ISSN: 2588-4115; Infection Epidemiology and Microbiology. 2026;12(2):153-160 doi 10.52547/iem.12.2.153

Surveillance of Infectious Agents in Acute Febrile Illnesses in a Tertiary Care Hospital in Northern India

ARTICLE INFO

Article Type
Original Article

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ABSTRACT

Background: Acute febrile illnesses (AFIs) are a major cause of morbidity in India, particularly during the monsoon season, posing significant diagnostic challenges due to overlapping clinical features. This study aimed to investigate the main AFI causes in northern India.

Materials & Methods: This prospective observational study was conducted at a tertiary care hospital in northern India from July 2023 to December 2024 to determine the aetiological spectrum of AFIs. A total of 8127 patients were evaluated using rapid diagnostic tests and standard microbiological methods for dengue, typhoid, hepatitis A and E, chikungunya, scrub typhus, and malaria.

Findings: Dengue and typhoid were the most frequently identified AFI causes, followed by viral hepatitis and other vector-borne infections. Mixed infections were also observed, highlighting diagnostic complexity.

Conclusion: The findings emphasize the importance of laboratory-supported surveillance to enable early outbreak detection, improve case management, and guide public health interventions in endemic regions.

Keywords: Acute febrile illness; Dengue; Typhoid; Hepatitis A, Hepatitis E; Scrub typhus; Surveillance

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How to cite this article
Khanna P., Gupta A., Sheemar Sh., Taperyal T., Taak S. Surveillance of Infectious Agents in Acute Febrile Illnesses in a Tertiary Care Hospital in Northern India.Infection Epidemiology and Microbiology. 2026;12(2): 153-160.

Article History
Received: February 24, 2026
Accepted: June 22, 2026
Published: July 27, 2026

CITATION LINKS

[1] Anthony DR, et al. The EMcounter... [2] Chrispal A, Boorugu H, Gopinath KG, Chandy S, Prakash JA, Thomas EM, et al. Acute... [3] Chaturvedi HK, Mahanta J, Pandey A. Treatment-seeking for... [4] Chakravarti A, Kumaria R. Eco-epidemiological analysis of... [5] Kadri SM, et al. Hepatitis A... [6] Singh S, Patel SS, Sahu C, Ghoshal U. Seroprevalence trends of... [7] Walker DH. Scrub typhus - scientific neglect, ever-widening... [8] Poddar N, Pathi BK, Panigrahi K, Pattnaik D, Jena J. Seroprevalence and... [9] Bashar MA, Begam N. Dengue outbreak of 2023 in the... [10] Satapathy P, Goel K, Sharma V, Sarkar S, Kang M, Dhingra S, et al. Outbreak investigation... [11] Chaudhary KN, Ponniah M, Srikumar R, Vijayakumar R, Chidambaram R, Jayalakshmi G, et al. Incidence of... [12] Monath TP, Tsai TF. Flaviviruses. In... [13] Basuki PS. Concurrent dengue infection and... [14] Mohan MV, Teja VD, Subhada K. Prevalence of acute... [15] Yong LS, Koh KC. A case of mixed infections in... [16] Palewar MS, Joshi S, Choudhary G, Das R, Sadafale A, Karyakarte R. Prevalence of... [17] Vitral CL, Silva-Nunes M, Pinto MA, Oliveira J, Gaspar AM, Pereira RC, et al. Hepatitis A... [18] Mittal A, Bithu R, Vyas N, Maheshwari RK. Prevalence of... [19] Samaddar A, Taklikar S, Kale P, Kumar CA, Baveja S. Infectious hepatitis... [20] Sharma A, Kumar N, Sood A. Seroprevalence of... [21] Murhekar MV, et al. Epidemiology of... [22] Hanagodu M, Rathod N, Patil G. Prevalence of... [23] Vashishtha A, et al. Scrub typhus... [24] Manipal Centre for Virus Research. Annual report of... [25] Morch K, et al. Acute undifferentiated... [26] Mittal G, et al. Aetiologies of acute... [27] Abhilash KP, et al. Acute undifferentiated... [28] World Health Organisation. World Malaria Report 2023...

Introduction

Acute febrile illnesses (AFIs) are among the most common reasons for healthcare visits globally and form a large proportion of outpatient complaints. Investigation of AFI causes requires comprehensive testing; however, where diagnostic facilities are limited, patient management may be suboptimal. Understanding the distribution of AFI aetiologies could improve patient outcomes. Fever is one of the most frequently reported symptoms in Indian hospitals. Epidemics of acute febrile illnesses have become a major concern in India [1, 2]. When a patient presents with fever, clinical correlation is essential for diagnosis and management. Because symptoms are often non-specific, delays or errors in diagnosis could lead to inappropriate therapy and adverse outcomes. Laboratory confirmation is crucial for specific and timely management [3].

