ONLINE EDUCATION STRATEGIES IN THE CARDIAC REHABILITATION OF PATIENTS WITH CORONARY HEART DISEASE

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Abstract

Introduction: The objective of this study was to investigate the impact of a blended learning strategy, utilizing the Xuexitong online educational platform, on cardiac rehabilitation (CR) for patients with coronary heart disease (CHD) following hospital discharge

Materials and methods: Seventy CHD patients discharged from Hebei University Affiliated Hospital between July 2022 and January 2023 were randomly divided into blended and conventional education groups. Both received routine CR education before discharge. Post - discharge, the conventional group got education and supervision via WeChat, and the blended group used Xuexitong for blended education. The study compared risk factor control, cardiovascular events, quality of life, and CR compliance between the two groups pre - and post - intervention.

Results: After intervention, the blended education group had a higher risk factor control rate (blood pressure 91.4%, LDL cholesterol 91.4%, glycemia 88.6%) than the conventional group (60%, 68.6%, 51.4% respectively, p<0.01). Cardiovascular events occurred in 5 (14.3%) in the blended group and 15 (43%) in the conventional group, with a relative risk of 0.33 (0.14-0.82). The blended group's quality of life (81 (76–85)) was higher than the conventional group's (62 (58–66), P<0.001). Also, the blended group's CR compliance (19 (17–20)) was higher than the conventional group's (15 (13–16)) during the intervention (P<0.001).

Conclusion: Applying a blended patient education strategy based on Xuexitong for patients with CHD after discharge can effectively control risk factors, reduce adverse cardiovascular events, improve quality of life, and enhance CR compliance.

Key words: coronary heart disease, cardiac rehabilitation, patient education, quality of life

Resumen

Estrategias de educación online en la rehabilitación cardiaca de pacientes con enfermedad coronaria

Introducción: Evaluar el efecto de una estrategia educativa combinada basada en Xuexitong sobre la rehabilitación cardiaca (RC) en pacientes con enfermedad coronaria (EC) tras el alta.

Materiales y métodos: Ensayo aleatorizado con 70 pacientes con EC dados de alta entre julio de 2022 y enero de 2023 en el Hospital Afiliado a la Universidad de Hebei. Ambos recibieron educación estándar de RC antes del alta. Después, el grupo convencional continuó educación y supervisión por WeChat; el combinado recibió educación mixta mediante Xuexitong. Se compararon control de factores de riesgo, eventos cardiovasculares, calidad de vida y cumplimiento.

Resultados: La educación combinada obtuvo mayor control de la presión arterial (91.4% vs. 60%), coleste-

rol LDL (91.4% vs. 68.6%) y glucemia (88.6% vs. 51.4%; p<0.01). Los eventos cardiovasculares fueron menores (5/35 [14.3%] vs. 15/35 [43%]; riesgo relativo 0.33; IC 95% 0.14–0.82). La calidad de vida fue superior (mediana 81 [76–85] vs. 62 [58–66]; p<0.001) y el cumplimiento de la RC aumentó (mediana 19 [17–20] vs. 15 [13–16]; p<0.001).

Conclusión: Una estrategia educativa combinada basada en Xuexitong, añadida a la educación estándar, mejora el control de factores de riesgo, reduce los eventos cardiovasculares y eleva la calidad de vida y el cumplimiento de la RC en pacientes con enfermedad coronaria tras el alta.

Palabras clave: enfermedad coronaria, rehabilitación cardíaca, educación del paciente, calidad de vida

KEY POINTS
Current knowledge

- Cardiac rehabilitation (CR) is a class I recommendation for coronary heart disease (CHD) and improves outcomes. Patient adherence to CR remains suboptimal, limiting benefits. Tele/online CR can yield outcomes comparable to center-based programs. Practical barriers (technology complexity, cost) constrain uptake and effectiveness.

Article's contribution to current knowledge

- Randomized 70 CHD patients to blended education (Xuexitong) vs. conventional WeChat for 6 months. Blended improved control of BP 91.4% vs. 60%, LDL-C 91.4% vs. 68.6%, glycemia 88.6% vs. 51.4%; reduced events 14.3% vs. 43%; higher SF-36 81 vs. 62 and adherence 19 vs. 15.

Coronary heart disease (CHD) is a prevalent cardiovascular condition and a leading cause of cardiovascular mortality[1]. Its prevalence and mortality rates are increasing, posing a significant threat to individuals' well-being[2]. Although various therapeutic modalities have been widely used in managing CHD and improving survival and quality of life among patients with CHD[3], there remains a risk of CHD reoccurrence and subsequent mortality or reduced quality of life for patients following discharge due to various factors[4]. Therefore, implementing secondary prevention strategies upon patient discharge,

such as managing risk factors and making lifestyle modifications, is vital[5,6].

