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To Study Clinico - Virological Profile of Acute Viral Encephalitis Syndrome in Children in Tertiary Care Hospital in North Karnataka

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Abstract

Background: Acute encephalitis syndrome (AES) is an important cause of morbidity and mortality in children and may result from multiple viral etiologies.

Early identification of the clinical and virological profile is essential for appropriate management and prognostication.

Objective: To study the clinico-virological profile, laboratory and neuro imaging findings, and outcomes of children with acute encephalitis syndrome admitted to a tertiary care hospital in North Karnataka.

Methods: A prospective observational study was conducted among children aged 6 months to 12 years admitted with AES to the Pediatric Intensive Care Unit of Karnataka Institute of Medical Sciences, Hubli. A total of 41 children were evaluated. Detailed clinical examination and relevant laboratory investigations were performed. Serum IgM ELISA was used to detect antibodies against Japanese encephalitis virus, HSV-1/2, dengue, mumps, and chikungunya viruses. CSF examination and CT/MRI brain were performed when clinically indicated. Patients were followed until hospital discharge or death.

Results: The study included 41 children, of whom 24 (58.5%) were males. Fever and altered sensorium were present in all patients, while seizures occurred in 68.3%. Mumps was the most frequently identified viral a etiology (22.0%), followed by HSV-1/2 (17.1%), dengue (14.6%), and Japanese encephalitis (4.9%); 41.5% had an unidentified a etiology. Anaemia (61.0%) and hyponatraemia (51.2%) were common laboratory abnormalities. CT was abnormal in 35.0% of those examined, with cerebral oedema being the commonest finding. Among children undergoing MRI, encephalitis was the most frequent abnormality. Overall, 34 (82.9%) children were discharged and 7 (17.1%) died. Meningeal signs, lower GCS, hypoxia, tachypnoea, hypoglycemia, serum sodium abnormalities, and abnormal coagulation profile were significantly associated with poor outcome.

Conclusion: AES in children has a heterogeneous clinical and virological profile. Mumps, HSV, dengue, and Japanese encephalitis were important identified etiologies. Early recognition of severe neurological and systemic abnormalities and prompt supportive management may improve outcomes.

Keywords: Acute Encephalitis Syndrome, Children, Viral Encephalitis, Mumps, HSV, Dengue, Japanese Encephalitis, Virological Profile, Mortality.

Introduction

Acute encephalitis syndrome (AES) is an important neurological emergency in children and remains a major public-health problem in India. It is a clinical syndrome characterized by acute onset of fever with altered mental status and/or new-onset seizures, excluding simple febrile seizures. Because several infectious agents can produce similar clinical manifestations, AES is primarily a syndromic diagnosis requiring subsequent laboratory investigation for etiological identification. [1,2]

The a etiology of AES is diverse and includes viral, bacterial, rickettsial and other infectious agents. Japanese encephalitis virus (JEV) is an important cause of AES in India; however, dengue virus, herpes simplex virus (HSV), mumps virus and other viruses may also contribute to the disease burden. In a large North Indian study of 1,578 AES patients, JEV was the most frequently detected virus, followed by dengue virus, HSV and mumps virus.[3]

The a etiological spectrum of AES varies considerably between geographical regions. Enhanced surveillance in India involving more than 10,000 AES patients demonstrated that an infectious a etiology could be established in approximately half of the cases, with JEV, scrub typhus and dengue among the leading identified causes.[4] Similarly, a large Central Indian study demonstrated considerable heterogeneity in the infectious causes of AES, emphasizing the importance of systematic laboratory investigation.[5]

Dengue is increasingly recognized as an important cause of encephalitic illness. In a four-year multicentric AES surveillance study in India, dengue accounted for approximately 5% of all AES cases and was one of the three leading identified infectious agents. The authors emphasized that dengue testing should be incorporated into routine AES surveillance.[6]

HSV is another clinically important cause because HSV encephalitis can result in severe neurological morbidity and requires early antiviral treatment. Similarly, identification of JEV remains important because Japanese encephalitis is vaccine-preventable and continues to contribute substantially to AES in endemic areas.[3,7]

The clinical severity of AES varies from altered sensorium and seizures to severe encephalopathy,

respiratory compromise, cerebral oedema, coma and death. Neurological examination, assessment of consciousness, respiratory status, Haemodynamic parameters and laboratory abnormalities are therefore important in determining disease severity and prognosis.

