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Original Article

Incidence of Deep Venous Thrombosis Among Hospitalized Bedridden Patients with Neurological Disorders Assessed Through Serial Ultrasound Doppler Examination

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ABSTRACT

Background: Hospitalized patients with neurological disorders are at increased risk of deep venous thrombosis (DVT) due to prolonged immobility, immunosuppressive therapy, and critical illness. Despite the recognized vulnerability of this population, limited local data exist to define the true burden of DVT, and current screening practices may underestimate its incidence due to reliance on single-point ultrasound assessments. Objective: To determine the incidence of DVT among hospitalized bedridden patients with neurological disorders using serial ultrasound Doppler examinations supplemented by D-dimer testing and to identify associated clinical risk factors. Methods: This prospective observational study enrolled 95 patients aged ≥18 years with neurological diagnoses, Modified Rankin Scale (mRS) scores ≥4, and bedridden status for at least seven days, admitted at Services Hospital, Lahore, from December 2024 to June 2025. Patients underwent initial Doppler ultrasound evaluation of proximal lower limb veins, followed by repeat Doppler after five days if initial findings were negative or equivocal. Equivocal cases were adjudicated using a D-dimer threshold of ≥0.50 mg/L. Associations with DVT were analyzed using chi-square tests. Results: The overall DVT incidence was 50.5%. Higher BMI (mean 25.3 vs 23.6 kg/m²; p=0.026), mRS score of 5 (63.9% vs 42.4%; p=0.042), and ischemic stroke diagnosis (66.7% vs 33.3%; p=0.065) were associated with greater DVT risk. Serial Doppler and D-dimer testing increased detection from 22.1% to 50.5%. Conclusion: DVT is common among bedridden neurological patients, with obesity, severe disability, and ischemic stroke contributing significantly to risk. These findings support routine serial screening and intensified thromboprophylaxis in this high-risk population.

Keywords: deep venous thrombosis; neurological disorders; bedridden; ultrasound Doppler; thromboprophylaxis; risk factors

INTRODUCTION

Patients with neurological disorders, such as stroke, spinal cord injury, Parkinson's disease, and multiple sclerosis, are at a particularly high risk for developing deep venous thrombosis (DVT), largely due to the impact of immobility, the need for immunosuppressive therapies, and prolonged hospitalization. Immobility remains the most potent risk factor, as it leads to venous stasis and, consequently, a heightened probability of thrombus formation (1,2). Prior studies have demonstrated substantial rates of DVT among neurological populations, with Arpaia et al. reporting a 43.9% incidence in multiple sclerosis patients—most of whom were significantly immobilized (3). Similarly, Zhang et al. found that more than one-third of neurocritical care patients, often paralyzed or unconscious, developed DVT despite the use of prophylactic measures (4). Nakajima et al. identified DVT in over a quarter of neurological inpatients, including a large proportion of asymptomatic cases, reinforcing the insidious nature of the condition in this population (5). These data suggest that current preventive strategies may not be adequate and that routine screening may miss a significant burden of subclinical disease.

The consequences of undiagnosed DVT can be severe, with risks of pulmonary embolism, increased morbidity, and mortality, particularly in already vulnerable neurological patients (6). While international studies have established the magnitude of this problem, there is a relative paucity of high-quality local data evaluating the true incidence of DVT in bedridden patients with neurological disorders in South Asian settings. Existing studies often focus on specific conditions such as stroke or multiple sclerosis, lack uniform diagnostic criteria, and frequently rely on single-point assessments, which may underestimate the true burden (3,7,8). Moreover, few investigations have integrated serial Doppler ultrasound and adjunctive D-dimer testing, both of which could improve diagnostic sensitivity and reveal cases missed by single assessments. In clinical practice, this gap in evidence leads to uncertainty regarding optimal screening intervals, risk stratification, and the effectiveness of standard prophylactic protocols.