Cardiac rehabilitation (CR) is crucial for the secondary prevention of CHD[7]. It comprises a comprehensive intervention including exercise training, promotion of physical activities, health education, cardiovascular risk management, and psychological support[8]. Postcardiac event CR has been endorsed as a Class I recommendation by the European Society of Cardiology, the American Heart Association, and the American College of Cardiology[9]. However, many patients engaging in CR struggle to adhere to and complete the program[10], and the optimal intervention measures for CR programs in patients with CHD continue to be a subject of debate[11].

Technological advancements have facilitated the utilization and widespread adoption of electronic devices, including smartphones, prompting some clinical professionals to propose and implement online-based CR initiatives[12]. Studies indicate that online CR may achieve similar effects as traditional in-person CR[13]. Nevertheless, patients participating in online CR often face difficulties such as complex functionalities and expensive exercise monitoring equipment, limiting its applicability. Xuexitong, a versatile software developed by Beijing Super Star Information Technology Co., Ltd., is widely used in China and accessible through smartphones. Platform introduction: Xuexitong (developed by Beijing Super Star Information Technology Co., Ltd.) is a widely adopted online education management system in China. Its core functions include: course creation and modular content upload, real-time assignment distribution and submission tracking, automated statistics on learner engagement (e.g., login frequency, task completion rates), integrated communication tools for instructor-student interaction. Therefore, to examine its applications for patients with CHD following discharge, this study adopts a blended patient education strategy for CR that integrates online, and in-person approaches through Xuexitong online educational platform.

Materials and methods

General patient information

A total of 70 patients with CHD discharged from Hebei University Affiliated Hospital between July 2022 and

January 2023 were selected as research participants. They were numbered according to discharge order and randomly divided, with 35 cases each in the blended and conventional education groups. The inclusion criteria were as follows: 1, meeting the diagnostic criteria for CHD described by the WHO; 2, about to be discharged and living locally; 3, having normal cognitive, literacy, and comprehension abilities; 4, having and using a smartphone; 5, being in good mental condition and capable of oral and written communication; 6, able to move freely; and 7, providing informed consent. The exclusion criteria included the presence of contraindications for exercise rehabilitation, such as unstable angina, acute myocardial infarction, uncontrolled arrhythmias, decompensated heart failure, complex ventricular arrhythmias, severe pulmonary hypertension, intracavitary thrombosis, recent thrombophlebitis with or without pulmonary embolism, severe obstructive cardiomyopathy, severe or symptomatic aortic valve stenosis, blood pressure > 220 mmHg, uncontrolled inflammatory or infectious diseases, any musculoskeletal diseases hindering exercise training, concurrent severe liver or kidney dysfunction, severe gastrointestinal diseases, and malignant tumors. The Ethics Committee of Hebei University Affiliated Hospital approved this study (Approval No. 3546/HU-A). All research participants and their family members were informed of the research contents and signed relevant informed consent forms.

Patient intervention methods
Predischarge cardiac rehabilitation

Both groups received the same CR intervention before discharge. The intervention method was as follows: CR education content was developed based on the latest guidelines and relevant literature. It comprised six parts, including prescriptions for exercise, medication, nutrition, psychological support, and smoking cessation, combined with basic knowledge of CHD and CR. The content was presented to the patients using PowerPoint. The patients were also played demonstration videos of suitable aerobic, resistance, and flexibility exercises.

Post-discharge cardiac rehabilitation for the conventional education group

After discharge, the conventional education group underwent six months of routine online CR. The intervention method involved creating a WeChat group and sending approved CR education content to the group. Patients were motivated to study independently, and the research team answered any questions raised by the patients. A reminder was sent to the group once a month, and data were collected after six months.

Post-discharge cardiac rehabilitation for the blended education group

In this study, we utilized Xuexitong to: deliver structured CR educational modules, monitor patient compliance through monthly tasks, provide personalized feedback via its messaging system.

The blended education group underwent six months of blended CR following discharge. The intervention method was as follows: 1) Registering and creating CR education courses on Xuexitong and uploading expert-reviewed CR education content to the chapter module. 2) Selecting five patients with CHD for a pre-experiment based on the study's inclusion and exclusion criteria, guiding them to use Xuexitong, receiving their feedback, and making corresponding improvements based on their suggestions. 3) Adding participants from the blended group to Xuexitong's CR education course, providing one-on-one instruction to each patient on how to use Xuexitong and requiring patients to demonstrate the platform operation method to ensure proficiency. 4) Establishing electronic patient records, including patients' demographic information, daily lifestyle, and disease-related information, which could be dynamically recorded during the intervention. 5) Investigating whether the patients complied with the exercise, medication, and nutritional prescriptions through assignments issued once a month for the first six months. Based on the patients' responses, their compliance was assessed and relevant guidance was provided using WeChat. 6) Supervising and evaluating tasks completed by each patient using Xuexitong's background statistics. Patients were encouraged to actively participate, with reminders and personalized guidance provided via WeChat to less active learners. 7) Using the class space to send notifications and reminders to patients and answer common questions monthly for the first six months. Data were collected at the end of the 6-month study period. 8) For patients with poor compliance and less active learning identified in steps 5 and 6, personalized guidance through WeChat and motivational interviewing techniques were used to inspire them to adhere to the CR program and improve compliance with exercise, medication, and risk factor control. 9) If individual guidance through WeChat was ineffective or the patients wished to receive face-to-face instruction, a time and place for offline in-person guidance was arranged.

