

Research Article

Manifestations and Myocarditis in Hospitalized Adults with Scrub Typhus: A Prospective Cohort Study from South India

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ABSTRACT:

Background: Scrub typhus is an important cause of acute febrile illness in South India and may produce cardiovascular involvement through endothelial injury, vasculitis and systemic inflammation. However, the burden and clinical impact of myocarditis in adult scrub typhus remain insufficiently characterized.

Materials and Methods: This prospective cohort study included 50 hospitalized adults with confirmed scrub typhus in a tertiary care centre in South India. Demographic details, clinical features, laboratory parameters, illness severity scores, electrocardiographic findings, cardiac biomarkers, echocardiographic parameters, treatment requirements and outcomes were recorded. Myocardial injury was defined by elevated troponin T, while myocarditis was presumed when myocardial injury was associated with global left ventricular systolic dysfunction.

Results: The mean age was 49.41 ± 16.1 years, with female predominance. Fever was universal, breathlessness occurred in 64%, and eschar was present in 40%. The cohort had severe systemic illness, with ICU admission in 60%, ventilatory support in 60%, vasoactive support in 56%, and mortality of 10%. Myocardial injury was observed in 31 patients (62%), myocardial dysfunction in 15 (30%), myocarditis in 11 (22%), diastolic dysfunction in 11 (22%), and pericardial involvement in 26 (52%). Patients with myocarditis had higher SOFA scores, more cardiovascular failure, greater inotropic and ventilatory requirement, and longer hospital stay. Mortality was comparable between groups.

Conclusion: Cardiac involvement is common in hospitalized scrub typhus. Systematic assessment with cardiac biomarkers and bedside echocardiography is useful, especially in patients with shock, respiratory failure or high SOFA score.

Keywords: Scrub typhus, Myocarditis, Troponin T, Echocardiography.

INTRODUCTION

Scrub typhus is an acute mite-borne rickettsial infection caused by *Orientia tsutsugamushi* and remains an important cause of acute undifferentiated febrile illness in the Asia-Pacific region, particularly within the "tsutsugamushi triangle".^[1,2] In India, scrub typhus has re-emerged as a major seasonal febrile illness and contributes substantially to hospital admissions during monsoon and post-monsoon periods. The clinical spectrum is highly variable, ranging from uncomplicated fever with myalgia and headache to severe

systemic illness with acute respiratory distress syndrome, renal dysfunction, hepatic involvement, shock, multiorgan dysfunction, and death.^[3]

The pathogenesis of scrub typhus is predominantly vasculotropic. After inoculation through the bite of infected chigger mites, *O. tsutsugamushi* disseminates hematogenously and targets endothelial cells, mononuclear cells, and tissue macrophages. This endothelial tropism produces diffuse vasculitis, increased vascular permeability, microvascular inflammation, and organ dysfunction.^[4] Such a

mechanism provides a biological basis for cardiovascular involvement, because myocardial inflammation in scrub typhus may result either from direct endothelial infection of small myocardial vessels or from immune-mediated inflammatory injury.

Cardiac manifestations in scrub typhus are increasingly recognized but remain insufficiently characterized in routine clinical practice. Reported abnormalities include nonspecific electrocardiographic changes, rhythm disturbances, elevated cardiac biomarkers, pericardial effusion, myocardial dysfunction, shock, and clinically apparent myocarditis.^[5] However, fever, tachycardia, dyspnea, hypotension, renal dysfunction, and metabolic derangements frequently coexist in severe scrub typhus, making it difficult to distinguish true myocardial involvement from systemic illness, sepsis-related myocardial depression, or hemodynamic instability. Electrocardiographic changes alone are often nonspecific, while cardiac biomarkers may identify myocardial injury but do not necessarily establish myocarditis.

Echocardiography provides an important bedside tool for identifying ventricular dysfunction and hemodynamic patterns in patients with suspected scrub typhus-related cardiac involvement. Assessment of left ventricular ejection fraction, regional wall motion abnormality, pericardial effusion, cardiac output, cardiac index, stroke volume index, inferior vena cava variability, and systemic vascular resistance may help differentiate myocardial dysfunction from predominantly vasodilatory shock. In resource-limited tertiary care settings, systematic evaluation using cardiac biomarkers and echocardiography is especially relevant because advanced modalities such as cardiac magnetic resonance imaging or endomyocardial biopsy are often unavailable.

