Original article

Effects of a telehealth program on the functional status and rehospitalization rates of patients after coronary artery bypass grafts

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Background: Patients with coronary artery bypass graft (CABG) exhibit a decrease in functional status during the postoperative period. The rehospitalization rate within the first month is 8.0% - 21.0%. Therefore, during the first month after discharge, most patients require help from health care teams. Telehealth programs promote health monitoring and share health information remotely during transitional stages, encouraging awareness, increasing cardiac rehabilitation and physical function. As a result, the number of rehospitalizations is also reduced.

Objectives: This quasi-experimental research aimed to study the effects of a telehealth program on the functional status and rehospitalization rates of patients with CABG.

Methods: Thirty-two patients who had undergone CABG surgery at two university hospitals in Bangkok were randomly assigned to the telehealth program, and 32 patients received the usual care. Data were collected using the Demographic Data, Functional Status and Rehospitalization questionnaires.

Results: The results showed that the functional status of the telehealth group was significantly higher than that of the control group at 2 weeks and 4 weeks ($P = 0.03$ and 0.007, respectively). In addition, the rate of rehospitalization within 28 days was significantly lower in the telehealth group than in the control group ($P = 0.026$). Moreover, the rehospitalization and revisitation rates in the telehealth group were significantly less than those in the control group ($P = 0.048$).

Conclusions: The telehealth program effectively increases patients' functional status and reduces rehospitalization rates. It may be reasonable to consider implementing a telehealth program using a multidisciplinary team after discharge from the hospital to improve the recovery process.

Keywords: Telehealth program, functional status, rehospitalization, coronary artery bypass graft.

Cardiovascular disease is the number-one cause of death worldwide [1] and the third leading cause of death in Thailand. [2] After coronary artery bypass graft (CABG) patients received treatment in the intensive care unit (ICU) for 1 - 2 days. They are stressed due to insufficient sleep during the postoperative period. Furthermore, mental health could be affected by decrease in physical activity and lack of exercise.[3 - 5]

CABG patients may have cognitive impairment, loss of memory, activity limitation, and decreased functional status. Hence, postoperative patients have limited daily activities in the early stages. [6 - 7] They were readmitted within 30 days and frequently return to see doctors in the emergency room nearly 25.0% of patients discharged after CABG surgery.[8] Most patients being readmitted in the first week after discharge from the hospital [9], which is related to the high morbidity and mortality rates.[8 - 9] Complications that may occur during cardiac rehabilitation following discharge from the hospital. Most patients with CABG experience pleural effusion.[9] According to the findings, postoperative infection ranks first (16.9%), followed by heart failure (12.8%) and "other complications" as surgical and medical reasons for readmission within 30 days. Patients undergoing CABG were found to have readmission rates ranging from 8.3 to 21.1%. [10]

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Promoting cardiac rehabilitation when returning home is beneficial to improve exercise and functional capacities. The study of patients with CABG who received home-based cardiac rehabilitation compared to the control group increased physical activity and significantly improved the quality of life in one month. [11]

A previous study found that telenursing is a convenient, cost effective training and follow-up care for patients after coronary artery bypass surgery that can improve patients' adherence to treatment plans in developing countries. [12] In addition, the use of telephone technology to communicate with patients and relatives helps patients improve their self-efficacy and self-care.[13]

Telehealth programs also help patients gain access to health information via a smartphone after discharge from the hospital. [14 - 16] Some studies show that telehealth programs encourage patients to engage in cardiac rehabilitation activities, which helps promote patient awareness and support the plan to exercise, strengthen muscles, reduce disability, and increase physical functionality. [12, 17]

There is a limitation of the study telehealth program that implements to patients with CABG. The latest action plan of the Thailand Ministry of Public Health is important for the adoption of e-health in the public health system. The smartphone and free applications are widely used in general society. Therefore, researchers are interested in studying the effects of the Telehealth program on the functional status and rehospitalization of patients. This program will provide knowledge, cardiac rehabilitation and monitoring of patients via a smartphone given to patients with CABG after discharge from the hospital.

This quasi-experimental study aimed to explore the effects of a telehealth program on the functional status and rehospitalization rates of patients who underwent CABG surgery at two university hospitals in Bangkok, Thailand.

Materials and methods

This study used the transitional care model (TCM)[18] as the framework to implemented a telehealth program of remote monitoring of patients with CABG, with a focus on promoting healthcare and cardiac rehabilitation. Nurses serve as the coordinators to assess risks and complications and promote knowledge related to the health status of each patient. The goal was to improve the quality of care after discharge.

