British Journal of Hospital Medicine

Br. J. Hosp. Med. (Lond) **2026**; 87(6): 55137
https://doi.org/10.31083/BJHM55137

Article

Effectiveness of a Bobath Concept-Based Nursing Model on Neurological Function and Independence in Daily Living After Arteriovenous Malformation Resection: A Retrospective Study

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Academic Editor: John Alcolado
Submitted: 26 August 2025 Revised: 30 October 2025 Accepted: 26 November 2025 Published: 22 June 2026

Abstract

Aims/Background: Arteriovenous malformation (AVM) resection may result in postoperative neurological deficits and reduced capacity to perform daily activities. This study aims to investigate the impact of a Bobath concept-based nursing model on neurological function and independence in daily living following AVM resection. **Methods**: We retrospectively included 91 brain AVM patients who underwent AVM resection at The Fourth Hospital of Hebei Medical University between April 2024 and April 2025. Based on the nursing model provided, patients were divided into a Bobath care group (n = 45) and a routine care group (n = 46). Neurological function, motor performance, health-related quality of life, hospital stay duration, postoperative complications, and nursing satisfaction were assessed preoperatively and postoperatively. **Results**: Compared with the routine care group, the Bobath care group exhibited significantly lower National Institutes of Health Stroke Scale (NIHSS) scores and improved modified Rankin Scale (mRS) scores postoperatively ($p < 0.05$). Fugl-Meyer Assessment (FMA) scores for upper and lower limb motor function, as well as total motor mobility, were higher in the Bobath care group ($p < 0.05$). Length of hospital stay and recovery milestones were reduced ($p < 0.05$). 36-Item Short Form Health Survey (SF-36) physical and mental health domain scores improved more markedly in the Bobath care group ($p < 0.05$). Complication rates were lower ($p < 0.05$), and patient satisfaction was higher ($p < 0.05$). **Conclusion**: The Bobath concept-based nursing model improves neurological function, motor ability, and quality of life in patients undergoing AVM resection. It also reduces complications, shortens hospitalization, and improves rehabilitation outcomes, indicating significant clinical value for postoperative AVM care. Further multicenter and prospective studies are needed to validate its long-term efficacy.

Keywords: Bobath concept; AVM; neurological rehabilitation; activities of daily living; postoperative care; nursing care

1. Introduction

Arteriovenous malformation (AVM) is a congenital cerebrovascular anomaly characterized by direct connections between arteries and veins through a tangled cluster of abnormal vessels, without normal capillary transitions [1,2]. This structural abnormality makes the vessels prone to rupture and hemorrhage. The most common clinical manifestations of AVM include intracranial hemorrhage, seizures, and neurological dysfunction [3]. Epidemiologically, AVM affects approximately 18 per 100,000 individuals, with an annual incidence of 1.1 per 100,000 person-years [4]. It is a major cause of hemorrhagic stroke in young and middle-aged adults, and without timely management, AVM may result in severe disability or even death [5].

Diagnosis of AVM typically relies on imaging techniques such as computed tomography angiography (CTA), magnetic resonance angiography (MRA), and digital subtraction angiography (DSA), which delineate the angioarchitecture, size, and location of the lesion. These methods allow for precise identification of vascular malformations and the evaluation of their complexity, thereby guiding the selection of appropriate therapeutic interventions [6]. Treatment options include microsurgical resection, endovascular embolization, and stereotactic radiosurgery, individually or in combination. Currently, microsurgical resection remains the primary treatment modality for AVM and is particularly suitable for low- to moderate-risk lesions classified as Spetzler-Martin grades I to III [7,8].

Although surgery effectively removes the vascular nidus and reduces the risk of hemorrhage, intraoperative manipulation of brain tissue and involvement of functional areas may lead to varying degrees of postoperative neurological deficits. These deficits, including hemiplegia, speech disorders, and reduced ability to perform daily activities, significantly impact the quality of life for patients [9]. Therefore, early, standardized, and effective postoperative rehabilitation nursing interventions are essential for promoting neurological recovery, enhancing self-care abilities, reducing length of hospital stay, and improving overall prognosis [10].

The Bobath concept, developed in the 1940s, is a rehabilitation framework based on neurodevelopmental theory and designed for individuals with neurological impairments [11]. It emphasizes improving postural control, inhibiting abnormal movement patterns, and facilitating the reconstruction of normal motor patterns to enhance functional mobility and independence in daily living. Initially developed for the rehabilitation of children with cerebral palsy, the Bobath concept has since been widely applied to neurological disorders such as stroke and traumatic brain injury, yielding favorable outcomes [12,13]. Research indicates that rehabilitation based on the Bobath concept can significantly enhance motor coordination, improve proprioceptive feedback, and promote neuroplasticity, thereby supporting the restoration of functional connections and behavioral patterns [14,15].

However, current evidence on the application of the Bobath concept in postoperative AVM patients remains limited, and robust clinical data are lacking. This study retrospectively analyzed inpatients who underwent AVM resection at our hospital from April 2024 to April 2025, comparing the effects of routine nursing care with systematic rehabilitation nursing based on the Bobath concept on neurological function, motor ability, and quality of life. The aim of the present study is to provide theoretical support and practical reference for optimizing postoperative rehabilitation nursing models for AVM patients.