Despite the clinical importance of this problem, data on the burden, spectrum, predictors, and outcomes of myocarditis in adult scrub typhus remain limited. Previous reports have largely consisted of case reports, small case series, or studies focused on severe scrub typhus rather than structured cardiac phenotyping.^[6] There is therefore a need for prospective data evaluating cardiac manifestations in hospitalized scrub typhus patients and comparing outcomes between those with and without myocarditis.

The present study was undertaken to assess the spectrum of cardiac manifestations among

hospitalized adults with scrub typhus in a tertiary care centre in South India. The study also aimed to estimate the incidence of myocarditis, compare clinical outcomes between patients with and without myocarditis, and identify factors associated with the development of myocarditis in scrub typhus.

MATERIALS AND METHODS:

This prospective cohort study was conducted in the Department of General Medicine at a tertiary care teaching hospital in South India over a period of 20 months, covering two seasonal peaks of scrub typhus transmission. Adult patients admitted through the emergency department or outpatient services with acute febrile illness and subsequently diagnosed with scrub typhus were screened for enrolment.

Patients aged more than 16 years with acute febrile illness fulfilling diagnostic criteria for scrub typhus were included. Scrub typhus was diagnosed in the presence of acute febrile illness with positive scrub typhus IgM ELISA or eschar, seroconversion on convalescent serum, or positive scrub typhus IgM ELISA with other relevant febrile illness serologies being negative. Patients with an alternative diagnosis explaining the febrile illness and those with autoimmune disorders were excluded. Patients unwilling to continue participation were withdrawn from the study.

After enrolment, demographic details, duration of illness, presenting symptoms, comorbidities, presence of eschar, clinical severity, organ dysfunction, laboratory parameters, electrocardiographic findings, cardiac biomarkers, echocardiographic parameters, treatment requirements, and outcomes were recorded using a structured proforma. Data were collected on the day of admission and updated daily until discharge or death.

All enrolled patients underwent baseline laboratory evaluation including complete blood counts, renal function tests, liver function tests, and other clinically indicated investigations. Severity of illness and organ dysfunction were assessed using SOFA and APACHE II scores. Organ dysfunction, requirement of intensive care, need for vasoactive support, mechanical ventilation, dialysis requirement, duration of hospital stay, duration of ICU stay, and survival status were recorded.

Cardiac evaluation included electrocardiography, serum cardiac

biomarkers, and transthoracic echocardiography. Troponin T and CK-MB were measured within 48 hours of admission. Echocardiographic assessment included left ventricular ejection fraction, regional wall motion abnormality, cardiac output, cardiac index, stroke volume index, systemic vascular resistance, E/A ratio, E/e' ratio, pericardial effusion, inferior vena cava variability, and estimated central venous pressure.

The primary outcome was the occurrence of myocarditis attributable to scrub typhus after exclusion of other identifiable causes. Myocardial injury was defined as troponin T elevation above 14 pg/mL. Myocarditis was presumed when myocardial injury was associated with global left ventricular systolic dysfunction in the setting of acute scrub typhus infection. Patients were categorized into myocarditis and non-myocarditis groups for comparison.

Secondary outcomes included in-hospital mortality, duration of hospital stay, ICU stay, requirement of mechanical ventilation, duration of ventilation, need for vasoactive agents, dialysis requirement, and overall

clinical outcome. Pre-existing cardiac disease, sepsis, renal failure, mechanical ventilation, and vasoactive drug requirement were considered potential confounders.

Data were entered into Microsoft Excel and analysed using appropriate statistical software. Continuous variables were expressed as mean with standard deviation, while categorical variables were expressed as frequency and percentage. Comparisons between patients with and without myocarditis were performed using suitable tests for continuous and categorical variables. Logistic regression analysis was used to identify predictors associated with myocarditis. A p-value less than 0.05 was considered statistically significant.

RESULTS:

A total of 50 hospitalized patients with confirmed scrub typhus were included. The mean age was 49.41 ± 16.1 years, suggesting a predominantly middle-aged to older adult study population. There was a slight female predominance, with 28 females (56%) and 22 males (44%).

