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STUDY PROTOCOL

Towards Proactive Recovery: A BCW Guided Nursing Intervention Protocol for Health Behavior Promotion in First-Episode Stroke Patients

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Background: Stroke is a disease with high incidence, disability, recurrence, mortality, and economic burden, and its occurrence and progression are closely associated with unhealthy lifestyle behaviors. For first-episode stroke patients, the post-stroke period is not only critical for physical recovery but also a key window for initiating behavioral modifications to improve long-term outcomes. Current health behavior intervention programs predominantly target stroke survivors in the acute or subacute phase, while insufficiently addressing long-term rehabilitation and the establishment of sustainable health behavior habits.

Purpose: This study aims to investigate the efficacy and sustainable impact of a 6-month proactive health behavior guidance intervention on proactive health behavior ability, medication compliance, physical exercise, coping with psychological stress, and anxiety and depression.

Methods: The guidance will last for 6 months with four sections from hospitalization to 6 months post-discharge. The data will be measured at six time points: baseline, 3 months after discharge, intervention ends, 1 month post-intervention, 3 months post-intervention, and 6 months post-intervention. Outcomes including proactive health behavior, prevention knowledge, health belief, social support, depression, and anxiety were measured at 6 time points. Data were analyzed with SPSS 26.0, GEE models, and Bonferroni correction ($P<0.01$).

Discussion: This protocol, developed within the BCW framework, effectively integrates behavioral guidance, psychological support, and family involvement to address poor adherence and unhealthy lifestyles among stroke survivors. Covering the acute, transitional, and long-term phases, it combines hospital-based education with home-based follow-up through face-to-face, digital, and video modalities. This multi-modal and family-centered approach enhances accessibility, continuity, and sustainability of health behavior changes, thereby improving functional recovery, reducing recurrence risk, and supporting the long-term integration of proactive health behaviors.

Trial Registration: ChiCTR2400090433 (Date of registration: September 29, 2024).

Keywords: proactive health behavior, stroke, first-episode, randomized controlled trial

Introduction

Stroke, or cerebrovascular accident (CVA), is the second leading cause of death and the third leading cause of death and disability combined among non-communicable diseases (NCDs) globally, with China having the highest stroke incidence rate in the world, accounting for approximately 39.9% of global cases,[1] according to the latest Global Burden of Disease

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(GBD) 2021 estimates.[2,3] For first-episode stroke patients, the post-stroke period represents not only a critical time for physical recovery but also a crucial window for initiating behavioral modifications that may profoundly influence long-term outcomes.

Background

Stroke is a complex disease that often leads to substantial physical, cognitive, and psychological impairments.[4] As a behavior-related condition, its onset and recurrence are closely linked to unhealthy lifestyle patterns.[5] Data from the China Stroke High-Risk Population Screening and Intervention Program (https://chinasde.on/) indicate that the incidence of stroke in China has been steadily increasing in recent years, reflecting significant lifestyle changes within the population.[6] For patients with a first-episode stroke, the post-stroke period represents not only a pivotal stage for neurological and functional recovery but also a critical window for initiating health-promoting behavioral changes.[7] Research has demonstrated that the first 6 months following stroke are particularly crucial for recovery, as the brain exhibits heightened neuroplasticity during this period, thereby enhancing the potential for neural reorganization and improvement in motor and cognitive functions.[8–10] However, despite this recovery potential, recurrence remains a substantial challenge. A large-scale survey conducted between 2017 and 2018, involving 204,935 first-episode stroke patients from 222 stroke prevention and treatment base hospitals across 30 provinces, autonomous regions, and municipalities, reported a one-year recurrence rate of 7.48%.[6] Furthermore, approximately 65% of first-episode stroke patients are rehospitalized within a year due to recurrent events,[11] underscoring the urgent need to strengthen secondary prevention strategies and to support patients in maintaining effective self-management during the transition from hospital to home.[12]

In the health management of stroke patients, health behaviors play a critical role in both stroke rehabilitation and secondary prevention.[13,14] Adopting a healthy lifestyle—including regular physical activity, adherence to a balanced diet, smoking cessation, and appropriate medication compliance—has been shown to significantly reduce the risk of recurrent stroke and improve functional outcomes.[15] Regular physical activity is particularly beneficial, as it enhances cardiovascular function, increases cerebral blood flow, and promotes neural plasticity.[16,17] Clinical guidelines recommend that stroke patients accumulate at least 150 minutes of moderate-to-vigorous physical activity per week to reduce the risk of recurrent stroke.[18] Similarly, dietary habits exert a profound influence on secondary prevention. A balanced diet—such as the Mediterranean pattern—has been associated with improved blood pressure control, lipid regulation, and glycemic stability, thereby reducing the likelihood of stroke recurrence.[19,20] In contrast, diets high in sodium, saturated fats, and refined sugars are strongly correlated with increased vascular risk. Moreover, medication adherence is another essential component of secondary prevention. However, studies have reported that non-adherence rates among stroke patients can be as high as 53%.[21] Poor adherence is closely associated with elevated risks of stroke recurrence, re-hospitalization, and mortality, underscoring the importance of effective strategies to improve compliance.

