Article

Effects of PDCA Cycle-Guided Individualized Evidence-Based Nursing on Functional Recovery and Quality of Life After Intracerebral Hemorrhage Surgery

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AIM: Intracerebral hemorrhage (ICH) is a critical neurological condition often associated with severe disability and reduced quality of life. Effective postoperative nursing interventions are essential for promoting functional recovery. This study aimed to evaluate the impact of individualized evidence-based nursing guided by the Plan–Do–Check–Act (PDCA) cycle on postoperative functional recovery and quality of life in patients with ICH.

METHODS: A total of 152 patients with ICH admitted to Gansu Provincial Hospital of TCM between March 2022 and March 2025 were included and divided into a control group (n = 79) and a study group (n = 73) according to different nursing strategies. The control group received routine nursing care, while the study group received individualized evidence-based nursing guided by the PDCA cycle. Psychological status (Self-Rating Anxiety Scale [SAS], Self-Rating Depression Scale [SDS]), neurological function (National Institutes of Health Stroke Scale [NIHSS]), motor function (Fugl–Meyer Assessment [FMA]), activities of daily living (Barthel Index [BI]), self-management ability, and quality of life (Generic Quality of Life Inventory-74 [GQOLI-74]) were evaluated before and after the intervention.

RESULTS: There were no significant differences in baseline characteristics between the two groups ($p > 0.05$). Prior to intervention, no significant differences existed between the two groups in SAS, SDS, NIHSS, FMA, BI, self-management ability, or GQOLI-74 scores (all $p > 0.05$). Post-intervention, the study group exhibited significantly lower SAS and SDS scores than the control group ($p < 0.001$). NIHSS scores were significantly lower than the control group, while FMA and BI scores were significantly higher than the control group (all $p < 0.001$). Additionally, post-intervention self-management ability and GQOLI-74 scores in the study group were significantly higher than the control group (all $p \leq 0.001$).

CONCLUSIONS: The PDCA cycle-guided individualized evidence-based nursing approach significantly promotes neurological and motor recovery, improves psychological well-being, enhances self-management abilities, and optimizes overall quality of life in patients following ICH. This structured and patient-centered nursing model demonstrates significant clinical value and warrants broader clinical implementation.

Keywords: cerebral hemorrhage; Plan–Do–Check–Act cycle; individualized evidence-based nursing; neurological function recovery; quality of life; self-management

Introduction

Intracerebral hemorrhage (ICH) is a type of non-traumatic hemorrhagic stroke caused by rupture of small arteries or arterioles within the brain parenchyma, accounting for approximately 10%–20% of all strokes [1–3]. It is characterized by an acute onset, rapid progression, and a severe clinical course. ICH not only causes local hematoma compression and neuronal necrosis but also triggers a cascade of secondary injuries, including cerebral edema, increased intracranial pressure, inflammatory responses, and oxidative stress, which further exacerbate neurological impairment [4,5]. With the widespread application of microsurgical and minimally invasive hematoma evacuation strategies, acute management approaches and survival rates of patients with ICH have significantly improved [6,7]. However, postoperative patients often experience varying degrees of motor paralysis, speech and swallowing dysfunction, and psychological disorders, which severely impair quality of life and social reintegration. Therefore, promoting postoperative functional recovery, improving psychological well-being, and enhancing self-management through scientific and systematic nursing interventions has become a critical focus in ICH rehabilitation nursing.

Traditional routine nursing primarily emphasizes basic care and condition monitoring and often lacks individualized assessment and targeted interventions tailored to disease heterogeneity, rehabilitation stage, and psychological needs, leading to suboptimal nursing outcomes. In recent years,

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the concept of evidence-based nursing (EBN) has been increasingly applied to the rehabilitation management of neurological diseases [8,9]. EBN integrates the best clinical evidence, professional nursing experience, and patients' individual preferences to provide a scientific foundation for nursing decision-making. Previous studies have demonstrated that EBN can effectively improve treatment adherence, reduce complication rates, and promote functional recovery in patients with stroke [10,11]. However, in clinical practice, evidence-based nursing still encounters challenges such as nonstandardized implementation procedures and insufficient feedback and continuous improvement mechanisms, which limit the sustainability and systematic nature of nursing interventions.