2. Methods

2.1 General Information

This study was a single-center retrospective analysis including 91 patients who underwent AVM resection at The Fourth Hospital of Hebei Medical University between April 2024 and April 2025. According to the type of nursing intervention received, patients were divided into a routine care group (n = 46) or a Bobath care group (n = 45).

Inclusion criteria: (1) Patients diagnosed with brain AVM confirmed by imaging (computed tomography [CT] or magnetic resonance imaging [MRI]) who underwent AVM resection surgery [16]. (2) Patients in stable condition postoperatively and capable of receiving rehabilitation nursing interventions. (3) Complete hospitalization records, including preoperative and postoperative neurological function assessments (e.g., National Institutes of Health Stroke Scale [NIHSS] score) and evaluations of daily living abilities. (4) Patients with normal mental status who were able to communicate with medical staff. (5) Patients aged 18 to 70 years.

Exclusion criteria: (1) Patients with other severe neurological diseases (e.g., Parkinson's disease, severe dementia) that may interfere with neurological assessments. (2) Patients who developed severe postoperative complications (e.g., massive cerebral hemorrhage or rebleeding) and were unable to participate in nursing interventions. (3) Patients with incomplete medical records or missing key outcome data. (4) Patients with severe systemic diseases (e.g., severe cardiopulmonary dysfunction, hepatic or renal insufficiency, or malignant tumors) that could significantly impact recovery or participation in rehabilitation (Fig. 1).

2.2 Intervention Methods

2.2.1 Routine Care Group Intervention Method

The routine care group followed a conventional intervention model, which included the following components: First, general postoperative care involved monitoring vital signs, observing neurological status, providing wound care, and preventing pressure ulcers. Second, basic daily care involved assisting patients with activities such as eating, toileting, and washing. Additionally, strict medication management was implemented to ensure the proper administration of medications, including those that lower intracranial pressure and antibiotics, while monitoring potential drug interactions and responses. In terms of safety management, emphasis was placed on preventing falls and bed-related accidents and delivering health education to patients. Psychological care aimed to alleviate anxiety and depression, aiming to improve treatment compliance. Finally, all patients received basic rehabilitation guidance, such as simple limb movement exercises performed in bed. Routine care was provided throughout the patient's postoperative hospitalization until discharge.

2.2.2 Bobath Care Group Intervention Method

The systematic rehabilitation nursing intervention model based on the Bobath concept [17] was implemented in the Bobath care group. This model, centered on Neurodevelopmental Therapy (NDT), focuses on regulating muscle tone, promoting normal movement patterns, and integrating sensory-motor functions to improve neurological function and daily living abilities. The specific intervention components were as follows: First, based on assessments and recommendations from certified rehabilitation therapists, nursing staff trained in Bobath theory assisted in tailoring and implementing personalized rehabilitation plans according to each patient's condition and dynamically adjusted daily intervention goals in collaboration with the rehabilitation team. Bobath concept-based interventions were applied systematically throughout the postoperative hospitalization period. Each individualized session lasted approximately 40–60 minutes and was conducted twice daily (morning and afternoon).

Nurses assisted patients in achieving proper positioning to maintain functional postures of muscles and joints, preventing abnormal muscle tone and joint contractures. Through posture guidance and movement control techniques, nurses promoted the development of symmetrical postures and core stability, helping patients gradually restore normal movement patterns and avoid compensatory movements. During motor training, methods such as tactile stimulation, joint traction, and proprioceptive input were employed to enhance limb perception and control, thereby improving coordination and functionality.

