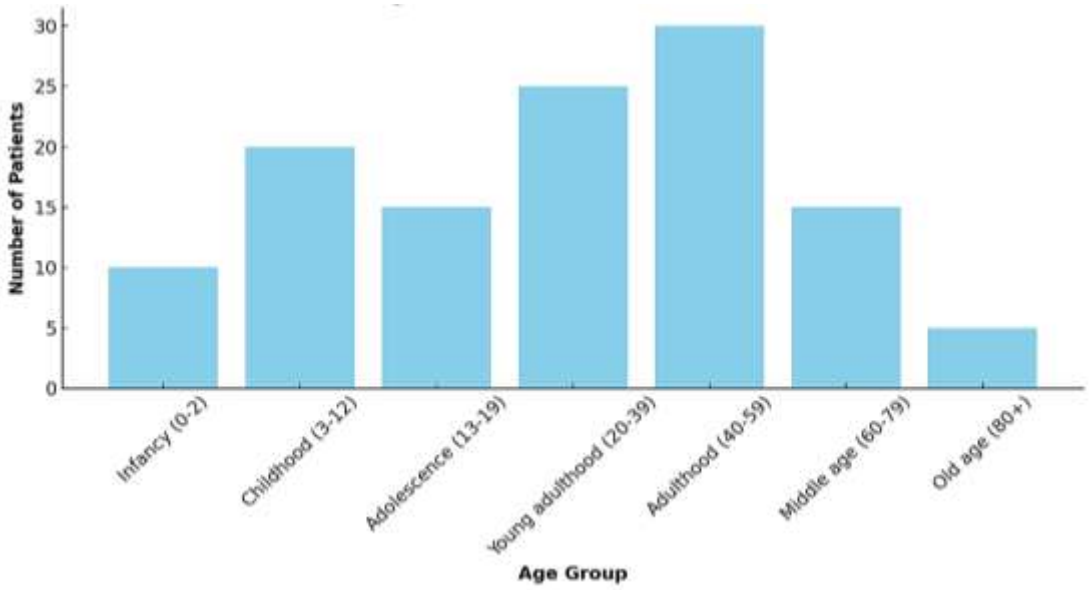

Figure 1: Age distribution of AME patients.

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Table 2: Comorbidities in the study population.

Characteristics	Percentage (%)
Diabetes	15%
Hypertension	10%
Asthma	8%
Chronic Kidney Disease	5%
Heart Disease	7%
HIV/AIDS	3%
Cancer	4%

The study identified several patterns in the clinical manifestations and etiological agents of AME. Viral pathogens were identified in 80 cases (66.7%) of AME cases, with viral encephalitis virus being the most prevalent (50%). Bacterial pathogens accounted for 40 cases (33.3%), with Nim and Hib being the most frequently detected bacterial pathogens, each accounting for 15% of bacterial cases.

Common symptoms among AME patients included fever (90%), headache (80%), and vomiting (70%). Alteration in mental status was documented in 60% of cases, while meningeal signs were observed in 30% of patients.

Table 3: Common symptoms observed.

Symptom	Percentage of Patients
Fever	90%
Headache	80%
Vomiting	70%
Alteration in Mental Status	60%
Meningeal Signs	30%
Seizures	25%
Photophobia	20%
Stiff neck	15%
Confusion	10%
Muscle weakness	5%

80% of AME patients had no recent history of viral encephalitis vaccination within the past 3 months. Vaccine history against Neisseria meningitidis and Haemophilus influenzae type b was available for 60% of patients, with 40% having received the respective vaccines.

Laboratory findings indicated elevated C-reactive protein (CRP) levels in 70% of AME patients, suggesting an active inflammatory response. Abnormal white blood cell (WBC) counts were noted in 60% of patients, indicating an underlying immune response. The table below summarizes the laboratory findings.

Table 4: Laboratory findings.

Laboratory Findings	Percentage of Patients
Elevated CRP Levels	70%
Abnormal WBC Counts	60%

Among the diagnosed cases, Tuberculous Meningitis (TBM) was the most common diagnosis (35%), followed by Purulent Meningitis (PYO, 25%). Other diagnoses included Viral Meningitis (15%), Herpes Meningitis (10%), Mixed Diagnosis (PYO/TBM, 5%), Dengue (4%), Malaria (3%), Mumps (2%), and Autoimmune Meningitis (1%).

Table 5: Diagnosis of the cases.