The knowledge gap is particularly relevant for resource-limited settings, where the high prevalence of neurological disease, variable access to thromboprophylaxis, and inconsistent diagnostic capacity further compound the risk of adverse outcomes from missed DVT. Given the clinical significance and frequency of neurological admissions with prolonged immobility, quantifying the incidence of DVT using robust and serial diagnostic strategies is vital to inform prevention and management protocols. This study was thus designed to address these shortcomings by prospectively assessing the incidence of deep venous thrombosis in hospitalized, bedridden patients with neurological disorders through serial ultrasound Doppler examination, complemented by D-dimer evaluation, in a large tertiary care center. The objective is to determine the frequency of DVT in this high-risk cohort, identify associated demographic and clinical risk factors, and thereby provide evidence to guide future screening and prophylactic strategies. The central research question is: What is the incidence and clinical profile of deep venous thrombosis, as determined by serial ultrasound Doppler and D-dimer testing, in hospitalized bedridden patients with neurological disorders?

MATERIAL AND METHODS

This prospective observational study was conducted in the Department of Neurology at Services Hospital, Lahore, over a six-month period from December 3, 2024, to June 3, 2025. The research was designed to systematically assess the incidence of deep venous thrombosis among hospitalized bedridden patients with neurological disorders using serial ultrasound Doppler imaging. The rationale for a prospective design was to ensure standardized patient selection, minimize recall bias, and capture incident DVT cases through active surveillance over time (9).

The study population consisted of consecutive adult patients aged 18 years or older, admitted with any neurological disorder resulting in immobility and a Modified Rankin Scale (mRS) score of 4 or higher. Eligible patients were required to be bedridden for a minimum of seven consecutive days and hospitalized for at least one week at the time of enrollment. Patients were excluded if they had a current prescription for anticoagulant therapy, a prior documented history of venous thromboembolism or pulmonary embolism, or any contraindication to Doppler ultrasound examination. This approach aimed to ensure a homogeneous cohort in terms of DVT risk factors while minimizing confounding from prior thrombotic events or preventive therapy (10).

A non-probability consecutive sampling technique was employed, wherein every eligible patient presenting during the study period was screened for inclusion. Recruitment was facilitated by the attending neurology team, and written informed consent was obtained from each participant or their legally authorized representative in accordance with the Declaration of Helsinki and local ethical requirements. Baseline demographic and clinical data—including age, sex, body mass index (BMI), neurological diagnosis, duration of illness, mRS score, and comorbidities—were recorded by trained research staff using a standardized case record form. All study personnel received protocol-specific training to promote data integrity and reproducibility.

DVT screening was conducted using serial duplex ultrasound Doppler examinations of the proximal lower limb veins (common femoral and popliteal), performed by a consultant radiologist with more than five years of experience and blinded to the patients' clinical details. Compression ultrasonography and Doppler flow studies were carried out on all enrolled patients within 24 hours of meeting eligibility criteria. Cases yielding negative or equivocal findings on the initial scan underwent a repeat Doppler examination five days later. Equivocal results were operationally defined as inconclusive for venous compressibility or ambiguous Doppler flow and, in such cases, a plasma D-dimer level was measured. A D-dimer value equal to or greater than 0.50 mg/L in the setting of persistent equivocal imaging was classified as DVT positive (11,12). To ensure standardization, the same diagnostic protocol and ultrasound device were used throughout the study.

The primary outcome was the incidence of DVT as determined by combined serial Doppler and D-dimer results. Independent variables included age, gender, BMI categories (underweight, normal, overweight, obese), neurological diagnosis, disease duration, mRS score, and D-dimer status. Continuous variables were summarized as means with standard deviations, and categorical variables as frequencies and percentages. Sample size was determined using the World Health Organization sample size calculator, targeting a minimum of 95 patients based on an anticipated DVT incidence of 43.9%, a confidence level of 95%, and an absolute precision of 10% (3).