India is endemic to several arboviruses, and its climate favours the transmission of arthropod-borne pathogens; therefore, diseases such as malaria, dengue, chikungunya, and scrub typhus, along with food- and water-borne diseases including typhoid and acute viral hepatitis (AVH) caused by hepatitis A and E viruses (HAV and HEV), are the major AFI causes in India [4, 5].

Rickettsial infections remain among the most neglected tropical diseases in developing countries. The obligate intracellular bacterium *Orientia tsutsugamushi*, transmitted by trombiculid mite larvae (both vector and reservoir), causes scrub typhus, which could present with fever, rash, headache, nausea, abdominal pain, and thrombocytopenia. Humans are incidental hosts [6, 7].

During the rainy season, AFI is the most common presentation in our hospital. Each year, particularly during and after the monsoon, epidemics of AFI occur in Punjab. Data on the relative contribution of different aetiological agents remain limited.

Objectives: This study was undertaken to establish the aetiological pattern of AFI cases over two monsoon seasons (July 2023–December 2024).

Materials and Methods

This prospective observational study was conducted at the Punjab Institute of Medical Sciences (PIMS) in Jalandhar, India, a tertiary-care charitable hospital. The study period spanned 18 months (July 2023–December 2024).

Acute febrile illness (AFI) is defined as a broad clinical syndrome, characterized by the rapid onset of fever, typically above 38 °C (100.4°F), lasting for a short duration, usually between 2 and 14 days, and accompanied by non-specific symptoms.

Samples from patients presenting with AFIs were included in the study. Diagnostic tests for dengue, malaria, *Salmonella* Typhi, hepatitis A virus (HAV), hepatitis E virus (HEV), chikungunya virus, and scrub typhus (*O. tsutsugamushi*) were performed according to clinical assessments and at the discretion of the treating physicians; no additional tests were performed solely for study purposes.

Samples with more than one infectious aetiology were considered as mixed infections. The following microbiological tests were done:

All samples tested for dengue serology were also tested for *S.* Typhi using RDTs (rapid diagnostic tests) as requested by the treating physician. Samples that were positive for both dengue and *S.* Typhi RDTs were classified as mixed infections. Samples that were positive for Typhidot IgM but negative for blood culture were classified as serologically-diagnosed typhoid fever.

Diagnostic investigations were performed according to the clinical judgment of the treating physician. Therefore, the number of samples tested for each pathogen varied,

S. No	Test Name (Kit/ Card/Strip)	Company	Kit Name	Catalogue No.	Sensitivity	Specificity
1	Dengue test card	Abbott	Bioline dengue IgG.IgM WB	11FK20	92.4% (dengue NS1Ag)94.2% (dengue IgG/ IgM)	98.4% (dengue NS1 Ag), 96.4% (dengue IgG/IgM)
2	Typhidot test card	Tulip	Enterocheck-WB	501030025	85.5%	88.6%
3	HAV test card	Tulip	Insight HAV-IgM	10501010	100%	93%
4	HEV test card	Tulip	Insight HEV-IgM	10502010	95.24%	95.24%
5	Malaria Ag test card	SD biosensor	Bioline malaria Ag P.F/Pv	09MAL20D	Pf-99.7% Pv-95.5%	Pf-99.5% Pv-99.5%
6	Chikungunya test card	J. Mitra	Advantage chikungunya IgN card	IR061010	97.5%	99.1%
7	Scrub typus test card	Abbott	Bioline tsutsugamushi	18FK10	99%	96%

Table 1) Contribution of various aetiological agents to AFIs

Aetiological Agent	Diagnostic Test	Positive Cases /Tested (n/N)	Percentage (%)
Dengue	RDT – Dengue NS1 & IgM	792/8127	9.75
Serologically positive typhoid	RDT – Typhidot IgM	646/6450	10.02
Hepatitis A	RDT – HAV IgM	115/2211	5.20
Hepatitis E	RDT – HEV IgM	50/2131	2.35
Chikungunya	RDT – Chikungunya IgM	14/321	4.36
Scrub typhus	RDT – IgM & IgG	11/321	3.43
Malaria	RDT – Malaria Ag test	10/3201	0.31
Mixed infection	Dengue + Typhi IgM	351/8127	4.32
Culture-proven enteric fever (typhoid)	Blood culture done on serologically positive typhoid patient samples	15/646	2.32

and pathogen-specific positivity rates were calculated using the respective number of samples tested for each pathogen as the denominator.

