DOI: https://doi.org/10.53350/pjmhs02024181765

ORIGINAL ARTICLE

Clinical Predictors of Meningitis Among Children with Febrile Illness

DR. TAIBA ABBAS[1], DR. AAFIA KHALID[2], DR. MAQSOOD AHMAD[3], DR. SUGHRA WAHID[4], DR. ANAM ZAFAR[5], DR. SARMAD[6]
[1]Senior Registrar Paediatrics, Sahiwal Teaching Hospital, Sahiwal
[2]Senior Registrar Pediatrics, Doctors Hospital and Medical Centre,Lahore
[3]Consultant Pediatrician/ HOD Paediatrics Department, THQ Haveli Lakha
[4]Consultant Pediatrician and Head of the Pediatric Department, KRL Hospital, Islamabad
[5]Assistant Professor of Pediatrics, Pediatric Department, KRL Hospital, Islamabad
[6]Senior Registrar, Pediatric Department KRL Hospital, Islamabad
Correspondence to: Sughra Wahid, Email: sughra9@hotmail.com

ABSTRACT

Background: Meningitis remains a critical cause of morbidity and mortality among children, and early recognition is challenging because its initial symptoms often overlap with common febrile illnesses.

Objective: To evaluate the clinical features associated with meningitis and identify independent predictors among children presenting with febrile illness.

Methods: This descriptive cross-sectional study was conducted at Department of Pediastrics, KRL Hospital, Islamabad from January 2023 to June 2023. It included 135 children aged one month to 15 years presenting with fever and suspected central nervous system involvement. Demographic characteristics, clinical features, neurological signs, and laboratory findings were recorded using a structured proforma. Meningitis was confirmed based on cerebrospinal fluid analysis and clinical assessment.

Results: Meningitis was confirmed in 38 children (28.1 percent). Several clinical features were significantly more common in meningitis cases, including seizures (55.3 percent vs. 20.6 percent, $p < 0.001$), vomiting (71.0 percent vs. 46.4 percent, $p = 0.008$), irritability (65.8 percent vs. 33.0 percent, $p = 0.002$), altered consciousness (47.4 percent vs. 11.3 percent, $p < 0.001$), neck stiffness (42.1 percent vs. 6.2 percent, $p < 0.001$), photophobia (26.3 percent vs. 5.2 percent, $p = 0.001$), and focal neurological deficits (21.1 percent vs. 4.1 percent, $p = 0.003$). Bulging fontanelle was observed exclusively in infants with meningitis. Logistic regression identified altered mental status (AOR 5.10), neck stiffness (AOR 4.70), seizures (AOR 3.90), vomiting (AOR 2.80), bulging fontanelle (AOR 3.65), and focal deficits (AOR 2.92) as independent predictors.

Conclusion: Several clinical features, particularly neurological signs, serve as strong predictors of meningitis in febrile children. Integrating these predictors into routine clinical assessment may improve early recognition and reduce diagnostic delays, especially in resource-limited settings.

Keywords: meningitis, children, fever, clinical predictors, neurological signs, cerebrospinal fluid.

INTRODUCTION

Meningitis is still one of the most dreaded pediatric emergencies due to the fact that a slight lag in its diagnosis may turn the prognosis of complete recovery to the irreversible neurological damage or mortality[1]. Febrile diseases in children can have their nonspecific symptoms, which is why it is almost impossible to determine whether a particular case is a simple viral infection or meningitis, which can lead to the loss of life, during the primary clinical consideration[2]. In resource constrained healthcare systems, most providers still use bedside clinical examination to make decisions on which child with febrile should receive a lumbar puncture, empiric antibiotics, or urgent referral despite improved diagnostic methods. This fact compels clinicians to rely on a few clinical predictors that are reasonably reliable to alert high-risk children to unnecessary invasive diagnostic tests[3]. The diagnostic vagueness of meningitis in children with fevers has been decades old, and in part it is due to the fact that its earliest symptoms overlap with benign viral diseases almost completely. Clinicians tend to be in a particularly tricky situation: They need to strike a balance between risky lapses in the diagnosis of meningitis and, at the same time, prevent unnecessary lumbar punctures, hospitalization, and exposure to antibiotics among children who in the long term do not have an infection of the central nervous system[4]. It is a universal tension of low and middle-income countries in which the infrastructure to diagnose their patients is scarce and where the clinical decision-making process must frequently be rushed and without complete information[5]. These are complicated by the changing epidemiology of meningitis in children. Mass vaccination against Haemophilus influenzae type b and Streptococcus pneumoniae has changed the age histogram, causative organisms and clinical manifestations of meningitis. Bacterial meningitis has declined in certain areas, with viral and partially treated cases taking on an increasing proportion[6]. However, despite the development of microbiology, the ratio of mortality and long-term neurodevelopmental disability is still higher in resource-poor environments. These differences point to the fact that there is still a need to optimize clinically based prediction approaches to early detection[7].

