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Original Research Article

Emerging Infectious Diseases in a Tertiary-Care Hospital in North Bihar (India): Epidemiology, Clinical Spectrum, and Real-World Management of Acute Febrile Illness

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Abstract

Background: Emerging and re-emerging infections increasingly present as acute undifferentiated febrile illness (AUFI) in South Asia, driven by climate variability, mobility, changing vectors, and zoonotic spillover.

Aim: To describe the etiologic spectrum, seasonality, and clinical outcomes of suspected emerging infectious diseases (EIDs) presenting to DMCH, and to evaluate determinants of severe outcomes and management patterns.

Methods: Hospital-based observational study (retrospective record abstraction with prospective follow-up where feasible). Consecutive AUFI/AES-suspect admissions were evaluated with syndrome-based diagnostics (NS1/IgM dengue, malaria smear/RDT, scrub typhus IgM, leptospira IgM, blood cultures, respiratory PCR where indicated). Primary outcome: severe disease (ICU admission and/or in-hospital death). Multivariable logistic regression assessed predictors of severe outcomes.

Results: Of 612 eligible admissions, 487 (79.6%) had a confirmed/probable EID diagnosis. Most cases occurred during monsoon/post-monsoon (July–October). Leading etiologies were dengue (31.0%), scrub typhus (21.1%), malaria (14.6%), leptospirosis (9.2%), and influenza-like illness/viral ARI (8.4%). Severe disease occurred in 78/487 (16.0%); overall in-hospital mortality was 3.3%. Independent predictors of severe outcomes included age ≥60 years (aOR2.31), hypotension at presentation (aOR 3.12), thrombocytopenia <50,000/µL (aOR 2.08), and serum creatinine ≥2.0 mg/dL (aOR 2.67) (all $p<0.05$).

Conclusion: The 2025 DMCH AUFI burden showed a vector-borne dominance with marked seasonality. Early syndrome-guided testing, timely doxycycline for scrub typhus, and sepsis-oriented bundled management were associated with improved stabilization and low mortality. Findings support strengthening AUFI algorithms, diagnostics, and antimicrobial stewardship in North Bihar.

Keywords: emerging infectious diseases; acute undifferentiated febrile illness; dengue; scrub typhus; leptospirosis; sepsis; Bihar; India.

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Introduction

Emerging infectious diseases (EIDs) constitute a major and evolving global health challenge, defined as infections that have newly appeared in a population or have existed previously but are rapidly increasing in incidence or geographic range [1]. These diseases may arise from previously unknown pathogens, newly evolved microbial strains, or recognized infections that expand into new ecological niches or host populations [2]. Over recent decades, the frequency of EID events has increased, emphasizing the dynamic interaction between humans, pathogens, and environmental conditions [3]. A large proportion of emerging infections originate from animals, highlighting the importance of zoonotic transmission in disease emergence. It is estimated that approximately 60% of known human pathogens are zoonotic and nearly 75% of emerging pathogens originate from animal

reservoirs [4]. Environmental disruption, deforestation, urbanization, climate change, and agricultural intensification have been identified as key drivers facilitating cross-species transmission and pathogen adaptation [5]. These factors increase human exposure to previously isolated microorganisms and promote ecological conditions favorable for vector proliferation and pathogen survival.

Globalization and increased human mobility further accelerate the spread of infectious diseases across geographic boundaries. Rapid international travel, trade, migration, and urban crowding can facilitate dissemination of pathogens within days, transforming localized outbreaks into global threats [6]. The emergence of recent viral epidemics has demonstrated how quickly infectious agents can spread in immunologically naïve populations, overwhelming health systems and causing substantial morbidity and mortality [7].

In addition to environmental and demographic influences, microbial evolution plays a crucial role in the emergence of infectious diseases. Pathogens can acquire genetic mutations or resistance determinants that enhance virulence, transmissibility, or drug resistance [8]. Antimicrobial resistance, in particular, is considered one of the most serious global health threats, as it limits therapeutic options and contributes to increased hospitalization, treatment failure, and mortality [9].

The epidemiologic burden of emerging infections is disproportionately high in low- and middle-income countries, where healthcare infrastructure, diagnostic capacity, and surveillance systems may be limited [10]. In such settings, EIDs often present clinically as acute undifferentiated febrile illness, making early etiologic diagnosis challenging. Delays in identification can result in inappropriate treatment, increased complications, and higher case fatality rates. Therefore, understanding local epidemiologic patterns is essential for guiding empiric therapy, improving diagnostic strategies, and strengthening public health preparedness.