Findings

A total of 8127 samples were evaluated during the study period. Of these, dengue and typhoid emerged as the leading causes of AFIs with positivity rates of 9.75 and 10.02%, respectively. HAV and HEV IgM antibodies were detected in 5.2 and 2.3% of the samples, respectively. Chikungunya, scrub typhus, and malaria accounted for 4.4, 3.43, and 0.3% of AFI cases, respectively. Mixed infections (primarily dengue with typhoid) were observed in 4.32% of the samples.

In Table 1, percentages were calculated using the number of samples tested for each pathogen as the denominator. Because diagnostic investigations were performed according to clinical indications, the denominators varied between pathogens.

In Table 2, percentages represent positivity rates within the respective testing period, calculated using the number of samples test-

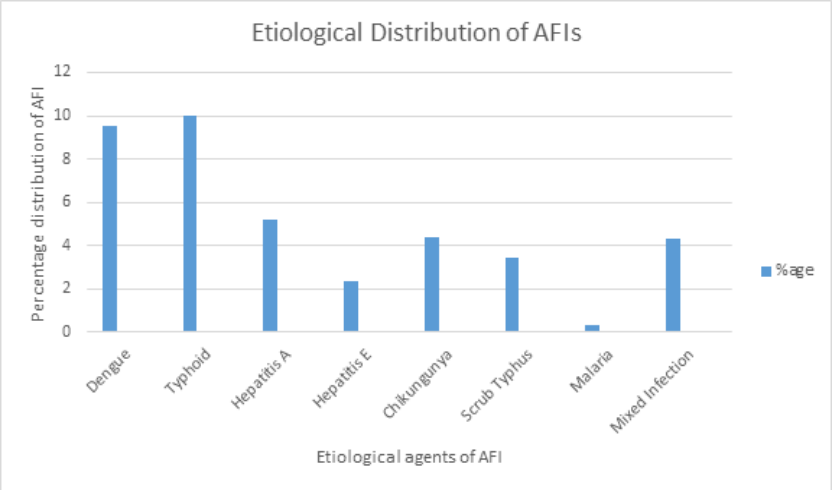

Figure 1) Aetiological distribution of acute febrile illnesses (AFIs) among patients evaluated during the study period (July 2023–December 2024)

Table 2) Six-month distribution of AFI aetiological agents

Pathogen	2023 (Jul–Dec)	2024 (Jan–Jun)	2024 (Jul–Dec)	Overall (18 months)
Dengue	10.58% (734/6938)	1.02% (5/486)	7.53% (53/703)	9.75% (792/8127)
Typhi	10.55% (612/5800)	4.0% (10/250)	6.0% (24/400)	10.02% (646/6450)
HAV	3.7% (26/700)	3.78% (25/661)	7.29% (62/850)	5.20% (115/2211)
HEV	2.37% (15/632)	2.14% (14/654)	2.48% (21/845)	2.34% (50/2131)
Chikungunya	4.49% (12/267)	0% (0/20)	3.7% (2/54)	4.36% (14/321)
Scrub typhus	4.60% (7/152)	2.12% (1/47)	2.45% (3/122)	3.43% (11/321)
Malaria	0.04% (1/2045)	0.57% (2/351)	0.87% (7/805)	0.31% (10/3201)
Mixed	4.81% (334/6938)	1.02% (5/486)	1.71% (12/703)	4.32% (351/8127)

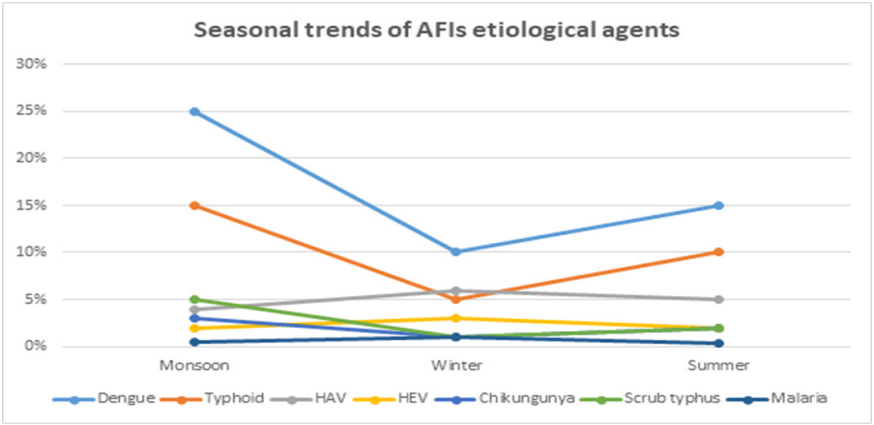

Figure 2) Seasonal distribution of AFI pathogens. Dengue and typhoid demonstrated higher positivity rates during the monsoon and post-monsoon seasons, while hepatitis A was relatively more prevalent during the winter months. Malaria remained infrequent throughout the study period.

ed for each pathogen during that period.