Diagnosis	Percentage of Patients
Tuberculous Meningitis (TBM)	35%
Purulent Meningitis (PYO)	25%
Viral Meningitis	15%
Herpes Meningitis	10%
Mixed Diagnosis (PYO/TBM)	5%
Dengue	4%
Malaria	3%
Mumps	2%
Autoimmune Meningitis	1%

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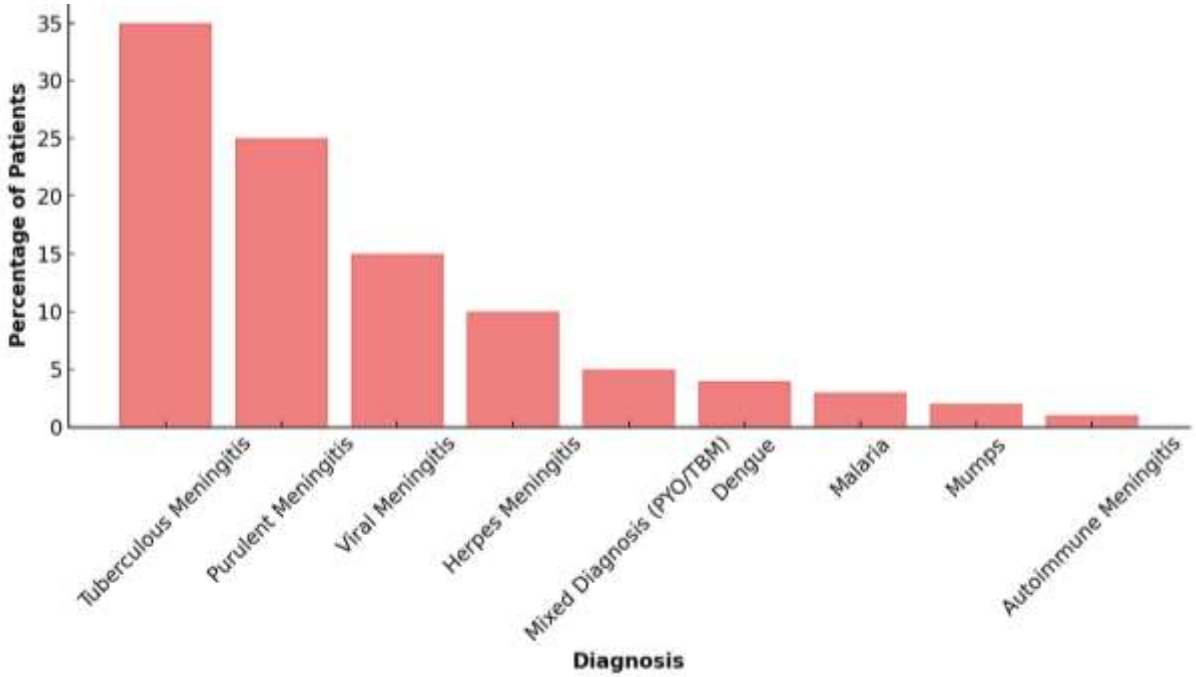

Figure 2: Diagnosis distribution of AME patients.

DISCUSSION.

The study investigated AME across 120 enrolled patients, spanning a wide age range from infancy to old age, with a mean age of 35 years (± 15). Gender distribution revealed 74 male and 46 female participants. Notably, the overall incidence rate of AME was calculated at 15.4 cases per 100,000 population per year, with a marked seasonal trend indicating a peak during the monsoon season, particularly between July and September, which accounted for 40% of total cases.

Pathogen analysis identified viral pathogens in 66.7% of cases, predominantly viral encephalitis virus (50%), while bacterial pathogens were detected in 33.3% of cases, with Nim and Hib being the most prevalent. Common symptoms among AME patients included fever (90%), headache (80%), vomiting (70%), alteration in mental status (60%), and meningeal signs (30%), highlighting the clinical presentation diversity.

Vaccination history revealed that 80% of patients lacked recent viral encephalitis vaccination, underscoring potential preventive strategies. Clinical markers such as elevated C-reactive protein (CRP) levels in 70% of patients and abnormal white blood cell (WBC) counts in 60% suggested an active inflammatory response and underlying immune activation, respectively.

Diagnoses encompassed various etiologies, with Tuberculous Meningitis (TBM) as the most common (35%), followed by Purulent Meningitis (PYO, 25%), emphasizing the multifaceted nature of AME cases. These findings offer comprehensive insights into the epidemiology, clinical characteristics, and potential management approaches for AME within the studied population.