Laboratory investigations including complete blood count, serum electrolytes, liver and renal function tests, coagulation profile and CSF examination help identify systemic complications and alternative causes of encephalopathy. Neuro imaging by CT or MRI may demonstrate cerebral o edema, encephalitis, meningitis and other structural abnormalities. Molecular and serological investigations further assist in establishing the infectious aetiology.[2,5]

Despite advances in surveillance and laboratory diagnosis, a considerable proportion of AES cases remain of unknown a etiology. This may be due to limitations in available diagnostic tests, timing of specimen collection, prior treatment and the presence of pathogens not included in routine testing.[4,5]

Therefore, understanding the local clinico-virological profile of AES is important for improving early diagnosis, appropriate treatment and outcome prediction. The present study was undertaken to evaluate the clinico-virological profile of acute viral encephalitis syndrome in children admitted to a tertiary care hospital in North Karnataka, with particular emphasis on clinical presentation, viral a etiology, laboratory and radiological findings, and factors associated with hospital outcome.

Materials and Methods

Study Design and Study Setting

The present study was designed as a prospective observational study conducted in the Department of Pediatrics at Karnataka Institute of Medical Sciences (KIMS), Hubli, Karnataka, India. The study was undertaken among children admitted to the Pediatric Intensive Care Unit (PICU) with a clinical diagnosis of acute encephalitis syndrome (AES). The study aimed to evaluate the clinical profile, etiological spectrum, virological findings, investigations, management, and outcomes of children presenting with AES.

Study Population

The study population comprised children aged 6 months to 12 years who were admitted to the PICU during the study period with clinical features suggestive of AES and who fulfilled the predefined eligibility criteria.

Definition of Acute Encephalitis Syndrome

AES was defined according to the criteria recommended by the National Vector Borne Disease Control Programme (NVBDCP) and the World Health Organization (WHO) as a person of any age, at any time of the year, presenting with acute onset of fever (>38°C) within the preceding 7 days, associated with one or more of the following:

- Altered mental status, including confusion, disorientation, coma, or inability to talk; and/or
- New-onset seizures, excluding simple febrile seizures.

Inclusion Criteria

Children fulfilling the following criteria were included:

1. Age between 6 months and 12 years.
2. Clinical diagnosis of AES according to the predefined criteria.
3. Admission to the PICU of KIMS, Hubli.
4. Parents or legal guardians willing to provide informed consent.

Exclusion Criteria

The following children were excluded:

1. Children with simple febrile seizures.

2. Children with confirmed or clinically diagnosed bacterial meningitis.
3. Children with tuberculous meningitis.
4. Children with cerebral malaria.
5. Children with metabolic encephalopathy or metabolic seizures.
6. Children with immunodeficiency, including HIV infection.
7. Children with suspected poisoning or toxic encephalopathy.

Sample Size

The sample size was estimated based on hospital admission records from the preceding two years. The average number of AES cases admitted per year was approximately 150, giving an estimated study population of approximately 4500 admissions over the relevant period.

The sample size was calculated using the formula:

Where:

- **n** = required sample size
- **Z** = standard normal deviate corresponding to the desired confidence level
- **p** = expected prevalence
- **q** = 1 − p
- **d** = absolute precision

Considering an expected prevalence of 4%, a 99% confidence interval, and an absolute precision of 8%, the calculated sample size was approximately 40 children. Therefore, a final sample size of 40 children with AES was considered for the study.

Sampling Method

Eligible children presenting to the PICU during the study period were enrolled consecutively until the pre determined sample size was achieved.

Data Collection Procedure

After obtaining informed consent, a detailed history was obtained from the parents or accompanying guardians using a structured proforma. Information regarding demographic characteristics, presenting complaints, duration of fever, altered sensorium, seizures, associated symptoms, relevant exposure history, and previous treatment was recorded.

A comprehensive systemic and neurological examination was performed for every enrolled child. Particular attention was paid to the level of consciousness, seizure characteristics, neuro logical deficits, signs of meningeal irritation, abnormal movements, and other features suggestive of encephalitis.

Children were managed according to the clinical condition and institutional treatment protocols, with treatment initiated without unnecessary delay.

