The Spread of Scrub Typhus in Andhra Pradesh: Epidemiology, Clinical Trends, and Public Health Responses

Kolasani Venkata Ramaiah[1], Kaanduri Sesha Sita Godha Mohana[2], Mule Venkatachennakesavareddy[3], Venkataprasannakumar.Goli[4], Mangalapudi Rami Reddy[5]
[1,2,3,4,5]*Final Year B.Pharm Student, Bapatla College of Pharmacy, Bapatla-522101, Andhra Pradesh, India*

***Abstract*—Scrub typhus is a re-emerging vector-borne zoonotic disease caused by Orientia tsutsugamushi and transmitted through the bite of infected chigger mites. In recent years, Andhra Pradesh has reported a notable rise in scrub typhus cases, particularly during the post-monsoon period, making it a significant contributor to acute undifferentiated febrile illness in the region. This article reviews the epidemiology, clinical manifestations, pathophysiology, and public health responses related to scrub typhus, with a specific focus on Andhra Pradesh. The disease presents with a wide clinical spectrum, ranging from mild fever and headache to severe complications such as acute respiratory distress syndrome, renal failure, myocarditis, and meningoencephalitis if diagnosis and treatment are delayed. Environmental factors, occupational exposure, and seasonal vector dynamics play a critical role in disease transmission. Strengthened surveillance, improved diagnostic capacity, early antibiotic therapy with doxycycline or azithromycin, and enhanced public awareness campaigns have significantly contributed to better disease control. Recent initiatives by the Andhra Pradesh government, including genome sequencing, task force formation, and stockpiling of essential medicines, demonstrate a proactive public health approach. Continued surveillance, clinician awareness, and integrated vector control strategies are essential to reduce morbidity, mortality, and future outbreaks of scrub typhus.**

***Index Terms*—Scrub typhus, Orientia tsutsugamushi, Chigger mite, Acute febrile illness, Epidemiology, Andhra Pradesh, Public health response**

I. INTRODUCTION

Scrub typhus, a rickettsial infection transmitted by chigger mites (Trombiculidae), has reemerged as a significant cause of acute febrile illness across India and is increasingly documented in Andhra Pradesh. After several years of sporadic reporting, Andhra Pradesh recorded roughly 1,566 confirmed cases in 2025 (compared with about 1,689 in 2024), with case clusters concentrated in districts such as Chittoor, Kakinada and Visakhapatnam. Clinical presentations remain protean, ranging from undifferentiated fever and headache to multi-organ dysfunction in severe cases, which has prompted wider testing of febrile patients and strengthened laboratory surveillance through regional VRDLs and ELISA/rapid test deployment. The recent occurrence of deaths in multiple districts has led state authorities to initiate whole-genome sequencing of isolates to investigate possible changes in strain virulence and to guide response measures. Meanwhile, public-health actions have emphasised early diagnosis, prompt doxycycline/azithromycin treatment, and expanded availability of medicines and test kits at primary-care centres.

II. SCRUB TYPHUS

Scrub typhus is an acute infectious disease caused by the bacterium Orientia tsutsugamushi. It spreads to humans through the bite of infected chigger mites (larval mites) commonly found in grassy and scrub-covered areas. The disease usually begins with sudden fever, headache, body pain, and sometimes a dark scab-like lesion at the bite site called an eschar. If not

treated early, it can lead to serious complications such as pneumonia, organ failure, or inflammation of the brain. Early diagnosis and treatment with appropriate antibiotics mainly doxycycline help ensure quick recovery.

III. EPIDEMIOLOGY

Global Burden & Distribution

- Historically, scrub typhus has been considered endemic mainly in a region known as the "Tsutsugamushi Triangle" roughly spanning from northern Japan/far-eastern Russia in the north, southwards to northern Australia, and west to Pakistan.
- Recent evidence shows that scrub typhus may be expanding beyond this "traditional" geographic zone. There are emerging reports from Africa, South America (e.g. Chile, Peru), and some Middle East regions.
- Overall, it's estimated that over one billion people worldwide live in areas at risk of scrub-typhus infection.
- The annual number of new infections globally is estimated at ~1 million cases per year

Seroprevalence, Incidence, and Mortality

- A global analysis combining many studies (over 148,000 samples) estimated the pooled seroprevalence (i.e., proportion of people with evidence of past or current exposure) of scrub typhus infections as ~24.9% (95% CI: 23.3–26.6%).
- Among healthy (asymptomatic) individuals, another meta-analysis found about 10.7% seroprevalence, while among febrile patients, the prevalence rose to 22.6%.
- Regarding clinical burden: in endemic countries, scrub typhus can account for as much as 25–30% of "acute undifferentiated febrile illness (AUFI)" cases i.e. fevers not diagnosed as malaria, dengue, etc.

Mortality / severe disease burden:

- In India, a systematic review estimated the case fatality rate (CFR) to be around 6.3% overall.
- Severe complications (multi-organ dysfunction, ICU admission, ventilation, acute kidney injury, ARDS, etc.) are common among hospitalised patients.
- If left untreated, mortality can be much higher; globally, some reports indicate fatality rates up to ~30% (or more, depending on strain, care access) in untreated cases.

Situation in India Distribution & Trends

- Recent national-level data (from a report under the Indian Council of Medical Research – National Centre for Disease Informatics and Research, ICMR-NCDIR) indicates that in 2022, there were ~ 32,355 reported scrub typhus cases across India; by 2023 that number rose to ~ 54,162
- By 2023, 32 states (out of 36 surveyed) reported confirmed scrub typhus cases showing that the disease has a widespread geographic presence across India, including north, south, east, west, central, and northeast.
- States/regions with particularly high burden historically: Tamil Nadu, Himachal Pradesh, Karnataka, Uttarakhand but more recently, many other states too.
- In India, certain characteristics are common among affected groups:
  1. Higher prevalence among agricultural labourers / rural population (since they are more exposed to vector habitats).
  2. Males and females are affected roughly equally.
- Recently, numerous cases have been reported in India, mainly in the state of Andhra Pradesh. Andhra Pradesh reported several hundred confirmed cases in the 2025 post-monsoon period: one news report (Dec 4, 2025) cited 791 confirmed cases from 4,771 samples tested statewide, with districts such as Chittoor, Kakinada and Visakhapatnam among the most affected. The state reported a small number of deaths historically (five total by that report) and has stocked antibiotic supplies at PHCs (public health centres) /UPHCs (urban public health centres). Following a cluster of suspected deaths, Andhra Pradesh authorities ordered whole-genome sequencing of samples to check for possible changes in circulating strains or increased virulence; several regional labs, including medical colleges and tertiary centres, were engaged. The government also mobilised VRDL labs and test kits for faster diagnosis. (Dec 2025).