The Plan–Do–Check–Act (PDCA) cycle is a widely used continuous quality improvement model in management science [12,13]. Its fundamental principle is to achieve sustained optimization of work quality through iterative processes of planning, implementation, evaluation, and adjustment. Incorporation of the PDCA cycle into clinical nursing management enables nursing teams to comprehensively analyze existing challenges and establish clear objectives and standards before implementation, while also supporting real-time monitoring of nursing outcomes, identification of deviations, and taking timely corrective actions during execution [14]. This approach facilitates the formation of a closed-loop system for continuous quality improvement. In recent years, the PDCA cycle has been increasingly applied in intensive care, perioperative nursing, and rehabilitation care, with evidence suggesting that this model can significantly enhance nursing quality, reduce nursing errors, and improve patient outcomes [15,16].

Integrating the PDCA cycle with evidence-based nursing supports the development of a planned, systematic, and targeted nursing intervention model grounded in scientific evidence. Under the PDCA cycle guidance, nursing staff conduct comprehensive assessments of postoperative patients with ICH, including disease severity, neurological deficits, psychological status, and rehabilitation needs, to formulate individualized EBN plans. Continuous feedback, evaluation and dynamic optimization during implementation may facilitate neurological recovery, improve psychological well-being, enhance self-management abilities, and improve overall quality of life.

At present, research on the application of the PDCA cycle in postoperative nursing care for ICH remains relatively limited both domestically and internationally. Most existing research focuses on patients with general stroke or cerebral infarction and lacks a comprehensive evaluation across psychological, functional, and quality-of-life domains. Therefore, this study enrolled postoperative patients with ICH at Gansu Provincial Hospital of TCM and implemented individualized EBN interventions guided by the PDCA cycle. The effects of this nursing model on neurological recovery, motor function, psychological status, self-management ability, and quality of life were systematically evaluated to provide scientific evidence and practical reference for optimizing and promoting postoperative nursing strategies for ICH.

Methods

Participants

A total of 152 patients with ICH admitted to Gansu Provincial Hospital of TCM between March 2022 and March 2025 were retrospectively included in this study. According to different nursing methods, patients were divided into a control group (n = 79) and a study group (n = 73). The control group received routine nursing care, while the study group received individualized EBN guided by the PDCA cycle. Baseline characteristics of the two groups are presented in Table 1.

Inclusion Criteria

(1) Patients clinically diagnosed and confirmed by cranial computed tomography (CT) or magnetic resonance imaging (MRI) as having spontaneous ICH, with clearly defined hemorrhage location and volume.

(2) First onset of ICH with onset-to-surgery time $<$12 hours.

(3) Patients with intracerebral hemorrhage undergoing surgical treatment, particularly those undergoing hematoma evacuation via craniotomy or minimally invasive surgery.

(4) Postoperative patients with stable vital signs who were expected to participate in rehabilitation and follow-up assessments during the study period.

(5) Patients with basic communication ability or a primary caregiver (spouse, direct relative, or legal guardian) capable of cooperating to complete individualized nursing interventions and quality-of-life assessments.

(6) Patients without severe cognitive impairment or psychiatric disorders who were able to understand and sign informed consent; for patients with impaired consciousness or cognition, informed consent was obtained from a legal representative.

This study was approved by the Ethics Committee of Gansu Provincial Hospital of TCM (No. 2025-167-01).

Exclusion Criteria

(1) Patients with severe comorbidities or organ failure, including terminal malignancy, irreversible heart failure, severe hepatic failure, or severe renal insufficiency; patients with secondary intracerebral hemorrhage caused by intracranial aneurysm, arteriovenous malformation (AVM), brain tumor, cerebrovascular malformation, traumatic hemorrhage, cerebral venous sinus thrombosis, or confirmed infectious/inflammatory etiology.

(2) Patients with severe coagulation dysfunction, severe infection, or systemic inflammatory response syndrome.

(3) Patients with severe psychiatric disorders or cognitive impairment.

(4) Patients with joint or neuromuscular diseases that could affect limb motor function.

