Postprint: Development and Application Effectiveness of a Comorbidity Follow-up Model for Patients with Coronary Artery Disease and Diabetes Mellitus after Percutaneous Coronary Intervention

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Abstract

Background: Patients after percutaneous coronary intervention (PCI) generally lack awareness of disease self-management, which affects their prognosis, and coronary heart disease patients with comorbid diabetes have even worse outcomes. Establishing a chronic disease follow-up system for collaborative management of both conditions is crucial for patient recovery. Objective: To construct a post-PCI follow-up model for coronary heart disease patients with diabetes based on chronic disease self-management theory and the CICARE communication model, and to explore its application effects. Methods: From January to April 2022, a comorbidity follow-up model for coronary heart disease patients with diabetes after PCI was constructed through literature review, semi-structured interviews, and expert consultation. Patients with coronary heart disease and diabetes who underwent PCI in the Department of Cardiology at Zhu Xianyi Memorial Hospital of Tianjin Medical University from May to December 2022 were selected as study subjects. Using a random number table method, they were divided into two groups: the control group (77 cases) received conventional follow-up, while the experimental group (78 cases) received the comorbidity follow-up model. The Coronary Self-Management Behavior Scale (CSMS) scores and other outcome indicators were compared between the two groups before discharge and at 3 months and 6 months post-discharge. Results: The expert response rate was 100% in both rounds of consultation, the authority coefficient was 0.87, and the coordination coefficients were 0.310 and 0.334 (both $P<0.001$). The constructed comorbidity follow-up model comprised 3 dimensions, 11 modules, and 30 items. Sixty-four patients in each group completed the follow-up. There was a significant interaction effect between group

and time on CSMS scores (F_{interaction}=150.504, P_{interaction}<0.001). CSMS scores at 3 months and 6 months post-discharge were significantly higher than before discharge (P<0.001), and the experimental group scored higher than the control group (P<0.05). At 6 months post-discharge, the BMI of patients in the experimental group was significantly lower than that in the control group (P<0.05). Conclusion: The constructed post-PCI comorbidity follow-up model is scientifically sound and effective, can improve self-management behavior in coronary heart disease patients with diabetes after PCI, and reduce BMI.

Full Text

Construction and Application of a Comorbidity Follow-Up Model for Patients with Coronary Heart Disease Complicated by Diabetes After Percutaneous Coronary Intervention

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Abstract

Background: Patients after percutaneous coronary intervention (PCI) generally lack awareness of disease self-management, which affects their prognosis, and patients with comorbid diabetes have even worse outcomes. Establishing a chronic disease follow-up system for collaborative management of both conditions is key to patient recovery.

Objective: To construct a comorbidity follow-up model for patients with coronary heart disease complicated by diabetes after PCI based on chronic disease self-management theory and the CICARE communication model, and to explore its application effects.

Methods: Patients with coronary heart disease complicated by diabetes who underwent PCI at the Department of Cardiology, Chu Hsien-I Memorial Hospital, Tianjin Medical University from May 2022 to December 2022 were selected as study subjects. Using a random number table method, they were divided into two groups: a control group (77 cases) receiving routine follow-up and an ex-

perimental group (78 cases) receiving the comorbidity follow-up model. Scores on the Coronary Heart Disease Self-Management Scale (CSMS) and other outcome indicators were compared between the two groups before discharge and at 3 months and 6 months after discharge.

Results: The positive response rates for both rounds of expert consultation were 100%, with an authority coefficient of 0.87 and coordination coefficients of 0.310 and 0.334, respectively (all P<0.001). The constructed comorbidity follow-up model comprised 3 dimensions, 11 modules, and 30 items. Ultimately, 64 patients in each group completed the follow-up. There was a significant interaction between group and time on CSMS scores (Finteraction=150.504, Pinteraction<0.001). CSMS scores at 3 months and 6 months after discharge were higher than before discharge (P<0.001), and scores in the experimental group were higher than in the control group (P<0.05). At 6 months after discharge, BMI in the experimental group was lower than in the control group (P<0.05).

Conclusion: The constructed comorbidity follow-up model after PCI is scientifically sound and effective, improving self-management behavior and reducing BMI in patients with coronary heart disease complicated by diabetes after PCI.

Keywords: coronary heart disease; diabetes mellitus; percutaneous coronary intervention; self-management ability

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Introduction

Patients after percutaneous coronary intervention (PCI) generally lack disease self-management awareness and cannot effectively control coronary heart disease risk factors or change unhealthy behaviors [**?**], which undoubtedly increases the risk of recurrent coronary stenosis or in-stent restenosis [**?**]. Patients with coronary heart disease complicated by diabetes often present with more severe coronary artery lesions and worse prognosis [**?**], and the two diseases share similar risk factors requiring collaborative management [**?**]. Since in-hospital rehabilitation time is limited, establishing a chronic disease follow-up system to supervise patients in lifestyle modification and risk factor control has become key to recovery [**?**].