In 2023 (July–December), dengue cases peaked at 734 (10.58%) cases, indicating an outbreak, as described in dengue epidemic in Uttar Pradesh (north India) by Bashar and Begam (2025) [9]. In 2024, dengue incidence declined to 4.88%, while HAV and HEV showed slight increases.

Table 3) Age-wise distribution of AFI aetiological agents

Age Group	Dengue (%)	HAV (%)	HEV (%)	Typhoid (%)	Chikungunya (%)	Scrub typhus (%)	Malaria (%)
Paediatric	25	5	4	15	3	1	0.4
Adult	24	4	3	20	2	3	0.2
Geriatric	15	6	4	10	1	2	0.2

Dengue infection cases peaked in the monsoon season (25%) and declined in the winter (10%). Typhoid was prevalent during the monsoon (15%) and summer (10%). HAV incidence rose slightly in the winter (6%), while malaria remained consistently low (<1%).

Statistical analysis revealed significant temporal variation in the prevalence of dengue, typhoid, HAV, and malaria with peak incidence in the monsoon season ($p< .001$), while no significant temporal variation was observed for the other AFI aetiologies.

In Table 3, percentages represent the distribution of positive cases across different age groups.

In the paediatric age group, dengue and typhoid were the most common infections. HAV and HEV incidence rates were higher in the geriatric population than in younger groups

Discussion

Acute febrile illnesses (AFIs) pose a diagnostic challenge due to their varied aetiologies and limited diagnostic facilities, even in tertiary-care hospitals. Most AFIs in India are caused by arthropod-borne viral pathogens, followed by bacterial and parasitic infections. Rapid serological tests remain useful AFI diagnostic tools as they are easy to perform and provide results within a few hours.

A higher incidence of AFIs was observed in 2023, with most cases occurring between August to November, corresponding to the monsoon and post-monsoon seasons, similar to trends reported in several regions of India, including Odisha [8], and reflecting regional outbreaks reported in northern India during the same period [9].

Dengue emerged as one of the leading causes of AFIs. The incidence rate was higher in 2023 (734 cases; 10.58%) than in 2024 (58 cases; 4.88%), likely reflecting regional 2023 outbreaks in neighbouring districts. The higher dengue incidence observed in 2023 was consistent with the outbreak reported by Bashar and Begam (2025) in neighbouring Indian states [9].

NS1 antigen and IgM positivity confirmed most cases. Acute-phase specimens were positive for NS1 antigen; however, the early appearance of IgM antibodies in secondary dengue infections compared to primary dengue infections has been reported by Satapathy et al. (2023) [10]. Mixed infections (dengue + typhoid) accounted for 4.32% of the samples, highlighting diagnostic complexity due to cross-reactivity between dengue and *S.* Typhi IgM assays, as also noted by Chaudhary et al. (2017) [11]. Symptoms of dengue may mimic those of other diseases such as typhoid, malaria, and scrub typhus, which are prevalent in dengue-endemic areas [12].

Serologically diagnosed typhoid accounted for 10.02% of AFI samples, with 2.32% of these positive samples also confirmed by culture. Dengue infection and typhoid fever may overlap, especially during the first few days of illness, and are indistinguishable from many other acute febrile illnesses [13]. This may have introduced bias because currently available serological assays have suboptimal specificity and may yield false-positive results. Although a negative culture may reflect prior antimicrobial exposure or a low bacterial load, the absence of microbiological confirmation

limits diagnostic certainty. The coexistence of typhoid with dengue underscores the need for careful interpretation of serological results to avoid misdiagnosis. Concurrent infections with more than one etiological agent could result in an illness with overlapping symptoms, making the diagnosis and management of such patients challenging [14, 15].

Numerous international and Indian investigations have documented variable prevalences ranging from 12.6 to 78.6% for HEV and from 1.7 to 67% for HAV [16, 5, 17-19]. In this study, the prevalence of HAV (5.2 %) was higher than that of HEV (2.3 %), mirroring the findings of Sharma and colleagues (2024) in Himachal Pradesh [20]. Both viruses spread via the faeco-oral route, often through contaminated water during the monsoon. VRDL (virus research & diagnostic laboratory) surveillance data confirm HAV predominance in northern India, while HEV prevails in western and central regions [21].

