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Original Research Article

Diagnostic utility of cerebrospinal fluid analysis in children presenting with acute neurological emergencies at a tertiary care hospital

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ABSTRACT

Background: Acute neurological emergencies include a wide range of conditions with variable and overlapping clinical presentations, making clinical diagnosis challenging. Advances in cerebrospinal fluid (CSF) analysis, serum antibody testing and neuroimaging have improved diagnostic accuracy. This study aimed to analyse the differentiating clinical, laboratory and neuroimaging features in children with various neurological emergencies.
Methods: It was prospective observational study in children aged 1 month to 18 years between July 2022 and June 2024 presenting with acute neurological emergencies necessitating CSF analysis. Data were collected and analysed using IBM SPSS version 29.
Results: Of the total (135), 37% were infants. CNS infections were most common (67; 49.6%), followed by demyelinating disorders (33; 24.4%), autoimmune encephalitis (7; 5.2%), metabolic encephalopathy (2; 1.5%) and other diagnoses (26; 19.3%). Bacterial meningitis (28.4%) and acute demyelinating encephalomyelitis (45.5%) were the most common conditions in their respective groups. Fever and lethargy predominated in CNS infections and demyelinating disorders. Key features in ADEM were difficulty in walking (45.5%) and acute onset weakness (45.5%). Altered sensorium (71.4%) and altered behaviour (42.9%) were predominant in autoimmune encephalitis. 93.3% ADEM and 87.5% optic neuritis were MOG (Myelin Oligodendrocyte Glycoprotein) antibody positive with MRI abnormalities (90.9%). 47% autoimmune encephalitis positive for anti-NMDAR (N-methyl-D-aspartate receptor) antibody with EEG (electroencephalogram) abnormalities (57.1%).
Conclusions: Serum antibody testing aids in diagnosing demyelinating and autoimmune disorders, while CSF polymerase chain reaction (PCR) helps identifying pathogens in culture-negative CNS infections. CSF analysis has limited utility in noninfective conditions.

Keywords: Acute neurological emergencies, Autoimmune encephalitis, CSF analysis, CNS infections, Demyelinating disorders

INTRODUCTION

Common acute neurological emergencies include stroke, infections, seizures, autoimmune conditions, metabolic imbalances, intracranial haemorrhage, hydrocephalus.[1] Acute neurological emergencies are a wide spectrum and their presentation vary with age. The variables include irritability, fever, excessive cry, lethargy in younger infants and headache, nausea, vomiting, neck stiffness, altered mental status, seizures, behavioural changes, visual disturbances or focal neurological symptoms in older children.[1] Acute onset fever with alteration in level

of consciousness with or without seizures is an important cause of hospital admissions among children in many parts of India.[2] It is mainly caused either by invasion of brain by infectious agent–virus, bacteria, protozoa, rickettsia, mycoplasma etc or by a host of non-infectious brain inflammations, infectious encephalopathies and other functional (such as toxic or metabolic encephalopathy) and structural brain disorders if associated with fever due to another cause.[3]

Both infective and noninfective conditions can have overlapping clinical findings and often difficult to diagnose clinically. CSF analysis and neuroimaging are often warranted in these children. Although advances in CSF analysis, serum antibody testing and neuroimaging have improved diagnostic precision, comparative pediatric studies evaluating these modalities across multiple neurological emergencies remain limited. In our study, we analysed the utility of CSF analysis in children with acute neurological conditions such as CNS infections, demyelinating disorders, autoimmune encephalitis, metabolic encephalopathy.

The following figure gives an overview of how acute neurological emergencies are classified (Figure 1).