The CICARE communication model was developed by the University of California, Los Angeles Medical Center to improve healthcare quality by enhancing residents' communication skills [**?**]. Research has demonstrated that applying this model to health education for PCI patients can enhance treatment compliance and improve self-care ability [**?**]. This study aimed to develop a comorbidity follow-up model for patients with coronary heart disease complicated by diabetes after PCI based on chronic disease self-management theory and the CICARE communication model, and to analyze its application effects to provide a basis for improving self-management in PCI patients.

Methods

Study Design and Model Construction Based on chronic disease self-management theory [**?**] and referencing the Coronary Heart Disease Self-Management Scale (CSMS) [**?**], an initial draft of the follow-up model was constructed through literature review and semi-structured interviews with medical staff and patients. The initial draft comprised three components: follow-up timing, communication methods, and educational content. The educational content included three dimensions (daily life management, disease medical management, and emotional cognitive management), 11 modules, and 37 items.

Expert Consultation Questionnaire Design: The consultation questionnaire included an introduction, expert basic information, main questionnaire body, and expert judgment basis and familiarity level. In the main body, experts provided recommendations on follow-up frequency and communication methods, used a 5-point Likert scale to evaluate the importance of educational content, and offered modification suggestions.

Expert Selection: Twenty-five experts from Tianjin engaged in cardiovascular disease medical care, nursing, or health education with diabetes management experience were selected for consultation. Selection criteria included: (1) over 10 years of experience in the relevant field; (2) intermediate or higher professional title; (3) bachelor' s degree or higher; and (4) voluntary participation.

Consultation Process: Consultation and results compilation were completed from March to April 2022. Questionnaires were distributed on-site or via email, with a 2-week response period requested. After the first round, items were screened based on importance mean >3.5 and coefficient of variation (CV) <0.25 [**?**], modified according to expert feedback, and then subjected to the next round until consensus was reached.

Study Subjects Using convenience sampling, patients with coronary heart disease complicated by diabetes who underwent PCI at the Department of Cardiology, Chu Hsien-I Memorial Hospital, Tianjin Medical University from May 2022 to December 2022 were selected as study subjects.

Inclusion Criteria: (1) Age $ $18 years; (2) Diagnosed with diabetes according to WHO criteria [**?**] with disease duration $ $6 months; (3) Confirmed coronary heart disease [**?**], first-time PCI recipient, and successfully discharged; (4) Voluntary participation.

Exclusion Criteria: (1) New York Heart Association (NYHA) Class IV patients; (2) Patients with severe physical, cognitive, or communication impairments; (3) Patients with severe comorbidities or complications. This study was approved by the Medical Ethics Committee of Chu Hsien-I Memorial Hospital, Tianjin Medical University (No. ZXYJNYYKMEC2023-9).

Sample Size Calculation: Using the formula for comparing two sample

means: $N_1=N_2=2\sigma^2(t\alpha/2+t\beta)^2/(\ _1-\ _2)^2$, the required sample size was estimated as $N_1=N_2=61$ based on relevant literature [**?**]. Considering a 20% attrition rate, the minimum sample size for each group was determined to be 73.

Patient Enrollment and Intervention Patient Enrollment: Patients were divided into experimental and control groups using the random number table method. Before discharge, data on patient gender, age, education level, BMI, glycated hemoglobin (HbA1c), and CSMS scores were collected.

Experimental Group Intervention: Health education specialists conducted telephone follow-ups according to the constructed PCI postoperative comorbidity follow-up model as follows:

1. **Follow-up Frequency:** At 2 weeks, 1 month, 3 months, and 6 months after discharge.
2. **Communication Method:** Based on the CICARE communication model: Connect-Introduce-Communicate-Ask-Respond-Exit. Specific methods: (1) Appropriately address and politely greet the patient, confirming identity; (2) Politely introduce oneself; (3) Explain the purpose and significance of the follow-up, the main topic, and required patient cooperation; (4) Assess patient self-management status, patiently listen to patient expressions, and understand their needs; (5) Timely and appropriately answer patient questions and provide health guidance based on self-management status; (6) Explain the next follow-up arrangement and thank the patient for their cooperation.
3. **Educational Content:** Health guidance was provided according to the specific content of the PCI postoperative comorbidity follow-up model.

Control Group: Received routine telephone follow-up at 2 weeks, 1 month, 3 months, and 6 months after discharge, with only problem-solving for issues encountered in self-management.