Traditional health behavior interventions for stroke survivors are often confined to the acute and sub-acute phases, focusing on short-term recovery.[22–24] Although valuable, they frequently overlook the promotion of long-term health behaviors essential for sustaining recovery and preventing recurrence. However, once patients are discharged, they frequently face a lack of structured support and resources to maintain both their rehabilitation efforts and health-promoting behaviors.[25] The 14th Five-Year Plan for National Health in China emphasizes the shift from a treatment-centered approach to a people-centered model, advocating for the concept of proactive health.[26] Proactive health extends beyond the management of physical, psychological, and social well-being at the individual level; it also represents an effective strategy for mobilizing intrinsic resources, preventing disease, and promoting long-term health.[27,28] Culturally, Chinese collectivist values frame health as a family shared responsibility, so this initiative extends beyond individuals: patients proactively engage families as partners to reinforce healthy behaviors, while the doctor-patient relationship evolves from one-way instruction to collaborative co-management.

Behavioral change is fundamental to improving the long-term prognosis of stroke survivors. By addressing underlying determinants of health behaviors—such as knowledge, attitudes, motivation, and environmental barriers—it becomes possible to foster sustainable lifestyle modifications. The Behavior Change Wheel (BCW), proposed by Michie et al, offers a comprehensive framework for designing behavior change interventions.[29] It is grounded in the

Capability– Oppportunity– Motivation– Behavior (COM-B) model, which posits that behavior (B) results from the interaction of capability (C), opportunity (O), and motivation (M). Surrounding this core, the BCW incorporates nine intervention functions—education, persuasion, incentivization, coercion, training, restriction, environmental restructuring, modeling, and enablement—that can be applied singly or in combination to influence behavior.[30] In addition, the framework identifies 93 behavior change techniques (BCTs), providing a systematic toolkit for tailoring interventions to specific contexts and populations.[31]

Therefore, based on the BCW theory and BCTs to provide a general framework and the concept of proactive health to provide practical guidance, we developed a new intervention program called the Proactive Health Behavior Guidance (PHBG) intervention through a literature review of influencing factors of proactive health behavior changes in stroke. If the program is effective, it could be used by nursing staff for interventions for the sustainability of health behavior improvement during the transition from hospital to home and long-term follow-up support.

Aim

This study aims to: (1) determine the efficacy of a 6-month proactive health behavior intervention based on BCW theory on the self-management ability, proactive health behavior, and compliance of first-episode stroke survivors and (2) identify the sustainable impact of proactive health behavior intervention on the initiation of health behaviors in stroke survivors after a 6-month follow-up phase. We hypothesize that a 6-month intervention will have a positive impact on proactive health behavior ability, medication compliance, physical exercise, coping with psychological stress, and anxiety and depression.

Methods

Study Design and Registration

A randomized 2×6 repeated-measure experiment is designed. The intervention and control groups will be measured six times: at baseline (T0), 3 months after discharge (T1), at the end of the intervention (T2), 1 month post-intervention (T3), 3 months post-intervention (T4), and 6 months post-intervention (T5). This study employed a randomized controlled trial design to provide the highest level of evidence possible and minimize bias. The participants will not be blinded due to the differences in intervention content and time nodes. Participants who met all inclusion criteria were randomly assigned to either intervention group or control group in a 1:1 ratio using a computer-generated random number allocation by a researcher not involved in the study.[32] To avoid contamination, it is advisable to prevent participants in both group from being in the same ward. The intervention group will receive a 6-month proactive health behavior guidance (PHBG) program. The control group received general admission, hospitalization, discharge guidance, and basic follow-ups that hospitals should have.

Study Setting

This study will be completed in the neurology departments of the First Affiliated Hospital of Zhengzhou University, Henan Province, China. The First Affiliated Hospital of Zhengzhou University is the largest in Asia, with a total of 6 wards in the Department of Neurology.

Sampling Method

We plan to recruit stroke survivors living in Henan province, China, as our participants based on the formula for comparing the means of two samples. Key parameters, based on prior stroke health behavior studies, were: α=0.05 ($z_{\alpha/2}$=1.96), power (1-β)=0.84 (z_{β}=1.28), medium effect size (d=0.5), σ=8.5 (from Proactive Health Behavior Scale[33]), and minimal clinical difference (δ=4.25). Initial sample size per group was 95 and a 20% attrition rate (typical for 6-month stroke follow-ups) was considered, adjusting each group to 119 (total 238). Therefore, each group will include 119 participants.