The epidemiological and clinical findings from various studies on acute viral meningoencephalitis, reveal significant insights into the disease's prevalence, etiology, and outcomes. The studies highlight the importance of understanding seasonal patterns, identifying high-incidence areas, and improving diagnostic and treatment approaches to reduce mortality and improve recovery outcomes.

In a study conducted in the sub-Himalayan Tarai region, which shares climatic similarities with Bihar, the mean age of children affected by acute viral meningoencephalitis was 5.2 ± 3.46 years, with a male-to-female ratio of 1.8:1. The study highlighted a seasonal peak in cases during the monsoon, indicating a possible link between climatic conditions and the incidence of the disease. Paramyxovirus (mumps) emerged as the most common virus detected, followed by Japanese encephalitis cases. The case fatality rate for Japanese encephalitis was notably high at 54.55%, particularly affecting the 3-7 years age group. At a 6-month follow-up, a significant portion, 71.4%, of patients were symptom-free, showcasing the potential for recovery with proper care [4].

Another study in Bihar reported 4400 cases of Acute Encephalitis Syndrome (AES) with an average annual case fatality rate of 30% over a six-year study period. Japanese Encephalitis (JE) accounted for 396 cases with a case fatality rate of approximately 14%. The study identified specific districts within Bihar, such as Gaya, Patna, Nawada, Jehanabad, and East Champaran, as

having the highest number of AES and JE cases, with annual prevalence rates ranging significantly, which emphasizes the need for targeted health interventions in these areas [5].

A study from Karnataka found a diverse etiological profile for meningoencephalitis. Tubercular etiology was the most common, accounting for 51.6% of cases, followed by viral (25%), bacterial (21.2%), and fungal causes (2.17%). The study showed that while 50% of patients fully recovered, a significant proportion experienced residual neurological deficits or died, underscoring the severe impact of meningoencephalitis on patient outcomes [6].

The epidemiological report of a study on the AES/JE outbreak in Bihar highlighted the increasing trend of AES cases in the state. The report recorded 928 AES cases and 314 deaths in 2014, up to October 17th, with JE constituting only 2% of the AES cases. The case fatality rate for AES was reported at 34%, indicating a high mortality rate associated with the condition. The report also pointed out that despite JE vaccination, AES cases have not significantly declined, suggesting that other etiological factors contribute to the AES outbreak and that more comprehensive control strategies are required [7].

GENERALIZABILITY.

The study findings can be applied to a larger population, standardized diagnostic and treatment protocols should be implemented across various healthcare settings, expanding surveillance networks to include diverse regions. Public health strategies such as targeted vaccinations during peak seasons and improved disease awareness can be informed by the study. Strengthening healthcare infrastructure, conducting multicenter studies, integrating data for predictive modeling, and training healthcare professionals are essential steps to scale the findings and improve AME management broadly.

CONCLUSION.

The study provides crucial insights into the epidemiology and clinical characteristics of AME in Bihar, India. The incidence rate was 15 cases per 100,000 population per year, with a seasonal peak during the monsoon. Viral pathogens, particularly viral encephalitis virus, accounted for 66.7% of cases, while bacterial pathogens made up 33.3%. Common symptoms included fever, headache, and vomiting. Tuberculous Meningitis was the most common diagnosis, followed by Purulent Meningitis. Elevated CRP levels and abnormal WBC counts indicated active inflammatory responses in many patients. These findings underscore the need for comprehensive surveillance, early detection, targeted vaccination, and tailored public health interventions to effectively manage and reduce the burden of AME.

LIMITATIONS.

The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of a comparison group also poses a limitation for this study's findings.

RECOMMENDATION.

To effectively manage AME outbreaks and lower related morbidity and mortality, strict surveillance, early diagnosis, and increased immunization, particularly against bacterial infections and encephalitis recommended.

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LIST OF ABBREVIATIONS.

AME: Acute Meningitis and Encephalitis
CNS: Central Nervous System
IgM: Immunoglobulin M
CDC: Centers for Disease Control and Prevention
CSF: Cerebrospinal Fluid
PCR: Polymerase Chain Reaction
TBM: Tuberculous Meningitis
PYO: Purulent Meningitis
CRP: C-reactive Protein
WBC: White Blood Cell
Nim: Neisseria meningitidis
Hib: Haemophilus influenzae type b
JE: Japanese Encephalitis
AES: Acute Encephalitis Syndrome

SOURCE OF FUNDING.

No funding was received.

CONFLICT OF INTEREST.

The authors have no competing interests to declare.

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