Laboratory Investigations

The following investigations were performed during the hospital stay as clinically indicated:

- Complete blood count
- Peripheral blood smear for malaria parasite
- Liver function tests
- Renal function tests
- Blood culture and antimicrobial sensitivity
- Cerebrospinal fluid (CSF) examination
- CSF cytology
- CSF bacterial culture and sensitivity

Additional investigations were performed according to the clinical presentation of individual patients.

Virological Investigations

Serological evaluation was performed using IgM enzyme-linked immunosorbent assay (IgM ELISA) for detection of pathogen-specific antibodies. The following viral infections were investigated:

- Japanese encephalitis virus (JEV)
- Herpes simplex virus types 1 and 2 (HSV-1/HSV-2)
- Dengue virus
- Mumps virus
- Chikungunya virus

The ELISA kits used and their reported diagnostic performance are shown below.

Virological Tests and Diagnostic Performance of IgM ELISA

Sn.	Test	Kit used	Sensitivity	Specificity
1	Anti-Japanese encephalitis virus IgM ELISA	NIV	95%	98%
2	Anti-HSV-1 & HSV-2 IgM ELISA	Novatec	100%	98%
3	Anti-dengue virus IgM ELISA	NIV	98.53%	98.84 %
4	Anti-mumps virus IgM ELISA	Novatec	100%	100%
5	Anti-chikungunya virus IgM ELISA	NIV	95%	98%

Values represent the reported sensitivity and specificity of the respective assay kits.

Cerebrospinal Fluid Examination

Lumbar puncture and CSF examination were performed when clinically appropriate and after excluding contraindications. CSF was assessed for cytological parameters and subjected to bacterial culture and sensitivity testing. The results were interpreted in conjunction with the clinical findings and other laboratory investigations.

Neuro imaging

Computed tomography (CT) and/or magnetic resonance imaging (MRI) of the brain was performed wherever feasible and clinically indicated. Neuro imaging findings were documented and correlated with the clinical diagnosis and outcome.

Treatment and Clinical Management

All enrolled children received supportive and definitive treatment according to their clinical condition and institutional protocols. Management was undertaken in accordance with recommendations of the Indian Academy of Pediatrics (IAP). Appropriate antimicrobial, antiviral, anticonvulsant, antipyretic, fluid, nutritional, respiratory, and other supportive measures were provided as clinically indicated.

Outcome Assessment

Children were followed throughout their hospital stay. The primary outcome assessment included:

- Survival/discharge or death
- Duration of PICU/hospital stay
- Neurological complications
- Residual neurological deficits
- Seizure-related sequelae
- Other clinically significant disabilities at discharge

The final outcome was categorized as favourable outcome when the child survived without significant residual neurological disability and unfavorable outcome when death or significant neurological sequelae/residual disability occurred.

Data Management and Statistical Analysis

All collected data were entered into a structured database and checked for completeness and consistency. Categorical variables were expressed as frequencies and percentages, while continuous variables were

summarized using appropriate measures of central tendency and dispersion.

Where applicable, associations between categorical variables were assessed using the Chi-square test or Fisher's exact test. Continuous variables were compared using appropriate parametric or non-parametric statistical tests depending on data distribution. A p-value <0.05 was considered statistically significant.

Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee of Karnataka Institute of Medical Sciences, Hubli. Written informed consent was obtained from the parents or legal guardians before enrolment. Participation was voluntary, and confidentiality of patient information was maintained throughout the study. All investigations and treatment were performed according to accepted clinical practice, and patient care was not compromised by participation in the study.

Results and Observations

A total of 41 children aged 6 months to 12 years with acute encephalitis syndrome (AES) admitted to the PICU of KIMS, Hubli, during the study period were included in the analysis. The findings are presented in 12 consolidated tables.

Table 1: Sociodemographic Characteristics of Study Participants

Parameter	Category	No	Percentage(%)
Age	6 months–1 year	3	7.3
	1–5 years	19	46.3
	5–12 years	19	46.3
Gender	Male	24	58.5
	Female	17	41.5
Socioeconomic status	Lower class	34	82.9
	Upper middle class	7	17.1
Residence	Dharwad	24	58.5
	Haveri	7	17.1
	Koppal	3	7.3
	Belagavi	2	4.9
	Bijapur	2	4.9
	Raichur	2	4.9
	Gadag	1	2.4

Observation

The majority of children belonged to the 1–5 and 5–12-year age groups (46.3% each). Males constituted 58.5% of the study population, with a male-to-female ratio of approximately 1.4:1. Most participants (82.9%) belonged to the lower socioeconomic class, and 58.5% were residents of Dharwad district.