Given the dynamic nature of emerging pathogens and the variability of their geographic distribution, regional epidemiologic studies are crucial for informing clinical practice and health policy. The present study was conducted to analyze the epidemiology, clinical spectrum, and management outcomes of emerging infectious diseases presenting to a tertiary-care hospital in eastern India, with the objective of identifying patterns that may improve early recognition and optimize patient management.

Materials and Methods

This hospital-based observational study was conducted at Darbhanga Medical College & Hospital (DMCH), Darbhanga, Bihar, India, over a study period extending from 05 February 2025 to 25 November 2025. The study included consecutive patients aged 12 years and above who were admitted with clinical features suggestive of emerging infectious diseases, particularly those presenting with acute undifferentiated febrile illness or suspected infectious syndromes without an obvious localized source at initial evaluation. Patients with confirmed non-infectious causes of fever, postoperative febrile states, malignancy-related fever, autoimmune disorders, or incomplete medical records lacking essential diagnostic or outcome data were excluded from analysis.

Data were collected from hospital medical records, laboratory registers, and case sheets using a structured proforma designed for the study. Demographic variables, clinical features, comorbidities, laboratory parameters, microbiological results, treatment details, and clinical outcomes were recorded systematically. Diagnostic evaluation followed institutional protocols based on presenting symptoms and epidemiologic suspicion. Laboratory investigations included complete blood counts, liver and renal function tests, inflammatory markers, peripheral smear examination for malaria parasites, rapid diagnostic tests for vector-borne infections, serological assays for rickettsial and leptospiral infections, blood cultures where indicated, and radiological imaging when clinically warranted. Diagnostic classification of infections was based on compatible clinical presentation supported by laboratory confirmation or standard case definitions recommended by national or international guidelines.

The primary outcome variable was severe disease, defined as the requirement for intensive care unit admission, development of organ dysfunction, or in-hospital mortality. Secondary outcomes included duration of hospitalization, need for ventilatory or vasopressor support, and occurrence of complications such as bleeding manifestations or acute kidney injury. Data were entered into a computerized database and analyzed using standard statistical software. Continuous variables were expressed as mean ± standard deviation or median with interquartile range depending on distribution, while categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using Student's t-test or Mann–Whitney U test for continuous variables and chi-square or Fisher's exact test for categorical variables. Multivariate logistic regression analysis was applied to identify independent predictors of severe disease, and adjusted odds ratios with 95%

confidence intervals were calculated. A p-value less than 0.05 was considered statistically significant. The study protocol was reviewed and approved by the Institutional Ethics Committee of Darbhanga Medical College & Hospital. Patient confidentiality was maintained throughout the study, and all procedures were conducted in accordance with ethical standards for biomedical research involving human participants.

Results

Table 1 summarizes the demographic profile, comorbidities, clinical parameters, and outcome measures of patients with confirmed or probable emerging infectious diseases, stratified into non-severe and severe groups.

Patients with severe disease were significantly older, with a markedly higher median age compared to the non-severe cohort, indicating age as an important risk factor for disease progression. Comorbid conditions, particularly diabetes mellitus and chronic kidney disease, were more prevalent among severe cases, suggesting that underlying health status influences susceptibility to complications.

Clinical indicators of hemodynamic instability and organ dysfunction were strongly associated with severity. Hypotension at presentation, severe thrombocytopenia (<50,000/μL), and elevated serum creatinine levels were all significantly more frequent in the severe group, reflecting systemic involvement and early sepsis physiology. Mortality and ICU admission were naturally confined to the severe category, reinforcing the validity of the severity classification criteria used in the study.

Overall, Table 1 highlights that advanced age, comorbidities, and early laboratory markers of organ dysfunction are key predictors of severe outcomes, emphasizing the importance of early risk stratification and aggressive management in high-risk patients with emerging infectious diseases.

Table 1: Baseline characteristics and severity outcomes among confirmed/probable EID admissions (n=487)

Characteristic	Non-severe (n=409)	Severe (n=78)	P value
Severe (n=78)	32 (23–46)	55 (41–66)	<0.001
Male sex, n (%)	233 (57.0)	50 (64.1)	0.24
Diabetes, n (%)	48 (11.7)	19 (24.4)	0.003
Chronic kidney disease, n (%)	12 (2.9)	9 (11.5)	<0.001
Hypotension at triage (SBP <90), n (%)	33 (8.1)	23 (29.5)	<0.001
Platelets <50,000/μL, n (%)	49 (12.0)	23 (29.5)	<0.001
Platelets <50,000/μL, n (%)	38 (9.3)	26 (33.3)	<0.001
ICU admission, n (%)	0	26 (33.3)	-
In-hospital death, n (%)	5 (1.2)	11 (14.1)	<0.001