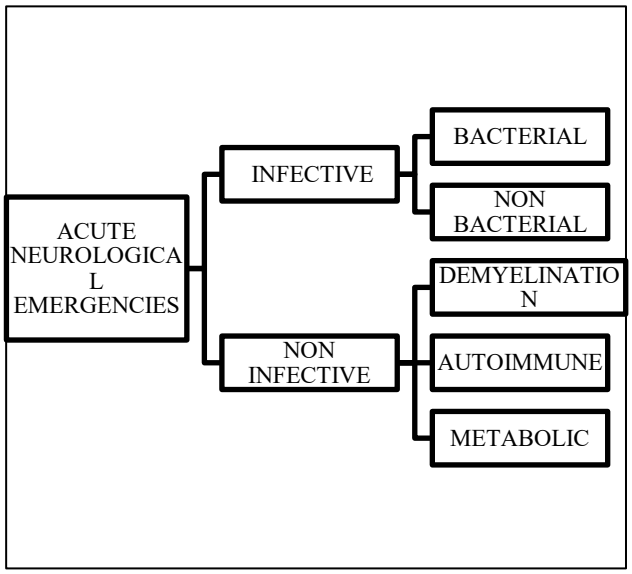

Figure 1: Classification of acute neurological emergencies in children.

Authors aimed to study the diagnostic utility of CSF analysis in children between 1 month and 18 years of age presenting with acute neurological emergencies. This study analyzed the differentiating clinical, laboratory and neuroimaging features in children with various neurological emergencies.

METHODS

This was a prospective observational study conducted in all children between 1 month and 18 years of age from July 2022 to June 2024 in our tertiary pediatric referral centre. This study included all children between 1 month and 18 years of age presenting with acute neurological emergencies requiring CSF analysis. For the purpose of the study, duration of symptoms less than 2 weeks was included. Children with clinical suspicion of one or more of the following conditions such as CNS infections, Demyelinating disorders, Autoimmune disorders, Metabolic disorders were included in our study group. Children who undergo CSF analysis for reasons other than acute neurological presentations like therapeutic Lumbar puncture (Pseudo tumour cerebri/ CNS chemotherapy) were excluded from our study. Any child with acute neurological symptoms who did not undergo CSF analysis were excluded.

The study was approved by institutional ethics committee (Approval No. KKCTH-CTMRF: IEC-PG THESIS/85/July 2022). Informed written consent was obtained from all parents /guardians of all study participants before recruitment in the study. A comprehensive medical history was obtained, followed by a thorough general and systemic examination and the final diagnosis was recorded. All cases underwent complete CSF analysis; relevant hematological investigations and some children underwent EEG and neuroimaging. The data obtained were tabulated and analysis was carried out using IBM SPSS Statistics Software version 29. For all statistical tests, a p-value of less than 0.05 was considered statistically significant.

RESULTS

135 children were enrolled during the study period. Among the study population, 50 children (37.0%) were infants aged less than one year, followed by 33 (24.4%) children aged 5–10 years, 28 (20.7%) aged 1–5 years and 24 (17.8%) aged 10–18 years. The association between age group and final diagnostic category was found to be statistically significant (Chi-square test, $p<0.001$). This age-specific distribution has important clinical implications, as it is an important predictor of the underlying etiology of pediatric neurological emergencies and can aid clinicians in prioritizing differential diagnoses, selecting appropriate investigations and initiating timely management (Table 1).

Males constituted 65.9% (n=89), while females accounted for 34.1% (n=46). Among 135 children, 67 children had CNS infections, accounting for 49.6% of the total cases. Demyelinating disorders were observed in 33 (24.4%) children, autoimmune encephalitis was diagnosed in 7 (5.2%) children and metabolic disorders were identified in 2 (1.5%) children. The remaining 26 children, who underwent CSF analysis, were found to have various other diagnoses (Table 2).

Among the 67 children with CNS infections, bacterial meningitis was the most frequent diagnosis (28.4%), followed by partially treated meningitis (25.4%), viral meningoencephalitis (19.4%) and aseptic meningitis

(14.9%). The diagnosis of partially treated meningitis was based on compatible clinical presentation and CSF characteristics of bacterial meningitis despite negative microbiological tests, likely attributable to prior antibiotic exposure before CSF analysis (Table 3).

Among bacterial meningitis cases, pneumococcal meningitis was the most common etiology (26.3%), followed by non-typhoidal *Salmonella meningitis* (15.8%). The most common cause of viral meningoencephalitis was enterovirus (61.6%), followed by HSV (30.8%). Among the 33 children with demyelinating disorders, ADEM was the predominant diagnosis (45.5%), followed by optic neuritis (24.2%) (Table 4).