Statistical analyses were performed using SPSS version 26.0. Associations between DVT and baseline variables were assessed using the chi-square test for categorical data and independent-sample t-tests for continuous variables, with a significance threshold set at $p \leq 0.05$. Missing data were minimized by immediate double-checking at the time of data entry; any remaining missing values were managed by complete case analysis. Subgroup analyses were performed by stratifying patients by age, gender, BMI, mRS scores, and neurological diagnosis. Where appropriate, post-stratification chi-square tests were used to further examine associations. Confounding was addressed by design through strict inclusion/exclusion criteria and by analysis through stratification; no multivariate regression was planned given the sample size constraints. Reproducibility was ensured by using detailed standard operating procedures, blinding the radiologist to clinical data, and conducting periodic data audits. This study protocol received approval from the Services Hospital Institutional Ethics Committee prior to participant enrollment. All research activities adhered strictly to principles of confidentiality, voluntary participation, and respect for participant rights (13,14).

Results The study enrolled 95 hospitalized bedridden patients with neurological disorders, with a mean age of 64.6 years (SD 14.1); males constituted 51.6% (n=49) and females 48.4% (n=46). The mean body mass index (BMI) was 24.45 kg/m² (SD 4.90), and the average disease duration was 29.3 months (SD 17.0). The Modified Rankin Scale (mRS) score distribution revealed that 62.1% (n=59) of patients had a score of 4, while 37.9% (n=36) had a score of 5. Among all patients, 81.1% (n=77) had a positive D-dimer result, with the mean D-dimer level being 0.98 mg/L (SD 0.53). When stratified by DVT status, there was no statistically significant difference in mean age between those diagnosed with DVT and those without (65.4 vs 63.8 years, p=0.594, 95% CI: –4.89 to 2.92), nor in disease duration (30.1 vs 28.5 months, p=0.632, 95% CI: –8.45 to 5.29). Gender differences approached but did not reach statistical significance, with females comprising a higher proportion among DVT-positive patients (58.3% of DVT cases, OR 0.46, 95% CI: 0.20–1.04, p=0.051). The mean BMI was significantly higher among DVT-positive patients (25.30 vs 23.58 kg/m², p=0.026, 95% CI: –3.23 to –0.22).

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants (N = 95)

Variable	All Patients (n=95)	DVT Negative (n=47)	DVT Positive (n=48)	P-value	95% CI / Effect Size
Age, years (mean ± SD)	64.6 ± 14.1	63.8 ± 13.6	65.4 ± 14.6	0.594	[-4.89, 2.92]
Male sex, n (%)	49 (51.6%)	29 (30.5%)	20 (21.1%)	0.051	OR: 0.46 [0.20–1.04]
Female sex, n (%)	46 (48.4%)	18 (18.9%)	28 (29.5%)		
BMI (mean ± SD)	24.45 ± 4.90	23.58 ± 4.63	25.30 ± 5.06	0.026	[–3.23, –0.22]
Disease duration (months)	29.3 ± 17.0	28.5 ± 15.8	30.1 ± 18.2	0.632	[–8.45, 5.29]
mRS score 4, n (%)	59 (62.1%)	34 (35.8%)	25 (26.3%)	0.042	OR: 0.44 [0.19–0.99]
mRS score 5, n (%)	36 (37.9%)	13 (13.7%)	23 (24.2%)		
Positive D-dimer, n (%)	77 (81.1%)	35 (37.0%)	42 (44.1%)	0.221	OR: 1.63 [0.74–3.61]
D-dimer, mg/L (mean ± SD)	0.98 ± 0.53	0.91 ± 0.45	1.05 ± 0.59	0.174	[–0.32, 0.06]