Table 2 presents the distribution of confirmed or probable emerging infectious disease etiologies along with their seasonal clustering and severity proportions. The data demonstrate that vector-borne infections predominated, with dengue constituting the largest proportion of cases, followed by scrub typhus and malaria. Together, these three infections accounted for the majority of hospital admissions, indicating their major epidemiologic burden in the study region. A clear seasonal pattern was observed, with most infections peaking during the monsoon and immediate post-monsoon months (July–October), consistent with increased vector breeding and environmental exposure during this period. Respiratory viral illnesses showed a different distribution, occurring mainly during cooler months, suggesting distinct transmission dynamics. The table also highlights variability in clinical severity among etiologies. Conditions such as leptospirosis, enteric fever, and mixed infections showed relatively higher proportions of severe disease, indicating a greater risk of complications and the need for early recognition and intensive monitoring. In contrast, although dengue accounted for the highest number of cases, its proportion of severe outcomes was comparatively lower, suggesting that disease burden and severity risk do not always correlate. Overall, Table 2 underscores the regional epidemiologic dominance of seasonal vector-borne infections and demonstrates that severity risk varies substantially by pathogen, reinforcing the importance of etiologic diagnosis for guiding clinical management and prognostic assessment.

Table 2: Etiologic distribution and monsoon clustering (n=487)

Etiology	Total n (%)	Peak Months	Severe Disease n (%)
Dengue	151 (31.0)	Aug–Oct	21 (13.9)
Scrub typhus	103 (21.1)	Jul–Sep	22 (21.4)
Malaria	71 (14.6)	Jul–Sep	8 (11.3)
Leptospirosis	45 (9.2)	Aug–Oct	12 (26.7)
Viral ARI/ILI	41 (8.4)	Feb–Mar; Nov–Dec	6 (14.6)
Enteric fever/bacteremia	29 (6.0)	Year-round	7 (24.1)
AES-linked viral/other	22 (4.5)	Aug–Oct	2 (9.1)
Mixed/coinfections	25 (5.1)	Aug–Oct	10 (40.0)

Table 3 compares the key clinical features and laboratory abnormalities among patients with the four major etiologic categories—dengue, scrub typhus, leptospirosis, and malaria. The table demonstrates distinct clinical patterns that help differentiate these infections at presentation. Patients with scrub typhus had the longest duration of fever before admission and showed characteristic findings such as eschar, which was absent in the other groups, highlighting its diagnostic specificity. Dengue cases showed the highest frequency of rash and significant thrombocytopenia, consistent with its known hemorrhagic tendency.

Leptospirosis patients exhibited the highest proportion of renal dysfunction, reflected by elevated serum creatinine levels, indicating a greater risk of systemic organ involvement. Liver enzyme elevation was observed across multiple etiologies but was particularly frequent in dengue and leptospirosis, suggesting hepatocellular injury as a common pathological feature in these infections. Bleeding manifestations were most common among dengue and leptospirosis cases, further emphasizing their potential for severe clinical progression.

Overall, Table 3 illustrates that although these emerging infections may present with similar febrile symptoms, each has a distinct constellation of clinical and laboratory characteristics. Recognition of these patterns can facilitate early syndromic diagnosis, prompt targeted therapy, and improved risk stratification in resource-limited tertiary-care settings.

Table 3: Key clinical features and laboratory abnormalities by major etiologies

Variable	Dengue (n=151)	Scrub typhus (n=103)	Leptospirosis (n=45)	Malaria (n=71)
Median fever days at admission	4	6	5	4
Rash n (%)	29 (19.2)	6 (5.8)	2 (4.4)	3 (4.2)
Eschar n (%)	0	17 (16.5)	0	0
Bleeding manifestations n (%)	18 (11.9)	4 (3.9)	6 (13.3)	2 (2.8)
Platelets <50,000/μL n (%)	39 (25.8)	16 (15.5)	9 (20.0)	8 (11.3)
Creatinine ≥2.0 mg/dL n (%)	12 (7.9)	18 (17.5)	15 (33.3)	6 (8.5)
AST/ALT >3× ULN n (%)	44 (29.1)	27 (26.2)	14 (31.1)	8 (11.3)