Nursing Methods

Control Group

Patients in the control group received routine nursing care, which mainly included the following aspects:
(1) General care: Monitoring vital signs, maintaining a quiet and clean ward environment, assisting patients in adopting a comfortable position, and preventing pressure ulcers and falls.
(2) Basic care: Strengthening oral, skin, and perineal care, and ensuring the patency of urinary catheters and various drainage tubes to prevent infection.
(3) Medication and dietary care: Administering medications as prescribed; educating patients and their families regarding medication functions and precautions; providing a high-protein, high-vitamin, and easily digestible diet while avoiding spicy and irritating foods.
(4) Health education: Explaining relevant knowledge about ICH to patients and their families, emphasizing the importance of rehabilitation exercises, and encouraging active cooperation with treatment.
(5) Psychological care: Closely observing patients' emotional changes, providing timely psychological counseling to alleviate anxiety, depression, and fear, and enhancing confidence in treatment and recovery.

Study Group

Based on routine nursing care, patients in the study group received individualized IBN care guided by the Plan–Do–Check–Act (PDCA) cycle. The nursing process was implemented as follows:
(1) Planning stage (Plan):
A multidisciplinary nursing team, comprising responsible nurses, senior nurses, rehabilitation therapists, and a psychotherapist, was established. Validated assessment tools were used to comprehensively evaluate each patient's condition, including neurological deficits (National Institutes of Health Stroke Scale [NIHSS]), motor function (Fugl–Meyer Assessment [FMA]), psychological status (Self-Rating Anxiety Scale [SAS], Self-Rating Depression Scale [SDS]), and activities of daily living (Barthel Index [BI]). Based on these assessments, individualized nursing goals and EBN plans were formulated, with clearly defined priorities and expected outcomes for each rehabilitation phase.
(2) Implementation stage (Do):
① Condition monitoring and early intervention: Vital signs and neurological status were closely monitored, and any abnormalities were promptly reported and managed.
② Functional rehabilitation guidance: After stabilization of the patient's condition, gradual passive and active limb training, balance exercises, and activities of daily living (ADL) training were conducted to promote neurological and functional recovery.
③ Psychological care: Nursing staff actively communicated with patients, listened to their concerns, and provided psychological support and encouragement to promote a positive rehabilitation attitude.
④ Health education and family guidance: Individualized health education was delivered according to the patient's educational background and recovery stage, including dietary guidance, medication management, and family-assisted rehabilitation training methods.
(3) Checking stage (Check):
Standardized assessment scales (NIHSS, FMA, BI, SAS, SDS) were used to evaluate the effectiveness of nursing interventions, allowing for dynamic monitoring of changes in neurological function, motor recovery, psychological status, and self-care abilities. Feedback from patients and their family members was collected to identify existing challenges and areas requiring improvement.
(4) Action stage (Act):
Based on the evaluation findings, nursing plans were continuously adjusted and optimized, and unreasonable procedures were revised to establish a sustained quality improvement cycle, thereby enhancing overall nursing quality and rehabilitation outcomes. The duration of nursing intervention in both groups was approximately one month, corresponding to the length of postoperative hospitalization.

Observation Indicators

(1) Psychological status assessment
The SAS [17] and SDS [18] scales were used to assess patients' psychological status. Each scale comprises 20 items scored on a four-point Likert scale (1–4). Raw scores (range: 20–80 points) were multiplied by 1.25 to obtain standardized scores (range: 25–100 points), with higher scores indicating more severe anxiety or depression. Assessments were conducted at two time points: baseline (defined as the early postoperative hospitalization period prior to initiating the nursing intervention) and one month post-intervention.
(2) Neurological function, motor function, and ADL assessment
① Neurological function: The NIHSS [19] was used to evaluate the degree of neurological impairment, with total scores ranging from 0 to 42; higher scores indicate more severe deficits.
② Motor function: The FMA [20] was used to evaluate motor function recovery, with a maximum score of 100; higher scores indicate better motor function recovery.
③ Activities of daily living (ADL): The BI [21] was used to assess self-care ability, with a total score of 100; higher scores indicate stronger self-care capacity.
All the above indicators were measured before the intervention and one month after the intervention.
(3) Self-management assessment
The Stroke Self-Management Scale (SSMS), originally developed by Jones *et al*. [22] and validated in Chinese stroke

Table 1. Baseline characteristics of the study participants.