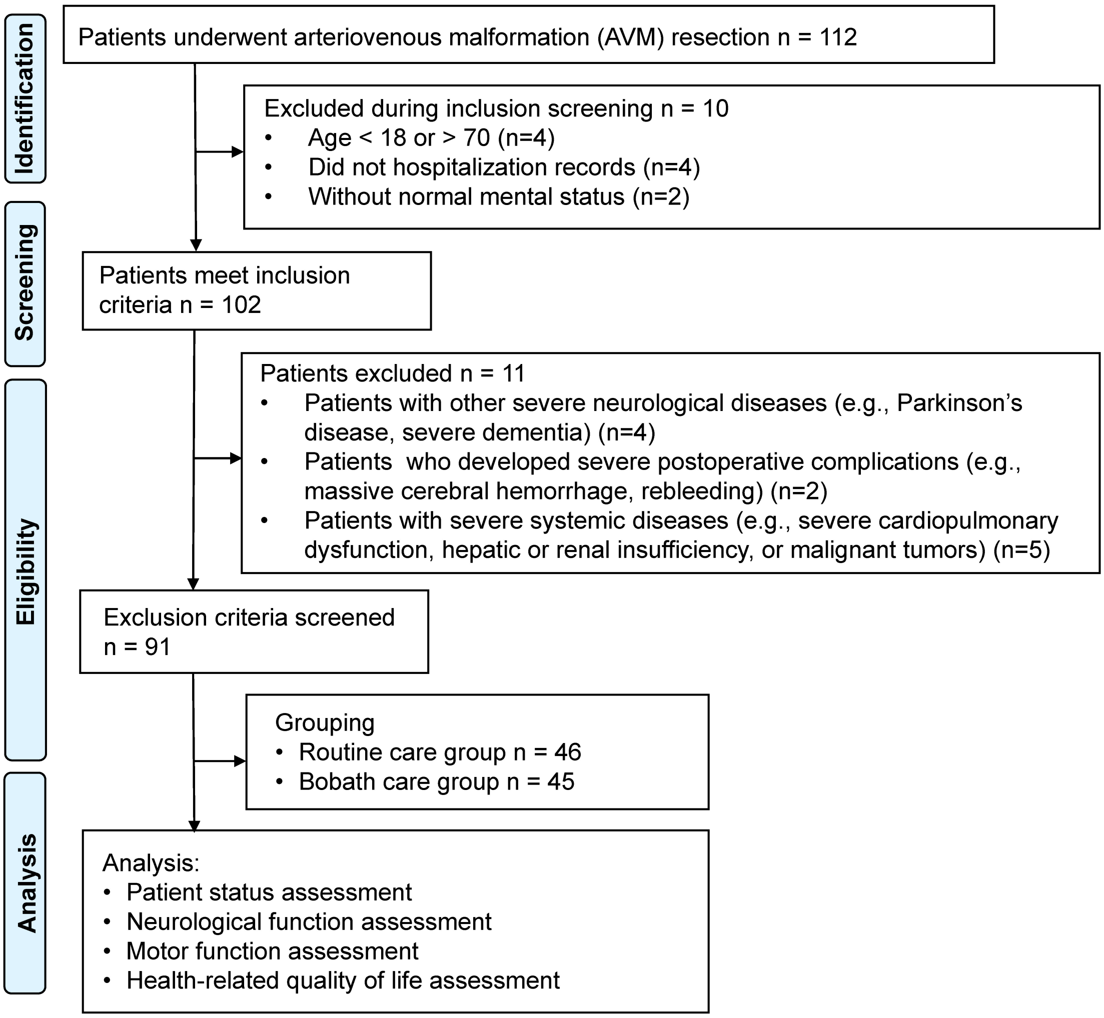

Fig. 1. Patient selection flowchart. Note: Fig. 1 was created using Microsoft PowerPoint for Microsoft 365 (Microsoft Corporation, Redmond, WA, USA).

The intervention followed a progressive training principle and included staged functional exercises such as turning in bed, sitting up, sitting-to-standing transitions, balance training, and walking practice. Activities of daily living (ADL) training, including eating, dressing, and toileting, was also provided, with the aim of improving independence and self-care ability. In addition, the nursing process emphasized active patient engagement and psychological support, encouraging patients to develop confidence and strengthen self-efficacy during rehabilitation. Nursing staff also provided education and technical training to family members on rehabilitation care, thereby improving family support capacity to ensure continuity of intervention after discharge. This intervention model is highly systematic and individualized, aiming to comprehensively enhance the post-surgical recovery of neurological function and the quality of life for patients.

All nursing staff implementing the Bobath interventions completed standardized Bobath concept training and held relevant certifications. Regular supervision was conducted by a senior Bobath-certified therapist to ensure adherence to the protocol and maintain inter-rater consistency. While interventions were nurse-led, the overall rehabilitation plan was developed in consultation with, and under periodic supervision from, certified rehabilitation therapists. The Bobath-specific intervention period extended from the first postoperative day (once the patient was stable and cleared for rehabilitation) until the tenth postoperative day. Routine nursing care (e.g., vital signs monitoring, wound care) continued throughout hospitalization as performed in the routine care group.

2.3 Observation Indicators

Neurological function was assessed using the National Institutes of Health Stroke Scale (NIHSS) and the modified Rankin Scale (mRS). The NIHSS includes 11 items that evaluate the level of consciousness, eye movement, visual fields, limb movement, and language ability, with a total possible score of 42; higher scores indicate more severe neurological deficits [18]. The mRS is a unidimensional scale used to evaluate the degree of independence in daily life, ranging from 0 (no symptoms) to 6 (death), with higher scores reflecting greater disability [19]. NIHSS scores were recorded preoperatively, 48 hours postoperatively, and 72 hours postoperatively to evaluate neurological impairment. mRS scores were assessed preoperatively and on the 10th postoperative day to determine functional independence.

Motor function was assessed using the Fugl-Meyer Assessment (FMA), which evaluates five dimensions: motor function, sensory function, balance, joint range of motion, and joint pain. The total score is 226, with the motor function subscale (comprising 66 points for upper limbs and 34 points for lower limbs) accounting for 100 points and serving as the primary evaluation indicator in this study. Higher scores indicate better recovery of neurological and motor function [20]. Assessments were performed preoperatively and on the 10th postoperative day.

Time to functional milestones was recorded through direct observation by rehabilitation nurses. The total postoperative hospital stay was defined as the time from the end of surgery to discharge. Time to first ambulation was defined as the earliest postoperative time (days) at which the patient could stand upright with assistance ($\geq$1 person) for $\geq$1 minute. Time to independent sit-to-stand was recorded when all of the following criteria were met: (a) Fugl-Meyer lower limb score $\geq$24/34; (b) independent transition from sitting to standing in $\leq$3 attempts; and (c) ability to maintain standing $\geq$30 seconds without support. Time to assisted walking refers to the earliest time at which the patient walked $\geq$10 meters with one-person assistance (light touch) without the use of gait aids. Assessments were conducted twice daily (8:00 and 16:00), and the earliest qualifying time point was documented.