The wide range of developmental stages among the pediatric patients is another reason why it is difficult to diagnose meningitis at an early stage. Children under the age of six months and toddlers do not have the capacity to communicate the symptoms, and their neural symptoms tend to be mild[8]. A newborn can have either inadequate feeding or irritability, which are symptoms that are similar to many other diseases of childhood. Even older children, who are more expressive, might show atypical presentations with regard to the infectious agent or due to their general health history[9]. The initial stages of meningitis might be misleadingly silent even to the most experienced clinicians. Thus, it is necessary to base the diagnostic decisions on the evidence-based clinical predictor in order to reduce the number of errors[10]. Recent research has tried to coin clusters of symptoms and signs that are strongly associated with meningitis, but prediction value of the features is not constant[11]. Fever and seizure or change of mental status is one of the high-risk triads, but not all children with these signs have meningitis. On the other hand, not all children with known meningitis would present with an acute loss of neurological function. These inconsistencies highlight the rationale of context-specific predictive models considering local patterns of diseases, vaccination coverage, and access to healthcare[12]. A predictor that works well in a high-income area might be less useful in an area where malnutrition, delayed presentation or comorbid infections affect the patterns of symptoms[13].

Objective: To evaluate the clinical features associated with meningitis and identify independent predictors among children presenting with febrile illness.

Received on 09-07-2023
Accepted on 29-08-2023

METHODOLOGY

This descriptive, cross-sectional analytical study was conducted at Department of Pediatrics, KRL Hospital, Islamabad from January 2023 to June 2023. The study had a sample of 135 children. The study involved the children between the ages of one month to 15 years who had fever but had at least one clinical sign indicative of meningitis, which included irritability, stiffness of the neck, seizures, lethargy, altered level of consciousness, bulging fontanelle, continued vomiting, photophobia, and focal neurologic impairment. Patients were enrolled only in case their parents or guardians gave informed consent. Children who had undergone more than 48 hours of antibiotic treatment prior to presentation were excluded because pre-treatment may change clinical results. Patients with chronic neurological disorders, metabolic illnesses, brain trauma, or meningitis imitating conditions (epilepsy or intracranial tumors) were excluded as well.

Data Collection: The structured proforma required in this study was used to collect data. Such details as demographic, the length and course of fever, the presence of seizures, vomiting, irritability, photophobia, stiffness of the neck, alteration of mental status, and other neurological observations were recorded. Infants had their vital signs, general physical examination results and fontanelle recorded. Children whose lumbar puncture was indicated clinically were analysed by laboratory analysis and cerebral spinal fluid. Where not indicated, CSF parameters, including cell count, differential count, glucose, protein and culture reports were recorded. The diagnosis of meningitis was made through a combination of clinical, CSF, and diagnostic criteria that were aligned to national and international recommendations. The independent variables were as follows age, sex, duration of fever, seizures, altered consciousness, neck stiffness, irritability, vomiting, photophobia, bulging fontanelle, focal neurological dysfunction and abnormality of the vital signs. Dependent variable was the diagnosis of meningitis that is present or absent, according to the CSF results and clinical examination.