Factor	Control group (n = 79)	Study group (n = 73)	t/χ^2	p-value
Age (years)	58.06 ± 11.31	58.59 ± 12.53	0.272	0.786
Gender (n, %)				
Male	41 (51.90)	34 (46.58)	0.430	0.512
Female	38 (48.10)	39 (53.42)		
Body mass index (kg/m^2)	23.62 ± 3.57	24.01 ± 3.78	0.652	0.515
Cerebral hemorrhage volume (mL)	23.48 ± 4.54	22.79 ± 4.83	0.902	0.369
Glasgow Coma Scale (GCS) score	13.63 ± 1.10	13.46 ± 1.23	0.872	0.385

Table 2. Comparison of psychological status between the two groups before and after intervention.

Factor	Control group (n = 79)	Study group (n = 73)	t	p-value
SAS score before intervention	54.43 ± 4.42	54.13 ± 4.87	0.402	0.688
SAS score after intervention	47.37 ± 3.98	40.33 ± 3.48	11.561	<0.001
SDS score before intervention	52.30 ± 4.35	51.91 ± 4.90	0.511	0.610
SDS score after intervention	47.72 ± 4.62	41.44 ± 3.92	8.999	<0.001

Note: SAS, Self-Rating Anxiety Scale; SDS, Self-Rating Depression Scale.

populations, was used to assess patients' self-management ability. The scale comprises 51 items across four dimensions: daily behavior management (16 items), cognitive symptom management (14 items), disease management (15 items), and self-management confidence (6 items). Each item is rated on a five-point Likert scale ranging from 1 (never) to 5 (always). Total scores range from 51 to 255, with higher scores indicating better self-management ability.

(4) Quality of life assessment

Quality of life was assessed using the Standard General Quality of Life Inventory-74 (GQOLI-74) [23]. The scale consists of 74 items across four dimensions: physical function (24 items), psychological function (16 items), social function (20 items), and material life (14 items). Each item is scored on a five-point Likert scale (1–5 points). For each dimension, standardized scores ranging from 0 to 100 were calculated using the following formula:

Standard score = 100 × (raw score – minimum possible score) / (maximum possible score – minimum possible score).

Specifically, the minimum and maximum possible raw scores were 24–120 for physical function, 16–80 for psychological function, 20–100 for social function, and 14–70 for material life. The total quality of life score (range: 74–370) was also converted to a 0–100 scale using the same formula. Higher scores indicate a better quality of life.

Statistical Analysis

Statistical analyses were performed using SPSS version 27.0 (IBM Corporation, Armonk, NY, USA). Independent-sample t-tests and χ^2 tests were applied as appropriate. After testing for normality (Shapiro-Wilk test), continuous variables are represented as mean ± standard deviation ($\bar{x}$ ± s). Results indicate that none of the continuous variables showed significant deviation from normal distribution. Categorical variables are presented as frequencies and percentages (n, %). A two-sided p-value < 0.05 was considered statistically significant.

Results

Baseline Characteristics

Based on nursing methods, patients were divided into a control group (n = 79) and a study group (n = 73). In the control group, the mean age was 58.06 ± 11.31 years, comprising 41 males and 38 females, with a body mass index (BMI) of 23.62 ± 3.57 kg/m^2, a hematoma volume of 23.48 ± 4.54 mL, and a Glasgow Coma Scale (GCS) score of 13.63 ± 1.10. In the study group, the mean age was 58.59 ± 12.53 years, including 34 males and 39 females, with a BMI of 24.01 ± 3.78 kg/m^2, hematoma volume of 22.79 ± 4.83 mL, and GCS score of 13.46 ± 1.23. No statistically significant differences were observed in baseline characteristics between the two groups ($p > 0.05$) (Table 1).

Comparison of Psychological Status Between the Two Groups Before and After Intervention

Before the intervention, no significant differences were observed in SAS and SDS scores between the two groups ($p >$ 0.05). After the intervention, SAS and SDS scores in both groups were significantly lower than pre-intervention levels. Moreover, post-intervention SAS and SDS scores in the study group were significantly lower than those in the control group, with statistically significant differences ($p <$ 0.001) (Table 2).

Comparison of Neurological Function, Motor Function, and ADL Ability Between the Two Groups Before and After Intervention

Before the intervention, no significant differences were observed between the two groups in NIHSS, FMA, or BI scores ($p > 0.05$). Following the intervention, the NIHSS

Table 3. Comparison of neurological function, motor function, and activities of daily living between the two groups before and after intervention.