Health-related quality of life was evaluated using the 36-Item Short Form Health Survey (SF-36) scale, which includes eight dimensions: general health, physical functioning, role-physical, bodily pain, vitality, social functioning, role-emotional, and mental health. Each dimension is scored from 0 to 100, with higher scores indicating a better quality of life [21]. Assessments were conducted preoperatively and on the 10th postoperative day.

Postoperative complications were monitored and recorded daily until discharge. Diagnostic criteria were standardized as follows: Deep Vein Thrombosis (DVT): symptomatic limb swelling or pain plus Doppler ultrasound confirmation of a thrombus [22]. Pulmonary Infection: For patients receiving mechanical ventilation, the diagnosis was based on a Clinical Pulmonary Infection Score (CPIS) $\geq$ 6 [23]. For non-ventilated patients, diagnosis required at least two of the following: new or worsening cough, purulent sputum, fever, or dyspnea, combined with new or progressive infiltrates on chest X-ray, and the initiation of antibiotic therapy for pneumonia. Pressure Ulcer: stage I or higher skin breakdown, based on National Pressure Ulcer Advisory Panel (NPUAP) criteria, persisting >24 hours [24]. Urinary Tract Infection (UTI): symptomatic bacteriuria [$>10^3$ colony-forming unit(s) (CFU)/mL] with pyuria [25].

Patient satisfaction with nursing care was evaluated using the Rehabilitation Nursing Satisfaction Scale (RNSS), adapted from the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) framework and modified for neurosurgical rehabilitation [26]. The RNSS demonstrated good internal consistency (Cronbach's α = 0.94 for the total scale, subscales 0.81–0.90) and satisfactory content validity (scale-level content validity index/average [S-CVI/Ave] = 0.93). These psychometric properties were derived from a separate pilot validation sample of 50 neurosurgical rehabilitation patients at The Fourth Hospital of Hebei Medical University prior to the start of this study, not from the current study sample. The RNSS includes 15 items grouped into five dimensions: communication clarity, professional skill competence, respect for patient needs, rehabilitation guidance, and overall experience. Dimension scores were calculated by averaging item responses and linearly transforming them to a 0–100 scale (higher scores = better satisfaction). Global satisfaction was computed as the mean of all dimension scores [27]. Willingness to recommend was measured as a separate binary item (Yes/No) within the RNSS: 'Would you recommend our hospital's rehabilitation nursing services to your friends and family?'. Assessments were completed at discharge.

All assessments (NIHSS, mRS, FMA, SF-36, RNSS) were performed by two trained research nurses who were blinded to the group allocation. Both assessors completed standardized training in scale usage and had more than three years of experience in neurosurgical rehabilitation assessment.

2.4 Statistical Analysis

A priori sample size calculation was performed using G*Power software (version 3.1.9.7; Heinrich Heine University, Düsseldorf, Germany). Based on effect sizes observed in preliminary data and similar rehabilitation studies targeting neurological function improvement, we anticipated a moderate effect size (d = 0.6) for the primary outcome (change in NIHSS score) between groups. With an alpha error of 0.05 and a power (1-β) of 0.8, the minimum required sample size per group was calculated as 45. The sample size was determined using the formula for comparing two independent means:

$$n = \left[2 \times (Z1\text{-}\alpha/2 + Z1\text{-}\beta)^2 \times \sigma^2\right] / d^2$$

where α = 0.05 (two-tailed), power (1-β) = 0.8, σ is the pooled standard deviation, and d is the effect size. The final sample sizes (n = 46 and n = 45) satisfied this requirement.

Table 1. Comparison of general characteristics between the two groups.

Factors	Routine care group (n = 46)	Bobath care group (n = 45)	t/χ^2	p-value
Age (years)	38.43 ± 8.70	40.44 ± 9.35	1.060	0.292
Gender (n/%)				
Male	24 (52.17)	23 (51.11)	0.010	0.919
Female	22 (47.83)	22 (48.89)		
SM stage (n/%)				
Grade I	10 (21.74)	11 (24.44)	0.117	0.990
Grade II	12 (26.09)	11 (24.44)		
Grade III	14 (30.43)	13 (28.89)		
Grade IV	10 (21.74)	10 (22.22)		
Preoperative symptoms (n/%)				
Hemorrhage	10 (21.74)	10 (22.22)	0.117	0.943
Hemorrhage combined with neurological dysfunction	13 (28.26)	14 (31.11)		
Hemorrhage combined with epilepsy	23 (50.00)	21 (46.67)		
Location of AVM (n/%)				
Supratentorial	25 (54.35)	22 (48.89)	0.271	0.602
Infratentorial	21 (45.65)	23 (51.11)		
AVM classification				
Nidus type	13 (28.26)	11 (24.44)	0.184	0.912
Fistula type	17 (36.96)	18 (40.00)		
Mixed type	16 (34.78)	16 (35.56)		

Note: Spetzler-Martin grading system (Grades I–V) was based on AVM size, pattern of venous drainage, and eloquence of adjacent brain tissue, with a higher grade indicating greater surgical complexity and risk. No patients with Spetzler-Martin grade V were included in either group. Patients with multiple symptoms are classified into the category that represents the most severe symptom manifestation. AVM classification was based on digital subtraction angiography (DSA) morphology. SM, Spetzler-Martin; AVM, arteriovenous malformation.