- Recent Expanded local surveillance and testing in Andhra Pradesh during 2024–2025 have produced hospital-based studies and prevalence reports (e.g., tertiary-care studies from Visakhapatnam showing ~9–10% prevalence among acute febrile illness cohorts in some series), and molecular investigations have characterised circulating O. tsutsugamushi serotypes in southern Andhra Pradesh. These hospital/study findings show clinical complications (ARDS, renal involvement) in a subset of hospitalised patients.
- Clinical burden: Causes a noticeable fraction of undifferentiated acute febrile illnesses in post-monsoon months; some patients require hospitalisation for complications such as respiratory failure or renal involvement. Hospital reports document severe cases and occasional deaths when diagnosis/treatment is delayed.
- Public-health response: Increased testing (ELISA/rapid kits), deployment of Viral Research & Diagnostic Labs (VRDLs), stockpiling of doxycycline/azithromycin at primary care centres, and genomic sequencing of fatal cases to monitor strain changes.
- Most cases are listed in rural and peri-urban districts after the monsoon, such as Chittoor, Kakinada, and Visakhapatnam, which reported among the highest in recent counts. This increases pressure on district hospitals and diagnostic services during the seasonal peak.

Etiology of Scrub Typhus

- According to recent epidemiological studies and reviews, the main factors contributing to scrub-typhus risk include:

Environment & climate: Warm, humid climates; scrub vegetation; forested or semi-forested areas; agricultural fields; plantations; grasslands these are optimal habitats for mites.

Seasonality: In many regions, incidence peaks during or after monsoon / rainy seasons when mite activity and human exposure (farming, forest work) increase.

Occupational/demographic factors: Farmers, agricultural workers, plantation labourers, rural residents more likely to be exposed.

Underdiagnosis/misdiagnosis: Because scrub typhus symptoms (fever, headache, body ache) overlap with many other febrile illnesses (malaria, dengue, typhoid, leptospirosis), many cases remain undiagnosed or misdiagnosed leading to underreporting.

Vector ecology: The disease is transmitted by larval trombiculid mites (chiggers) the abundance of these mites depends on climate, vegetation, presence of rodents (their primary hosts), and land use patterns

IV. CHIGGER MITE (TROMBICULID MITE)

Fig 1: Chigger mite (larval trombiculid mite), the vector responsible for transmitting Orientia tsutsugamushi, the causative agent of scrub typhus.(This Photo by Unknown Author is licensed under CC BY-SA-NC)

Kingdom: Animalia
Class: Arachnida
Order: Trombidiformes
Family: Trombiculidae
Important Genera (scrub typhus vectors):
Leptotrombidium deliense
Leptotrombidium akamushi
Leptotrombidium scutellare
morphology

Extremely small: 0.2–0.4 mm (almost invisible to the naked eye)
Colour: Bright red, orange, yellow, or brown
Shape: Round body, 6 legs (larvae only)
Adult mites and nymphs: Have 8 legs, but only the 6-legged larva bites humans
Life Cycle of Chigger Mites

- The life cycle of Chigger Mites contains four stages, as given in fig (2)

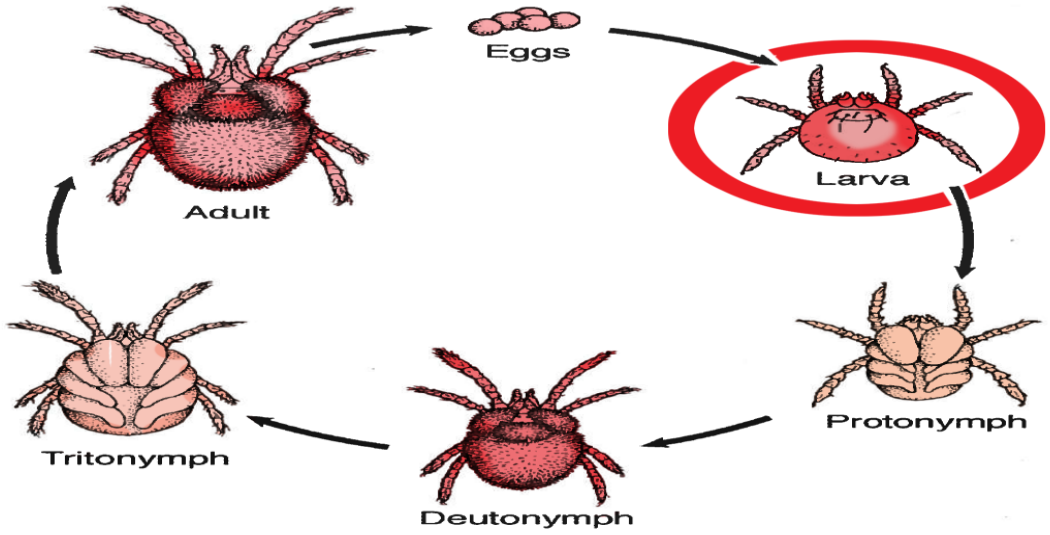

Fig 2: life cycle of Chigger Mite (Trombiculid Mite)