Chikungunya fever accounted for 4.36% of AFI cases. Transmitted by *Aedes aegypti* and *A. albopictus* mosquitoes, the disease has re-emerged globally since 2005 due to favorable vector ecology [22]. In this study, confirmed chikungunya cases declined from 4.94% (n=12) in 2023 to 3.70% (n=2) in 2024, matching the national downward trend reported by Hanagodu and colleagues (2024)[22].

In the current study, scrub typhus was detected in 11 samples, therefore remaining an under-recognised zoonosis. Seven cases occurred during the 2023 monsoon and four in 2024. Widespread outbreaks and fatalities in 2023 (especially in Himachal Pradesh, Odisha, and Rajasthan) emphasize the need for clinician awareness in endemic regions [23]. Since its prevalence has been increasing in various parts of the country during recent years, scrub typhus has been identified by various studies as a frequent aetiology of acute febrile illness, with frequencies varying from 9 to 48% [2, 24-27].

Although malaria prevalence was low (0.31%), vigilance remains essential. The fall in cases reflects national control efforts and aligns with the World Health Organization World Malaria Report 2023, which documents significant reductions in incidence and mortality rates since 2017 [28]. A slight rise from one case (0.04%) in 2023 to nine cases (0.78%) in 2024 may represent a localized cluster.

The study demonstrates that typhoid and dengue are the principal causes of AFIs in northern India, followed by HAV, HEV, chikungunya, scrub typhus, and malaria. Mixed infections underline the limitations of single rapid tests and the importance of confirmatory diagnostics. Comparable regional variation was reported in Telangana state by Mohan and colleagues (2019) [14].

Conclusion

Typhoid and dengue were the leading causes of AFIs in Jalandhar, with hepatitis A, hepatitis E, chikungunya, scrub typhus, and malaria contributing substantially. Mixed infections (mainly dengue + typhoid) were detected in 4.3% of the samples. Because of overlapping symptoms, reliance solely on clinical presentation could lead to misdiagnosis; laboratory confirmation is vital for appropriate management and improved outcomes. Active AFI surveillance enables early outbreak detection and timely public-health response through strengthened vector-control and sanitation measures.

This study has certain limitations. Diagnostic investigations were performed at the discretion of the treating physicians; therefore, not all patients underwent uniform testing for all infectious agents, which may have introduced selection bias.

A limitation of this study is the classification of culture-negative but RDT-positive cases as typhoid fever. As serological tests have limited specificity and may yield false-positive results, the prevalence of typhoid may have been overestimated. Therefore, the reported burden of typhoid should be interpreted with caution.

This research was a single-centre, hospital-based study conducted in a resource-limited population, and the findings may not fully represent the epidemiological profile of the wider community or other geographic regions.

Most diagnoses were based on rapid diagnostic tests (RDTs) without molecular confirmation, such as polymerase chain reaction (PCR), which may have affected diagnostic accuracy.

In addition, potential serological cross-reactivity between dengue and *S.* Typhi IgM assays may have contributed to overestimation of mixed infections in some cases.

Acknowledgements

The authors sincerely acknowledge the Punjab Institute of Medical Sciences, Jalandhar, for providing the necessary infrastructure and institutional support to conduct this study. We also extend our appreciation to the technical and laboratory staff of the Microbiology Department for their diligent work, accurate laboratory reports, and consistent support throughout the study period.

Funding: No external funding was received.

Conflicts of interests: The authors declare no conflict of interest.

Ethical approval: This study was approved by the Institutional Ethics Committee of the Punjab Institute of Medical Sciences, Jalandhar.

Consent to Participate: As the study involved the evaluation of samples received in the Microbiology department, without any interaction with patient, consent to participate was not obtained.

Declaration of Artificial Intelligence (AI) Use: The authors used [ChatGpt and Grammarly] to assist with grammar checking and language editing. All content has been reviewed and revised by the authors. The authors take full responsibility for the accuracy and originality of the work.

Authors' contributions: Priyanka khanna Chetal: Main researcher, formal analysis, discussion author, writing the original draft. Ashu Gupta: Assistant researcher, introduction writer, data analyst, discussion author. Sheevani Sheemar: methodologist, scientific guidance & validation, reviewer. Tushar Taperyal: Introduction writer, data analyst. Savi Taak: Introduction writer, data analyst.

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