Fever (94.0%), lethargy (89.6%), poor feeding (71.6%) and seizures (61.2%) were the most common symptoms among children with CNS infections. Among demyelinating disorders, fever (72.7%) and lethargy (57.6%) were the predominant symptoms, while difficulty in walking and acute-onset weakness was observed in 45.5% of cases each. In autoimmune encephalitis, lethargy (85.7%), seizures (71.4%) and altered sensorium (71.4%) were the most frequent presenting manifestations.

Severe neurological impairment, reflected by glasgow coma scale ≤8/15, was most frequent in autoimmune encephalitis. Bulging anterior fontanelle was present in 57.2% of CNS infection cases among children younger than 18 months of age. Meningeal signs were most frequently observed in CNS infections (22.4%).

Peripheral Blood Leucocytosis (TLC ≥11000/µl) was more commonly observed among children with CNS infections, accounting for 45 cases (67.2%), followed by demyelinating disorders with 21 cases (63.6%) and other conditions with 15 cases (57.7%). In contrast, normal TLC (<11000/µl) was more frequently noted in autoimmune disorders, seen in 4 cases (57.1%). Similarly, elevated ANC (≥4500/µl) was predominantly observed in CNS infections, comprising 54 cases (80.6%), while lower ANC values (<4500/µl) were relatively more common among autoimmune disorders (57.1%). The association of elevated TLC and ANC with CNS infectious etiologies was statistically significant (p=0.002 for TLC and p=0.001 for ANC) (Table 5).

Analysis of CSF appearance demonstrated that turbid CSF was predominantly associated with CNS infections, observed in 41 cases (61.2%), whereas clear CSF was seen in 26 cases (38.8%). In contrast, clear CSF was the predominant finding in demyelinating disorders (87.9%), autoimmune disorders (100%), metabolic conditions (100%) and other neurological conditions (88.5%). Turbid CSF was infrequently observed in demyelinating disorders (12.1%) and other conditions (11.5%), while no cases of turbidity were noted in autoimmune or metabolic disorders. The difference in CSF appearance across diagnostic groups was statistically highly significant (p<0.001) (Table 6).

Reduced CSF glucose levels (<2/3rd of blood glucose) were predominantly observed in CNS infections, accounting for 52 cases (77.6%), followed by demyelinating disorders with 18 cases (54.5%). All metabolic cases (100%) demonstrated low CSF glucose levels. Conversely, normal CSF glucose levels (≥2/3rd of blood glucose) were more commonly observed in autoimmune disorders, seen in 5 cases (71.4%) and other neurological conditions, accounting for 20 cases (76.9%). The association between reduced CSF glucose levels and CNS infectious conditions was statistically significant (p <0.001) (Table 7).

The white blood cell (WBC) count in cerebrospinal fluid (CSF) was high (≥ 10 cells/cu.mm) among CNS infection cases (85.1%), followed by demyelinating disorders (51.5%). Among CNS Infection cases, 66.7% had lymphocyte predominance in cerebrospinal fluid. Among bacterial meningitis cases, diagnosis was established by CSF culture in 68.5%, CSF-PCR in 15.7%, serum IgM in 10.5% and CSF-NGS in 5.3%.

Serum MOG antibody positivity was remarkably high in acute disseminated encephalomyelitis (93.3%) and optic neuritis (87.5%). Additionally, 47% of autoimmune encephalitis were CSF anti–NMDAR (N-methyl-D-aspartate receptor) antibody positive. Among the 33 children with demyelinating disorders, all underwent MRI and abnormalities were detected in 30 children (90.9%). Among the 67 children with CNS infections, 60 underwent MRI, of whom 31 (51.7%) had abnormal findings. All seven children with autoimmune encephalitis underwent EEG, which demonstrated abnormalities in four children (57.1%).

Table 1: Age group distribution of children among various conditions.

Age group (in years)	Final group										Total		P value
	CNS infection		Demyelination		Autoimmune		Metabolic		Others				
	N	%	N	%	N	%	N	%	N	%	N	%	
<1	36	53.7	2	6.1	2	28.6	2	100	8	30.8	50	37	
1-5	12	17.9	7	21.2	0	0	0	0	9	34.6	28	20.7	
5-10	12	17.9	13	39.4	1	14.3	0	0	7	26.9	33	24.4	<0.001
10-18	7	10.4	11	33.3	4	57.1	0	0	2	7.7	24	17.8	
Total	67	100	33	100	7	100	2	100	26	100	135	100	

Table 2: Distribution of final diagnosis in children who underwent CSF analysis.