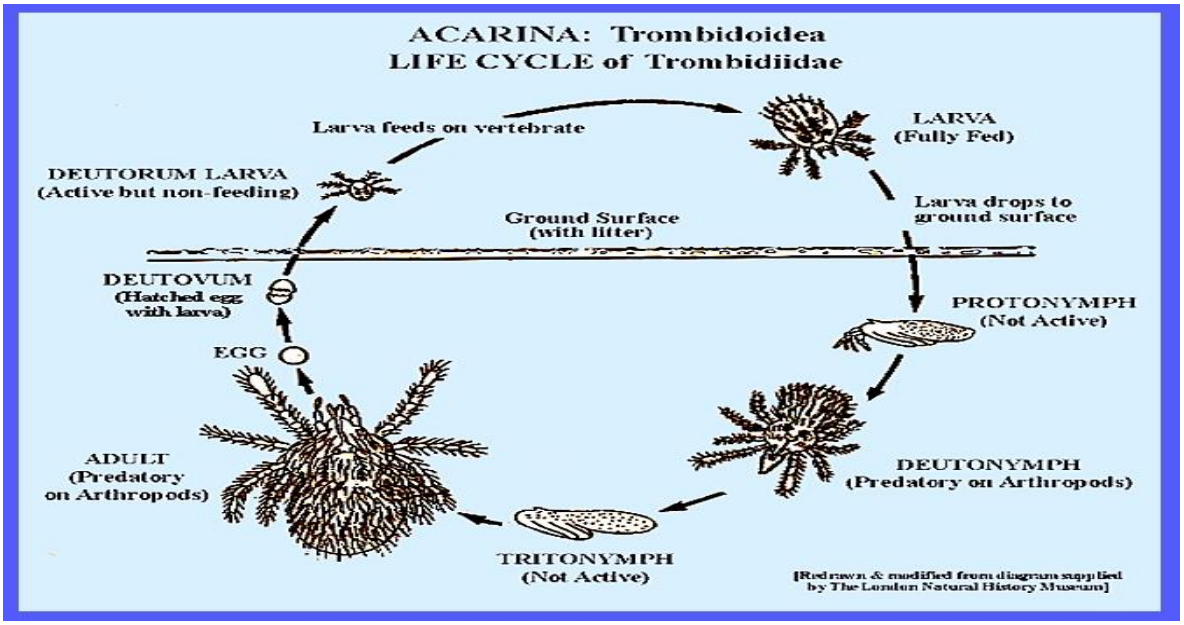

Fig 3: Complete life cycle of Chigger Mite (Trombiculid Mite)

1. Egg: they lay eggs in soil/vegetation
2. Larva (Chigger): the only stage that bites humans; this is the disease-transmitting stage
3. Nymph: does not bite humans
4. Adult mite: free-living, feeds on insects/organic matter

Total life cycle: 2–12 months, depending on temperature and humidity.

How Chiggers Cause Scrub Typhus

- in scrub typhus cases (Fig 5)
- Only the larval stage transmits Orientia tsutsugamushi.
- They do not suck blood. Instead, they:

1. Inject digestive enzymes into the skin
2. dissolve surface cells
3. feed on liquefied tissue

which leads to:

- Itchy red bumps are shown in (Fig 4)
- A necrotic black eschar

Fig 4: Itchy red bumps (This Photo by Unknown Author is licensed under CC BY-SA-NC)

Fig 5: A necrotic black eschar in scrub typhus cases

Behaviour and Habitat of

- Most active in wet seasons (monsoon, late summer).
- Live in: soil surface, leaf litter, grassy fields
- They prefer shady areas, dense vegetation, and places with rodents (their main natural host). Chiggers typically attach when a person sits or lies on grass, walks through tall bushes, or works in fields or forests

Why Their Bite Causes Severe Itching

The enzymes they inject cause:

- breakdown of skin cells
- local inflammation

- intense itching lasting days to weeks However, the eschar (black scab) is diagnostic in scrub typhus.

What Chiggers Do Not Do

- They do not jump or fly.
- They do not burrow under the skin (common myth).
- They do not stay on the body for long; they drop off after feeding.

How to Prevent Chigger Bites

- Wear long sleeves and pants.
- Tuck pants into socks.
- Apply DEET on exposed skin.
- Treat clothing with permethrin.
- Avoid sitting on bare ground.
- Shower soon after outdoor exposure.

V. PATHOPHYSIOLOGY OF SCRUB TYPHUS

(Caused by Orientia tsutsugamushi)

Scrub typhus is primarily a vascular endothelial infection leading to widespread vasculitis, organ dysfunction, and systemic inflammatory response. Below is the full, step-by-step mechanism

1. Transmission & Entry

Chigger Bite (Larval Trombiculid Mite)

- The infectious stage is the 6-legged larva.
- During the bite, the chigger releases salivary enzymes localized tissue necrosis.
- O. tsutsugamushi is inoculated into the dermis.

Formation of Eschar

- Local bacterial replication → necrosis → black eschar forms (pathognomonic).
- Eschar contains numerous infected macrophages & dendritic cells.

2. Local Infection & Dissemination

A. Invasion of Immune Cells

- Bacteria enter into Dendritic cells, Monocytes/macrophages, Endothelial cells
- They spread through lymphatics to regional lymph nodes → lymphadenopathy.

B. Hematogenous Spread

- From the lymph nodes, bacteria enter the bloodstream and disseminate to:

1. Blood vessels
2. Lungs
3. Liver & spleen
4. Kidneys
5. CNS
6. Heart

3. Cellular Mechanism of Injury

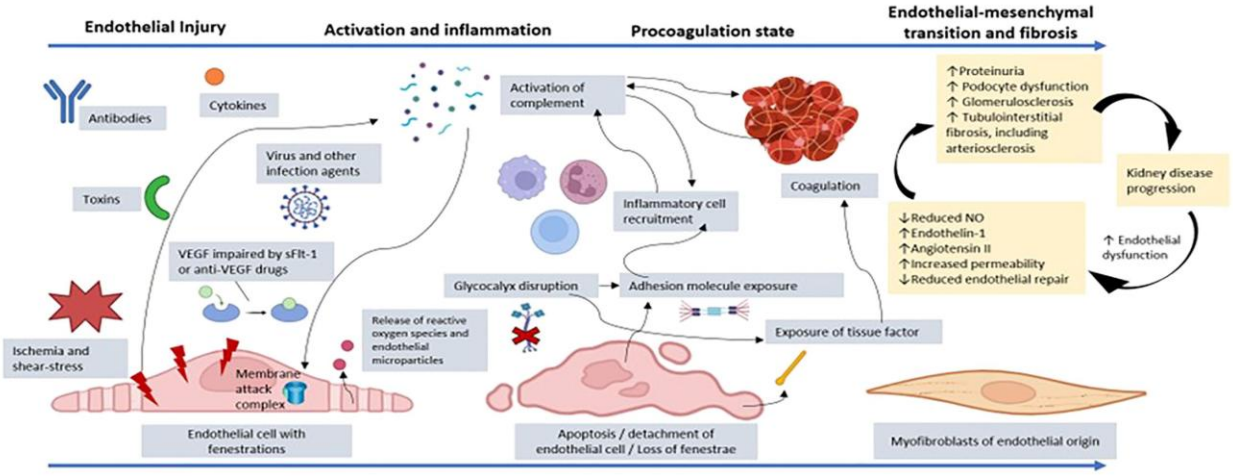

Fig 6: damage caused by the organism

A. Intracellular Tropism

- O. tsutsugamushi is an obligate intracellular bacterium. It multiplies in:

I. Endothelial cells → primary target

II. Monocytes/macrophages → amplify inflammation

III. Smooth muscle cells, Endothelial Cell Damage

- Causes: Vasculitis, Perivascular inflammation, Increased vascular permeability. This leads to plasma leakage, edema, and hypotension.