The research instruments included the instruments for data collection and the telehealth program. Instruments for data collection such as Thai Mental State Examination (TMSE) [19], demographic data record, functional status questionnaires, rehospitalization record. The telehealth program was modified and developed from the telehealth program established by O'Connor M, *et al*. [20], and a study by Kleinpell RM, *et al*. [17] O'Connor M, *et al*. [20], used a telehealth program that employed a 4G wireless tablet-based system that collected patients' vital signs (weight, heart rate, blood pressure and blood oxygenation). The patients' data were transmitted daily in real-time to the telehealth team.

This study uses the transitional care model (TCM) [18], as the framework for developing a telehealth program, which is intended to reduce readmission and increase the functional status of patients. The program provided information, which included CABG health information and exercise based on cardiac rehabilitation guidelines, through smartphones. Smartphone line@ application is a free program that is used widely in Thailand. It is used to send messages, voice messages, pictures and video clips to promote daily activity and cardiac rehabilitation. Patients were taught to use the line@ application before discharge from the hospital, Nurses taught patients to practice uploading their health status/ symptoms honestly, correctly and timely to be monitored by nurses after discharge from the hospital. The health information from the nurse is written on the infographic pictures and is easy to read.

The documents were modified with the telehealth program and included the following: 1) the CABG Health Information Handbook; 2) Discharge Risk Record; 3) Health and Monitoring Record Form; 4) Patients' Self-Record Form; and 5) infographic pictures.

Functional Status -This instrument measured functional status using the enforced social dependency scale (ESDS). The total score ranged from 10 to 51 with higher scores reflecting lower functional status.

Participants

Research proposal was approved by the ethics committee. Patients who underwent CABG surgery were moved from the critical care unit back to the ward for 3 - 5 days. The patients had to meet the following inclusion criteria: 1) underwent CABG for the first time; 2) had a New York Heart Association

functional classification of I–III; 3) had a TMSEscore >23; 4) could communicate and understand the Thai language; and 5) could communicate via a smartphone.

The sample groups from similar previous studies of Naylor MD, *et al*. [18], were calculated. The effect size was 0.72 (d = ($\bar{x}$ 1 - $\bar{x}$ 2)/SD, (27.9 - 18.3)/ 13.4 = 0.72), the power of the test was 0.80, and the significance level was set at 0.05 based on a two-sided unpaired *t*-test. It was analyzed using G power. A sample size of 26 patients in each group was chosen. The researcher added another 20.0% to the study group and control group in case of withdrawal or loss; therefore, there were 32 patients in the study group and 32 patients in the control group for a total of 64 patients.

The patients received information and consented to participate in the research. The participants were randomized to the telehealth group and control group using the nonreturn lottery method. All steps were performed by the researcher.

Control group and telehealth group

The control group received routine care information was instructed by the ward nurses before returning home by using D-METHOD discharge planning contains recommendations for D-diagnosis, M-medicine, E-environment, T-treatment, H-health, O-Out patient, D-diet**.**

Telehealth group

The researcher met with the patients in the ward to assess their health status, plan the monitoring by smartphone and plan the follow up after discharge. This process took approximately 30 minutes per patient.

The telehealth program was Follow-up CABG patients post discharge by alert patients with infographic pictures and follow up on health information including blood pressure, pulse, weight, exercise, and symptom abnormalities. Additionally, daily activity and cardiac rehabilitation were promoted by communicating via the smartphone application LINE @ at 1- 4 weeks after discharge from the hospital. Telephone communication was used to follow up on the patients' behavior and the management of the patients' abnormal symptoms. The researcher made contact on days 1, 3, 7, 14, 21 and 28, while patients could call the researcher 24 hours a day. The researcher consulted a multidisciplinary team in case of problems. After four weeks of monitoring, the researcher evaluated the health care outcomes with the health care team. The patients were informed of the results.

The trained nursing research assistant evaluated the functional status of patients, blinded to group assignment, using Enforced Social Dependency Scale (ESDS), at 2 weeks and 4 weeks after discharge, and the rate of rehospitalization at 4 weeks by telephone interview. Inter-rater reliability of telephone interviews using the Enforced Social Dependency Scale was given by the researcher at random periods.

Statistical analysis

SPSS version 18.0 was used to analyze personal data and health information such as age, gender, diagnosis, NYHA functional class, surgery, date of operation, working status, average income per family, and the number of hospitalizations. Data are presented in the form of frequency distribution, percentage, mean, and standard deviation (SD).

The data were analyzed using chi-square statistics to compare patient characteristics and rehospitalization rates between the experimental and control groups. In addition, unpaired *t* - test and Mann-Whitney U test were used to compare the mean functional status scores at 2 and 4 weeks after discharge.