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants

Category	Variable	Value
Study population	Total included patients	50
Demographic profile	Age, years, mean $\pm$ SD	49.41 ± 16.1
	Female	28 (56%)
	Male	22 (44%)
	Female:male ratio	28:22
Clinical presentation	Duration from illness onset to presentation, days, mean $\pm$ SD	8.11 ± 3.11
	Fever	50 (100%)
	Breathlessness	32 (64%)
	Cough	18 (36%)
	Myalgia	14 (28%)
	Vomiting	14 (28%)
	Altered mental status	9 (18%)
Clinical sign	Eschar present	20 (40%)
Comorbidities/risk factors	Diabetes mellitus	10 (20%)
	Essential hypertension	9 (18%)
	Coronary artery disease	1 (2%)
	Smoking	2 (4%)
	Alcohol use	2 (4%)

The mean duration from illness onset to hospital presentation was 8.11 ± 3.11 days, indicating that most patients presented after nearly one week of illness. Fever was present in all patients (100%), followed by breathlessness in 32 patients (64%) and cough in 18 patients (36%). Other symptoms

included myalgia and vomiting in 14 patients each (28%), while altered mental status was seen in 9 patients (18%).

An eschar was documented in 20 patients (40%), supporting its diagnostic utility but also showing that a significant proportion of patients did not have a clinically detectable

eschar. Among comorbidities, diabetes mellitus was present in 10 patients (20%) and essential hypertension in 9 patients (18%), while coronary artery disease was uncommon,

seen in only 1 patient (2%). Smoking and alcohol use were each reported in 2 patients (4%).

Table 2: Laboratory Profile, Illness Severity and Organ Dysfunction in Hospitalized Patients with Scrub Typhus (N=50)

Variable	Value	95% CI / range
Laboratory profile		
Hemoglobin, g/dL	11.45 ± 2.56	4.0-20.4
Total leukocyte count, cells/cmm	10400 ± 4825.11	2700-30400
Platelet count, cells/cmm	69700 ± 70372.34	4000-364000
Creatinine, mg/dL	1.71 ± 1.43	0.4-8.1
Total bilirubin, mg/dL	2.06 ± 1.92	0.3-9.6
Direct bilirubin, mg/dL	1.55 ± 1.71	0-9.0
Serum albumin, g/dL	2.58 ± 0.58	0.5-4.1
SGOT, U/L	139.05 ± 92.39	28-428
SGPT, U/L	68.65 ± 49.32	10-366
Alkaline phosphatase, U/L	199.14 ± 107.01	43-593
Severity scores		
SOFA score	8.94 ± 3.95	8.06-9.81
APACHE II score	15.68 ± 7.01	14.13-17.23
APACHE II predicted mortality, %	25.25 ± 18.59	22.14-30.37
Organ involvement by SOFA score		
Hematological involvement	49 (98.0%)	
Respiratory involvement	45 (90.0%)	
Cardiovascular involvement	32 (64.0%)	
Liver involvement	27 (54.0%)	
Renal involvement	26 (52.0%)	
Central nervous system involvement	10 (20.0%)	
Number of organ systems involved		
One organ	1 (2.0%)	
Two organs	6 (12.0%)	
Three organs	17 (34.0%)	
Four organs	10 (20.0%)	
Five organs	12 (24.0%)	
Six organs	4 (8.0%)	

Abbreviations: SOFA, Sequential Organ Failure Assessment; APACHE II, Acute Physiology and Chronic Health Evaluation II; SGOT, serum glutamic-oxaloacetic transaminase; SGPT, serum glutamic-pyruvic transaminase.

The laboratory and severity profile showed severe systemic illness. The mean platelet count was 69,700 ± 70,372.34/cumm, with thrombocytopenia being a major abnormality. Transaminase elevation was seen with mean SGOT 139.05 ± 92.39 U/L and SGPT 68.65 ± 49.32 U/L, while hypoalbuminemia was

evident with mean serum albumin 2.58 ± 0.58 g/dL. The mean SOFA score was 8.94 ± 3.95, and the mean APACHE II score was 15.68 ± 7.01, with predicted mortality 25.25 ± 18.59%. SOFA-based organ involvement was predominantly hematological 49 (98%), followed by respiratory 45 (90%), cardiovascular 32 (64%), hepatic 27 (54%), renal 26 (52%), and CNS involvement 10 (20%). ICU care was required in 30 patients (60%), ventilation in 30 (60%), vasoactive support in 28 (56%), and overall hospital mortality was 5 (10%).