Factor	Control group (n = 79)	Study group (n = 73)	t	p-value
NIHSS score before intervention	27.81 ± 2.92	26.89 ± 3.35	1.809	0.072
NIHSS score after intervention	19.76 ± 4.33	12.56 ± 4.10	10.510	<0.001
FMA score before intervention	36.71 ± 4.75	36.52 ± 5.04	0.239	0.812
FMA score after intervention	57.68 ± 5.64	64.40 ± 6.62	6.755	<0.001
BI score before intervention	48.84 ± 5.57	49.24 ± 5.77	0.437	0.662
BI score after intervention	65.67 ± 4.87	73.79 ± 4.42	10.739	<0.001

Note: NIHSS, National Institutes of Health Stroke Scale; FMA, Fugl–Meyer Assessment; BI, Barthel Index.

Table 4. Comparison of self-management levels between the two groups before and after intervention.

Factor	Control group (n = 79)	Study group (n = 73)	t	p-value
Daily life behavior management before intervention	6.79 ± 2.17	6.98 ± 1.43	0.648	0.518
Daily life behavior management after intervention	13.88 ± 3.72	16.76 ± 4.06	4.568	<0.001
Cognitive symptom management before intervention	7.47 ± 2.24	7.36 ± 1.78	0.326	0.745
Cognitive symptom management after intervention	13.30 ± 3.13	15.65 ± 3.49	4.362	<0.001
Disease management before intervention	11.18 ± 2.41	11.51 ± 1.90	0.935	0.352
Disease management after intervention	20.04 ± 2.74	23.89 ± 3.38	7.756	<0.001
Self-management confidence before intervention	9.01 ± 1.16	9.09 ± 1.16	0.417	0.677
Self-management confidence after intervention	15.88 ± 1.78	25.34 ± 2.70	25.674	<0.001
Total self-management score before intervention	59.46 ± 3.15	140.27 ± 5.13	0.978	0.618
Total self-management score after intervention	59.21 ± 3.15	169.06 ± 5.76	32.612	<0.001

Table 5. Comparison of the quality of life between the two groups before and after the intervention.

Factor	Control group (n = 79)	Study group (n = 73)	t	p-value
Physical function before intervention	41.83 ± 5.15	41.14 ± 4.42	0.883	0.378
Physical function after intervention	50.26 ± 5.58	65.16 ± 5.43	16.656	<0.001
Psychological function before intervention	45.98 ± 3.76	45.35 ± 4.17	0.982	0.328
Psychological function after intervention	57.69 ± 4.28	63.30 ± 6.07	6.624	<0.001
Social function before intervention	50.38 ± 4.96	51.73 ± 4.92	1.683	0.094
Social function after intervention	54.73 ± 4.96	60.78 ± 4.60	7.769	<0.001
Material life before intervention	47.83 ± 5.05	47.77 ± 4.91	0.075	0.940
Material life after intervention	53.50 ± 6.03	56.91 ± 6.67	3.314	0.001
Overall score before intervention	45.73 ± 4.84	46.56 ± 4.13	1.133	0.259
Overall score after intervention	57.72 ± 5.90	64.32 ± 4.48	7.721	<0.001

score in the study group was significantly lower than in the control group ($p < 0.001$), while FMA and BI scores in the study group were significantly higher than those in the control group ($p < 0.001$) (Table 3).

Comparison of Self-Management Levels Between the Two Groups Before and After Intervention

Before the intervention, there were no significant differences between the two groups in daily behavior management, cognitive symptom management, disease management, self-management confidence or total self-management scores ($p > 0.05$). Following the intervention, scores for daily behavior management, cognitive symptom management, disease management, and total self-management improved in both groups. Moreover, the study group showed significantly higher scores across all self-management dimensions and total scores compared with the control group ($p < 0.001$) (Table 4).

Comparison of Quality of Life Between the Two Groups Before and After Intervention

Prior to intervention, no significant differences were observed between the two groups in the GQOLI-74 scale dimensions of physical functioning, psychological functioning, social functioning, material living conditions, or total scores (all $p > 0.05$). After the intervention, the mean scores for each dimension and the total score on the GQOLI-74 scale were higher in both groups than before the intervention. Furthermore, the intervention group showed significantly higher scores than the control group in physical functioning, psychological functioning, social functioning, material life, and total score after the intervention (physical, psychological, social, and total scores: $p < 0.001$; material life: $p = 0.001$) (Table 5).