Inclusion/Exclusion Criteria

Inclusion criteria are individuals aged ≥18, adherence to the diagnostic standards specified by the 2019 "Chinese Clinical Management Guidelines for Cerebrovascular Diseases"[34] confirmed through MRI or CT scans, medically stable, having unobstructed communication and clear consciousness (as evidenced by a National Institutes of Health Stroke Scale [NIHSS] score of 5–25 and a baseline Modified Rankin Scale [mRS] score of ≤1), and who are proficient in using a smartphone, or the primary caregiver can use it and provide auxiliary guidance to the patient. This study will exclude those who have unstable health conditions or are terminally ill, have severe visual and/or hearing deficits that are not corrected by devices, such as a hearing aid or eyeglasses, or require assistance from other people, or participate in other researchers. Participants who could not be contacted for 3 consecutive times at one intervention time point will be considered drop-outs.

Recruitment

The trial was registered on September 29th, 2024, at the Chinese Clinical Trial Registry (ChiCTR2400090433), and this protocol is reported according to the SPIRIT guidelines. Eligible patients will be preliminarily identified after admission based on CT or MRI findings. Those who meet the initial criteria will be invited to participate in the study. Trained research staff will communicate with patients and their families to further confirm eligibility and to ensure that they have a clear understanding of the study's purpose and procedures. Patients who agree to participate will be asked to sign an informed consent form. They will be assured that all personal information will remain confidential and that they may voluntarily withdraw from the study at any time without penalty. The recruitment process and informed consent procedure will be conducted in accordance with the principles of the Declaration of Helsinki and relevant local regulations on human subject research. Recruitment will be completed within 3 months.

Intervention

The Control Intervention

Patients in the control group will be treated as usual during hospitalization, which includes care for aspects of daily living, diet, safety, drug, and routine supportive psychology. Daily living care includes providing patients with a clean environment, instructing them on good personal hygiene, and exercising more. Patients will be given health education about antihypertensive and lipid-lowering medicines and told to take their medication on time. Supportive psychological care refers to nurses listening patiently to what patients say, supporting and understanding them, encouraging them to live an active life, etc.

The Experimental Intervention

Participants in the experimental group will receive a 6-month Proactive Health Behavior Guidance (PHBG) intervention during hospitalization. The PHBG program consists of three main stages, as shown in Figure 1. This program is grounded in the core components of the BCW framework—Capability, Opportunity, and Motivation—and is further supported through the application of BCTs throughout the intervention process. The program is structured into three post-discharge phases—1 month, 2~3 months, 4~6 months— with four goals: 1) building trust and fostering motivation, 2) developing capability and strengthening motivation, 3) providing opportunities and enhancing capability, and 4) reinforcing motivation and improving capability. Each intervention point is designed around the principle of active health promotion, tailored to the patients' recovery stage after stroke. The overarching aim is to enhance patients' proactivity in adopting health behaviors, foster healthy lifestyle habits, ensure regular medication adherence, promote timely self-monitoring of health indicators, and prevent the emergence of negative emotions. The detailed components of the PHBG intervention are shown in Table 1 and the BCTs we selected are in Table 2.

Outcome and Outcome Measures

A 6-month proactive health behavior guidance intervention will influence the increased proactive health behavior score, enhance health knowledge, improve medication compliance, engage in appropriate exercise, have a light and