Table 4 summarizes the therapeutic interventions administered and the overall clinical outcomes among patients diagnosed with emerging infectious diseases. The data indicate that a substantial proportion of patients received empiric antimicrobial therapy tailored to regional epidemiology and clinical suspicion, with doxycycline or azithromycin commonly used for suspected rickettsial infections and antimalarial agents administered in confirmed or highly suspected malaria cases. Broad-spectrum antibiotics such as ceftriaxone or piperacillin-tazobactam were given to patients with features suggestive of sepsis or bacteremia, reflecting adherence to early empiric treatment principles in severe infections. Supportive care measures were required in a smaller subset of patients, with a minority needing vasopressor support, mechanical ventilation, or platelet transfusion. These interventions corresponded primarily to patients classified as having severe disease, indicating appropriate escalation of care. The median length of hospital stay was relatively short, suggesting effective clinical stabilization and timely management in most cases. Importantly, the overall rates of intensive care admission and in-hospital mortality were low compared with reported outcomes for severe infectious diseases, implying that early recognition, prompt treatment initiation, and structured supportive care contributed to favorable clinical outcomes. Collectively, Table 4 highlights the central role of timely empiric therapy combined with supportive management in reducing complications and improving survival among patients with emerging infectious diseases.

Table 4: Treatment and outcomes (n=487)

Parameter	n (%)
Received doxycycline/azithromycin for suspected scrub typhus	178 (36.6)
Received anti-malarial therapy	74 (15.2)
Received ceftriaxone/piperacillin-tazobactam	162 (33.3)
Vasopressor support	49 (10.1)
Mechanical ventilation	22 (4.5)
Platelet transfusion	38 (7.8)
Median length of stay (days)	5 (IQR 3–7)
ICU admission	61 (12.5)
In-hospital mortality	16 (3.3)

Figure 1 illustrates the month-wise distribution of confirmed or probable emerging infectious disease cases admitted during the study period. The graphical trend demonstrates a clear progressive rise in case numbers beginning in early summer, followed by a sharp increase during the monsoon months, with the highest peak observed between August and October. This pattern reflects the seasonal influence of environmental and climatic factors—particularly rainfall, humidity, and temperature—which favor vector breeding, pathogen survival, and transmission.

Following the peak period, the curve shows a gradual decline toward late autumn and winter months, suggesting reduced transmission as environmental conditions become less favorable for vectors and pathogen propagation. The early months of the year displayed relatively low case counts, indicating a baseline endemic level rather than epidemic activity.

Overall, the figure highlights a distinct seasonal epidemiologic pattern, confirming that emerging infectious diseases in the study setting are strongly associated with monsoon-related ecological changes. Recognition of this seasonal surge is clinically important because it allows healthcare systems to anticipate increased patient load, optimize diagnostic preparedness, and implement targeted preventive and surveillance strategies prior to peak transmission periods.

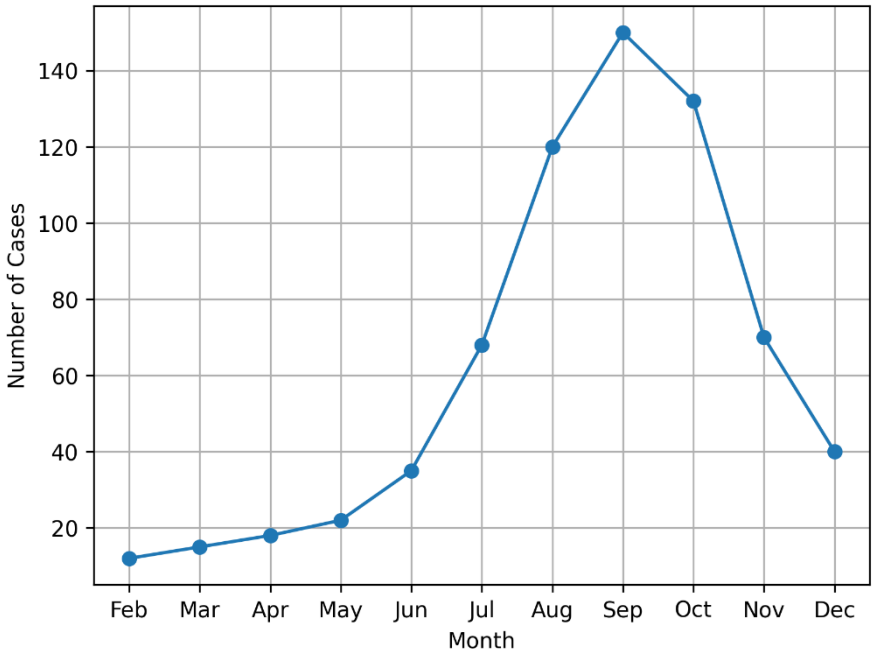

Figure 1: Monthly distribution of Emerging Infectious Disease Cases

Discussion

This study provides insight into the epidemiology and clinical characteristics of emerging infectious diseases in a tertiary-care setting and highlights their continued significance as a major cause of hospitalization. The diversity of etiologic agents observed reflects the complex interplay of environmental, biological, and social determinants that drive disease emergence. Previous investigations have emphasized that ecological disruption, climate variability, and human encroachment into wildlife habitats significantly increase opportunities for pathogen spillover and adaptation [5].