Groups	N	%
CNS infections	67	49.6
Demyelinating disorders	33	24.4
Autoimmune disorders	7	5.2
Metabolic disorders	2	1.5
Others	26	19.3

Table 3: Etiological distribution of CNS infections (n=67).

CNS infections	N	%
Aseptic meningitis	10	14.9
Bacterial meningitis	19	28.4
Dengue encephalopathy	3	4.5
Partially treated meningitis	17	25.4
Subacute sclerosing panencephalitis (SSPE)	3	4.5
Tubercular (TB) meningitis	2	3.0
Viral meningoencephalitis	13	19.4
Total	67	100.0

Table 4: Distribution of demyelinating disorders (n=33).

Demyelinating disorders	N	%
Acute transverse myelitis	4	12.1
ADEM	15	45.5
Multiple sclerosis	2	6.0
Optic neuritis	8	24.2
Guillain barre syndrome (GBS)	4	13.1
Total	33	100.0

Table 5: Total leucocyte count and absolute neutrophil count in various groups.

Parameter		CNS infections		Demyelination		Autoimmune		Others		P value
		N	%	N	%	N	%	N	%	
TLC	**<11000 /µl**	22	32.8	12	36.4	4	57.1	11	42.3	0.002
	≥11000/µl	45	67.2	21	63.6	3	42.9	15	57.7	
ANC	**<4500/µl**	13	19.4	12	36.4	4	57.1	8	30.8	0.001
	≥4500/µl	54	80.6	21	63.6	3	42.9	18	69.2	

Table 6: Appearance of cerebrospinal fluid across diagnostic groups.

CSF appearance	CNS infections		Demyelination		Autoimmune		Metabolic		Others		P value
	N	%	N	%	N	%	N	%	N	%	
Clear	26	38.8	29	87.9	7	100	2	100	23	88.5	<0.001
Turbid	41	61.2	4	12.1	0	0	0	0	3	11.5	

Table 7: Glucose level in CSF among diagnostic groups.

Glucose level in CSF (mg/dl)	CNS infections		Demyelination		Autoimmune		Metabolic		Others		P value
	N	%	N	%	N	%	N	%	N	%	
< 2/3rd of blood glucose	52	77.6	18	54.5	2	28.6	2	100	6	23.1	<0.001
≥ 2/3rd of blood glucose	15	22.4	15	45.5	5	71.4	0	0	20	76.9	

Table 8: Significance of myelin oligodendrocyte glycoprotein (MOG) antibody testing in demyelinating disorders.

Acute disseminated encephalomyelitis	N	%
Antibody negative encephalomyelitis	1	6.7
MOG Ab positive encephalomyelitis	14	93.3
Total	15	100.0
Optic neuritis		
MOG Ab positive optic neuritis	7	87.5
Antibody negative optic neuritis	1	12.5
Total	8	100.0

DISCUSSION

In the current study, demyelinating disorders were more common in the 5–10 age range (39.4%), while CNS infections were more common in children under a year old (53.7%). The majority of older children with autoimmune disorders (57.1%) were between the ages of 10 and 18. Singhi et al reported similar results, showing that newborns and younger children presenting with neurological emergencies had a much higher incidence of CNS infections.[4] Likewise, Garg et al documented that demyelinating and autoimmune neurological disorders predominantly affect older children and adolescents.[5] Among the 67 children with CNS infections in our study, 44 (65.7%) received antibiotics prior to CSF analysis. In contrast, a study conducted by Adhikari et al showed that among 114 cases with CNS infections, 49 children (43%) had received intravenous antibiotics before the initial lumbar puncture.[6]

Among the 19 children with bacterial meningitis, CSF cultures were positive in 13 (68.5%). Polymerase chain reaction (PCR) testing, performed in nine children, identified pathogens in three cases (15.8% of the total cohort). Additionally, serum IgM testing confirmed leptospirosis and scrub typhus in one child each (5.3%) and next-generation sequencing (NGS) identified Salmonella enterica in one child (5.3%). In a study conducted by Welinder-Olsson et al among 74 children diagnosed with bacterial meningitis, 26 patients had CSF specimens positive by PCR and 14 patients had specimens positive by culture.[7] A number of factors such as prior antibiotic therapy and frequency of samples subjected to culture and PCR testing can influence the rate of CSF culture positivity and positive PCR results.