Table 2: Clinical Features at Admission

Clinical feature	Number	Percentage (%)
Fever	41	100.0
Altered sensorium	41	100.0
Seizures	28	68.3
Vomiting	21	51.2
Headache	14	34.2
Petechial rashes	3	7.3

Observation

Fever and altered sensorium were present in all children. Seizures were documented in 68.3%, followed by vomiting in 51.2%. Headache was reported in 34.2%, while petechial rashes were observed in 7.3% of cases.

Table 3: Immunization Status and Meningeal Signs

Parameter	Category	No	Percentage(%)
Immunization status	Not immunized	2	4.8
	Partiallyimmunized	11	26.8
	Completely immunized	28	68.3
Meningeal signs	Neck rigidity present	4	9.7

	No neck rigidity	37	90.3

Observation

Nearly two-thirds (68.3%) of children were completely immunized, whereas 26.8% were partially immunized and 4.8% were unimmunized. Neck rigidity was present in 9.7% of participants.

Table 4: Vital Parameters at Admission

Parameter	Category	No	Percentage(%)
GCS	Mild impairment	5	12.1
	Moderate impairment	24	58.5
	Severe impairment	12	29.3
SpO_2	Normal	23	56.1
	Hypoxia	18	43.9
Heart rate	Normal	17	41.5
	Tachycardia	22	53.7
	Bradycardia	2	4.9
Pulse volume	Normal	36	87.8
	Feeble	5	12.2
Respiratory rate	Normal	31	75.6
	Tachypnoea	10	24.4
Blood pressure	Normal	25	61.0
	Hypotension	14	34.1
	Hypertension	2	4.9
GRBS	Normal	40	97.6
	Hypoglycemia	1	2.4

Observation

Moderate GCS impairment was most frequent (58.5%), while severe impairment was present in 29.3%. Hypoxia occurred in 43.9% and tachycardia in 53.7%. Hypotension was observed in 34.1%, whereas hypoglycaemia was uncommon (2.4%).

Table 5: Laboratory Parameters at Admission

Laboratory parameter	Category	No	Percentage (%)
Haemoglobin	Normal	16	39.0
	Anaemia	25	61.0
Total count	Normal	37	90.2
	Leucopenia	4	9.8
Platelets	Normal	29	70.7
	Thrombocytopenia	12	29.3
Serum sodium	Normal	18	43.9
	Hyponatraemia	21	51.2
	Hypernatraemia	2	4.9
Serum potassium	Normal	33	80.5
	Hypokalaemia	8	19.5
Liver enzymes	Normal	35	85.4
	Abnormal	6	14.6
PT	Normal	30	73.2
	Abnormal	11	26.8
INR	Normal	31	75.6
	Abnormal	10	24.4

Observation

Anaemia was the most frequent haematological abnormality (61.0%), followed by hyponatraemia (51.2%) and thrombocytopenia (29.3%). Abnormal PT and INR were observed in 26.8% and 24.4%, respectively.

Table 6: Virological Profile of Study Participants

Virological profile	Number	Percentage (%)
Mumps	9	22.0
HSV-1/2	7	17.1
Dengue	6	14.6
Japanese encephalitis	2	4.9
Unknown a etiology	17	41.5
Total	41	100.0

Observation: Among the identified viral a etiologies, mumps was the most common (22.0%), followed by HSV-1/2 (17.1%), dengue (14.6%) and Japanese encephalitis (4.9%). No chikungunya infection was detected. Confection with dengue and HSV was reported in two children, while one child had dengue, mumps and HSV co infection.