Table 3: Cardiac Manifestations and Electrocardiographic Profile of Scrub Typhus Patients

Domain	Parameter	n assessed	Value
Cardiac involvement phenotype	Myocardial injury	50	31 (62%)

	Myocardial dysfunction	50	15 (30%)
	Myocarditis	50	11 (22%)
	Diastolic dysfunction	50	11 (22%)
	Pericardial involvement	50	26 (52%)
Cardiac biomarkers	CK-MB	50	6.69 ± 9.4; 95% CI: 4.88–9.07
	Troponin T	50	83.1 ± 212.2; 95% CI: 36.21–130.04
Echocardiographic parameters	LVEF	50	57.59 ± 14.16; 95% CI: 54.46–60.72
	Cardiac output	39	4.37 ± 1.38; 95% CI: 4.02–4.71
	Cardiac index	39	2.65 ± 0.89; 95% CI: 2.43–2.88
	Systemic vascular resistance	40	2363.47 ± 949.35; 95% CI: 2128.23–2598.71
	E/A ratio	48	1.16 ± 0.36; 95% CI: 1.08–1.25
	E/e' ratio	48	9.77 ± 3.49; 95% CI: 8.98–10.56
	CVP	47	11.25 ± 5.23; 95% CI: 10.05–12.44
Electrocardiographic findings	Sinus tachycardia	50	23 (46%)
	ST-T changes	50	9 (18%)
	T wave inversion	50	4 (8%)
	QRS morphology changes	50	7 (14%)
	Supraventricular tachycardia	50	1 (2%)
	Atrial fibrillation	50	2 (4%)
	Wide QRS tachycardia	50	1 (2%)
	Sinus bradyarrhythmia	50	3 (6%)

Cardiac involvement was frequent in this cohort. Myocardial injury was observed in 31 patients (62%), whereas myocardial dysfunction was present in 15 (30%) and myocarditis in 11 (22%). Pericardial involvement was noted in 26 patients (52%), and diastolic dysfunction in 11 (22%). Troponin T levels showed wide dispersion with

a mean of 83.1 ± 212.2, while mean LVEF remained 57.59 ± 14.16, indicating that biochemical injury was more frequent than overt systolic dysfunction. ECG abnormalities were largely nonspecific; sinus tachycardia was the commonest finding, seen in 23 patients (46%), followed by QRS morphology changes in 7 (14%).

Table 4: Severity, Organ Failure, Outcomes and Predictors among Scrub Typhus Patients with and Without Myocarditis

Domain	Variable	With myocarditis (n=11)	Without myocarditis (n=39)	p value / OR (95% CI)
Severity profile	SOFA score	10.82 ± 3.02	8.43 ± 4.03	p=0.026
	APACHE II score	17.35 ± 7.49	15.12 ± 6.95	p=0.254
	Predicted mortality (%)	30.24 ± 21.06	25.19 ± 17.91	p=0.323
Organ failure	Respiratory failure	6 (54.5%)	12 (30.8%)	p=0.153
	Cardiovascular failure	9 (81.8%)	17 (43.6%)	p=0.006
	Hematological failure	7 (63.6%)	20 (51.3%)	p=0.413

Clinical outcomes	ICU care	9 (81.8%)	21 (53.8%)	p=0.051
	Inotropic support / shock	10 (90.9%)	18 (46.2%)	p<0.001
	Ventilatory support	9 (81.8%)	21 (53.8%)	p=0.05
	Haemodialysis	1 (9.1%)	2 (5.1%)	p=1.00
	Duration of ICU stay (days)	3.7 ± 4.4	6.1 ± 4.4	p=0.0474
	Duration of hospital stay (days)	11.7 ± 4.63	8.59 ± 4.52	p=0.014
	ICU mortality	1 (9.1%)	4 (10.3%)	p=1.00
	Hospital mortality	1 (9.1%)	4 (10.3%)	p=1.00
Regression predictors	SOFA score	—	—	OR 1.171 (1.014-1.351); p=0.031
	Ventilatory support	—	—	OR 4.242 (1.109-16.22); p=0.035
	Duration of hospital stay	—	—	OR 1.142 (1.021-1.278); p=0.020
	Duration of illness (multivariate)	—	—	OR 0.7157 (0.5404-0.9478); p=0.020