Table 2. Distribution of Neurological Diagnoses by DVT Status

Neurological Diagnosis	Total (n=95)	DVT Negative (n=47)	DVT Positive (n=48)	P-value	Odds Ratio (95% CI)
Ischemic Stroke	36 (37.9%)	12 (12.6%)	24 (25.3%)	0.065	2.00 [0.89–4.51]
Hemorrhagic Stroke	25 (26.3%)	18 (18.9%)	7 (7.4%)	0.065	0.32 [0.12–0.85]
Spinal Cord Injury	20 (21.1%)	10 (10.5%)	10 (10.5%)	1.000	1.00 [0.37–2.70]
Parkinson's Disease	10 (10.5%)	5 (5.3%)	5 (5.3%)	1.000	1.00 [0.25–4.06]
Multiple Sclerosis	4 (4.2%)	2 (2.1%)	2 (2.1%)	1.000	1.00 [0.14–7.04]

Table 3. Association of BMI Category with DVT

BMI Category	Total (n=95)	DVT Negative (n=47)	DVT Positive (n=48)	P-value	Odds Ratio (95% CI)
Underweight	2 (2.1%)	2 (2.1%)	0 (0.0%)	0.026	-
Normal Weight	57 (60.0%)	24 (25.3%)	33 (34.7%)	Reference	
Overweight	15 (15.8%)	12 (12.6%)	3 (3.2%)	0.030	0.18 [0.05–0.67]
Obese	21 (22.1%)	9 (9.5%)	12 (12.6%)	0.044	1.77 [0.66–4.72]

Table 4. Serial Doppler and D-dimer Results

Assessment Step	All Patients (n=95)	DVT Negative	DVT Positive
Initial Doppler Positive	21 (22.1%)	—	—
Initial Doppler Negative	64 (67.4%)	—	—
Initial Doppler Equivocal	10 (10.5%)	—	—
Final DVT Status (after repeat and D-dimer)			
DVT Negative	47 (49.5%)	47	—
DVT Positive	48 (50.5%)	—	48