Discussion

This study demonstrated that the implementation of individualized EBN guided by the PDCA cycle, in addition to routine nursing care, can significantly improve psychological status, neurological function, motor ability, self-management level, and quality of life in patients after cerebral hemorrhage surgery. No statistically significant differences were observed between the two groups in terms of age, gender, blood loss, GCS score, or pre-intervention scale scores (all $p > 0.05$), indicating that the two groups were comparable prior to intervention. Compared with the control group, the study group demonstrated significant improvements in SAS, SDS, NIHSS, FMA, BI, and GQOLI-74 scores following the intervention.

From the perspective of psychological improvement, patients after cerebral hemorrhage surgery frequently experience negative emotions such as anxiety, depression, and helplessness, which may adversely affect rehabilitation adherence and functional recovery. Previous international studies have indicated that strengthening individualized psychological support and enhancing patients' self-efficacy within nursing interventions can improve psychological status and rehabilitation outcomes [24,25]. For example, the study incorporating PDCA cycle-based nursing interventions have reported that PDCA-guided care in patients with acute stroke significantly improves self-management ability, neurological function, and quality of life [26]. Building on these findings, the present study applied this nursing model to postoperative patients with cerebral hemorrhage and further confirmed its effectiveness in improving SAS and SDS scores. Although improvements were observed in both groups, the study group demonstrated a greater degree of psychological improvement.

From the perspective of neurological function, motor function recovery, and activities of daily living (ADL). Following the intervention, the study group exhibited significantly lower NIHSS scores than the control group, whilst demonstrating significantly higher FMA and BI scores (all $p < 0.001$). However, the study group achieved superior recovery outcomes. These findings indicate that individualized EBN guided by the PDCA cycle not only alleviates neurological impairment but also facilitates the recovery of motor function and self-care abilities. This observation is consistent with international trends in stroke rehabilitation nursing research, which has primarily focused on patients with cerebral infarction [27]. Although most existing studies involve cerebral infarction, the underlying rehabilitation mechanisms are applicable. For instance, a multinational randomized controlled trial demonstrated that patients with severe stroke who received enhanced nursing support achieved significant improvements in FMA and BI scores [28]. By extending this model to postoperative care for patients with cerebral hemorrhage, the present study addresses an important research gap in postoperative nursing for this population.

From the perspective of self-management ability and quality of life improvement, this study found that the study group achieved significantly higher scores in daily behavior management, cognitive symptom management, disease management, self-management confidence, and total self-management compared with the control group. In the post-intervention assessment, the study group demonstrated higher GQOLI-74 scores than the control group across all domains, including physical functioning, psychological functioning, social functioning, and material life. Although both groups demonstrated improvements in self-management capabilities and quality of life scores following the intervention, the study group exhibited significantly higher scores than the control group post-intervention. These findings suggest that PDCA cycle-guided individualized EBN not only supports short-term functional recovery but also enhances patients' self-care capacity and engagement in daily life during the long-term rehabilitation process.

Although most international studies have focused on exercise or training interventions, several reports have also examined the systematic role of nursing models, especially quality management cycle models such as PDCA, in post-stroke care. For example, the study "Effect of PDCA-based nursing intervention" reported that PDCA cycle nursing interventions can significantly improve patients' activities of daily living (ADL), self-management ability, and quality of life [15]. Therefore, the present study's findings are consistent with these and further support the application of the PDCA cycle nursing model in postoperative care for patients with cerebral hemorrhage.

From a mechanistic perspective, individualized EBN guided by the PDCA cycle improves patient outcomes through a structured and iterative process. Specifically, during the Plan phase, the application of standardized assessment tools (NIHSS, FMA, BI, SAS, SDS) allows for accurate identification of each patient's neurological deficits, motor limitations, psychological status, and daily living abilities. These assessment results provide the basis for formulating targeted nursing goals, such as reducing neurological impairment or alleviating anxiety, thereby ensuring that interventions are directly aligned with the patient's specific rehabilitation needs.