In bacterial meningitis, the most common clinical presentations were lethargy (100%), fever (94.7%), poor feeding (84.2%) and seizures (73.7%). Leucocytosis in the peripheral blood was common, observed in 73.7% of the cases and 84.2% had neutrophilia. CRP was positive in 84.2% of the cases. The CSF appeared turbid in 16 children (84.2%). CSF analysis revealed low glucose and high protein levels in 17 children (89.5%). CSF leucocytosis was observed in 18 children (94.7%), with neutrophil predominance in 61.1% of these cases.

In a comparable study conducted in Vietnam by Nguyen-Huu et al involving 33 children with bacterial meningitis, the most common clinical presentations were fever (93.9%), vomiting (60.6%), poor feeding (48.5%) and seizures (41.4%).[8] Peripheral blood leucocytosis was observed in 18.2% of the cases, with neutrophilia in 48.5% of these instances. CRP was positive in 72.7% of the cases. The CSF appeared turbid in 18 children (54.5%). CSF analysis showed low glucose levels in 30.3% of the cases and high protein levels in 97%. CSF leucocytosis was observed in all children (100%), with a predominance of neutrophils.

The current study showed that children with CNS infections had considerably higher TLC and ANC, indicating an active systemic inflammatory response. Molyneux et al found similar results, reporting significant neutrophilia and leucocytosis in children bacterial CNS infections.[9] Similarly, Nigrovic et al found significantly elevated peripheral blood leukocyte counts among children with meningitis compared to non-infectious neurological disorders.[10]

In the study, among 67 children with CNS infections, 10 were diagnosed with aseptic meningitis. The common symptoms among these children were fever (90%), lethargy (80%), poor feeding (60%), seizures (50%) and vomiting (50%). CSF analysis showed pleocytosis in 90% of cases, with lymphocytic predominance in 90% of these instances. Low glucose and high protein levels in CSF were observed in 60% and 50% of the cases, respectively. All CSF samples sent for PCR assays were found to be negative. Notably, one child with aseptic meningitis was also diagnosed with Kawasaki disease.

In a comparable study conducted by Shukla et al among 105 children with aseptic meningitis, the common presentations were fever (86.7%), vomiting (74.8%) and headache (60%).[11] CSF analysis was consistent with an infective aetiology in all children. All CSF samples sent for PCR assays were negative. In the study, three children were diagnosed with SSPE and all had a history of primary measles infection (100%). The common presentations at admission included movement disorders (100%), altered behaviour (66.7%) and seizures (66.7%). Measles-specific IgG antibodies in CSF were detected in all 3 cases (100%) and EEG abnormalities were observed

in all patients (100%). Among 67 cases of CNS infections, 13 children were diagnosed with viral meningoencephalitis. The most common virus causing meningoencephalitis was enterovirus (61.6%), followed by HSV (30.8%). Additionally, one child was diagnosed with adenoviral meningoencephalitis.

Among the four children diagnosed with HSV encephalitis, the most common presentations at admission were fever, seizures and lethargy, observed in all children (100%). CSF analysis showed lymphocytic pleocytosis in all cases, with universally low glucose and high protein levels. HSV-PCR testing in CSF was positive in all children and MRI brain was also abnormal in all cases (100%). In a study conducted by Salih et al among 18 children with HSV encephalitis, most common presenting symptoms were fever (100%), seizures (72%) irritability (50%) and weakness (39%).[12] CSF pleocytosis was found in 62% and raised proteins in 52% and HSV by PCR testing was positive in 50% (6/12). MRI revealed abnormalities in 91% (10/11).