4. Immune Response & Cytokine Storm
- Infected macrophages release pro-inflammatory cytokines: TNF-α, IFN-γ, IL-1, IL-6, IL-8, and reactive oxygen species
- Consequences: High continuous fever, Systemic inflammatory response syndrome (SIRS), Tissue damage due to uncontrolled inflammation

5. Microvascular Pathology
- The hallmark pathology is microvascular leakage due to endothelial injury.

This causes:
1. Lungs
- Interstitial pneumonitis
- Pulmonary edema

2. Kidneys
- Acute tubular necrosis

3. Liver
- Hepatocellular injury → elevated transaminases
- Kupffer cell hyperplasia

4. CNS
- Meningoencephalitis
- Cerebral edema

5. Heart
- Myocarditis
- Hypotension/shock due to excessive capillary leak

6. Multi-Organ Dysfunction
- Unchecked vasculitis + inflammation → MODS (Multiple Organ Dysfunction Syndrome) Common complications: ARDS, Hepatitis, Renal failure, Meningoencephalitis, Myocarditis, Shock, Mortality rises sharply if untreated.

7. Immunology & Antigenic Variation
- O. tsutsugamushi has high antigenic variability (especially the 56-kDa outer membrane protein).
- Effects: No long-lasting immunity, Reinfection is common, Vaccine development is difficult

Organs Affected in Scrub Typhus & Mechanism of Damage

Scrub typhus affects multiple organs because Orientia tsutsugamushi infects endothelial cells and macrophages, causing vasculitis, microvascular leakage, and hypoperfusion. Here is a system-by-system explanation:

1. Lungs (Most commonly affected)

How lungs are affected:
- Infection of endothelial cells in lung capillaries
- ↑ Vascular permeability → fluid leaks into alveoli
- Intense inflammation → interstitial pneumonitis
- Severe cases → pulmonary edema → ARDS

Clinical outcomes: Cough, Breathlessness, Hypoxia

2. Heart

How the heart is affected:
- Direct bacterial invasion of myocardial cells
- Vasculitis of the coronary microcirculation
- Systemic inflammatory cytokines affect cardiac contractility
- Clinical outcomes: Myocarditis, Arrhythmias, Hypotension, Shock (due to capillary leak + myocardial dysfunction)

3. Central Nervous System (CNS)

How the brain is affected:
- Endothelial infection of cerebral vessels → cerebral vasculitis
- Capillary leakage → cerebral edema
- Macrophage inflammation → meningoencephalitis
- Clinical outcomes: Severe headache, Confusion, Seizures, Meningeal signs, Altered sensorium → coma (late stage)

4. Liver

How the liver is affected:
- Kupffer cell activation
- Hepatocyte injury due to inflammation
- Microvascular leakage → hypoxic damage
- Inflammatory cytokines → hepatocellular stress

Clinical outcomes: Elevated AST/ALT, Hepatomegaly, Jaundice (occasionally), Part of multiorgan failure

5. Spleen

How the spleen is affected:
- Immune activation → splenic congestion

- Endothelial inflammation
- Reticuloendothelial hyperplasia
- Clinical outcomes: Splenomegaly, Pain in the left upper abdomen

6. Kidneys

How kidneys are affected:

- Vasculitis of renal microcirculation
- Hypoperfusion
- Direct tubular damage due to inflammation
- Capillary leak → reduced intravascular volume

Clinical outcomes: Acute kidney injury (AKI), Oliguria, Electrolyte imbalances

7. Blood & Blood Vessels

How affected:

- Endothelium is the primary target → widespread vasculitis
- Platelet consumption → thrombocytopenia
- Capillary leak → hemoconcentration
- Coagulation abnormalities may occur

Clinical outcomes: Thrombocytopenia. Small hemorrhages. Hypotension/shock

8. Skin

How skin is affected

- Local chigger bite → cell necrosis
- Bacterial replication → inflammation
- Vascular necrosis → eschar formation

Clinical outcomes: Eschar (black scab), Rash (maculopapular), Regional lymphadenopathy

9. Gastrointestinal System

How the GI system is affected:

- Vasculitis of intestinal vessels
- Hypoperfusion → mucosal damage
- Increased vascular permeability

Clinical outcomes: Abdominal pain, Vomiting, Diarrhea, GI bleeding (rare)

VI. TREATMENT OF SCRUB TYPHUS

- The mainstay of treatment is antibiotic therapy, and early initiation dramatically reduces complications and mortality.

First-Line Drug

1. Doxycycline

Dose: Adults: 100 mg twice daily for 5–7 days
Children >8 years: 2.2 mg/kg twice daily

- Most effective and most widely used
- Mechanism of action: Doxycycline binds to the 30S ribosomal subunit of O. tsutsugamushi and blocks protein synthesis → inhibits bacterial growth
- It is bacteriostatic (prevents replication)
- Highly active against intracellular organisms like Orientia

Clinical response

- Fever usually resolves within 24–48 hours
- Rapid improvement confirms diagnosis (therapeutic diagnosis)

Alternative Drugs

Azithromycin

- Dose:
  Adults: 500 mg on day 1 → 250 mg/day for 4 days
  Children: 10 mg/kg on day 1 → 5 mg/kg for 4 days
- Preferred in: Pregnancy, Doxycycline intolerance, Some regions with possible reduced doxycycline response

Mechanism of action: Binds to the 50S ribosomal subunit and Inhibits translocation step of protein synthesis

- It is Effective against intracellular bacteria
- Bacteriostatic

Why useful?