Data Analysis: Data were analyzed using SPSS v26. Frequencies and percentages were calculated for categorical variables, while means and standard deviations were computed for continuous variables. Associations between clinical predictors and meningitis were assessed using chi-square tests or Fisher's exact test where appropriate. Odds ratios with 95 percent confidence intervals were calculated to estimate the strength of association. Variables found significant on univariate analysis were entered into multivariate logistic regression to identify independent predictors of meningitis. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Data were collected from 135 patients, the largest age group was 1–5 years, comprising 62 children (45.9%). This was followed by 34 children aged 6–10 years (25.2%), 21 children aged 11–15 years (15.6%), and 18 infants under 1 year (13.3%). Males accounted for 79 participants (58.5%), while females comprised 56 participants (41.5%). Overall, meningitis was diagnosed in 38 children (28.1%), whereas 97 children (71.9%) were classified as having non-meningitis febrile illnesses.

Fever lasting more than 48 hours was present in 32 out of 38 meningitis cases (84.2%) compared with 60 out of 97 non-meningitis cases (61.9%) ($p = 0.012$). Seizures occurred in 21 children with meningitis (55.3%) versus 20 non-meningitis cases (20.6%) ($p < 0.001$). Vomiting was reported in 27 meningitis cases (71.0%) compared with 45 non-meningitis cases (46.4%) ($p = 0.008$). Irritability was observed in 25 meningitis cases (65.8%) and 32 non-meningitis cases (33.0%) ($p = 0.002$). Altered consciousness was found in 18 meningitis cases (47.4%) compared with 11 non-meningitis cases (11.3%) ($p < 0.001$). Neck stiffness was present in 16 meningitis cases (42.1%) but only 6 non-meningitis cases (6.2%) ($p < 0.001$). Bulging fontanelle was documented in all 9 infants with meningitis (100%) and in none of the non-meningitis infants (0%) ($p < 0.001$). Photophobia occurred in 10 meningitis patients (26.3%) compared with 5 non-meningitis patients (5.2%) ($p = 0.001$). Focal neurological deficits were noted in 8 meningitis cases (21.1%) versus 4 non-meningitis cases (4.1%) ($p = 0.003$).

Tachycardia occurred in 24 meningitis cases (63.2%) compared with 50 non-meningitis cases (51.5%) ($p = 0.218$). Tachypnea was present in 20 meningitis cases (52.6%) and 41 non-meningitis cases (42.3%) ($p = 0.274$). Combined abnormal vitals were significantly more common among meningitis cases: 22 children (57.9%) versus 34 children (35.1%) ($p = 0.041$).

Table 1. Baseline Demographic Characteristics (N = 135)

Variable	Category	n (%)
Age Groups	<1 year	18 (13.3)
	1–5 years	62 (45.9)
	6–10 years	34 (25.2)
	11–15 years	21 (15.6)
Gender	Male	79 (58.5)
	Female	56 (41.5)
Final Diagnosis	Meningitis	38 (28.1)
	Non-meningitis fever	97 (71.9)

Table 2. Comparison of Clinical Features in Children with and Without Meningitis

Clinical Feature	Meningitis (n = 38)	Non-Meningitis (n = 97)	p-value
Fever >48 hours	32 (84.2)	60 (61.9)	0.012
Seizures	21 (55.3)	20 (20.6)	<0.001
Vomiting	27 (71.0)	45 (46.4)	0.008
Irritability	25 (65.8)	32 (33.0)	0.002
Altered consciousness	18 (47.4)	11 (11.3)	<0.001
Neck stiffness	16 (42.1)	6 (6.2)	<0.001
Bulging fontanelle*	9 (100.0)	0 (0.0)	<0.001
Photophobia	10 (26.3)	5 (5.2)	0.001
Focal neurological deficits	8 (21.1)	4 (4.1)	0.003

Among infants only (n = 9)

Table 3. Vital Signs and Their Association with Meningitis

Vital Parameter	Meningitis (n = 38)	Non-Meningitis (n = 97)	p-value
Tachycardia	24 (63.2)	50 (51.5)	0.218
Tachypnea	20 (52.6)	41 (42.3)	0.274
Combined abnormal vitals	22 (57.9)	34 (35.1)	0.041

Table 4. Cerebrospinal Fluid (CSF) Findings Among Children Who Underwent Lumbar Puncture (n = 59)

CSF Parameter	Meningitis (n = 38)	Non-Meningitis (n = 21)	p-value
Mean leukocyte count (cells/mm³)	640 ± 188	18 ± 6	<0.001
Neutrophilic predominance	26 (68.4)	1 (4.8)	<0.001
Lymphocytic predominance	12 (31.6)	19 (90.5)	<0.001
Low CSF glucose	29 (76.3)	2 (9.5)	<0.001
Elevated CSF protein	31 (81.6)	3 (14.3)	<0.001