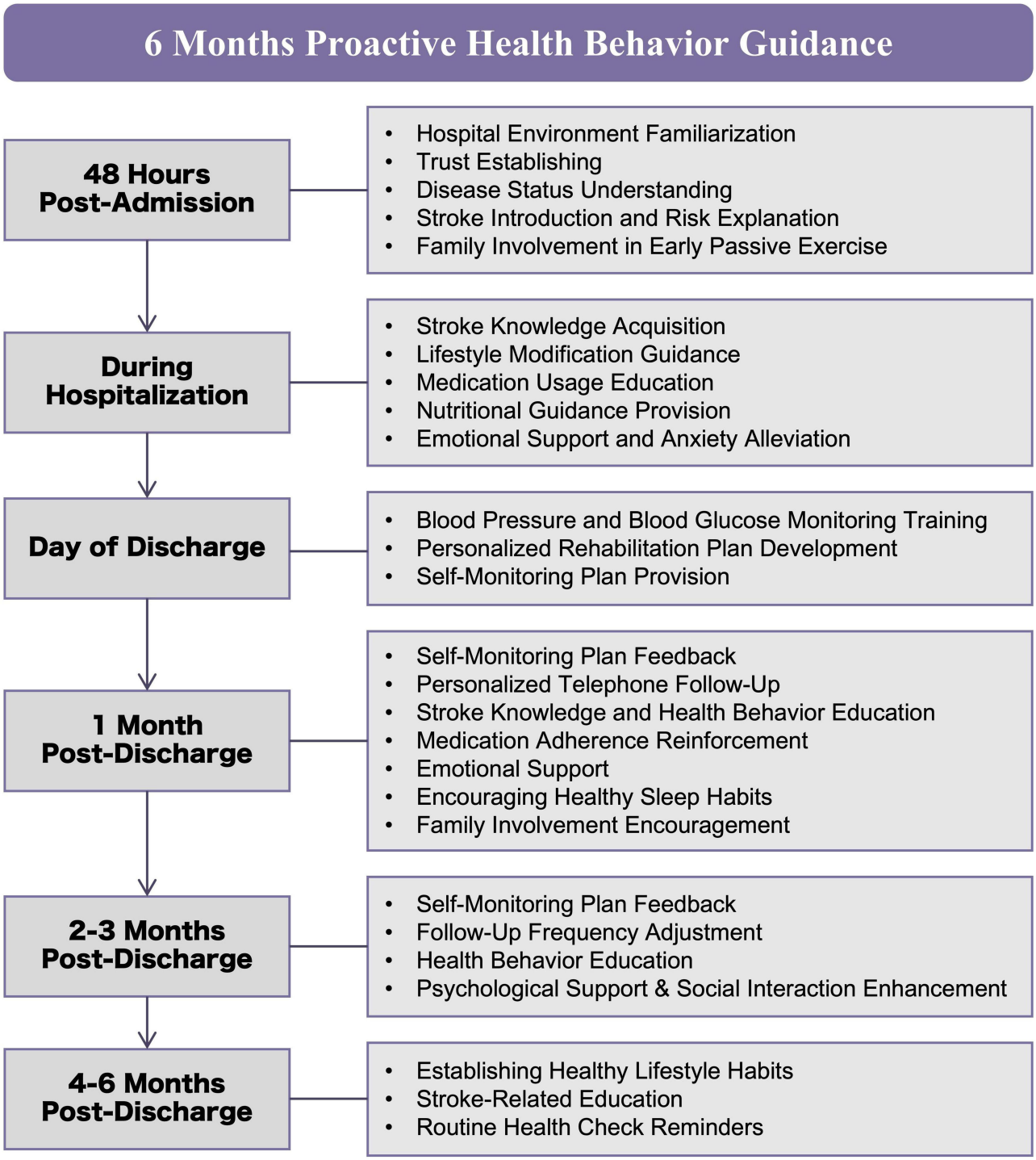

Figure 1 Process of 6-month Proactive Health Behavior Guidance.

balanced diet, alleviate patients' negative emotions, and develop the habit of taking the initiative to have regular check-ups.

Proactive Health Behavior

The primary outcome, Proactive Health Behavior Scale for Patients with Chronic Diseases, was developed by Chen et al,[33] based on the Glasgow Illness Resource Scale,[35] Walker and Pender's Health-Promoting Lifestyle Profile,[36] and

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Table 1 Outline of the BCW-PHB Intervention for Patients with Stroke