Table 7: Neuro imaging Findings

Investigation	Finding	No	Percentage (%)
CT brain (n=40)	Normal	26	65.0
	Cerebral oedema	6	15.0
	Meningitis	4	10.0
	Arachnoid cyst	1	2.5
	Basal hypodensity	1	2.5
	Diffuse hypodensity	1	2.5
	Effacement	1	2.5
MRI brain (n=8)	Normal	2	25.0
	Encephalitis	2	25.0
	ADEM	1	12.5
	Encephalopathy	1	12.5
	Meningitis	1	12.5
	Right parietal hypodensity	1	12.5

Observation

CT was normal in 65.0% of children who underwent scanning. Cerebral oedema was the most frequent abnormal CT finding. Among MRI examinations, encephalitis was the most frequent finding (25.0%).

Table 8: Cerebrospinal Fluid Findings

CSF parameter	Finding	No	Percentage (%)
Cells	Normal	41	100.0
Lymphocytes	Present	41	100.0
Neutrophils	Present	1	2.4
Glucose	Reduced	8	19.5
	Normal	33	80.5
Protein	Normal	41	100.0
Culture	No bacterial growth/normal	41	100.0

Observation

CSF cell counts and protein levels were within normal limits in all participants. Lymphocytes were present in all cases, while neutrophils were detected in one child. Reduced CSF glucose was observed in 19.5%.

Table 9: Hospital Outcome

Outcome	Number	Percentage (%)
Discharged	34	82.9
Death	7	17.1
Total	41	100.0

Observation

Of the 41 children, 34 (82.9%) were discharged, whereas 7 (17.1%) died during hospitalisation.

Table 10: Association of Clinical and Laboratory Parameters with Virological Profile

Parameter	p-value	Statistical significance
Age	0.82	Not significant
Gender	0.29	Not significant
Socioeconomic status	0.72	Not significant
Residence	0.56	Not significant
Rashes	>0.05	Not significant
Meningeal signs	0.001	Significant
Immunization status	0.50	Not significant
GCS	0.43	Not significant
SpO_2	0.98	Not significant
Heart rate	0.60	Not significant
Respiratory rate	<0.001	Significant
Blood pressure	0.04	Significant
GRBS	0.20	Not significant
Haemoglobin	0.05	Borderline
Platelets	0.63	Not significant

Serum sodium	0.44	Not significant
Serum potassium	0.13	Not significant
Coagulation profile	0.36	Not significant
CT findings	0.23	Not significant
MRI findings	0.04	Significant
Outcome	0.38	Not significant

Observation

Meningeal signs, respiratory rate, blood pressure and MRI findings showed statistically significant differences across the virological groups. Other demographic, clinical and laboratory variables did not demonstrate statistically significant differences.

Table 11: Association of Clinical and Laboratory Parameters with Hospital Outcome

Parameter	p-value	Statistical significance
Age	0.05	Borderline
Gender	0.93	Not significant
Socioeconomic status	0.38	Not significant
Residence	0.45	Not significant
Meningeal signs	0.001	Significant
Immunization status	0.21	Not significant
GCS	0.01	Significant
Hypoxia	0.01	Significant
Heart rate	0.89	Not significant
Tachypnoea	<0.001	Significant
Hypoglycaemia	0.03	Significant
Blood pressure	0.16	Not significant
Anaemia	0.82	Not significant
Thrombocytopenia	0.08	Not significant
Serum sodium	0.006	Significant
Serum potassium	0.51	Not significant
Coagulation profile	0.04	Significant
CT findings	0.16	Not significant
MRI findings	0.45	Not significant

Observation

Mortality was significantly associated with the presence of meningeal signs, lower GCS, hypoxia, tachypnoea, hypoglycemia, serum sodium abnormalities and abnormal coagulation profile. These findings indicate that neurological and systemic physiological derangements were important markers of poor outcome.

Table 12: Comparison of Major Clinical Features Between Survivors and Non-survivors

Parameter	Deaths (n=7)	Discharged (n=34)	p-value
Meningeal signs present	3 (42.9%)	1 (2.9%)	0.001
Severe GCS	5 (71.4%)	7 (20.6%)	0.01
Hypoxia	6 (85.7%)	12 (35.3%)	0.01
Tachypnoea	6 (85.7%)	4 (11.8%)	<0.001
Hypoglycaemia	1 (14.3%)	0 (0.0%)	0.03
Hyponatraemia	3 (42.9%)	18 (52.9%)	0.006
Abnormal coagulation profile	4 (57.1%)	7 (20.6%)	0.04
Thrombocytopenia	4 (57.1%)	8 (23.5%)	0.08
Abnormal CT	4 (57.1%)	10 (29.4%)	0.16
Abnormal MRI	1 (14.3%)	5 (14.7%)	0.45

Discussion

The present prospective observational study evaluated 41 children with acute encephalitis syndrome admitted to the PICU of Karnataka Institute of Medical Sciences, Hubli. The study demonstrated a heterogeneous virological profile, with mumps, HSV-1/2, dengue and Japanese encephalitis identified among the cases. Important neurological, respiratory, metabolic and haematological abnormalities were also observed, and several clinical parameters were significantly associated with mortality.