Results

A total of 64 subjects who met the criteria for participation were approached for the study, and 32 patients were randomized to the telehealth program intervention, and 32 patients were assigned to the control group. All of the subjects who joined the project participated throughout the study period without leaving the group. The characteristics of the participants between the telehealth and control groups were compared by using chi-square or Fisher's exact test, but the differences were not statistically significant ($P > 0.05$). (Table 1). Functional status (higher scores of enforced social dependency scale (ESDS) reflecting lower functional status). The comparison of ESDS scores via the Mann-Whitney U test at baseline before discharge from the hospital between the telehealth group and the control group. There were no differences between the 2 groups. The mean scores were 33.8 and 31.2, respectively ($P = 0.57$) (Table 2).

Table 1. General characteristics of the subjects.

Patient data	Telehealth (n = 32) Number (%)	Control (n = 32) Number (%)	Total (n = 64) Number (%)	χ^2	*P* - value
Gender				0.00	1.0
Male	24 (75.0)	24 (75.0)	48 (75.0)		
Female	8 (25.0)	8 (25.0)	16 (25.0)		
Age (years)				1.24	0.54
< 60	11 (34.4)	8 (25.0)	19 (29.7)		
60 – 70	11 (34.4)	12 (37.5)	23 (35.9)		
> 70	10 (31.2)	12 (37.5)	22 (34.4)		
$\bar{x}$ (years)	64.91	67.20	66.08		
SD (years)	11.05	8.23	9.74		
Min (years)	48	51	48		
Max (years)	87	80	87		
NYHA Classification				0.00	1.0
Class 2	9 (28.1)	9 (28.1)	18 (28.1)		
Class 3	23 (71.9)	23 (71.9)	46 (71.9)		
Ejection fraction				0.76	0.96
< 40%	5 (15.6)	5 (15.6)	10 (15.6)		
40 - 60%	15 (46.9)	16 (50.0)	31 (48.4)		
> 60%	12 (37.5)	11 (34.4)	23 (35.9)		
No Comorbidities	2 (6.3)	3 (9.4)	3 (9.4)	1.8	0.72
Comorbidities				1.6	0.81
DM, HT	9 (28.1)	5 (15.6)	14 (21.9)		
DLP, HT, CKD	9 (28.1)	11 (34.4)	20 (31.3)		
DLP, HT,	7 (21.9)	8 (25.0)	15 (23.4)		
Stroke					
DLP, HT, DM, CKD	5 (15.6)	5 (15.6)	10 (15.6)		
Pre-op HF	6 (18.8)	5 (15.6)	11 (17.2)		

Table 2. Comparison of functional status scores at baseline before discharge from the hospital between the experimental group and the control group using the Mann-Whitney U test.

Group	Functional status baseline				Mann Whitney U (Z)	*P* - value
	Median	Max	Min	Mean Rank		
Telehealth (n = 32)	35	38	29	33.8	470	0.57
Control (n = 32)	34	39	28	31.2		
Total (n = 64)	34.5	39	28			

A low score indicates a high ability to perform daily activities (functional status)

The comparison of the ESDS scores using unpaired *t* - test at week 2 and week 4 after discharge from the hospital between the telehealth group and the control group. At week 2, the mean ESDS score for the control group was significantly higher than those in the telehealth group (23.8 and 20.0, respectively) ($P = 0.03$). At week 4, the mean ESDS score in the control group was significantly higher than those in the telehealth group (13.59 and 17, respectively) ($P = 0.007$). (Table 3).

Rehospitalization

Rehospitalization within 28 days after discharge from the hospital between the telehealth group and the control group using Fisher's exact test. This study found that 5 of 64 patients (7.8%) were rehospitalized because of cardiac- pulmonary- and surgery-related issues within 28 days after discharge. In the control group, 5 of 32 patients (15.6%) were rehospitalized, and no patients were rehospitalized in the telehealth group. It was found that the experimental group had a lower rate of rehospitalization than the control group ($P = 0.026$). (Table 4).

The comparison of rehospitalization and revisitation (ER, OPD) within 28 days after discharge from the hospital between the telehealth group and the control group using the chi-square test (χ^2). The findings revealed that the rehospitalization and revisitation rates in the telehealth group (5 cases, 15.6%) were significantly lower than those in the control group (12 cases, 37.5%) ($P = 0.048$). (Table 5).

Table 3. Comparison of functional status scores at week 2 and week 4 after discharge from the hospital between the experimental group and the control group using unpaired *t* - test.