- Does NOT affect fetal development → safe in pregnancy
- Works even when doxycycline doesn't (rare cases of reduced susceptibility)

Chloramphenicol

(Second-line; rarely used now due to toxicity)

- Dose: 500 mg four times daily for 7–10 days
- Mechanism of action: Binds to the 50S ribosomal subunit, blocks peptidyl transferase, → inhibits protein synthesis
- Bacteriostatic

Limitations

- Risk of aplastic anemia, bone marrow suppression
- Avoid if safer alternatives are available

Rifampicin

- Used when patients do NOT respond to doxycycline (rare)
- Particularly helpful in severe cases or co-infection situations

Mechanism of action: Inhibits DNA-dependent RNA polymerase, Stops mRNA synthesis → bactericidal, works well because Orientia is intracellular and needs rapid RNA production

- Not used if TB co-infection is suspected, as it might cause drug-resistance masking.

During Severe Cases

When to consider severe: ARDS, Shock, Multi-organ dysfunction, Meningoencephalitis, Hepatic/renal failure

Management:

- Doxycycline IV (or azithromycin IV if the patient is pregnant)
- ICU supportive care: Fluids (careful due to capillary leak), Oxygen/ventilation, Vasopressors for shock, Treat complications (AKI, myocarditis, etc.)

Supportive Treatment

- Antipyretics (paracetamol)
- Avoid NSAIDs in severe disease (risk of renal injury)
- Manage thrombocytopenia and coagulopathy
- Monitor liver and kidney function
- Adequate hydration
- Early treatment reduces mortality from 30% (untreated) to <3% (treated)

VII. PREVENTION MEASURES BY WHO

The key World Health Organisation (WHO) related recommendations and general global best practices for the prevention of communicable disease control standards and vector-borne disease prevention principles.

1. Disease Recognition & Surveillance

- WHO-recommended communicable disease surveillance frameworks include scrub typhus (also called mite-borne typhus or tsutsugamushi disease) as a condition that should be monitored in endemic regions.
- Surveillance helps identify trends, outbreaks, and high-risk periods, enabling timely public health action.

2. Avoiding Chigger (Vector) Bites

- Because scrub typhus is transmitted by larval trombiculid mites (chiggers), the central preventive strategy is reducing human exposure to infected mites: Personal Protection
- Wear protective clothing long sleeves, full-length trousers, socks and closed shoes especially in areas with dense vegetation or known chigger habitats.
- Use effective insect repellents on exposed skin and clothing (e.g., DEET-based repellents), following manufacturer directions\
- Treat clothing and gear with permethrin (a residual mite repellent for fabrics) where appropriate; do not apply permethrin directly to skin
- Avoid sitting or lying directly on bare ground or grass in endemic areas; use ground covers or mats instead.

Environmental & Vector Control

- Clear thick vegetation/bushes near homes or pathways to reduce mite habitat.
- Consider environmental control, such as insecticide treatment of vegetation in high-risk zones (where permitted and safe).
- Rodent control & habitat modification to reduce mite reservoir populations (since mites often live on rodents).

3. Health Education & Community Awareness

- Raise awareness about scrub typhus symptoms (like fever, headache, malaise, body aches, and possible eschar, a scab-like sore at the bite site) and when to seek medical help.
- Educate communities, especially agricultural workers, forest visitors, and rural residents, about risk factors and how to minimise exposure during peak seasons (monsoon/post-monsoon in many regions).

4. Early Detection & Clinical Management

- Although not strictly a “prevention” measure, WHO-aligned frameworks emphasise early diagnosis and prompt treatment to prevent severe outcomes, especially in endemic regions
- Healthcare providers in endemic areas should consider scrub typhus when patients present with prolonged fever and risk exposure.

- Early empirical antibiotic treatment (most often doxycycline or azithromycin) can prevent complications and reduce mortality; this supports prevention of severe disease progression.

5. Integrated Public Health Approach

- WHO and allied public health literature encourage an integrated approach combining surveillance, vector control, clinical management, and community education reflecting principles of "One Health" that consider human, animal, and environmental factors together in managing vector-borne diseases like scrub typhus.

VIII. THE RECENT ACTIONS TAKEN BY THE ANDHRA PRADESH (AP) GOVERNMENT REGARDING SCRUB TYPHUS (TYPHUS SCRUB DISEASE)

Fig 7: AP government actions against the typus scrub

Task Force Formation

- Chief Minister N. Chandrababu Naidu has instructed the formation of a special task force with national and international medical experts.
- The aim is to study scrub typhus more deeply and assess field-level conditions

Enhanced Surveillance and Testing

- The Health Department has intensified surveillance and lab testing in response to rising case numbers. Rapid Response Teams are active in affected districts.
- ASHA(Accredited Social Health Activist) workers are formed into small groups and collected data from each house hold, they played important role by conducting awareness campaigns and symptom recognition(they are trained to recognise key symptoms and immediately report to nearest health facility) and conducting awareness campaigns at village level.
- Genome sequencing has been ordered for samples from deceased patients with suspected scrub typhus to determine the exact cause of death.

Public Awareness Campaigns

- The government has launched public awareness drives aimed at educating people about symptoms (like prolonged fever and black bite sores) and preventive measures (e.g., protective clothing, clearing bushes, early treatment).
- District Collectors and health officials are instructing rapid response teams to conduct awareness and prevention outreach, especially in rural and high-risk areas.

Stock & Treatment Preparedness

- Reports indicate health centres are stocked with essential antibiotics like Doxycycline and Azithromycin to ensure timely treatment.

Health Department Clarifications

- The medical department has stated that scrub typhus cases are within expected seasonal ranges and not officially declared as a widespread outbreak, emphasizing that deaths suspected to be from the disease have not yet been conclusively confirmed.

Why These Measures?