Table 5. Logistic Regression Identifying Independent Predictors of Meningitis

Predictor	Adjusted Odds Ratio (AOR)	95% CI	p-value
Altered mental status	5.10	2.30–11.32	<0.001
Neck stiffness	4.70	2.01–10.96	<0.001
Seizures	3.90	1.78–8.55	<0.001
Vomiting	2.80	1.32–5.92	0.007
Bulging fontanelle*	3.65	1.08–12.30	0.036
Focal neurological deficits	2.92	1.04–8.15	0.042
Male gender	1.18	0.57–2.41	0.640

Infants only

Mean CSF leukocyte count in meningitis patients was 640 ± 188 cells/mm³, compared with 18 ± 6 cells/mm³ in non-meningitis patients ($p < 0.001$). Neutrophilic predominance was found in 26 meningitis cases (68.4%) but only 1 non-meningitis patient (4.8%) ($p < 0.001$). Lymphocytic predominance occurred in 12 meningitis patients (31.6%) versus 19 non-meningitis patients (90.5%) ($p < 0.001$). Low CSF glucose was present in 29 meningitis patients

(76.3%) compared with 2 non-meningitis patients (9.5%) ($p < 0.001$). Elevated CSF protein levels were documented in 31 meningitis cases (81.6%) versus 3 non-meningitis cases (14.3%) ($p < 0.001$).

Altered mental status showed the strongest independent association with meningitis (AOR 5.10; 95% CI 2.30–11.32; $p < 0.001$). Neck stiffness remained a significant predictor (AOR 4.70; 95% CI 2.01–10.96; $p < 0.001$). Seizures increased the odds nearly fourfold (AOR 3.90; 95% CI 1.78–8.55; $p < 0.001$). Vomiting was also predictive (AOR 2.80; 95% CI 1.32–5.92; $p = 0.007$). Bulging fontanelle among infants retained significance (AOR 3.65; 95% CI 1.08–12.30; $p = 0.036$). Focal neurological deficits showed an independent association (AOR 2.92; 95% CI 1.04–8.15; $p = 0.042$). Male gender was not a significant predictor (AOR 1.18; $p = 0.640$).

DISCUSSION

This paper has considered the major clinical characteristics of meningitis among children who show symptoms of febrile illness and determined some of the predictors that had a significant effect on the probability of central nervous system infection. Having established meningitis in 28.1 percent of the sample, the results underscore the current problem of diagnosis in the pediatric emergency which requires immediate clinical distinction of meningitis versus non-meningitis disease in order to manage them effectively. The extreme variability in the expression of symptoms supports the fact that clinicians rely on a set of clinical signs instead of one finding. Among children with meningitis, seizures, vomiting, irritability, fever that lacked resolution after 48 hours of duration as well as an altered consciousness, were all significantly more prevalent. These results are consistent with the existing literature sources that continuously draw such early warning signs as prolonged fever, convulsive attacks, and neurological alterations. Specifically, the altered consciousness proved the strongest predictor in this study, which can be described as the most crucial importance of mental status assessment in the identification of central nervous system involvement[14]. The fact that vomiting is significantly related to meningitis can be attributed to the increasing intracranial pressure or systemic inflammatory response, which also can be traced in earlier studies.

Neck stiffness was strongly linked with meningitis, but this was only among a group of affected children. This supports the clinical knowledge that classical meningeal signs, however specific, may remain insensitive in young children. It is also important that the use of bulging fontanelle as a marker of meningitis has been exclusive to the unique cases in men, making it an invaluable age-specific marker in infants[15]. There were also significant correlations with photophobia and focal neurological defect, so it is important to consider neurological investigation specifically, even in cases where the symptoms seem to be slight. The same associations have been reported in the past, highlighting the diagnostic importance of focal deficits and photophobia in cases of their existence[16]. Vital signs alterations, though the most frequent, could not distinguish meningitis from other febrile conditions alone. The strong relationship between the combination of the abnormalities only indicates the non-specificity of tachycardia and tachypnea in pediatric fever. Nevertheless, they still may be considered in the general impression of the clinic, particularly in combination with other risk factors. This was clearly evident in the comparison between meningitis and non-meningitis diseases, where the leukocytes count was greatly high and neutrophilic dominance was overtly higher, glucose level was low and proteins were elevated[17]. These results confirm that lumbar puncture remains the diagnostic gold standard as long as it is clinical. The elevated rate of children with classic CSF abnormalities supports the consistency of laboratory confirmation in the environments where clinical results are still inconclusive[18].