Evaluation indicators
Control of risk factors

The achievement of standard risk factor control was assessed at the time of patient discharge and six months after the intervention. The target levels for controlling CHD risk factors specified by the American College of Cardiology/American Heart Association (ACC/AHA) in their 2007 revised PCI treatment guidelines were used as the standard. These targets areas are as follows: blood pressure < 140/90 mm Hg (< 130/80 mmHg for those with diabetes), low-density lipoprotein cholesterol < 2.6 mmol/L, and fasting blood sugar < 6.1 mmol/L.

Occurrence of cardiovascular adverse events

Adverse cardiovascular events during the intervention period were recorded, including the number of instances of angina pectoris, myocardial infarction, and heart failure. Patients were excluded if they had other diseases or were regularly followed up in outpatient clinics. Each occurrence was recorded as one instance.

Quality of life

The patients' quality of life was assessed at discharge and after six months of intervention using the Short Form Health Survey (SF-36). The questionnaire comprised 9 dimensions with 36 items, namely, physical function, physical role, bodily pain, general health, vitality, social function, emotional role, mental health, and health change. Each item was scored from 0 to 100, with high scores indicating a better quality of life.

Patient cardiac rehabilitation compliance

Patients' compliance with CR was assessed using an author-prepared treatment compliance questionnaire from Hebei University Affiliated Hospital. The questionnaire comprises seven dimensions: medication adherence, regular follow-ups, appropriate diet, proper rest, adequate exercise, smoking cessation, and alcohol restriction, with a total score of 20. A high score indicates better CR compliance.

Statistical methods

Continuous variables were assessed for normality using Shapiro-Wilk tests. Normally distributed data were reported as mean ± standard deviation and compared with independent t-tests; non-normally distributed data (SF-36 scores and CR compliance scores) were expressed as median (interquartile range) and analyzed using Mann-Whitney U tests. Categorical variables were reported as frequencies (%) and compared with χ^2 tests. A p-value <0.05 was considered statistically significant. Analyses were performed using SPSS 25.0 and GraphPad Prism 9.0.

Results

Demographic data

The blended education group comprised 18 males and 17 females, aged 44–87 years (67 ± 11.6 years); 11 had a high school education or above, 22 had primary or junior high school education, and 2 were illiterate. The Killip heart function classification comprised 20 cases of Grade I and 15 of Grade II, with 18, 15, and 2 patients having single-, double-, and triple-vessel disease, respectively. Meanwhile, the conventional education group comprised 19 males and 16 females, aged 45-86 years (67.0 ± 10.6 years); 12 had a high school education or above, 20 had a primary or junior high school education, and 3 were illiterate. The Killip heart function classification comprised 21 cases of Grade I and 14 of Grade II, with 20, 12, and 3 patients having single-, double-, and triple-vessel disease, respectively. There were no statistically significant differences in the general data between the two groups (p > 0.05).

Comparison of patient compliance with risk factor control

At discharge, there were no statistically significant differences (p > 0.05) between the two groups regarding blood pressure, blood lipid levels, and blood glucose control rates. However, following intervention, the blended education group showed significantly better risk factor control than the conventional education group (p < 0.05) (Table 1).

Comparison of adverse cardiovascular events among patients

During follow up, there was one case of angina in the blended education group, three cases of myocardial infarction, and one case of heart failure, with a cardiovascular adverse event rate of 14.29%. In contrast, the conventional education group experienced five cases of angina, six of myocardial infarction, and four of heart failure, resulting in a cardiovascular adverse event rate of 42.86%. Thus, the blended education group had a significantly lower rate of adverse cardiovascular events than the conventional education group (p < 0.05). Relative risk 0.33 (95% CI 0.14-0.82) (Table 2).