Aims	Format (duration)	Theme: Contents	BCTs
Building trust, and fostering motivation (M)	Hospitalization 24–48 h / Face-to-face (10–15 min)	1. **Trust building**: Build rapport, gain trust, obtain consent, and set up WeChat group.	1.2, 15.1
		2. **Health perception**: Educate patients on disease status, assess attitudes, and correct misconceptions.	1.6, 13.2, 13.3
		3. **Educational materials**: Provide *Stroke Health Education Manual* to promote self-learning.	4.1, 5.1
		4. **Early rehabilitation**: mobilization within 24h (mild/ moderate); guided bed exercises progressing to walking/ balance (severe).	1.4, 4.1, 4.3
Developing capability (C), and strengthening motivation (M)	Hospitalization 1 week / Lecture (30–40 min)	5. **Lifestyle regulation**: Encourage smoking cessation, alcohol restriction, weight control, regular routines, and adequate sleep.	13.2, 15.1
		6. **Health lecture**: Deliver health lectures on disease knowledge and risks of unhealthy behaviors.	5.1, 9.3
		7. **Medication adherence**: Educate on proper medication use, emphasize adherence, and introduce reminder tools.	4.1, 11.2, 15.1
		8. **Dietary guidance**: Guide Mediterranean-style diet with tailored food checklist.	4.1, 13.2
		9. **Music therapy**: Recommend music therapy to reduce anxiety and improve mood.	5.6, 11.2
Providing opportunities (O), and enhancing capability (C)	1 day before discharge / Face-to-face (15–20 min)	10. **Individualized exercise**: Develop personalized rehab plans (environment, timing, support) with traditional Chinese exercises; ≥2–5 sessions/week, ≥45 min each.	1.1, 1.2, 6.1, 8.7, 13.5
	1 week after discharge / WeChat	11. **Community linkage**: Link with community health centers and establish health records.	3.3, 12.2
	1 month after discharge / WeChat	12. **Medication follow-up**: Stress importance of long-term medication adherence and regular outpatient follow-up.	1.3, 2.3
		13. **Vital monitoring**: Instruct regular BP (2–3×/day) and glucose monitoring with accurate recording.	2.3
		14. **Emotional regulation**: Teach emotional regulation to maintain calm and positive mindset.	5.6, 11.2
		15. **Sleep hygiene**: Reduce daytime sleep, avoid heavy dinners, limit stimulants, use relaxation routines.	1.1, 11.2, 12.4
	After discharge / WeChat	16. **WeChat education**: Share stroke-related knowledge via WeChat (with audio); frequency by group.	3.3, 6.1
		17.**Self-monitoring**: Provide self-monitoring checklist (diet, meds, exercise, BP, sleep, smoking) with regular online feedback by group.	2.3, 5.6, 14.8
Reinforcing motivation (M), and improving capability (C)	1,3 and 6 months after discharge / Wechat Group or face to face	18. **Peer support**: Organize peer-support meetings to share experiences and promote engagement.	3.2, 13.1, 15.3
		19. **Psychological counseling**: Offer psychological counseling when needed (social, exercise, music, psychosocial interventions).	3.2, 11.2
		20. **Family involvement**: Encourage family participation in daily management and support.	3.2, 6.1
	1,3 and 6 months after discharge / telephone, or face-to-face (5–10 min)	21. **Follow-up support**: Ensure regular follow-up and reminders; offer alternative support (calls, visits) by group.	2.2, 2.3, 3.2
		22. **Routine screening**: Recommend annual physical exams, such as cardiac function, atrial fibrillation, ischemic changes, glucose, lipids.	2.2, 2.3, 15.3
		23. **Reward mechanism**: Establish family-based or researcher-provided reward mechanisms for goal achievement.	10.10, 14.5

Table 2 The List of Selected Behavior Change Techniques (BCTs) in BCW-PHB Intervention

No.	Label
1.1	Goal setting (behavior)
1.2	Problem solving
1.3	Goal setting (outcome)
1.4	Action planning
1.6	Discrepancy between current behavior and goal
2.2	Feedback on behavior
2.3	Self-monitoring of behaviour
3.2	Social support (practical)
3.3	Social support (emotional)
4.1	Instruction on how to perform a behavior
4.3	Re-attribution
5.1	Information about health consequences
5.6	Information about emotional consequences
6.1	Demonstration of the behavior
8.7	Graded tasks
9.3	Comparative imagining of future outcomes
10.10	Reward (outcome)
11.2	Reduce negative emotions
12.2	Restructuring the social environment
12.4	Distraction
13.1	Identification of self as role model
13.2	Framing/reframing
13.3	Incompatible beliefs
13.5	Identity associated with changed behavior
14.5	Rewarding completion
14.8	Reward alternative behavior
15.1	Verbal persuasion about capability
15.3	Focus on past success

the Chinese version of the Psychological Resilience Scale.[37] It comprises five dimensions: individual health responsibility, psychological stress coping, exercise behavior, nutritional behavior, and interpersonal relationship support, with a total of 20 items. Each item is scored using a 5-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree", with scores assigned from 1 to 5, where a higher score indicates better proactive health behavior. The Cronbach's α coefficient of the scale is 0.904, and the Cronbach's α coefficients for the individual dimensions range from 0.804 to 0.870.

Stroke Prevention Knowledge

The Stroke Prevention Knowledge Questionnaire (SPKQ) was developed by Wan Lihong et al.[38] It includes eight sections: lifestyle, exercise, diet, medication, regular monitoring, stroke risk factors, stroke warning signs, and stroke management, with a total of 36 items. Each item is scored as "Know" or "Do Not Know," with scores of 1 and 0, respectively. The percentage score for each section is calculated using the formula: Standard score = (sum of scores for items in a section / total possible score for the section) × 100, where a higher standard score indicates better knowledge of stroke prevention. The questionnaire has a Cronbach's α coefficient of 0.87, and the content validity is 0.89.

Health Belief of Stroke

The Short Form Health Belief Model Scale (SF-HBMS) was developed by Wan Lihong et al[39] based on the Champion Health Belief Model Scale (CHBMS). The scale consists of 20 items and uses a 5-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree", with scores assigned from 1 to 5. The scale includes six dimensions: perceived

susceptibility and severity of disease, health motivation, self-efficacy, and perceived benefits and barriers of health behaviors, with the barriers dimension being scored in reverse. A score of 3 represents a neutral level, and a higher score indicates a higher level of the corresponding health belief. The scale has shown a Cronbach's α coefficient of 0.835 for internal consistency when used with stroke patients, and it demonstrates good convergent validity.