Data were processed using SPSS version 27.0 (SPSS Inc., Chicago, IL, USA). Categorical variables were expressed as frequencies and percentages [n (%)] and compared using the chi-square (χ^2) test when the theoretical frequency (T) was $\geq$5. When T was <5, the continuity-corrected chi-square test was applied. For sample sizes <40 or when T <1, Fisher's exact test was applied. The Shapiro–Wilk test was used to assess the normality of continuous variables. Continuous variables were presented as mean ± standard deviation (mean ± SD). Between-group comparisons were performed using the independent-samples t-tests, and within-group comparisons were performed using paired samples t-tests. A p-value < 0.05 was considered statistically significant.

3. Results

3.1 Comparison of General Characteristics Between the Two Groups

As shown in Table 1, no statistically significant differences were observed between the routine care group and the Bobath care group in terms of age, gender, Spetzler-Martin (SM) grade, preoperative symptoms (hemorrhage, hemorrhage with neurological deficits, hemorrhage with epilepsy), AVM location, or AVM classification ($p > 0.05$).

3.2 Comparison of NIHSS and mRS Scores Between the Two Groups

The preoperative NIHSS scores showed no significant difference between the two groups ($p > 0.05$). At 48 hours post-operation, both groups demonstrated significant reductions in NIHSS scores compared with their respective preoperative values ($p < 0.05$). This trend continued at 72 hours post-operation, with both groups again showing significant decreases from baseline ($p < 0.05$). Notably, the NIHSS scores at 48 hours and 72 hours postoperatively in the Bobath care group were significantly lower than those in the routine care group ($p < 0.05$) (Table 2).

The preoperative mRS scores between the two groups showed no significant difference ($p > 0.05$). However, the 10-day postoperatively mRS scores were significantly lower than the preoperative values in both groups, and the Bobath care group demonstrated markedly greater reduction in mRS scores than the routine care group ($p < 0.05$) (Table 3).

3.3 Comparison of Motor Function Between the Two Groups

There were no statistically significant differences in preoperative upper limb score, lower limb score, or FMA score between the two groups ($p > 0.05$). At 10 days postoperatively, both groups showed significantly higher upper

Table 2. Comparison of NIHSS scores between the two groups.

Time point	Routine care group (n = 46)	Bobath care group (n = 45)	t	p-value
Preoperative NIHSS score	14.29 ± 2.87	14.94 ± 3.58	0.950	0.345
48-hour postoperative NIHSS score	11.07 ± 1.98*	10.00 ± 1.62*	2.832	0.006
72-hour postoperative NIHSS score	7.74 ± 1.77*#	6.17 ± 1.85*#	4.140	<0.001

Note: *$p < 0.05$ compared with preoperative score; *#$p < 0.05$ compared with 48-hour postoperative score. NIHSS, National Institutes of Health Stroke Scale.

Table 3. Comparison of mRS scores between the two groups.

Factors	Routine care group (n = 46)	Bobath care group (n = 45)	t	p-value
Preoperative mRS score	4.18 ± 0.77	4.31 ± 0.86	0.762	0.448
Postoperative 10-day mRS score	2.15 ± 0.39*	1.76 ± 0.27*	5.615	<0.001

Note: *$p < 0.05$ compared with preoperative score. mRS, modified Rankin Scale.

Table 4. Comparison of motor function between the two groups.

Factors	Routine care group (n = 46)	Bobath care group (n = 45)	t	p-value
Preoperative upper limb score	22.54 ± 3.53	22.73 ± 3.24	0.272	0.786
10-day postoperative upper limb score	38.72 ± 4.54*	46.42 ± 5.32*	7.431	<0.001
Preoperative lower limb score	19.08 ± 2.37	19.07 ± 2.18	0.012	0.990
10-day postoperative lower limb score	26.72 ± 3.20*	29.47 ± 3.92*	3.666	<0.001
Preoperative FMA score	39.47 ± 6.01	38.91 ± 5.44	0.472	0.638
10-day postoperative FMA score	65.58 ± 8.04*	75.74 ± 8.39*	5.903	<0.001

Note: *$p < 0.05$ compared with preoperative score. FMA, Fugl-Meyer Assessment.

Table 5. Comparison of hospital stay duration and functional recovery efficiency between the two groups.

Factors	Routine care group (n = 46)	Bobath care group (n = 45)	t	p-value
Total postoperative length of hospital stay (days)	18.12 ± 4.92	15.07 ± 3.74	3.322	0.001
Time to first ambulation (days)	4.82 ± 1.68	3.85 ± 1.22	3.161	0.002
Time to achieve independent sit-to-stand (days)	8.12 ± 2.67	6.40 ± 2.15	3.379	0.001
Time to achieve assisted walking (days)	11.71 ± 3.85	9.60 ± 3.12	2.861	0.005

limb scores, lower limb scores, and FMA scores compared with preoperative values ($p < 0.05$). Moreover, at 10 days postoperatively, the Bobath care group demonstrated significantly higher upper limb scores, lower limb scores, and FMA scores than the routine care group ($p < 0.05$) (Table 4).

3.4 Comparison of Hospital Stay Duration and Functional Recovery Efficiency Between the Two Groups

In comparing the length of hospital stay and functional recovery efficiency between the routine care group and the Bobath care group, significant differences were observed in all assessed indicators (Table 5). Notably, the total postoperative hospital stay was significantly shorter in the Bobath care group compared with the routine care group ($p < 0.05$). Similarly, the time to first ambulation was significantly reduced in the Bobath care group relative to the routine care group ($p < 0.05$). Additionally, the time to achieve independent sit-to-stand and the time to achieve assisted walking were both significantly shorter in the Bobath care group than in the routine care group ($p < 0.05$).