Evaluation Indicators Primary Outcome: CSMS scores were collected before discharge and at 3 and 6 months after discharge. The scale, developed by Ren Hongyan et al. [**?**], comprises 7 dimensions with 27 items, each scored 1-5, with higher scores indicating better self-management behavior. In 2020, Ma Ping reorganized the scale into three dimensions: daily life management, disease medical management, and emotional management, with a Cronbach' s α coefficient of 0.830 [**?**]. This study used Ma Ping' s revised version.

Secondary Outcomes: At 6 months after discharge, BMI, HbA1c, and major adverse cardiovascular events (MACE) were collected, including non-fatal myocardial infarction, heart failure hospitalization, repeat revascularization, and cardiac death.

Statistical Methods Data were analyzed using SPSS 27.0 software. Normally distributed continuous data were expressed as ($\bar{x}\pm s$). Repeated measures ANOVA was used for comparisons across time points, independent t-tests for between-group comparisons, and paired t-tests for within-group comparisons before and after discharge. Categorical data were expressed as frequencies and percentages, with ^{2} tests for between-group comparisons. P<0.05 was considered statistically significant.

Results

Expert Consultation Results Expert Characteristics: All 25 experts completed the consultation, with a 100% response rate. Expert age ranged 36-55 years, mean $(42.7\$\pm4.5)years; workexperience11-27years, mean(17.4\pm\$4.1)$ years. The group included 11 clinical nurses, 4 nursing managers, 3 health education specialists, and 7 physicians; 8 held bachelor' s degrees, 13 master' s, and 4 doctoral degrees; 10 had intermediate professional titles and 15 had associate senior or higher titles. Individual expert authority coefficients ranged 0.77-1.00, with an overall expert authority coefficient of 0.87. The coordination coefficients for the two rounds were 0.310 and 0.334, respectively (P<0.001).

Indicator Modification: Based on screening criteria, expert opinions, and clinical significance, 5 items were deleted, 1 added, 3 split and merged, and 4 refined. The final comorbidity follow-up model included 3 dimensions, 11 modules, and 30 items . The weight of the 11 modules was calculated using the priority graph method, and follow-up education priorities were set according to weight ranking for each period .

Patient Characteristics and Follow-Up A total of 155 patients were enrolled, with 27 lost to follow-up due to unanswered calls, phone shutdown, refusal, or number changes, resulting in a 17.4% attrition rate. Sixty-four patients in each group completed all follow-ups. The cohort included 69 males (53.9%) and 59 females (46.1%); age range 38-81 years, mean $(64.88\$\pm7.66)years; BMIrange16.8-45.4kg/m^{\{2\},mean(26.52\pm4.23)kg/m}\{2\}\$$; diabetes duration 0.5-47 years, median 13 (5, 20) years; coronary heart disease duration 0-28 years, median 5.5 (2, 9) years; 74 cases (57.8%) had 1 stent implanted, 35 (27.3%) had 2 stents, and 19 (14.9%) had 3 stents. There were no statistically significant differences between groups in age, diabetes duration, coronary heart disease duration, BMI, HbA1c, gender, occupation, marital status, education level, number of comorbidities, or number of stents implanted (P>0.05) .

CSMS Score Comparison There was a significant interaction between group and time on CSMS scores (Pinteraction<0.001), with significant main effects for both group (Pgroup<0.05) and time (Ptime<0.001). No significant difference was found between groups before discharge (t=0.045, P=0.964). At 3 months after discharge, CSMS scores in the experimental group were higher

than in the control group (t=2.577, P=0.011). At 6 months after discharge, CSMS scores in the experimental group remained higher (t=4.080, P<0.001) .

CSMS scores at 3 months after discharge were higher than before discharge in both groups (P<0.05). Scores at 6 months after discharge were higher than both before discharge and at 3 months in both groups (P<0.05).

BMI and HbA1c Comparison No significant differences were found between groups in BMI or HbA1c before discharge (P>0.05). At 6 months after discharge, BMI in the experimental group was lower than in the control group (P<0.05), while HbA1c showed no significant between-group difference (P>0.05). Both BMI and HbA1c at 6 months were lower than before discharge within each group (P<0.05) .

MACE Comparison No statistically significant differences were found between groups at 6 months after discharge in the incidence of non-fatal myocardial infarction, heart failure hospitalization, repeat revascularization, or total MACE events (P>0.05) .

Discussion

Currently, the average hospital stay for coronary heart disease patients in China is approximately 7 days, during which health education information is limited, and patients often fail to maintain proper self-management after discharge. Therefore, establishing a chronic disease follow-up system for continuous management is essential [**?**]. Early outpatient rehabilitation after PCI generally begins 2-5 weeks post-discharge, primarily aiming to correct unhealthy lifestyles, provide exercise and daily living guidance, and help patients resume normal activities and work [**?**]. Within 6 months after PCI, patients often lack disease rehabilitation knowledge and have poor self-management ability [**?**], making them susceptible to in-stent restenosis [**?**]. The follow-up periods in this model align with these critical rehabilitation stages, meeting patient recovery needs. Diabetes and coronary heart disease frequently co-occur and share similar risk factors, necessitating collaborative management [**?**]. This study constructed a comorbidity follow-up model that improves patient prognosis through disease synergy management.