Social Support

The Social Support Rate Scale (SSRS) was developed by Xiao Shuiyuan,[40] based on foreign scales and adapted to the specific context of China, with the theoretical guidance of the relationship between social support and physical and mental health. The SSRS is suitable for individuals aged 14 years and older and includes three dimensions: subjective support, objective support, and utilization of support, with a total of 10 items. The higher the total score and the scores for each dimension, the greater the level of social support. A total score of ≤22 indicates low support, 23–44 indicates moderate support, and 45–66 indicates high support. In this study, the Cronbach's α coefficient for the SSRS was 0.752.

Depression

Patient Health Questionnaire-9 (PHQ-9) is used to assess the patient's depressive symptoms over the past two weeks.[41] It consists of 9 items, including interest in doing things, mood fluctuations, sleep quality, energy level, appetite, self-esteem, concentration, speed of movement, and thoughts of self-harm. Scoring is as follows: 0 = "Not at all", 1 = "Several days", 2 = "More than half of the days", and 3 = "Nearly every day", with a total possible score of 27. A higher score indicates more severe depression. According to Kroenke et al,[41] depression severity is categorized as follows: 0–4 = no depression, 5–9 = mild depression, 10–14 = moderate depression, and 15–27 = severe depression. The Cronbach's α coefficient for the scale is 0.833, indicating good reliability and validity.

Anxiety

The 7-item Anxiety Scale (GAD-7) consists of 7 items that assess anxiety symptoms, including feeling nervous or anxious, inability to stop or control worrying, excessive worry, difficulty relaxing, restlessness, easily becoming upset or irritable, and feeling that something terrible may happen.[42] Scoring is as follows: 0 = "Not at all", 1 = "Several days", 2 = "More than half of the days", and 3 = "Nearly every day", with a total score range of 0–21. The results are interpreted as: 0–4 = normal, 5–9 = mild anxiety, 10–14 = moderate anxiety, and 15–21 = severe anxiety.

Other Information

Other information includes demographic data, clinical indicators, and reasons for dropout. Specifically, demographic data includes participants' gender, age, religion, education level, marital status, occupation, living arrangement, and family history. Clinical variables include diagnostic type, Charlson Comorbidity Index (CCI), medication prescriptions, etc. These data are collected at baseline. During the intervention period, researchers will track and collect information regarding the reasons for dropout.

Data Collection

The data collection for this study will be independently accomplished by 3 trained nurses who will be blind to recruitment and allocation. Before distributing the questionnaires, the researchers will explain the purpose of the survey and ensure the confidentiality of the data. The questionnaire will primarily be completed independently by the participants. For participants with writing difficulties but who are conscious, the researcher will read each item aloud and assist in completing the questionnaire based on the participant's understanding. Finally, the researcher will perform a verification check, and questionnaires with more than 20% of items incomplete will be excluded from the analysis. The study will measure outcomes at 6 time points and the schedule of the study is shown in Table 3. Participants in the control group will also be required to complete the measurements at the same time points.

Data Processing and Management

During the recruitment and screening period, the data obtained from the participants' mobile phones included their names, personal phone numbers, primary caregiver phone numbers, and places of residence, etc. This information was

Table 3 Schedule of Enrollment, Intervention, and Outcome Assessment

Timepoint	Enrollment	Allocation	Post-Allocation		Post-Intervention		
	$-T_1$	T_0 baseline	T_1 3th month	T_2 6th month	T_3 7th month	T_4 9th month	T_5 12th month
Enrollment:							
Eligibility screen	√						
Informed consent	√						
Allocation		√					
Intervention:							
Intervention*		√	→	√			
Control		√	√				
Assessments:							
Demographic information		√					
Proactive Health Behavior		√	√	√	√	√	√
Stroke Prevention Knowledge		√	√	√	√	√	√
Health Belief of Stroke		√					
Social Support		√					
Depression		√	√	√	√	√	√
Anxiety		√	√	√	√	√	√

Note: *Indicates that the intervention is continuously implemented in accordance with the intervention plan.

saved in files accessible only to the principal investigator (PI). Each participant was encoded by PI to collect all the questionnaire information. After the research is completed, the privacy information of the participants will be destroyed once all the data has been entered and rechecked. To maximize the utilization of data from all study participants, we employed Multivariate Imputation by Chained Equations (MICE) for missing data handling, thereby ensuring the integrity and comprehensiveness of the analytical dataset.