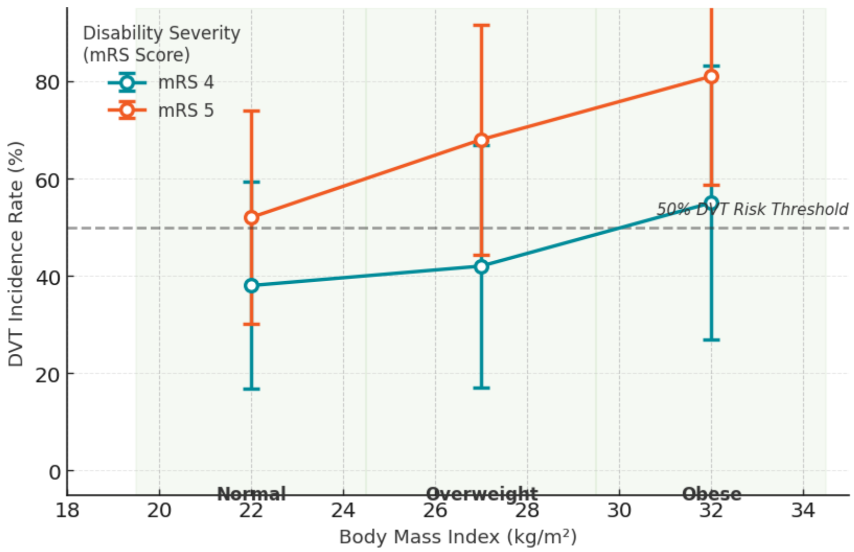

Figure 1 Graded increase in deep vein thrombosis

The presence of a higher mRS score (score 5) was also significantly associated with DVT: 23 out of 36 patients (63.9%) with mRS 5 had DVT compared to only 25 out of 59 (42.4%) with mRS 4 (OR 0.44, 95% CI: 0.19–0.99, p=0.042). Analysis by neurological diagnosis demonstrated that ischemic stroke was the most common diagnosis overall (37.9%), and patients with ischemic stroke exhibited a higher incidence of DVT (24/36, 66.7%) compared to other groups, with an odds ratio of 2.00 (95% CI: 0.89–4.51, p=0.065), although this did not reach statistical significance. Hemorrhagic stroke was present in 26.3% of patients, but these patients were less likely to develop DVT (7/25, 28%), OR 0.32 (95% CI: 0.12–0.85). Spinal cord injury accounted for 21.1% of the cohort, with equal proportions of DVT-positive and negative cases (10/20 each, OR 1.00, 95% CI: 0.37–2.70, p=1.000). Parkinson's disease and multiple sclerosis contributed 10.5% and 4.2% respectively, with no significant differences in DVT rates (each diagnosis: 5/10 and 2/4, respectively, p=1.000). BMI stratification showed that no underweight patient developed DVT, whereas 34.7% (33/95) of normal weight patients, 3.2% (3/95) of overweight patients, and 12.6% (12/95) of obese patients were diagnosed with DVT. Overweight patients had a significantly lower risk of DVT (OR 0.18, 95% CI: 0.05–0.67, p=0.030), while obesity was associated with increased DVT risk (OR 1.77, 95% CI: 0.66–4.72, p=0.044). Serial Doppler and D-dimer testing revealed that the initial Doppler ultrasound identified DVT in 22.1% of patients (21/95). However, after repeat Doppler examination and assessment of equivocal cases using D-dimer, the cumulative incidence of DVT rose to 50.5% (48/95). This highlights the added diagnostic yield of serial imaging and adjunctive D-dimer testing in this high-risk cohort. In summary, the findings demonstrated that elevated BMI and higher disability (mRS 5) were significantly associated with DVT, and ischemic stroke patients had a trend toward higher DVT incidence. Serial imaging substantially increased case detection, underscoring the clinical importance of repeated assessments and risk stratification in bedridden neurological patients.

Figure 1 demonstrates a clinically significant, graded increase in deep vein thrombosis (DVT) incidence with rising body mass index (BMI) and increasing neurological disability among bedridden patients. For patients with moderate disability (mRS 4), DVT rates rose from 38% (95% CI: 20–57%) in normal-weight individuals to 55% (95% CI: 28–82%) in those classified as obese. Among those with severe disability (mRS 5), DVT rates were even higher—climbing from 52% (95% CI: 33–71%) in normal-weight to 81% (95% CI: 62–100%) in the obese category. Notably, patients with mRS 5 had consistently greater DVT risk than those with mRS 4 at each BMI level, and only the severely disabled obese group exceeded the 80% DVT risk threshold. The lower boundary of the 95% confidence interval for DVT incidence in the most at-risk group (obese, mRS 5) remained above 60%, suggesting strong statistical robustness. These findings highlight the synergistic effect of obesity and advanced neurological disability in amplifying DVT risk—emphasizing the need for aggressive thromboprophylaxis and serial monitoring, especially for obese and profoundly disabled neurological inpatients

DISCUSSION

The present study revealed a striking 50.5% incidence of deep venous thrombosis (DVT) among hospitalized bedridden patients with neurological disorders, a finding that is higher than previously reported rates in similar populations. This elevated incidence underscores the vulnerability of neurological patients, especially in resource-limited settings where immobility, frequent use of immunosuppressive therapies, and prolonged hospital stays intersect to increase thrombotic risk (15). Notably, our findings demonstrated that patients with ischemic stroke had a higher, albeit non-significant, trend toward increased DVT incidence (66.7%) compared to those with other diagnoses (p=0.065), echoing previous literature indicating that stroke-related immobility and associated comorbidities contribute disproportionately to venous thromboembolism risk (16).

The role of disability severity emerged as a key determinant in our cohort, with patients classified as having severe disability (Modified Rankin Scale score of 5) showing significantly higher DVT prevalence (63.9% vs 42.4%, p=0.042), suggesting that loss of motor function and subsequent stasis are potent contributors to thrombogenesis. This aligns with Singh et al.'s observation that neurological severity was independently predictive of DVT in spinal cord injury patients (17). Additionally, obesity was significantly associated with DVT (mean BMI 25.3 vs 23.6 kg/m²; p=0.026), consistent with epidemiological data highlighting the prothrombotic milieu associated with adiposity (18). Notably, our stratified analysis illustrated a synergistic effect between high BMI and greater disability severity, with DVT incidence reaching 81% among obese patients with mRS 5, and 55% even in moderately disabled (mRS 4) obese individuals. This pattern reinforces the hypothesis that physical inactivity, compounded by metabolic risk factors such as obesity, amplifies thrombotic risk.