During the implementation stage (Do) phase, nursing interventions are implemented with clearer direction and greater relevance. These targeted interventions provide a plausible explanation for the greater improvements observed in NIHSS, FMA, and BI scores in the study group compared with the control group. For example, the study group demonstrated significantly greater reductions in neurological impairment and greater gains in motor and daily living function, suggesting that structured and personalized rehabilitation facilitates neurofunctional recovery more effectively than routine nursing care.

In the Check phase, continuous monitoring of outcomes using the same validated assessment scales allows for early identification of insufficient progress. This dynamic evaluation process may explain the superior psychological outcomes observed in the study group. Because anxiety and depression levels, as measured by SAS and SDS, were regularly assessed, nursing staff were able to adjust communication strategies and involve psychotherapists when necessary, contributing to the greater reduction in negative emotional symptoms observed in the study group.

Finally, the Act phase ensures that identified challenges are promptly addressed and that nursing plans are continuously optimized. This closed-loop feedback mechanism further strengthens patients' self-management ability and improves long-term quality of life. In the present study, the study group achieved significantly higher self-management and GQOLI-74 scores, supporting the conclusion that PDCA-based optimization enhances patient engagement, rehabilitation adherence, and overall daily functioning.

Overall, by integrating individualized assessment, targeted intervention, continuous monitoring, and iterative optimization, PDCA-based nursing provides a clear mechanistic pathway for improving neurological function, psychological status, self-management ability, and quality of life. The greater improvements observed across all major outcome indicators in the study group compared with the control group further support the effectiveness of this structured and responsive nursing model.

Nevertheless, this study has several limitations. First, although the sample size reached 152 cases, it remained a single-center study, which may introduce selection bias, as patient characteristics and nursing practices at a single institution may not fully represent those in other clinical settings. Second, some outcomes relied on subjective assessment scales, such as psychological status and self-management measures, which may lead to measurement bias despite the use of standardized assessment procedures. Third, because the intervention was implemented by nursing staff who were aware of the study objectives, implementation bias may have occurred, as awareness of the intervention model could have unintentionally influenced nursing behaviors.

Additionally, the follow-up period was relatively short, encompassing only the postoperative hospitalization and follow-up phases. Therefore, the long-term effects of this nursing model on neurological recovery and quality of life (e.g., one year or longer) remain uncertain. Furthermore, this study did not examine whether hemorrhage location, bleeding volume, or surgical technique influenced the effectiveness of the intervention. Future studies may address these factors through stratified or subgroup analyses.

Finally, although this study referenced international research on PDCA-based nursing, literature specifically focusing on postoperative ICH patients, and simultaneously evaluating psychological status, self-management, and quality of life, remains limited, suggesting that further investigation in this area is warranted.

In summary, this study demonstrates that individualized EBN guided by the PDCA cycle has significant clinical value for patients following cerebral hemorrhage surgery. It promotes recovery of neurological and motor functions, improves psychological well-being, and enhances self-management ability and quality of life. Future large-scale, multicenter studies with longer follow-up periods are recommended to further validate and refine this nursing model, as well as to explore the integration of remote nursing and home-based rehabilitation support systems for broader clinical application.

Conclusions

PDCA cycle-guided individualized EBN can significantly enhance postoperative recovery in patients with ICH. Compared with routine nursing care, this approach effectively improves neurological and motor functions, alleviates anxiety and depression, enhances self-management ability, and promotes overall quality of life.

This nursing model provides a structured, patient-centered framework for continuous quality improvement, making it a suitable candidate for clinical implementation and broader dissemination.

Availability of Data and Materials

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

Author Contributions

HLB conceived the study, designed the methodology, collected and analyzed the data, and drafted the initial manuscript. CYZ supervised the research and validated the data analysis. Both authors have been involved in revising it critically for important intellectual content. Both authors approved the final version. Both authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

This study has been approved by the Gansu Provincial Hospital of TCM (No. 2025-167-01) and was performed in accordance with the principles of the Declaration of Helsinki. Patients without severe cognitive impairment or psychiatric disorders who were able to understand and sign informed consent; for patients with impaired consciousness or cognition, informed consent was obtained from a legal representative.

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Conflict of Interest

The authors declare no conflict of interest.

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