In our study, eight children were diagnosed with enteroviral meningoencephalitis. The common presentations at admission were fever (100%), lethargy (100%), poor feeding (62.5%) and seizures (37.5%). CSF analysis showed pleocytosis in all children, with lymphocyte predominance in 75% of these cases. MRI brain abnormalities were noted in three children (37.5%). A study conducted by Shahroodi et al showed that out of 23 children with suspected meningitis, 8 were diagnosed with enteroviral meningoencephalitis.[13] CSF pleocytosis was observed in 75% of these cases, with neutrophil predominance noted in 33% of instances.

In the current investigation, clear CSF was more frequently seen in demyelinating, autoimmune, metabolic and other neurological diseases, whereas turbid CSF was primarily linked to CNS infections (61.2%). Similar results were reported by Tunkel et al who claimed that increased inflammatory cells and protein content in pyogenic meningitis commonly result in turbid CSF.[14] Similarly, Kaplan et al found that while non-infectious diseases typically show clear CSF, bacterial meningitis frequently shows murky or turbid CSF.[15]

In this study, the majority of CNS infections (77.6%) had lower CSF glucose levels (less than two thirds of blood glucose). Brouwer et al observed similar findings, identifying hypoglycorrhachia as a significant indicator of tubercular and bacterial meningitis.[16] Comparing infectious CNS disorders to non-infectious neurological conditions, Hasbun et al found considerably lower CSF glucose levels.[17] The current investigation showed that 85.1% of CNS infection cases had high CSF WBC counts (≥10 cells/cu.mm), with lymphocyte predominance seen in 66.7% of cases. Logan et al found significant lymphocytic pleocytosis in juvenile CNS illnesses, including viral and tubercular meningitis.[18] Similarly, lymphocyte-predominant CSF results in viral and tuberculous CNS illnesses were noted by Thwaites GE et al.[19] In the study, among 33 children, the most common demyelinating disorder observed was ADEM, accounting for 45.5% (15 children) of the total cases. This was followed by optic neuritis, which comprised 24.2% (8 children) of the cases. Additionally, 4 children (12.1%) had acute transverse myelitis, 4 children (12.1%) had GBS and 2 children (6%) had multiple sclerosis.

A study conducted by Hino-Fukuyo et al showed that among 17 children with demyelinating disorders, 9 (52%) were positive for serum MOG antibody.[20] Of these 9 children, 3 were diagnosed with ADEM, 3 had optic neuritis and 3 had multiple sclerosis. In the study, among 15 children with ADEM, 14 (93.3%) tested positive for anti-MOG antibody. Similarly, among 8 children with optic neuritis, 7 (87.5%) were positive for Anti-MOG antibody. Notably, one child had relapse MOG antibody associated disease (Table 8).

Among the 15 children with ADEM, the most common symptoms were fever (93.3%), seizures (73.3%), drowsiness (73.3%), difficulty in walking (66.7%), headache (40%) and visual disturbance (20%). Laboratory results showed neutrophil leucocytosis in 9 children (60%). CSF analysis revealed pleocytosis in 8 children (53.3%) and MRI abnormalities were noted in all cases (100%).

In a study conducted by Giri, et al, showed that among 36 children, 92% had encephalopathy, 44% had fever, 53% had weakness of limbs. CSF analysis showed pleocytosis in 31% and MRI was abnormal in all children (100%).[21] Among 8 children with optic neuritis, 5 (62.5%) had bilateral disease. All presented with sudden loss of vision. CSF analysis was normal in 50% of cases, 7 children (87.5%) were positive for anti-MOG antibody. MRI orbit was abnormal in all children. In a study conducted by Brady et al among 25 children, 56% had bilateral disease. CSF analysis was performed in 21 children, with 12 (57.1%) showing normal CSF findings.[22] MRI orbit abnormalities were noted in 78.2% of the cases.

Among four children with acute transverse myelitis (ATM), the most common clinical presentations were limb weakness (100%), bladder symptoms (75%), fever (75%), seizures (75%) and sensory symptoms (25%). MRI abnormalities were present in all cases. Notably, one child had an abnormal visual evoked potential. A study conducted in United Kingdom, showed that among 41 children with ATM, 83% had weakness of the legs, 66% had sensory symptoms, 63% had bladder symptoms. MRI abnormalities were noted in 69.2% of total cases.[23]