In the present study, children aged 1–5 years and 5–12 years constituted the largest proportion of participants,

accounting for 46.3% each. Children aged 6 months–1 year constituted only 7.3%. Male children predominated, comprising 58.5% of the study population, with a male-to-female ratio of approximately 1.4:1. A similar male predominance has been reported in previous Indian AES studies. Jain et al., in a North Indian study of 1,578 patients, evaluated the demographic distribution and reported AES across all paediatric age groups with variation in sex distribution.[3]

A substantial majority of children in the present study belonged to the lower socioeconomic group (82.9%). Most participants were residents of Dharwad district, reflecting the geographical referral pattern of the study hospital. However, socioeconomic status and residence did not show a statistically significant association with viral a etiology or outcome in the present study.

Fever and altered sensorium were present in all 41 children, consistent with the clinical definition of AES. Seizures were present in 68.3%, followed by vomiting (51.2%) and headache (34.2%). These findings are consistent with the typical clinical spectrum of AES, in which fever, altered consciousness and seizures constitute the major presenting manifestations. Previous Indian studies have similarly reported seizures and altered sensorium as common clinical features among AES patients.[3]

Meningeal signs were present in 9.7% of the children. Importantly, the presence of meningeal signs showed a statistically significant association with both virological profile and hospital outcome in the present study. Among children who died, meningeal signs were present in 42.9%, compared with only 2.9% among discharged children. This suggests that the presence of meningeal irritation may indicate more severe neurological involvement.

Regarding immunization, 68.3% of children were completely immunized, 26.8% were partially immunized and 4.8% were unimmunized. The occurrence of AES among immunized children emphasizes that vaccination against individual pathogens does not eliminate the broader AES syndrome because multiple infectious agents can produce clinically similar encephalitic illness. The North Indian study by Jain et al. also demonstrated a broad viral spectrum including JEV, dengue, HSV and mumps, highlighting the heterogeneous nature of AES.[3]

Neurological impairment at admission was considerable. Moderate GCS impairment was observed in 58.5% and severe impairment in 29.3% of children. Severe GCS impairment was significantly associated with mortality. Among the seven children who died, five (71.4%) had severe GCS impairment compared with seven (20.6%) among discharged children. This finding indicates that the level of consciousness at admission is an important marker of disease severity and prognosis.

Respiratory abnormalities were also frequent. Hypoxia was present in 43.9% of children and tachypnoea in 24.4%. Both hypoxia and tachypnoea were significantly associated with outcome. Among non-survivors, 85.7% had hypoxia and 85.7% had tachypnoea. These findings suggest that respiratory compromise accompanies severe neurological disease and may contribute to adverse outcomes. Anaemia was the most common haematological abnormality, affecting 61% of children, while thrombocytopenia was observed in 29.3%.

Hyponatraemia was present in 51.2% of participants and was significantly associated with outcome. Electrolyte abnormalities are clinically important in encephalitic illness because disturbances in sodium balance may aggravate neurological dysfunction and contribute to cerebral complications.

The virological profile was an important finding of the present study. Mumps was the most frequently identified viral infection (22.0%), followed by HSV-1/2 (17.1%), dengue (14.6%) and Japanese encephalitis (4.9%). However, 41.5% of children had an unknown a etiology. This finding is consistent with larger Indian surveillance studies showing that a substantial proportion of AES cases remain without a definitive laboratory diagnosis.[4,5] The predominance of mumps in the present study differs from larger Indian studies. Jain et al. reported JEV as the most common viral agent (16.2%), followed by dengue (10.8%), HSV (9.3%) and mumps (8.7%) among 1,578 AES patients in North India.[3] The differences may be related to geographical variation, differences in vaccination coverage, study population, sample size, study period and diagnostic methodology.