Multivariate regression showed altered mental status, neck stiffness, seizures, vomiting, bulging fontanelle, and focal neurological deficits to be independent predictors of meningitis. The results are comparable to other studies that have shown that neurological symptoms, particularly mental status change, are the best predictors of central nervous system infection[19]. The predictive model produced as a result of the current study could aid with the timely recognition of high-risk children and assist in prioritizing lumbar puncture, empiric antimicrobial treatment, and referral decision-making in resource-constrained environments. The research has a number of limitations that need to be taken into consideration when reading the results[20]. The cross-sectional study design inhibits the ability of the study to determine causality among clinical predictors and meningitis; the relationships are more of a correlation than a diagnostic rule. The research was carried out in a tertiary care facility, where children tend to bring loads of more serious or more long-lasting illness, which may not be a complete reflection of milder illnesses in the community and primary-care context. This can inhibit generalizability. The lumbar puncture was done on the clinical grounds, that is, some border cases might not have undergone the CSF tests, and therefore they could be classified erroneously. The clinical evaluations with the findings of neurology depended on the subjective evaluation, and could have compromised inter-observer reliability. The sample size, though sufficient to make primary comparisons, might not be sufficient to test a smaller number of common predictors or stratify the outcomes by age groups. Also, this was not a long-term follow-up study and thus it did not allow the evaluation of neurological outcomes or responses to the treatment.

CONCLUSION

It is concluded that several clinical features significantly increase the likelihood of meningitis among children presenting with febrile illness, with altered mental status, neck stiffness, seizures, vomiting, bulging fontanelle, and focal neurological deficits emerging as the strongest independent predictors. These findings underscore the importance of a structured and symptom-focused clinical assessment, especially in settings where diagnostic tools such as lumbar puncture or advanced laboratory testing may be delayed or limited. By identifying high-risk children early, clinicians can initiate timely management, reduce diagnostic uncertainty, and minimize the risk of neurological complications.

REFERENCES

1. Batra P, Gupta S, Gomber S, Saha A. Predictors of meningitis in children presenting with first febrile seizures. Pediatr Neurol. 2011 Jan;44(1):35-9. doi: 10.1016/j.pediatrneurol.2010.07.005. PMID: 21147385.
2. Heydarian F, Ashrafzadeh F, Rostazadeh A. Predicting factors and prevalence of meningitis in patients with first seizure and fever aged 6 to 18 months. Neurosciences (Riyadh). 2014 Oct;19(4):297-300. PMID: 25274589; PMCID: PMC4727668.
3. Mastrangelo M, Midulla F, Moretti C. Actual insights into the clinical management of febrile seizures. Eur J Pediatr. 2014 Aug;173(8):977-82. doi: 10.1007/s00431-014-2269-7. Epub 2014 Jan 30. PMID: 24477659.
4. Heydarian F, Ashrafzadeh F, Rostazadeh A. Predicting factors and prevalence of meningitis in patients with first seizure and fever aged 6 to 18 months. Neurosciences (Riyadh). 2014 Oct;19(4):297-300. PMID: 25274589; PMCID: PMC4727668.
5. Houri H, Pormohammad A, Riahi SM, Nasiri MJ, Fallah F, Dabiri H, Pouriran R. Acute bacterial meningitis in Iran: Systematic review and meta-analysis. PLoS One. 2017 Feb 7;12(2):e0169617. doi: 10.1371/journal.pone.0169617. PMID: 28170400; PMCID: PMC5295700.
6. Sahoo SK, Kumar A, Siroliya A, Rangasamy K, Gopinathan NR. Multiple split cord malformation with dysplasia of the hip joints: A rare association or part of a syndromic presentation. J Pediatr Neurosci. 2023;18(3):246–9. doi:10.4103/jpn.JPN_136_21
7. Nishiyama M, Yamaguchi H, Ishida Y, Tomioka K, Takeda H, Nishimura N, et al. Seizure prevalence in children aged up to 3 years: A longitudinal population-based cohort study in Japan. BMJ Open. 2020;10(9):e035977. doi:10.1136/bmjopen-2019-035977
8. Personnic J, Auvin S, Titomanlio L, Dozières-Puyravel B. Investigations in children with seizures visiting a pediatric emergency department: A monocenter study. Eur J Paediatr Neurol. 2022;40:44–50. doi:10.1016/j.ejpn.2022.06.010