In the study, 7 children were diagnosed with autoimmune encephalitis. Among them, 3 (47%) tested positive for CSF Anti-NMDAR antibodies, while the remaining 4 (53%) were negative for antibody testing. The common presentations in our study population were lethargy (85.7%), seizures (71.4%), altered sensorium (71.4%)

and altered behaviour (42.9%). Severe neurological impairment, reflected by Glasgow Coma Scale ≤8/15, was most frequent in autoimmune encephalitis. CSF analysis showed normal glucose and protein levels in 5 children (71.4%) and all children had a normal cell count in CSF. One child was tested positive for serum Anti-NMDAR antibody. EEG abnormalities were noted in 4 children (57.1%) and MRI brain abnormalities were observed in only 2 children (28.6%). PET-CT was performed on one child, which was suggestive of autoimmune encephalitis.

Additionally, in the study, it was observed that two children diagnosed with Anti-NMDAR encephalitis had a history of HSV encephalitis occurring one month earlier. In a study conducted by Hacohen et al among 48 children with autoimmune encephalitis, most common presentations were seizures (83%), behavioral change (63%), confusion (50%) and movement disorder (38%).[24] Serum antibodies were detected in 21 (44%) patients. CSF analysis revealed lymphocytosis in 8 (17%) patients. CSF antibody testing was not performed due to the unavailability of samples. EEG demonstrated slow background consistent with an encephalopathy in 70%, MRI was normal in 38 (73%) children.

In this study, 26 children had other diagnosis. It was observed that among other causes in children who underwent CSF analysis, fever triggered seizure was the most common (42.3%), followed by viral illness (26.9%). Additionally, three children (11.5%) were diagnosed with behavioural disorders, three (11.5%) with seizure disorders, one with hypocalcemic seizure and one with valproate-induced encephalopathy. Among the 11 children diagnosed with fever triggered seizures, 5 cases (45.5%) presented with febrile status epilepticus, the remaining 6 cases (54.5%) were diagnosed with complex febrile seizures. Notably, all children in this group had normal CSF analysis, indicating no underlying central nervous system infection or inflammation.

Overall, the findings demonstrate that while CSF analysis remains fundamental in evaluating pediatric neurological emergencies, its diagnostic utility is significantly enhanced when interpreted alongside clinical features, neuroimaging, molecular diagnostics and antibody testing. Unlike previous studies that focused on individual disease entities, our study provides a comprehensive comparative evaluation of infective and non-infective neurological emergencies within a single pediatric cohort, thereby contributing valuable evidence for improving diagnostic approaches and clinical decision-making.

CONCLUSION

CSF analysis plays a pivotal role in the evaluation of acute neurological emergencies in children and aids in differentiating conditions of diverse etiologies. In the present study, CNS infections were the most common diagnosis and predominantly affected children younger than one year, whereas demyelinating disorders were more frequent among children aged 5–10 years and autoimmune encephalitis was more commonly observed in adolescents aged 10–18 years.

Distinct clinical patterns were identified across the disease groups. Fever, lethargy, poor feeding and seizures were common presenting features of CNS infections, while fever, lethargy, acute-onset weakness and visual disturbances were frequently associated with demyelinating disorders. Autoimmune encephalitis commonly presented with seizures, altered sensorium and behavioral abnormalities. Peripheral blood leucocytosis and neutrophilia were more frequently observed in CNS infections.

CSF cytology and biochemical analysis demonstrated characteristic abnormalities in CNS infections and were valuable in establishing the diagnosis. Molecular diagnostic techniques, particularly CSF PCR, enhanced pathogen detection, especially in culture-negative cases. In contrast, CSF findings were often normal or nonspecific in demyelinating and autoimmune disorders, thereby limiting their standalone diagnostic utility. Antibody testing, including anti-MOG and anti-NMDAR antibodies, significantly contributed to the diagnosis of demyelinating and autoimmune neurological disorders.

Neuroimaging, particularly MRI, proved highly useful in differentiating demyelinating disorders from CNS infections and demonstrated the highest rate of abnormalities among demyelinating conditions. EEG abnormalities were most frequently observed in autoimmune encephalitis. Taken together, a comprehensive approach integrating clinical assessment, CSF analysis, serological testing, neuroimaging and electrophysiological studies provides the greatest diagnostic yield in children presenting with acute neurological emergencies.

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