Table 1 | Comparison of risk factors control

Categories	Blood pressure		Blood lipids		Blood glucose	
	At discharge	After intervention	At discharge	After intervention	At discharge	After intervention
Blended education group (n= 35)	34 (97.1)	32 (91.4)	31 (88.57)	32 (91.4)	30 (85.71)	31 (88.6)
Conventional education group (n= 35)	32 (91.4)	21 (60.0)	34 (97.1)	24 (68.6)	33 (94.2)	18 (51.4)
X^2	0.2652	9.4007	0.8615	5.7143	0.6349	11.4966
p	0.6066	0.0022	0.3533	0.0168	0.4256	0.0007

The data indicate a value of n (%)

Table 2 | Adverse cardiovascular events during the follow up

Categories	Angina pectoris	Myocardial infarction	Heart failure	Total occurrences
Blended education group (n = 35)	1 (2.9)	3 (8.6)	1 (2.9)	5 (14.2)
Conventional education group (n = 35)	5 (14.2)	6 (17.1)	4 (11.4)	15 (42.9)
X^2				10.2260
p				0.0014

The data indicates a value of n (%)

Comparison of patients' quality of life

There were no statistically significant differences in quality of life between the two groups at discharge (p > 0.05). However, following the intervention, the quality-of-life scores for both groups of patients improved compared with their scores at discharge. Additionally, the blended education group had statistically significantly higher quality of life scores than the conventional education group (p < 0.05) (Table 3).

Comparison of patient compliance rates

Patients in the blended education group achieved a higher total score in compliance compared to those in the conventional education group, and this difference was statistically significant (P < 0.001) (Table 4).

Discussion

CR serves as the pivotal foundation of secondary CHD prevention, playing an indispensable role in improving patients' health and enhancing their quality of life[14]. Advancements in technology have surmounted the limitations of traditional CR, and online CR has demonstrated comparable outcomes to offline CR[15]. This investigation found that a blended approach of online and offline CR substantially contributes to augmenting CHD patients' adherence to CR following discharge, effectively managing their risk factors, reducing the incidence of adverse cardiovascular events, and elevating their quality of life.

Discharge is a critical phase for patients with CHD, during which they must adjust their lifestyles and become more susceptible to experiencing additional cardiac incidents[16]. Typically, CR encompasses the education of risk factors, supervised exercise training, and psychological support[17]. In particular, risk factor education enhances patients' ability to manage cardiovascular risk factors and facilitates transformative lifestyle modifications[18], which are crucial for diminishing adverse cardiovascular events and enhancing patients' quality of life[19]. Supervised exercise training, a fundamental component

Table 3 | Comparison of patients' quality of life

Categories	At discharge	After intervention
Blended education group (n = 35)	36 (32-40)	81 (76-85)*
Conventional education group (n = 35)	36 (31-39)	62 (58-66)*
p	0.553	<0.001

*Caption: Data as median (IQR); *p<0.001 by Mann-Whitney U test*

Table 4 | Comparison of patient compliance rates

Categories	Adhere to medication prescribed by the doctor	Attend regular follow-up appointments	Follow a balanced diet	Get adequate rest
Blended education group (n = 35)	3 (1-5)	3 (1-4)	3 (1-4)	3 (1-4)
Conventional education group (n = 35)	2 (1-4)	2 (1-4)	2 (1-3)	2 (1-3)
p	<0.001	<0.001	<0.001	<0.001
Categories	**Engage in regular exercise**	**Quit smoking and drinking**	**Take measures to prevent infections**	**Total score**
Blended education group (n = 35)	3 (1-4)	2 (1-3)	3 (1-4)	19 (17-20)
Conventional education group (n = 35)	2 (1-3)	2 (1-2)	2 (1-4)	15 (13-16)
p	<0.001	<0.001	0.053	<0.001

Mann-Whitney U test

of CR programs, has demonstrated its capacity to improve patients' cardiovascular health and quality of life[20]. Through a blended patient education strategy that encompasses online and offline components for patients with CHD, this study found that those engaged in the blended strategy demonstrated enhanced compliance with risk factor management and experienced fewer adverse cardiovascular events compared with individuals undergoing conventional online CR. Ultimately, this difference translated into an improved quality of life. Therefore, the blended patient education strategy that integrates online and offline facets efficaciously manages CHD risk factors, diminishes the prevalence of cardiovascular adverse events, and improves quality of life.

Although the benefits of CR for patients with CHD have been substantiated, improving compliance with CR remains a formidable challenge[21]. Although the advent of online CR has somewhat improved patient adherence to CR[22], certain studies suggest that it has a limited impact on enhancing patients' adherence to medication[23]. Notably, this study found that the blended patient education strategy leads to greater CR adherence than the conventional strategy. This finding highlights the efficacy of a blended patient education strategy in ensuring compliance with CR among patients with CHD.

In conclusion, implementing a blended patient education strategy, combining online and offline elements, for patients with CHD following discharge efficiently manages their risk factors, diminishes the incidence of cardiovascular adverse events, improves their quality of life, and augments their compliance with CR.

Conflict of interest: None to declare

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