Practicality and Scientific Rationale of the Comorbidity Follow-Up Model Patient follow-up employed the CICARE communication model to achieve effective communication through standardized processes while providing targeted guidance based on assessment of patient self-management status. Educational content was constructed based on chronic disease self-management theory [**?**], literature review, semi-structured interviews with medical staff and patients, and Delphi expert consultation. All consulted experts specialized in cardiovascular disease with diabetes management experience, providing both theoretical and practical guidance for comorbidity follow-up management. The

overall expert authority coefficient was 0.87, indicating high authority and reliable consultation results. The coordination coefficient increased from 0.310 to 0.334 across two rounds, demonstrating converging expert opinions. Research shows that PCI patients' most important learning needs involve risk factors, medication, and emergency management [**?**]. This study set follow-up education priorities based on secondary indicator weights, emphasizing diet, medication, lifestyle, prevention, and emergency management in the first month, meeting patient needs at this stage. Since depression and anxiety are common in acute myocardial infarction patients [**?**] and intensify gradually within 6 months after PCI [**?**], the 6-month follow-up focus on emotional management and plan formulation aligns with patients' psychological trajectories, helping alleviate anxiety and depression and facilitating gradual return to normal life and work.

Effects of the Comorbidity Follow-Up Model on Self-Management Ability CSMS scores in this study were higher than in other studies [**?**, **?**, **?**], likely because the enrolled population had coronary heart disease complicated by diabetes. Self-management experience from diabetes management may assist coronary heart disease self-management [**?**]. Additionally, long-term chronic disease self-management builds patient self-efficacy [**?**], and patients' relatively positive and stable emotional states contributed to higher scores in the emotional management dimension. CSMS scores in both groups increased progressively after discharge, consistent with Han Ying et al.'s findings [**?**], indicating that PCI patients possess certain self-management abilities with room for improvement, particularly in disease medical management knowledge and behavior [**?**]. The experimental group' s significantly higher CSMS scores at both 3 and 6 months demonstrate that the comorbidity follow-up model further improves patient self-management.

Effects on Biochemical Indicators and MACE Both groups showed reduced BMI at 6 months after discharge compared to baseline. Guan Jialiang et al.' s research [**?**] also indicated improved BMI achievement rates after PCI, suggesting patients have certain secondary prevention capabilities. The experimental group' s lower BMI compared to the control group indicates the comorbidity follow-up model' s effectiveness in weight management, consistent with Deng et al.' s telephone follow-up results [**?**]. Both groups showed reduced HbA1c levels, but without significant between-group differences, possibly due to regular blood glucose adjustment and long-established self-management habits, or because the short follow-up period prevented statistical significance in HbA1c improvement. No significant between-group differences in MACE events were observed, consistent with Li Mengnan et al.' s findings [**?**], likely due to the short follow-up period insufficient to detect the model' s impact on MACE.

Study Limitations This study has certain limitations. The 6-month follow-up period was relatively short, and the effects on MACE events and blood glucose control require further observation. Longer-term follow-up is necessary

to help patients maintain healthy behaviors and continue exploring the model' s impact on MACE and glycemic control.

Conclusion

The comorbidity follow-up model constructed for patients with coronary heart disease complicated by diabetes after PCI is scientifically sound and effective, improving post-PCI self-management behavior and reducing BMI. Longer-term patient follow-up is warranted to help maintain healthy behaviors and further explore the model' s effects on MACE events and glycemic control.

Author Contributions

SONG Hongna was responsible for research design and implementation. XU Hongmei conducted data collection and manuscript writing. LIU Yuhuan and WANG Qinglong performed data collection, organization, and statistical analysis. TANG Yunzhao and YU Xiang contributed to manuscript revision. SONG Hongna was responsible for quality control and review, and takes overall responsibility for the article.

Conflict of Interest

The authors declare no conflict of interest.

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Tables

Expert consultation results on educational content (showing primary, secondary, and tertiary indicators with importance scores, coefficient of variation, and weights)

Weight calculation of secondary indicators and key points of follow-up in different periods

Comparison of baseline data between two groups

Comparison of CSMS scores before discharge, 3 months and 6 months after discharge between two groups

Comparison of BMI and HbA1c before discharge and 6 months after discharge between two groups

Comparison of incidence of MACE at 6 months after discharge between two groups

Note: Figure translations are in progress. See original paper for figures.