3.5 Comparison of SF-36 Scores Between the Two Groups

There were no statistically significant differences between the two groups in preoperative general health, physical functioning, role-physical, bodily pain, vitality, social functioning, role-emotional, mental health, or total SF-36 score ($p > 0.05$). On postoperative day 10, both groups showed significant improvements in general health, physical functioning, role-physical, bodily pain, vitality, social functioning, role-emotional, mental health, and total SF-36 scores compared with their preoperative values ($p < 0.05$). Moreover, on postoperative day 10, the Bobath care group demonstrated significantly higher scores across all SF-36 dimensions and the total SF-36 score compared with the routine care group ($p < 0.05$) (Table 6).

3.6 Comparison of Postoperative Complication Rates Between the Two Groups

Table 7 presents the comparison of postoperative complication rates between the routine care group and the Bobath care group. Significant differences were identified in the incidence of DVT, pulmonary infections, and pressure ulcers favoring, with lower rates observed in the Bobath

Table 6. Comparison of SF-36 quality of life scores between the two groups.

Factors	Routine care group (n = 46)	Bobath care group (n = 45)	t	p-value
Preoperative general health score	54.19 ± 4.20	54.33 ± 3.77	0.157	0.876
Postoperative 10-day general health score	65.13 ± 4.79*	70.43 ± 5.38*	4.941	<0.001
Preoperative physical functioning score	49.50 ± 4.23	49.06 ± 4.50	0.473	0.638
Postoperative 10-day physical functioning score	60.23 ± 5.24*	67.81 ± 5.75*	6.574	<0.001
Preoperative physical role functioning score	64.72 ± 5.39	64.46 ± 5.38	0.231	0.818
Postoperative 10-day physical role functioning score	74.97 ± 6.47*	80.29 ± 7.10*	3.737	<0.001
Preoperative bodily pain score	57.03 ± 6.52	56.34 ± 6.12	0.522	0.603
Postoperative 10-day bodily pain score	75.05 ± 7.73*	81.40 ± 8.74*	3.669	<0.001
Preoperative vitality score	53.00 ± 4.57	52.62 ± 4.56	0.394	0.694
Postoperative 10-day vitality score	76.06 ± 4.99*	84.41 ± 5.88*	7.316	<0.001
Preoperative social functioning score	57.42 ± 4.33	57.03 ± 4.02	0.446	0.657
Postoperative 10-day social functioning score	78.04 ± 5.57*	83.66 ± 6.12*	4.582	<0.001
Preoperative emotional role score	58.82 ± 6.07	59.06 ± 6.28	0.189	0.851
Postoperative 10-day emotional role score	70.92 ± 7.15*	76.06 ± 8.29*	3.167	0.002
Preoperative mental health score	55.78 ± 5.21	55.76 ± 5.20	0.020	0.984
Postoperative 10-day mental health score	71.76 ± 5.90*	77.19 ± 6.16*	4.295	<0.001
Preoperative SF-36 total score	50.42 ± 5.36	50.63 ± 5.25	0.197	0.844
Postoperative 10-day SF-36 total score	71.45 ± 6.55*	76.66 ± 6.84*	3.709	<0.001

Note: *$p < 0.05$ compared with preoperative score; SF-36, 36-Item Short Form Health Survey.

Table 7. Comparison of postoperative complication rates between the two groups [n (%)].

Factors	Routine care group (n = 46)	Bobath care group (n = 45)	χ^2	p-value
DVT	8 (17.39)	1 (2.22)	4.294	0.038
Pulmonary infection	9 (19.57)	2 (4.44)	4.894	0.027
Pressure ulcer	6 (13.04)	0 (0.00)	-	0.026
UTI	7 (15.22)	3 (6.67)	0.939	0.333
Overall complication rate	18 (39.13)	6 (13.33)	7.796	0.005

Note: Overall complication rate was calculated as the number of patients who experienced at least one post-operative complication divided by the total number of patients in each group. DVT, Deep Vein Thrombosis; UTI, Urinary Tract Infection.

care group ($p < 0.05$). However, no significant difference was observed in the rate of UTI between the two groups ($p > 0.05$). The overall complication rate was significantly lower in the Bobath care group compared with the routine care group ($p < 0.05$).

3.7 Comparison of Nursing Satisfaction Between the Two Groups

Table 8 shows the comparison of nursing satisfaction between the routine care group and the Bobath care group. The Bobath care group demonstrated significantly higher global satisfaction scores compared with the routine care group ($p < 0.05$). Notably, significant differences were also observed in communication clarity, professional skill competence, respect for patient needs, rehabilitation guidance, and overall experience ($p < 0.05$). Additionally, a significantly higher proportion of patients reported willingness to recommend services in the Bobath care group compared with the routine care group ($p < 0.05$).

4. Discussion

This study retrospectively analyzed 91 brain AVM patients who underwent AVM resection. By comparing the effects of the Bobath concept-based nursing model with conventional nursing interventions on neurological function, motor function, and quality of life, the study demonstrated that the Bobath care group achieved better outcomes in NIHSS scores, mRS scores, FMA scores, and SF-36 scores than the routine care group. Additionally, the length of hospital stay was shorter, functional milestones were reached more rapidly, and complication rates (e.g., DVT, pulmonary infections) were reduced. These findings indicate that this intervention model provides a significant advantage in promoting postoperative functional recovery.