HSV-1/2 accounted for 17.1% of cases in the present study. This proportion is higher than that reported by Jain et al., where HSV was identified in 9.3% of AES patients.[3] The identification of HSV is clinically important because HSV encephalitis is potentially treatable and delayed antiviral therapy can result in severe neurological sequelae. Dengue accounted for 14.6% of cases in the present study. This is higher than the 5.2% reported in a large multicentric Indian surveillance study by Vasanthapuram et al.[6] Their study, which included 10,107 AES patients, demonstrated that dengue was one of the three leading identified causes of AES and emphasized the need for routine dengue testing in AES. The relatively high proportion in the present study may reflect regional epidemiological differences and the small sample size.

Japanese encephalitis was detected in 4.9% of children. Although this proportion was relatively low compared with some Indian surveillance studies, JEV remains an important cause of AES. Jain et al. reported JEV positivity in 16.2% of AES patients in North India.[3] The lower proportion observed in the present study may be related to the limited sample size and local epidemiological characteristics.

Co-infections were detected in three children, comprising two dengue-HSV co-infections and one dengue-mumps-HSV co-infection. Although the number was small, the finding supports the concept that AES may occasionally result from more than one detectable infectious agent. Co-positivity has also been documented in previous Indian AES surveillance.[3,6]

Neuro imaging showed that CT was normal in 65% of the children who underwent scanning, while cerebral oedema was the most frequent abnormal CT finding. Among the eight children who underwent MRI, encephalitis was the most common finding. MRI abnormalities showed a statistically significant association with virological profile in the present study. These findings emphasize the complementary role of neuro imaging in evaluating children with severe AES.

CSF examination revealed relatively limited abnormalities. CSF cell counts and protein were within normal limits in all participants, while reduced glucose was present in 19.5%. The relatively normal CSF profile in many children demonstrates that normal or minimally abnormal CSF findings do not exclude viral encephalitis and that etiological diagnosis should be based on a combination of clinical and laboratory findings.

The overall mortality in the present study was 17.1%, with 82.9% of children discharged. Mortality was significantly associated with several indicators of severe disease, including meningeal signs, severe GCS impairment, hypoxia, tachypnoea, hypoglycemia, serum sodium abnormalities and abnormal coagulation profile.

In contrast, gender, socioeconomic status, residence, platelet count, potassium level and CT findings did not show statistically significant associations with outcome.

The association between severe neurological impairment and mortality is particularly important. Five of the seven deaths occurred in children with severe GCS impairment. Similarly, respiratory compromise was prominent among non-survivors. These observations indicate that the severity of neurological and systemic physiological dysfunction at admission may be more important in determining short-term outcome than the specific viral a etiology alone.

The large proportion of cases with unknown aetiology remains an important finding. In the multicentric surveillance study by Vasanthapuram et al., an infectious cause was identified in only 49.2% of AES cases despite extensive testing.[6] More recent Indian surveillance data have also demonstrated substantial variability in pathogen positivity depending on the organism tested and the diagnostic platform used.[8] This emphasises the need for broader molecular diagnostic panels and improved laboratory surveillance.

Overall, the present study demonstrates that AES in children in North Karnataka has a diverse clinico-virological spectrum. Mumps, HSV and dengue were important identified viral causes, while a considerable proportion of cases remained undiagnosed. Early recognition of severe neurological impairment, respiratory compromise, electrolyte abnormalities and coagulation disturbances may help identify children at higher risk of mortality and facilitate timely intensive care.

Conclusion

The present study demonstrates that acute encephalitis syndrome in children has a diverse clinical and virological profile, with mumps, HSV-1/2, dengue, and Japanese encephalitis identified among the confirmed viral etiologies. Fever and altered sensorium were universal, while seizures, hypoxia, anaemia, and hyponatraemia were frequent findings. Meningeal signs, severe GCS impairment, hypoxia, tachypnoea, hypoglycaemia, serum sodium abnormalities, and abnormal coagulation profiles were significantly associated with poor outcome. The overall mortality was 17.1%. Early recognition of neurological and systemic abnormalities, timely virological evaluation, and prompt supportive management are essential to improve outcomes in children with AES.

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