Patients with myocarditis had greater acute illness severity, with a significantly higher SOFA score than those without myocarditis (10.82 ± 3.02 vs 8.43 ± 4.03 ; $p=0.026$), while APACHE II score and predicted mortality were not significantly different. Cardiovascular organ failure was markedly more frequent in the myocarditis group (81.8% vs 43.6%; $p=0.006$). Clinically, myocarditis was associated with higher requirements for inotropic support (90.9% vs 46.2%; $p<0.001$)

and ventilatory support (81.8% vs 53.8%; $p=0.05$). Total hospital stay was significantly longer among patients with myocarditis (11.7 ± 4.63 vs 8.59 ± 4.52 days; $p=0.014$), whereas mortality was comparable between the two groups. On regression analysis, SOFA score, requirement for ventilatory support, and duration of hospital stay were associated with myocarditis, while duration of illness remained significant on multivariate analysis.

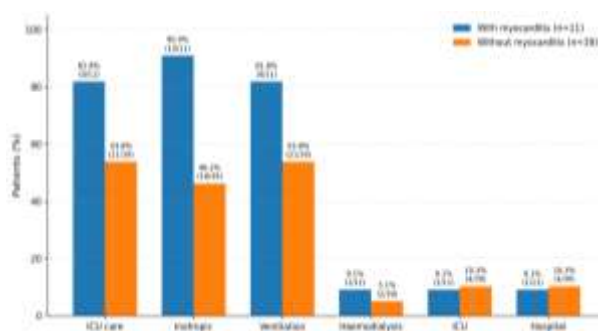


Figure 1: Comparison of Key Clinical Outcomes in Scrub Typhus Patients with and Without Myocarditis

Patients with myocarditis had a higher requirement for intensive care, vasoactive support and mechanical ventilation compared with those without myocarditis. ICU care was required in 9/11 patients (81.8%) with myocarditis versus 21/39 patients (53.8%) without myocarditis, while inotropic support was required in 10/11 (90.9%) versus 18/39 (46.2%) patients. The need for ventilation was also higher in the myocarditis group [9/11

(81.8%) vs 21/39 (53.8%)]. In contrast, haemodialysis requirement and mortality were low and comparable between the two groups, with hospital mortality of 1/11 (9.1%) in the myocarditis group and 4/39 (10.3%) in the non-myocarditis group.

DISCUSSION

Burden of systemic illness: The present study evaluated cardiac manifestations among

50 hospitalized adults with scrub typhus. The cohort represented a clinically significant form of disease, with delayed presentation after a mean illness duration of 8.11 ± 3.11 days and frequent breathlessness (64%). Fever was universal, while eschar was identified in 40% of patients, supporting its diagnostic value but emphasizing that its absence does not exclude scrub typhus. ICU care was required in 30 patients (60%), ventilatory support in 30 (60%), vasoactive agents in 28 (56%), and overall hospital mortality was 5 (10%). Similar Indian studies have described scrub typhus as an important cause of acute febrile illness with respiratory failure, shock, renal dysfunction, and multiorgan involvement.^[7]

The laboratory profile reflected systemic vasculitic illness. The mean platelet count was $69,700 \pm 70,372.34/\text{cumm}$, indicating prominent thrombocytopenia. Transaminase elevation was common, with mean SGOT 139.05 ± 92.39 U/L and SGPT 68.65 ± 49.32 U/L, while mean serum albumin was 2.58 ± 0.58 g/dL and mean creatinine was 1.71 ± 1.43 mg/dL. The mean SOFA score was 8.94 ± 3.95 and mean APACHE II score was 15.68 ± 7.01 , with predicted mortality of $25.25 \pm 18.59\%$. SOFA-based organ involvement was most commonly hematological (49; 98%), followed by respiratory (45; 90%), cardiovascular (32; 64%), hepatic (27; 54%), renal (26; 52%), and central nervous system involvement (10; 20%).