Consistent with previous studies, the principles emphasized by the Bobath approach, “promoting normal movement patterns and inhibiting abnormal movement patterns”, have been widely validated as effective in stroke and brain injury rehabilitation. For example, Gülşah Sütçü *et al*. [28] emphasized, in their qualitative analysis of the

Table 8. Comparison of nursing satisfaction between the two groups.

Factors	Routine care group (n = 46)	Bobath care group (n = 45)	t/χ^2	p-value
Global satisfaction	77.73 ± 4.30	83.25 ± 3.90	6.410	<0.001
Communication clarity	77.26 ± 9.93	83.04 ± 8.35	3.006	0.003
Professional skill competence	82.75 ± 9.21	88.06 ± 8.89	2.800	0.006
Respect for patient needs	74.78 ± 10.02	80.33 ± 8.76	2.810	0.006
Rehabilitation guidance	75.23 ± 10.45	81.56 ± 9.98	2.954	0.004
Overall experience	78.62 ± 8.31	83.24 ± 7.47	2.787	0.007
Willingness to recommend	33 (71.74)	40 (88.89)	4.216	0.040

Bobath approach, that this intervention focuses on coordinating postural control and sensory input, thereby improving neuroplasticity and supporting the functional reconstruction of neural pathways. In this study, the Bobath care group showed significantly lower NIHSS scores at 48 and 72 hours postoperatively compared to the routine care group, confirming the positive impact of this model on early postoperative neurological recovery.

In terms of independence in daily living, the mRS scores indicated a marked improvement in the Bobath care group's functional independence by the 10th postoperative day. This finding is consistent with the results of Fen Zhang *et al*. [29], who reported significant improvements in mRS scores among patients with moderate to severe brain injuries following a Bobath-based functional training program, suggesting that this model yields reproducible clinical benefits in functional recovery. We acknowledge that the mRS is conventionally used at 3–6 months after neurological events, whereas we assessed it on postoperative day 10 to capture early rehabilitation effects to guide discharge planning. The significant improvement in mRS scores within 10 days in the Bobath care group suggests that the intervention may accelerate early recovery. Several factors may explain this rapid improvement: the reversible nature of AVM resection without irreversible damage to surrounding brain tissue, the high-intensity twice-daily Bobath-based training, and the considerable baseline disability that allowed measurable early gains. Future studies should include longer follow-ups to determine whether these early gains are sustained over time.

In terms of motor function recovery, the Fugl-Meyer Assessment (FMA) revealed that the Bobath care group significantly outperformed the routine care group in upper limb, lower limb, and total FMA scores. This aligns with the systematic review by María J Díaz-Arribas *et al*. [30], which concluded that Bobath training is more effective than passive exercise in improving motor ability and coordination in patients with hemiplegia. Additionally, compared with traditional rehabilitation strategies, the Bobath model emphasizes multidimensional interventions, such as postural guidance, core stability training, and proprioceptive stimulation, that support the development of more stable and efficient motor control patterns. The observed improvement in FMA scores in this study is notably larger and faster than typical recovery rates reported in stroke rehabilitation literature, where FMA gains of approximately 10–20 points are often observed within one month. Several factors may explain this accelerated improvement. First, AVM resection differs from ischemic stroke in that it removes an abnormal vascular lesion rather than treating an infarct; the surrounding brain tissue is often not irreversibly damaged, allowing more rapid functional reorganization. Second, the Bobath-based intervention was delivered twice daily for 40–60 minutes per session, which is a higher intensity than many standard rehabilitation protocols. Third, the FMA assessments were performed by trained nurses who were blinded to group allocation, but the early postoperative period may capture both true neurological recovery and early motor learning effects. Finally, the baseline FMA scores in both groups indicate moderate motor impairment, leaving substantial room for improvement. We caution that these FMA gains should be interpreted as early postoperative improvements, and longer-term follow-up is needed to determine whether they translate into sustained functional benefits.

In terms of quality of life, the SF-36 results revealed significantly higher scores in the Bobath care group than the routine care group across multiple dimensions, including physical functioning, emotional role, and mental health. These findings are consistent with those by Fen Zhang *et al*. [29], who observed that interventions based on the Bobath concept not only promote functional recovery but also effectively alleviate anxiety and depression, thereby enhancing patients' subjective well-being and overall quality of life. Regarding the use of the SF-36 scale on postoperative day 10, we recognize that this instrument is typically designed to assess health status over the preceding 4 weeks. Thus, patients' responses at the 10-day postoperative time point might have integrated both preoperative and postoperative experiences, potentially introducing recall bias. Moreover, the acute recovery period may influence subjective quality-of-life ratings. Despite these limitations, the SF-36 scores in the Bobath care group were consistently higher than those in the routine care group, and the direction of change was as expected. The magnitude of between-group differences remained significant, supporting the robustness of the findings. Future studies should consider using instruments designed for repeated short-interval assessments or including a longer follow-up to minimize recall bias.