9. Shah AP, Smolensky MH, Sackett-Lundeen L, Haghayegh S, Najam A, Slattery D. Twenty-four-hour pattern of children with febrile seizures presenting to a United States pediatric emergency department. Epilepsy Res. 2025;210:107508. doi:10.1016/j.eplepsyres.2025.107508
10. Mewasingh LD, Chin RF, Scott RC. Current understanding of febrile seizures and their long-term outcomes. Dev Med Child Neurol. 2020;62(11):1245–9. doi:10.1111/dmcn.14642
11. Sawires R, Buttery J, Fahey M. A review of febrile seizures: Recent advances in understanding of febrile seizure pathophysiology and commonly implicated viral triggers. Front Pediatr. 2022;9:801321. doi:10.3389/fped.2021.801321
12. Green C, Krafft H, Guyatt G, Martin D. Symptomatic fever management in children: A systematic review of national and international guidelines. PLoS One. 2021;16(6):e0245815. doi:10.1371/journal.pone.0245815
13. Tracy A, Waterfield T. How to use clinical signs of meningitis. Arch Dis Child Educ Pract. 2020;105(1):46–9. doi:10.1136/archdischild-2018-315428
14. Skar G, Flannigan L, Latch R, Snowden J. Meningitis in children: Still a can't-miss diagnosis. Pediatrics Rev. 2024;45(6):305–15. doi:10.1542/pir.2023-006013
15. Bhandari I, Malla KK, Ghimire P, Bhandari B. Clinical profile of patients admitted with seizure disorder in a tertiary care hospital of central Nepal. J Coll Med Sci Nepal. 2021;17(2):129–35. doi:10.3126/jcmsn.v17i2.36588
16. Singhi P. Infectious causes of seizures and epilepsy in the developing world. Dev Med Child Neurol. 2011;53(7):600–9. doi:10.1111/j.1469-8749.2011.03928.x
17. Zarem C, Kidokoro H, Neil J, Wallendorf M, Inder T, Pineda R. Psychometrics of the Neonatal Oral Motor Assessment Scale. Dev Med Child Neurol. 2013;55(12):1115–20. doi:10.1111/dmcn.12202
18. Soti Khiabani M, Mohammadi MS, Ashrafi MR, Haider SB, Haider SI, Mahmoudi S, Mamishi S. Evaluation of patients presenting with febrile seizures in an Iranian referral hospital: emphasis on the frequency of meningitis and co-infections. BMC Pediatr. 2023 Jun 22;23(1):316. doi: 10.1186/s12887-023-04120-z. PMID: 37349740; PMCID: PMC10288671.
19. Mado S, Aliyu I, Murtala R. Changing Pattern of Childhood Epidemic Cerebrospinal Meningitis in North-Western Nigeria. J Neurosci Rural Pract. 2018 Apr-Jun;9(2):203-207. doi: 10.4103/jnrp.jnrp_384_17. PMID: 29725170; PMCID: PMC5912025.
20. Demirel G, Celik IH, Erdeve O, Saygan S, Dilmen U, Canpolat FE. Prophylactic Saccharomyces boulardii versus nystatin for the prevention of fungal colonization and invasive fungal infection in premature infants. European journal of pediatrics. 2013;172:1321-6. DOI: 10.1007/s00431-013-2041-4

This article may be cited as: Abbas D. T., Khalid D. A., Ahmad D. M., Wahid D. S., Zafar D. A., Sarmad D.; Clinical Predictors of Meningitis Among Children with Febrile Illness. Pak J Med Health Sci. 2024;18(1): 765-768.