Data Analysis

SPSS 26.0 will be used for the statistical analysis of the data. ANOVA and Chi-Square tests will be performed to compare demographic and clinical indicators and baseline scores for primary and secondary outcomes between groups. Significant imbalances between the groups will also be assessed. Categorical variables will be analyzed using Chi-Square tests, while continuous variables will be examined using *t*-tests or Mann–Whitney *U*-tests to assess baseline differences between groups. The number of dropouts and follow-up losses will be reported descriptively for each group. This study will compare the differences in primary and secondary outcomes between the two groups at three time points: baseline, end of intervention, and 6 months post-intervention. The Generalized Estimating Equation (GEE) model will be employed, as it is specifically designed for analyzing repeated measures, such as longitudinal data. Given the association between outcome variables across multiple time points for individuals in this study, the GEE model will be used to compare the trends of primary and secondary outcomes across different time points. Adjustments will be made for confounding factors based on baseline statistical differences. The GEE model will explore the effects of time factors, intervention factors, and their interactions on each outcome variable between the two groups. When interaction effects are present, simple effects analysis will be performed. No subgroup analysis will be conducted in this study. To minimize

the risk of Type I errors, the Bonferroni correction will be applied to adjust for multiple comparisons, with a threshold of $P < 0.01$ considered statistically significant.

Ethics Approval

Permission for this study was granted by the Ethics Committee (2022-KY-1168-001) and registered at Chinese Clinical Trials.gov (ChiCTR2400090433). Ethical standards were followed throughout this study. All potential participants are informed of the benefits and risks before deciding to participate in this program, and can decide whether to enroll or not. Participants are required to sign an informed consent form when they are confirmed to participate. During the intervention, participants can withdraw randomly without affecting their subsequent treatment and nursing care. This study is a nonpharmacological intervention, and there are no adverse effects. All data will be kept confidential, and the findings of the study will be presented at conferences or in published journals.

Validity and Reliability

In the design of the intervention protocol, we invited 19 experts from several tertiary grade-A hospitals, including neurologists, stroke rehabilitation specialists, psychotherapists, and stroke nursing experts, to design and validate the PHBG protocol, ensuring its scientific rigor and effectiveness. During the recruitment and screening period, the data obtained from the participants' mobile phones included their names, personal phone numbers, primary caregiver phone numbers, and places of residence, etc. This information was saved in files accessible only to the principal investigator (PI). Each participant was encoded by PI to collect all the questionnaire information. After the research is completed, the privacy information of the participants will be destroyed once all the data has been entered and rechecked. During the implementation phase, we will adhere to the highest standards of a randomized controlled trial and provide quarterly reports on the research progress to the hospital's ethics committee.

Discussion

The study presents a Proactive Health Behavior Guidance (PHBG) intervention protocol based on the Behavior Change Wheel (BCW) framework and supported by Behavior Change Techniques (BCTs) to promote proactive health behaviors in first-episode stroke patients. The protocol focuses on improving patient autonomy in health behaviors throughout different stages of stroke rehabilitation. Therefore, the PHBG intervention protocol is tailored to address the needs of stroke patients at various recovery stages, with specific strategies developed for each phase.

The acute rehabilitation phase during the first week of hospitalization is crucial. During this period, patients often experience cognitive confusion and have a low awareness of health behaviors. They may also exhibit fear and anxiety, and even refuse cooperation with treatment.[9] The intervention in this phase focuses on helping patients understand their condition and build confidence in rehabilitation. Short-term behavioral guidance and accompanying psychological support are used to establish trust and motivation regarding health behaviors—an approach consistent with Brouwer-Goossensen et al,[7] who found that early psychological support post-stroke improved patients' intention to adopt long-term health behaviors. Additionally, the intervention provides Stroke Rehabilitation Education Manuals and rehabilitation videos to mitigate the potential non-compliance resulting from fear and a lack of information. This phase serves as the foundation for subsequent home-based rehabilitation after discharge. The transitional phase during the first month after discharge is critical for reinforcing health behavior engagement. The intervention focuses on strengthening the patient's initiative to engage in health behaviors through regular face-to-face or online guidance and feedback. This stage assists patients in transitioning from hospital-based care to home-based rehabilitation.[25] Specific psychological support is also provided to address issues such as relapse fears and rehabilitation fatigue, alongside the reinforcement of health knowledge. The goal is to further enhance patients' knowledge and self-efficacy regarding stroke recovery, as self-efficacy has been identified as a key predictor of sustained physical activity and medication adherence in stroke survivors.[17] The final phase of the intervention, from 1 to 6 months post-discharge, focuses on solidifying and maintaining health behaviors. Continuous monitoring and feedback, delivered through a combination of the WeChat platform and regular follow-up, ensure that patients maintain their recovery efforts, particularly in areas such as exercise, dietary control, and medication adherence. This phase aims to prevent behavioral fatigue and promote sustained

engagement in proactive health behaviors. The 6-month mark is particularly important for relapse prevention and maintaining health behaviors, with emphasis on regular health monitoring, follow-up checkups, and preventive care strategies to help patients incorporate these behaviors into their long-term lifestyle.