Weeks	Amount n = 64	Functional status scores (10 - 51)						*P* - value
		Telehealth (10 - 51)			Control (10 - 51)			
		Min	Max	Mean ± SD	Min	Max	Mean ± SD	
Week 2	32	10	34	20.0 ± 5.2	10	46	23.8 ± 8.1	0.003
Week 4	32	10	25	13.6 ± 3.4	10	42	17.0 ± 6.0	0.007

A low score means a high ability to perform daily activities (functional status)

Table 4. Comparison of rehospitalization within 28 days after discharge from the hospital between the experimental group and the control group using Fisher's exact test.

Group	Rehospitalization		Fisher's Exact
	Number	Rate (%)	
Telehealth (n = 32)	0	0	0.026
Control (n = 32)	5	15.6	

Table 5. Comparison of rehospitalization and revisitation (emergency, out patient department) within 28 days after discharge from the hospital between the experimental group and the control group using the chi-square test (χ^2).

Group	Rehospitalization and revisit			Total	Rate	χ^2	*P* - value
	Rehospitalization	OPD visit	ER visit				
Telehealth (n = 32)	0	4	1	5	15.6	3.9	0.048
Control (n = 32)	5	5	2	12	37.5		

Discussion

There was no difference in baseline functional status between the telehealth group and the control group. As a result of being in the postoperative recovery period in the hospital, the patients were limited in their activities physically, mentally and socially. [4, 11] Patients who participate in the telehealth group provide good cooperation throughout the delivery of health information. No one leaves the project ahead of time.

This study showed a positive impact from the telehealth program that significantly improved the functional status in patients with coronary artery bypass in the 2nd and 4th weeks after discharge. Rehospitalization was reduced during the 28 days after discharge from the hospital. When considering all, rehospitalization and revisitation (emergency, out patient department) during the 28 days was significantly lower in the telehealth group than in the control group. In accordance with Barnason S, *et al.* [21], we found that patients with CABG who enrolled in the telehealth program had a significantly higher functional status than those who did not enroll in the program ($P < 0.01$), and the number of patients returning to the emergency department was less than that in the control group. Consistent with the study of telehealth programs for patients with congestive heart failure by O'Connor M, *et al*. [20], patient vital signs, including blood pressure, pulse, oxygen saturation, and body weight, were monitored and tracked. Overall, collecting data via the internet can reduce rehospitalization rates. This finding is similar to that of the study by Kleinpell RM, *et al*. [17] on the use of telehealth intervention for patients with CABG; although the functional status was not different in the study group, the telehealth intervention reduced ER visits in 1 month.

This telehealth program monitored the patients at home via smartphone application. A focus on the risk of returning to the hospital is particularly important during the transition period after hospital discharge, promotes cardiac rehabilitation and individual symptom monitoring. Monitoring via a smartphone application and telephone call was beneficial to improving patient's compliance that affect health conditions and providing early detection of symptoms for patients with CABG at various stages. [22] As a result of Sawatzky JA, *et al*. [23] who implemented the telephone follow-up intervention in patients who had cardiac surgery, the intervention group showed significantly fewer symptoms and higher physical functioning status at 2 weeks post discharge.

Cardiac rehabilitation monitoring in this telehealth program of exercise training was based on individual health status. Exercise can promote oxygen consumption in the muscles of the elderly. [24] Promoting physical activity and active daily routines boosts exertion and increases physical activity. [23, 25, 26] Promotion of exercise and management of early symptoms have the benefit of reducing readmission within the first 30 days following discharge. [27] Patients will benefit from the promotion of postoperative cardiac surgery at an early stage, particularly elderly patients and patients with comorbidities who are at high risk for rehospitalization and require resolutions for their health problems. Thus, patients can recover and return to living at home with the correct health behavior. [28]

According to telemedicine using telephone applications in developing countries could be provided wide patients and to close the distance between rural areas and specialized hospitals. This telehealth program is a convenient approach to practice that is in line with current economic and social conditions. The researcher was able to monitor the patients, receive health information and offer consultation for patients at all times. Patients at risk for rehospitalization require advice and surveillance of symptoms before serious complications occur. Patients can thus exercise appropriately, prevent serious complications, increase their functional status and reduce rehospitalization rates with the telehealth program.

Conclusions

Patients with CABG have complex conditions and comorbidities. A telehealth program has a potentially positive impact on the improvement of functional status and can reduce rehospitalization during the 28 days after discharge from the hospital.

Learning and development of a telehealth program based on both knowledge and empirical evidence include plans for monitoring individual health statuses and is recommended for continuance of the program. These features will help nurses follow the patients remotely using a smartphone application and increase the effectiveness of patient monitoring and evaluation including cooperation with a multidisciplinary team to improve patient recovery following discharge from the hospital.

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Conflicts of interest

The authors declare that they have no conflicts of interest in the research.

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