- Scrub typhus cases and suspected deaths have been reported across many districts, prompting government action.
- Although some deaths are flagged as suspected, officials are emphasizing verification through genome studies and improved reporting methods

IX. CONCLUSION

Scrub typhus has re-emerged as a significant and often under-recognized public health challenge in Andhra Pradesh, contributing substantially to cases of acute undifferentiated febrile illness, particularly during the post-monsoon season. The disease's wide clinical spectrum ranging from mild febrile illness to life-threatening multi-organ dysfunction combined with diagnostic overlap with other endemic infections, continues to drive underdiagnosis and delayed treatment. Epidemiological trends from the state highlight the role of environmental conditions, occupational exposure, and seasonal vector dynamics in sustaining transmission. The documented burden, occasional fatalities, and evidence of severe complications underscore the need for heightened clinical suspicion and strengthened surveillance across both rural and peri-urban settings. Encouragingly, recent public health responses in Andhra Pradesh including expanded laboratory capacity, deployment of rapid diagnostics, ensured availability of effective antibiotics, genomic surveillance of circulating strains, and community awareness initiatives reflect a proactive and integrated approach to disease control. Early recognition and prompt treatment remain the most effective tools to reduce morbidity and mortality, while sustained surveillance, clinician training, and community engagement are essential for long-term control. Moving forward, a coordinated "One Health" strategy that integrates clinical management, vector control, environmental modification, and research into pathogen diversity will be critical to mitigating the impact of scrub typhus and preventing future outbreaks in the region.

REFERENCES

[1] Chaturvedi, R., Hussain, S., Sampath, H., Rahi, M., Mirdha, B., & Sharma, A. Spatiotemporal epidemiology and clinical manifestations of two decades of scrub typhus in India: a systematic review and meta-analysis. BMJ Global Health. 2025; 10. https://doi.org/10.1136/bmjgh-2025-018998.

[2] Kummara SK. Naidu orders task force to combat scrub typhus spread. ETHealthworld.com [Internet]. 2025 Dec 10; Available from: https://health.economictimes.indiatimes.com/news/policy/naidu-orders-task-force-to-combat-scrub-typhus-spread/125887685?utm_source=chatgpt.com

[3] Varghese, G., Raj, D., Francis, M., Sarkar, R., Trowbridge, P., & Muliyil, J. Epidemiology & risk factors of scrub typhus in south India. The Indian Journal of Medical Research. 2016; 144. https://doi.org/10.4103/0971-5916.193292.

[4] , J., Nema, R., Singh, A., Raj, D., Gupta, P., Tiwari, R., & Purwar, S. Deciphering the Genotypic Diversity and Epidemiology of Scrub Typhus Genotypes in India: A Systematic Review and Meta-Analysis.. Microbial pathogenesis. 2024 https://doi.org/10.1016/j.micpath.2024.107182.

[5] Devasagayam, E., Dayanand, D., Kundu, D., Kamath, M., Kirubakaran, R., & Varghese, G. The burden of scrub typhus in India: A systematic review. PLoS Neglected Tropical Diseases. 2021; 15. https://doi.org/10.1371/journal.pntd.0009619.

[6] Chunduru, K., R, M., Poornima, S., H, M., M, M., Varghese, G., Devaki, R., & Saravu, K. Clinical, laboratory, and molecular epidemiology of Orientia tsutsugamushi infection from Southwestern India. PLOS ONE. 2023; 18. https://doi.org/10.1371/journal.pone.0289126.

[7] RamachandraRao, I., Thulasiram, K., & LaxmanHVS, S. A study of clinical and epidemiological characteristics of scrub typhus in tertiary care hospital in andhra pradesh. Journal of Evolution of medical and Dental Sciences. 2015; 4. https://doi.org/10.14260/jemds/2015/852.

[8] Umarani, Y., Sarada, D., Jyothi, P., Vandana, E., Kalyani, R., & Rajarajeswari, M. Outbreak of scrub typhus in pyrexia of unknown origin during cooler months in guntur district, andhra pradesh, south india.. International Journal of Approximate Reasoning. 2017; 5. https://doi.org/10.21474/ijar01/5368.

[9] Kummara SK. AP orders genome sequencing after nine suspected scrub typhus deaths. The Times of India [Internet]. 2025 Dec 8; Available from: https://timesofindia.indiatimes.com/city/vijayawada/ap-orders-genome-sequencing-after-nine-suspected-scrub-typhus-

deaths/amp_articleshow/125841734.cms?utm_source=chatgpt.com

[10] Kore, V., & Mahajan, S. Recent Threat of Scrub Typhus in India: A Narrative Review. Cureus. 2022; 14. https://doi.org/10.7759/cureus.30092.

[11] Bonell, A., Lubell, Y., Newton, P., Crump, J., & Paris, D. Estimating the burden of scrub typhus: A systematic review. PLoS Neglected Tropical Diseases. 2017; 11. https://doi.org/10.1371/journal.pntd.0005838.

[12] Gitau, M., Asiago, O., Rogers, O., Reddy, K., Pradeepkumar, B., Sudheer, A., Pasala, P., & Swarna, P. A Comprehensive Review on Scrub Typhus: Epidemiology, Transmission, Diagnosis and Management. UTTAR PRADESH JOURNAL OF ZOOLOGY. 2024 https://doi.org/10.56557/upjoz/2024/v45i84002.

[13] Xu, G., Walker, D., Jupiter, D., Melby, P., & Arcari, C. A review of the global epidemiology of scrub typhus. PLoS Neglected Tropical Diseases. 2017; 11. https://doi.org/10.1371/journal.pntd.0006062.

[14] Bhowmick, S., Mohapatra, I., Panigrahi, K., & Das, A. IJCM_309A: Epidemiological Trends, Clinical Features, and Outcomes in Scrub typhus patients admitted to a tertiary care hospital in Odisha. Indian Journal of Community Medicine: Official Publication of Indian Association of Preventive & Social Medicine. 2024; 49. https://doi.org/10.4103/ijcm.ijcm_abstract309.

[15] Usha, K., Kumar, E., Kalawat, U., Kumar, B., Chaudhury, A., & Gopal, D. Molecular characterization of Orientia tsutsugamushi serotypes causing scrub typhus outbreak in southern region of Andhra Pradesh, India. The Indian Journal of Medical Research. 2016; 144. https://doi.org/10.4103/0971-5916.200886.

[16] Ramyasree, A., Kalawat, U., Rani, N., & Chaudhury, A. Seroprevalence of Scrub typhus at a tertiary care hospital in Andhra Pradesh. Indian Journal of Medical Microbiology. 2015; 33. https://doi.org/10.4103/0255-0857.148381.