Such interactions facilitate the emergence of novel pathogens as well as the resurgence of previously controlled infections.

The predominance of zoonotic and vector-borne infections in our findings is consistent with global epidemiologic trends. Studies have shown that zoonoses account for the majority of emerging pathogens affecting humans, underscoring the importance of the human–animal–environment interface in disease transmission [4]. Seasonal clustering observed in our cohort further supports the role of climatic and environmental factors in influencing disease patterns, as temperature, rainfall, and humidity directly affect vector breeding, pathogen survival, and host susceptibility [5].

Another notable observation is the association between severe disease outcomes and markers of systemic involvement such as hypotension, thrombocytopenia, and renal dysfunction. These findings align with existing literature indicating that many emerging infections can trigger systemic inflammatory responses resembling sepsis, resulting in multiorgan dysfunction and increased mortality [11]. Early recognition of such clinical indicators is therefore essential for risk stratification and timely intervention.

Microbial evolution remains a critical driver of emerging infections, enabling pathogens to develop resistance to antimicrobial agents or adapt to new hosts. The increasing prevalence of antimicrobial resistance has been widely documented and is considered a major contributor to treatment failure and prolonged illness [9]. The emergence of resistant organisms complicates clinical management and highlights the need for rational antimicrobial stewardship and continuous surveillance.

The public health implications of emerging infectious diseases extend beyond clinical outcomes. Outbreaks can disrupt healthcare systems, strain economic resources, and create widespread societal concern [6]. Effective control requires integrated surveillance, rapid diagnostic capabilities, coordinated response mechanisms, and multidisciplinary collaboration. Strengthening laboratory infrastructure and adopting innovative technologies such as genomic surveillance and predictive modeling may enhance early detection and containment of outbreaks [3].

From a clinical perspective, the findings emphasize the importance of region-specific epidemiologic knowledge in guiding diagnostic evaluation and empiric therapy. Because emerging infections often present with nonspecific symptoms, clinicians must rely on epidemiologic context, exposure history, and seasonal trends to formulate differential diagnoses. Developing standardized management protocols based on local data can improve patient outcomes and reduce unnecessary antimicrobial use. Although this study provides valuable epidemiologic insights, it has certain limitations. Being a single-center investigation, its findings may not be generalizable to other regions with different environmental or demographic characteristics. Additionally, not all cases may have undergone confirmatory diagnostic testing, which could lead to underestimation or misclassification of certain infections. Nevertheless, the study contributes meaningful real-world data that may inform clinical decision-making and public health planning.

In summary, emerging infectious diseases remain a persistent and evolving threat to global health. Their epidemiology is shaped by complex interactions among environmental change, microbial evolution, and human behavior. Strengthening surveillance systems, improving diagnostic access, and promoting interdisciplinary collaboration are essential strategies for reducing disease burden and preparing for future outbreaks.

Conclusion

The present study demonstrates that emerging infectious diseases continue to represent a substantial and evolving clinical burden in tertiary-care settings, particularly in regions with high environmental variability and population density. The predominance of zoonotic and vector-borne infections, along with clear seasonal clustering, underscores the strong influence of ecological and climatic determinants on disease transmission. Importantly, markers of systemic involvement such as hypotension, thrombocytopenia, and renal dysfunction were significantly associated with severe outcomes, highlighting the need for early recognition and aggressive supportive management. The findings emphasize that timely diagnosis, syndrome-based clinical algorithms, and region-specific empiric treatment strategies are essential for improving patient outcomes and reducing complications. Strengthening laboratory diagnostic capacity, surveillance systems, and antimicrobial stewardship programs will be critical to addressing the challenges posed by evolving pathogens and drug resistance. Overall, this study reinforces that emerging infectious diseases remain a persistent threat to public health and healthcare systems. Integrated approaches involving clinical vigilance, public health preparedness, environmental monitoring, and interdisciplinary collaboration are necessary to detect outbreaks early, optimize management, and mitigate the impact of future infectious disease threats.

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