Cardiac involvement in scrub typhus

Cardiac involvement was frequent in this cohort. Myocardial injury, defined by troponin T elevation, was observed in 31 patients (62%), left ventricular systolic dysfunction in 15 (30%), and myocarditis in 11 (22%). This distinction is important because isolated biomarker elevation in severe scrub typhus may overestimate true myocarditis, particularly in the presence of sepsis, renal dysfunction, and multiorgan failure. Earlier pathological and clinical reports have shown that scrub typhus can involve the myocardium through small-vessel endothelial infection, interstitial inflammation, edema, and immune-mediated injury.^[8,9]

The myocarditis prevalence of 22% indicates that clinically significant myocardial involvement is not rare among hospitalized scrub typhus patients, although it affects a smaller subset than biomarker-defined myocardial injury. These findings support combined clinical, biomarker, and echocardiographic assessment rather than

reliance on troponin alone, since troponin elevation identifies myocardial injury but does not by itself establish myocarditis.^[10]

Electrocardiographic and Echocardiographic Profile

Electrocardiographic abnormalities were largely nonspecific. Sinus tachycardia was the most common ECG finding, present in 23 patients (46%), while other rhythm and repolarization abnormalities were less frequent. This pattern likely reflects systemic inflammatory and hemodynamic stress rather than a specific myocarditis signature. Previous studies have also shown that ECG changes in scrub typhus may be nonspecific and insufficient to diagnose myocardial inflammation.^[11]

Echocardiography provided more clinically useful information. The mean left ventricular ejection fraction was $57.59 \pm 14.16\%$, with systolic dysfunction in 15 patients (30%). Diastolic dysfunction was present in 11 patients (22%), predominantly mild, and pericardial involvement was noted in 26 patients. These findings show that cardiac involvement in scrub typhus is heterogeneous and may include myocardial injury, systolic dysfunction, diastolic dysfunction, and pericardial effusion. Bedside echocardiography is therefore useful for identifying clinically meaningful myocardial dysfunction and assessing hemodynamic status in patients with shock.

Myocarditis and Clinical Outcomes

The main clinical impact of myocarditis was increased morbidity rather than mortality. Patients with myocarditis had a higher frequency of cardiovascular organ failure than those without myocarditis (81.8% vs 43.6%; $p=0.006$). Vasoactive agent requirement was also higher in the myocarditis group (90.9% vs 46.2%; $p<0.001$), as was ventilatory support (81.8% vs 53.8%; $p=0.05$), indicating greater cardiopulmonary compromise.

Hospital stay was significantly longer in patients with myocarditis (11.7 ± 4.63 vs 8.59 ± 4.52 days; $p=0.014$). However, ICU mortality and hospital mortality were comparable, with mortality of 1/11 (9.1%) in the myocarditis group and 4/39 (10.3%) in the non-myocarditis group. Thus, myocarditis increased organ-support requirement and hospitalization duration, but was not associated with higher mortality in this cohort.

Predictors and Clinical Implications

SOFA score was associated with myocarditis on bivariate analysis (OR 1.171; 95% CI: 1.014–1.351; $p=0.031$), while APACHE II score was not significant. This suggests that organ dysfunction burden may correlate more closely with cardiac involvement than overall acute physiological score. Age, sex, eschar, effusion, and creatinine were not useful predictors. Outcome-based analysis showed that mechanical ventilation (OR 4.242; 95% CI: 1.109–16.22; $p=0.035$) and duration of hospital stay (OR 1.142; 95% CI: 1.021–1.278; $p=0.020$) were associated with myocarditis.

Clinically, hospitalized scrub typhus patients with high SOFA score, shock, breathlessness, vasoactive requirement, or ventilatory need should undergo systematic cardiac evaluation. ECG alone may be insufficient, and troponin elevation should be interpreted cautiously. Early troponin assessment combined with bedside echocardiography is a practical strategy to identify clinically meaningful myocardial dysfunction.

Limitations

The study was limited by its relatively small sample size and single-centre design. Echocardiographic measurements may be influenced by mechanical ventilation, vasoactive agents, and fluid status. Troponin T may lack specificity in severe systemic illness and renal dysfunction. Endomyocardial biopsy or cardiac magnetic resonance imaging was not performed; therefore, myocarditis was defined clinically using myocardial injury with global left ventricular systolic dysfunction.

CONCLUSION:

Cardiac involvement was common among hospitalized adults with scrub typhus, with myocardial injury in 62%, myocardial dysfunction in 30%, and myocarditis in 22% of patients. Myocarditis was associated with greater cardiovascular failure, increased vasoactive agent use, higher ventilatory requirement, and longer hospital stay. However, myocarditis was not associated with increased mortality in this cohort. Systematic cardiac evaluation using biomarkers and bedside echocardiography should be considered in severe scrub typhus, especially in patients with shock, respiratory failure, or high SOFA score.

Conflict of Interest: The authors declare no conflict of interest.

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Data Availability Statement: The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

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