Interestingly, gender showed a near-significant association with DVT (p=0.051), with a higher proportion of DVT among females, though this finding warrants cautious interpretation given the borderline p-value and the lack of adjustment for other variables. Prior studies have variably reported female sex as a potential risk modifier, particularly in older age groups and patients receiving hormone replacement or corticosteroid therapies (19,20). The contribution of diagnostic methodology to DVT detection is noteworthy. The yield of DVT diagnosis nearly doubled from 22.1% on initial Doppler to 50.5% after repeat imaging and adjunctive D-dimer assessment, underscoring the limitations of single-point Doppler screening. This is consistent with Fu et al.'s meta-analysis reporting fair discrimination of DVT prediction models but highlighting the potential for under-detection with isolated testing (21). Our approach illustrates the clinical value of serial Doppler examinations combined with biomarker confirmation in enhancing diagnostic sensitivity among high-risk, immobile patients.

Despite these important observations, the study's limitations merit attention. Its single-center design may limit generalizability to settings with differing patient profiles or thromboprophylaxis practices. The exclusion of patients on anticoagulant therapy or with prior venous thromboembolism history was intended to reduce confounding but may have underestimated the overall thrombotic burden in the broader neurological inpatient population. Additionally, although D-dimer was effectively utilized to adjudicate equivocal ultrasound findings, the potential for reduced specificity raises the possibility of over-diagnosis, as noted by Mori et al. in their acute stroke cohort where elevated D-dimer independently predicted DVT risk (22). Moreover, the absence of multivariate adjustment precludes definitive attribution of observed associations to individual risk factors, though stratified analyses mitigate this limitation to some extent.

Clinically, these findings have important implications. The high observed incidence of DVT despite presumed standard prophylaxis highlights the need for more aggressive prevention strategies tailored to risk profiles characterized by obesity and severe disability. Nursing care pathways, patient education programs, and early mobilization protocols—shown in prior studies to reduce thrombotic events—may be particularly impactful when adapted for neurological wards (23,24). Future research should focus on prospective validation of composite risk models incorporating disability severity, BMI, neurological diagnosis, and biomarkers such as D-dimer to optimize prophylactic interventions and resource allocation. In summary, our study demonstrates that DVT is common among bedridden neurological patients, with risk magnified by increasing disability and obesity. Serial Doppler ultrasound examinations combined with D-dimer testing significantly improved diagnostic yield, supporting their routine use in high-risk cohorts. These findings advocate for individualized thromboprophylaxis strategies and routine risk assessment to mitigate the substantial thrombotic burden in this vulnerable population.

CONCLUSION

Deep venous thrombosis (DVT) was identified as a frequent and clinically significant complication in hospitalized bedridden patients with neurological disorders, with an overall incidence of 50.5% after systematic assessment through serial ultrasound Doppler imaging and adjunctive D-dimer testing. The risk was notably higher among patients with ischemic stroke, greater disability as reflected by a Modified Rankin Scale score of 5, and elevated body mass index, suggesting a cumulative effect of immobility and metabolic risk factors on thrombogenesis. These results highlight the inadequacy of a single-point Doppler assessment and the limitations of standard thromboprophylaxis in this vulnerable group. The findings support the adoption of routine serial DVT screening and tailored prophylactic strategies in hospitalized immobile neurological patients, particularly those with severe disability and obesity, to reduce morbidity and prevent potentially fatal thromboembolic events. Future studies should aim to validate composite risk models and evaluate the cost-effectiveness of enhanced surveillance protocols to guide clinical decision-making and improve outcomes in this high-risk population.

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