[17] Jain, H., Das, A., Dixit, S., Kaur, H., Pati, S., Ranjit, M., Dutta, A., & Bal, M. Development and implementation of a strategy for early diagnosis and management of scrub typhus: an emerging public health threat. Frontiers in Public Health. 2024; 12. https://doi.org/10.3389/fpubh.2024.1347183.

[18] , V., Pautu, L., Lalmalsawma, P., Rosangkima, G., Sarma, D., Chinzah, H., Malvi, Y., Kodali, N., Amarthaluri, C., Balasubramani, K., & Nina, B. Epidemiology of scrub typhus and other rickettsial infections (2018–22) in the hyper-endemic setting of Mizoram, North-East India. PLOS Neglected Tropical Diseases. 2023; 17. https://doi.org/10.1371/journal.pntd.0011688.

[19] Konyak, B., Soni, M., Saikia, S., Chang, T., Gogoi, I., Khongstid, I., Chang, C., Sharma, M., & Pandey, R. Scrub typhus in Northeast India: epidemiology, clinical presentations, and diagnostic approaches.. Transactions of the Royal Society of Tropical Medicine and Hygiene. 2023 https://doi.org/10.1093/trstmh/trad082.

[20] Varghese, G., Janardhanan, J., Trowbridge, P., Peter, J., Prakash, J., Sathyendra, S., Thomas, K., David, T., Kavitha, M., Abraham, O., & Mathai, D. Scrub typhus in South India: clinical and laboratory manifestations, genetic variability, and outcome.. International journal of infectious diseases : IJID : official publication of the International Society for Infectious Diseases. 2013; 17 11. https://doi.org/10.1016/j.ijid.2013.05.017.

[21] Narlawar, U., Lilare, R., & Gawande, B. Epidemiology and clinical profile of scrub typhus outbreak in a tertiary care centre of central India. International Journal Of Community Medicine And Public Health. 2019 https://doi.org/10.18203/2394-6040.ijcmph20195070.

[22] Nelapati, S., Kiranmayi, C., Rao, T., & Suresh, B. Prevalence and Molecular Characterization of Scrub Typhus in Sub-Urban Regions of Vijayawada, Andhra Pradesh, India. International Journal of Current Microbiology and Applied Sciences. 2018; 7. https://doi.org/10.20546/ijcmas.2018.705.101.

[23] Panda, S., Swain, S., & Sarangi, R. An epidemiological outbreak of scrub typhus caused by Orientia tsutsugamushi – A comprehensive review. Journal of Applied Biology & Biotechnology. 2022 https://doi.org/10.7324/jabb.2022.100509.

[24] Sivarajan, S., Shivalli, S., Bhuyan, D., Mawlong, M., & Barman, R. Clinical and paraclinical profile, and predictors of outcome in 90 cases of

scrub typhus, Meghalaya, India. Infectious Diseases of Poverty. 2016; 5. https://doi.org/10.1186/s40249-016-0186-x.

[25] Krishnamoorthi, S., Goel, S., Kaur, J., Bisht, K., & Biswal, M. A Review of Rickettsial Diseases Other Than Scrub Typhus in India. Tropical Medicine and Infectious Disease. 2023; 8. https://doi.org/10.3390/tropicalmed8050280.

[26] Thakur, S. Scrub typhus: an underestimated endemic disease of Northwestern Himalayas, India. Current Science. 2021 https://doi.org/10.18520/cs/v121/i7/899-905.

[27] Kalal, B., Puranik, P., Nagaraj, S., Rego, S., & Shet, A. Scrub typhus and spotted fever among hospitalised children in South India: Clinical profile and serological epidemiology. Indian Journal of Medical Microbiology. 2016; 34. https://doi.org/10.4103/0255-0857.188315.

[28] Sultan, A., Shuaib, A., Rizvi, M., Khan, F., Chaudhry, R., & Thakur, C. Scrub Typhus: An Emerging Etiology among Undiagnosed Febrile Cases in Western Part of Uttar Pradesh, India. Journal of Pure and Applied Microbiology. 2022 https://doi.org/10.22207/jpam.16.1.60.

[29] Murmu, R., Mondal, G., Biswas, K., & Bala, A. Prevalence, Clinico-Laboratory Features and Outcomes of Paediatric Scrub Typhus Cases in a Tertiary Care Centre in Eastern India. Sultan Qaboos University Medical Journal. 2024; 24. https://doi.org/10.18295/squmj.6.2024.032.

[30] Takhar, R., Bunkar, M., Arya, S., Mirdha, N., & Mohd, A. Scrub typhus: A prospective, observational study during an outbreak in Rajasthan, India.. The National medical journal of India. 2017; 30 2.

[31] Mukhopadhyay, S., Gupta, R., Shukla, S., Bhattacharjee, P., Bhatnagar, R., Yadav, S., Kamal, S., Virk, A., Imran, S., & Liyakath, A. Once Forgotten Now Re-emerging: Scrub Typhus Infection in Pediatric Patients From North West India. Cureus. 2023; 15. https://doi.org/10.7759/cureus.44044.

[32] Nallan, K., Rajan, G., Sivathanu, L., Devaraju, P., Thiruppathi, B., Kumar, A., & Rajaiah, P. Molecular Detection of Multiple Genotypes of Orientia tsutsugamushi Causing Scrub Typhus in Febrile Patients from Theni District, South India. Tropical Medicine and Infectious Disease. 2023; 8. https://doi.org/10.3390/tropicalmed8030174.

[33] Saheed, S., Goswami, D., Niyas, V., & Ananthanaryanan, R. Scrub Typhus in Kerala: Demographic, Clinical, and Laboratory Predictors of ICU Admission in a Tertiary Care Setting.. Le infezioni in medicina. 2025; 33 1. https://doi.org/10.53854/liim-3301-10.

[34] Jain, D., Nand, N., Giri, K., & Bhutani, J. Scrub typhus infection, not a benign disease: an experience from a tertiary care center in Northern India. Medicine and Pharmacy Reports. 2019; 92. https://doi.org/10.15386/cjmed-1088.

[35] Rout, D., Praharaj, I., Dalai, S., Mishra, S., & Otta, S. Rising Menace of Scrub Typhus - Current Status and Challenges. Journal of Pure and Applied Microbiology. 2023 https://doi.org/10.22207/jpam.17.4.39.