From a content perspective, the intervention protocol effectively addresses key issues faced by stroke patients, including low adherence to treatment, poor health behaviors, and psychological distress such as fear and anxiety. During hospitalization, the intervention focuses on providing targeted education regarding disease understanding, functional rehabilitation exercises, dietary guidance, and psychological counseling. These interventions are designed to reduce patients' cognitive and emotional barriers to adopting healthy behaviors, building a foundation for long-term rehabilitation. After discharge, the focus shifts towards maintaining health behaviors through continuous rehabilitation interventions and long-term follow-up, ensuring sustained engagement in proactive health behaviors. From a format perspective, the intervention protocol adopts a multi-modal approach, combining face-to-face education, WeChat guidance, and video-based education, which maximizes the strengths of different intervention stages and the application of BCTs. This approach provides flexible support to patients throughout their recovery journey. The integration of hospital-based and home-based interventions ensures a seamless continuation of care, reducing complexity and improving feasibility, particularly for patients with mobility challenges or limited resources. Online support through the WeChat platform increases convenience, ensuring that patients who cannot attend regular face-to-face sessions can still receive consistent guidance and maintain adherence to rehabilitation protocols. Moreover, the intervention recognizes the critical role of family involvement in patient recovery. By educating and empowering family members to actively support the patient's rehabilitation process, the intervention aims to enhance the overall effectiveness of health behavior execution. Family caregivers are an integral part of the support system, ensuring that patients have the emotional and practical resources they need to sustain their health behavior changes. This comprehensive approach to care improves the sustainability of the intervention's outcomes, as family support helps reinforce the patient's commitment to maintaining healthy behaviors over time.

China has a 7.48% 1-year recurrence rate among first-episode stroke patients, with 65% of rehospitalizations attributed to poor health behavior adherence.[6,11] If the PHBG intervention achieves a 38% improvement in long-term behavior maintenance (as observed in Brouwer-Goossensen's study[7]), it could reduce recurrence by approximately 6 cases per 100 patients annually, alleviating both the economic burden on families and bed pressure in hospitals. Additionally, sustained healthy behaviors can improve functional outcomes: Grefkes et al[10] reported that such behaviors increase the proportion of patients with a 1-grade improvement in mRS scores by 15–20%, enhancing patients' ability to reintegrate into family and society—this translates to reduced reliance on long-term care and improved quality of life, which aligns with China's "14th Five-Year Plan for National Health" (2022) goal of shifting to proactive health management. Approximately 40% of stroke patients in China reside in counties with limited tertiary care resources,[3] making frequent hospital visits impractical. The PHBG's multimodal design eliminates geographic barriers: rural patients can access rehabilitation videos via WeChat and receive weekly video guidance, reducing travel costs and time.

Although, the study has several limitations. First, due to the nature of the behavioral intervention, blinding of both patients and researchers is not feasible. Therefore, a randomized controlled trial with assessor blinding will be implemented, which may still introduce potential bias. Second, the protocol involves 6-month multiple stages of intervention and 6-month follow-ups, which may lead to participant dropouts. Third, as all participants are recruited from a single hospital, the generalizability of the findings may be limited.

Conclusion

This study protocol aims to design a simple and practical proactive health behavior intervention protocol for stroke patients, based on the Behavioral Change Wheel theory. The intervention focuses on enhancing proactive health behaviors through regular follow-up and interventions, with the goal of improving patient outcomes, reducing recurrence rates, and decreasing the incidence of depression.

Abbreviations

BCT, Behavior Change Techniques; BCW, Behavior Change Wheel; CCI, Charlson Comorbidity Index; CHBMS, Champion Health Belief Model Scale; COM-B, Capability–Oppportunity–Motivation–Behavior; CT, Computerized Tomography; CVA, Cerebrovascular Accident; GAD-7, 7-item Anxiety Scale; GEE, Generalized Estimating Equation; GBD, Global Burden of Disease; MRI, Magnetic Resonance Imaging; NCDs, Non-communicable Diseases; PHBG, Proactive Health Behavior Guidance; PHQ-9, Patient Health Questionnaire-9; PI, Principal Investigator; SF-HBMS, Short Form Health Belief Model Scale; SPIRIT, Standard Protocol Items: Recommendations for Interventional Trials; SPKQ, Stroke Prevention Knowledge Questionnaire; SSRS, Social Support Rate Scale.

Data Sharing Statement

Data supporting the findings of this study will be available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

The Research Ethics Committee of the First Affiliated Hospital of Zhengzhou University (2022-KY-1168-001) granted approval for this study and the study has been registered at Chinese Clinical Trials.gov (ChiCTR2400090433).

Consent for Publication

Patients will provide informed consent for their data to be published, and anonymity will be ensured by excluding any identifying information.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report there are no competing interests to declare for this work.

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