Furthermore, in terms of hospital stay and functional recovery efficiency, the Bobath care group demonstrated significantly shorter postoperative hospital stays and more rapid achievement of key functional milestones, including ambulation, independent sit-to-stand, and assisted walking, compared with the routine care group. These results highlight the effectiveness of the Bobath approach in accelerating functional recovery while reducing the burden on healthcare systems [15,31]. The reduction in hospital stay also suggests potential cost savings for both patients and healthcare institutions.

The incidence of postoperative complications, including DVT, pulmonary infections, and pressure ulcers, was significantly lower in the Bobath care group. This reduction in complications may be attributed to the comprehensive nature of the Bobath intervention, which emphasizes active patient participation, posture guidance, and core stability training. Such multidimensional interventions not only improve motor function but also enhance overall health status, thereby reducing the risk of secondary complications [28,30].

In terms of nursing satisfaction, the Bobath care group reported significantly higher global satisfaction scores compared with the routine care group. Patients in the Bobath care group rated communication clarity, professional skill competence, respect for patient needs, rehabilitation guidance, and overall experience more positively. Additionally, a higher proportion of patients expressed willingness to recommend services in the Bobath care group. These findings suggest that the Bobath-based intervention not only benefits patients physically but also improves their psychological well-being and overall satisfaction with care [32].

Despite the positive findings of this study, certain limitations should be acknowledged. Firstly, as a single-center retrospective study with a limited sample size, the generalizability of the results may be constrained, and the potential for selection bias cannot be fully ruled out despite balanced baseline characteristics. Therefore, the findings should be interpreted as preliminary and hypothesis-generating. Secondly, the intervention and assessment period were relatively short-term (10 days postoperatively), focusing on early recovery. No follow-up was conducted to evaluate the medium- to long-term functional recovery of the patients, quality of life, or the durability of the observed benefits. Future studies should adopt multicenter, prospective designs with extended follow-up to validate these findings and assess long-term efficacy. Additionally, although the outcome measures (NIHSS, mRS, FMA, SF-36) are appropriate, the statistical analysis is basic. To strengthen the validity of our conclusions, future research should consider exploratory multivariable modeling or propensity score matching to adjust for potential confounding factors. Furthermore, reporting effect sizes and confidence intervals would help readers better interpret the clinical significance of the results. The satisfaction instrument (RNSS) used in this study appears to be a modified tool, and we acknowledge the need for further validation of its reliability and validity in the neurosurgical rehabilitation setting. Future investigations should include psychosocial variables to provide a more comprehensive evaluation.

Additionally, it is important to consider why the Bobath-based nursing model may specifically benefit AVM patients compared with stroke or traumatic brain injury (TBI) populations. The pathophysiological mechanisms underlying AVM resection differ from those of stroke or TBI, potentially leading to distinct patterns of neurological recovery. For instance, AVM resection involves the removal of abnormal vasculature, which can directly influence local cerebral perfusion and neural connectivity. The Bobath approach, with its emphasis on facilitating normal movement patterns and inhibiting abnormal ones, may therefore be particularly suited to addressing the specific motor and sensory deficits encountered by AVM patients in the postoperative period. Further research is needed to explore these differences and their implications for optimizing rehabilitation strategies.

5. Conclusion

This study demonstrates that a systematic rehabilitation nursing intervention based on the Bobath concept can significantly improve neurological function, motor ability, and quality of life in patients after AVM resection, outperforming conventional nursing approaches. By promoting normal movement patterns and providing individualized training, this intervention facilitates neurological recovery and enhances independence in daily living. Although this study is a single-center retrospective analysis, further validation through multicenter studies with larger sample sizes is required. Nevertheless, its clinical value in rehabilitation nursing is evident and supports its broader application. However, given the preliminary nature of these findings, future studies should aim to confirm the observed results and further explore the unique pathophysiological mechanisms involved in AVM recovery.

Key Points

• This study evaluates a Bobath concept-based nursing model for patients recovering from AVM resection surgery.

• Compared with routine care, the Bobath-based intervention was associated with significantly greater improvements in early neurological function, motor recovery, and independence in daily activities.

• Patients receiving Bobath care also experienced a higher quality of life, lower complication rates, shorter length of hospital stay, and expressed greater satisfaction with their nursing care.

• The findings suggest that this structured, neurodevelopmentally focused approach may serve as a valuable component of early rehabilitation following AVM surgery.

• Further prospective, multicenter research with long-term follow-up is recommended to validate these benefits and establish evidence-based guidelines for implementation.

Availability of Data and Materials

The data that support the findings of this study are available from the corresponding authors upon reasonable request.

Author Contributions

FZ, XXX, and LZ designed the research study. FZ, XXX, and LZ performed the research. LZ analyzed the data. FZ wrote the first draft. All authors contributed to the important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study received approval from The Fourth Hospital of Hebei Medical University Ethics Review Committee (Ethics Approval Number: 2024KS179) and adheres to the principles outlined in the Declaration of Helsinki. For retrospective analyses involving anonymized medical records, the requirement for individual informed consent was waived because the study posed minimal risk and did not involve interventions beyond standard care. All data were anonymized and handled confidentially in accordance with institutional and legal regulations.

Acknowledgment

Not applicable.

Funding

This research was funded by Medical Science Research Project of Hebei (Application of the Bobath-based care model in cerebral arteriovenous malformation rupture haemorrhage), grant No. 20241699.

Conflict of Interest

The authors declare no conflict of interest.

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