[36] Alam, A., Gillespie, C., Goodall, J., Damodar, T., Turtle, L., Vasanthapuram, R., Solomon, T., & Michael, B. Neurological manifestations of scrub typhus infection: A systematic review and meta-analysis of clinical features and case fatality. PLOS Neglected Tropical Diseases. 2022; 16. https://doi.org/10.1371/journal.pntd.0010952.

[37] Wei, Y., Guan, X., Zhou, S., Zhang, A., Lu, Q., Zhou, Z., Chen, J., Zhang, H., Ji, Y., Jiang, B., Yang, Y., Yang, Z., Li, H., Fang, L., & Liu, W. Epidemiological and Clinical Features of Patients with Scrub Typhus Guangzhou City, Guangdong Province, China, 2012–2018. China CDC Weekly. 2021; 3. https://doi.org/10.46234/ccdcw2021.261.

[38] Shil, R. Scrub Typhus – An Emerging Public Health Threat in Northern India. Saudi Journal of Medical and Pharmaceutical Sciences. 2023 https://doi.org/10.36348/sjmps.2023.v09i10.002

[39] Dhar, B., & Sajid, M. Mathematical analysis of scrub typhus seasonal infection with re-scaled transmission rate considering Northeast India reported data from 2010 to 2022. Scientific Reports. 2025; 15. https://doi.org/10.1038/s41598-025-95548-z.

[40] Chakraborty, S., & Sarma, N. Scrub Typhus: An Emerging Threat. Indian Journal of Dermatology. 2017; 62. https://doi.org/10.4103/ijd.ijd_388_17.

[41] Mallik, S., Bhattacharjee, B., Banik, S., Halder, P., & Das, S. Clinico-epidemiological and

laboratory profiles of scrub typhus in a tertiary care hospital in eastern India: an observational study. MGM Journal of Medical Sciences. 2025 https://doi.org/10.4103/mgmj.mgmj_213_24.

[42] Kumar, D., & Jakhar, S. Emerging trends of scrub typhus disease in southern Rajasthan, India: A neglected public health problem. Journal of Vector Borne Diseases. 2022; 59. https://doi.org/10.4103/0972-9062.342357.

[43] Kispotta, R., Kasinathan, A., Kommu, P., & Manikandan, M. Analysis of 262 Children with Scrub Typhus Infection: A Single-Center Experience.. The American journal of tropical medicine and hygiene. 2020 https://doi.org/10.4269/ajtmh.20-1019.

[44] Dasgupta, S., Asish, P., Rachel, G., Bagepally, B., & Purushothaman, G. Global seroprevalence of scrub typhus: a systematic review and meta-analysis. Scientific Reports. 2024; 14. https://doi.org/10.1038/s41598-024-61555-9.

[45] Nila, S., Aung, M., Haque, N., Paul, S., Nasreen, S., Roy, S., Ahmed, S., Khanam, J., Sayeed, M., Paul, S., Urushibara, N., Kawaguchiya, M., Ohashi, N., & Kobayashi, N. Epidemiological features of scrub typhus and molecular characteristics of Orientia tsutsugamushi in north-central Bangladesh. IJID Regions. 2025; 14. https://doi.org/10.1016/j.ijregi.2025.100571.

[46] Murhekar, M. Acute Encephalitis Syndrome and Scrub Typhus in India. Emerging Infectious Diseases. 2017; 23. https://doi.org/10.3201/eid2308.162028.

[47] Mahajan, S., Chaudhary, N., Bajaj, M., Sharma, M., & Chaudhary, A. Epidemiological Profile and Outcome Predictors of Pediatric Scrub Typhus at a Tertiary Care Health Institution in the Sub-Himalayan Region. Pediatric Infectious Disease. 2023 https://doi.org/10.5005/jp-journals-10081-1376.

[48] Huang, J., Deng, K., Chen, J., & Zhang, M. Epidemiological and clinical characteristics of scrub typhus in northern Fujian, China, from 2015 to 2019. BMC Infectious Diseases. 2023; 23. https://doi.org/10.1186/s12879-023-08451-1.

[49] Peter, J., Sudarsan, T., Prakash, J., & Varghese, G. Severe scrub typhus infection: Clinical features, diagnostic challenges and management.. World journal of critical care medicine. 2015; 4 3. https://doi.org/10.5492/wjccm.v4.i3.244.

[50] Viswanathan, S., Muthu, V., Iqbal, N., Remalayam, B., & George, T. Scrub Typhus Meningitis in South India A Retrospective Study. PLoS ONE. 2013; 8. https://doi.org/10.1371/journal.pone.0066595.

[51] Dahiphle, A., Achliya, A., Chhajed, N., Rode, V., & Bhise, K. Study of Clinical and Demographic Profile of Scrub Typhus Patients Admitted to a Tertiary Care Hospital in Central India. International Journal of Integrated Health Sciences. 2024 https://doi.org/10.15850/ijihs.v12.n1.3788.

[52] Farhat, S., M, N., Behara, S., A, R., S, S., Jeevitha, S., S, B., Srivastava, P., Vellingiri, B., Malik, M., & Krishnan, J. The Epidemiology of Scrub typhus in Thiruvarur, Tamil Nadu. . 2024 https://doi.org/10.1101/2024.12.06.24317365.

[53] Parai, D., Pattnaik, M., Kshatri, J., Rout, U., Peter, A., Nanda, R., Sahoo, S., Mansingh, A., Choudhary, H., Dash, G., Praharaj, I., Bhattacharya, D., & Pati, S. Scrub typhus seroprevalence from an eastern state of India: findings from the state-wide serosurvey.. Transactions of the Royal Society of Tropical Medicine and Hygiene. 2022 https://doi.org/10.1093/trstmh/trac075.

[54] Katoch, P., Roach, V., & Chaudhary, S. Scrub Typhus Re-Emergence of The Neglected, Silent Killer in Himachal Pradesh (India). Journal of Microbes and Research. 2023 https://doi.org/10.58489/2836-2187/013.

[55] Pandey, A., Nigam, A., Chaudhary, A., & Pandey, V. Clinical Manifestations and Complications Seen with Scrub Typhus: A Case Series from Indore. Apollo Medicine. 2020; 17. https://doi.org/10.4103/am.am_26_20.