Respiratory function and drug compliance postoperative monitoring with a mobile application after coronary artery bypass graft surgery: a randomized controlled trial

Aydanur Aydın[1], Dilek Çilingir[2], Binnaz Sever[2], Banu Aykan[2], Kübra Şimşek[2], Buket Taspınar[2], Asena Kıraç[2]

[1]Department of Nursing, Health Sciences Faculty, Gumushane Unıversıty, Gumushane, Turkey
[2]Department of Nursing, Health Sciences Faculty, Karadeniz Technical University, Trabzon, Turkey

Pielęgniarstwo Chirurgiczne i Angiologiczne 2022; 16(2): 53–59

Submitted: 29.12.2021; Accepted: 18.03.2022

Address for correspondence:
Aydanur Aydin, PhD, Gumushane University, Turkey, e-mail: aydin.aydanur@hotmail.com

Summary

Introduction: Patients do not feel competent in managing their post-heart surgery processes. They need access to the right information to manage their symptoms. A mobile app is the right tool for this process, with its accessibility and reminder features at any time.

We investigated the effects of 4-week mobile app training on respiratory functions and maintenance of drug compliance in patients after heart surgery.

Material and methods: This paper reported the findings of an experimental study, which recruited a total of 120 participants of whom all underwent heart surgery. The following outcomes were measured: TriFlo results, the Morisky Questionnaire – self-reported measure of adherence, and results of the Symptom Interpretation Questionnaire.

Results: All groups showed a significant difference in Symptom Interpretation Scale subscales after using the mobile app. When the results of the research are evaluated, it can be said that there is a need for nurses to produce new-generation technological equipment to meet the needs of new products to be used in the field of health.

Conclusions: Individuals can solve their post-operative symptom management problems with a mobile app. The use of a mobile app positively contributes to the management of the 2 most common symptoms after heart surgery. Mobile apps are used in many disease processes in the world. The results of these studies contribute to the limited information presenting results regarding drug compliance and lung capacity in patients with a bypass between mobile apps.

Key words: heart surgery, mobile health, technology, care, symptom management.

Introduction

The continuation of the perfusion of the myocardium, which could not be bled as a result of the narrowing or occlusion of the coronary vessels feeding the heart, by using arterial and vein grafts, is now provided by coronary artery bypass graft (CABG) [1]. It is aimed to maintain the perfusion of the myocardium with CABG surgery, which is used in the surgical treatment of coronary artery disease [2].

Coronary artery bypass graft surgery, which affects the patient physically, psychologically, socially, and economically, is seen as a major and high-risk surgical procedure. Respiratory system problems (atelectasis, pleural effusion, pneumothorax, etc.), thromboembolism, rib traumas, pain, fatigue, wound infections, and deterioration in renal perfusion are observed in patients with CABG [3]. In the study of Yılmaz and Çiftçi (2010), it was determined that within a week of discharge, all patients experienced problems with activity, 95.6% with nutrition, 88.9% with sleep, and 86.7% had discharge problems [4]. The fact that CABG surgery is related to a vital organ creates a sense of loss of life in the patient and affects the recovery time [5]. In a study, while all of the patients had problems in coping with stress, 80% of them stated that they had problems with social patterns such as roles and relationships [4]. In addition to these complications, anxiety, depression, unhappiness, changes in sexual life, work life and social relations are also seen [6]. Another study found that all patients experienced at least one health problem after discharge [7].

Technological development continues its speed in the field of health as in every field, and developing technological equipment is used in all processes of dis-

eases [8]. It is used as a powerful method in maintaining the follow-up of patients, patient care, and informing, in addition to the developing technology treatment methods in health [9]. In one study, it was pointed out that using the advantage of easy access to mobile apps for the maintenance of health services will provide positive contributions [10]. In another study, it was stated that the use of mobile apps in health has increased at a level acceptable to the society [11]. It is anticipated that the use of mobile apps will be beneficial in the management of postoperative problems in patients, ensuring their participation in their own care and maintaining information sharing. The mobile app is thought to be the right choice to provide the patients with the opportunity to manage their postoperative processes and to facilitate access to the right information.

Thus, in this study, we conducted a randomized controlled trial to investigate the effects of mobile applications on respiratory functions and maintaining drug compliance in patients with heart surgery who were discharged from hospital.

Material and methods

Participants

The study was conducted with 120 patients who underwent heart surgery and met the acceptance criteria of the study, without choosing the sample. Inclusion criteria for the study were the ability to read and understand Turkish, not have chronic lung disease, have been using smartphones for one year, and being 18 years of age or older. In total, 120 patients meeting the acceptance criteria (n = 30 breaths, n = 30 drugs, n = 30 both app, and n = 30 controls) were randomly grouped and included in the study. We conducted two-sample Mendelian randomization for influence of the same conditions on educational attainment in independent adult samples. In the power analysis performed using the GPOWER package program, the Morisky [11] scale score averages, which are the dependent variables of the research, were used. As a result of the analysis, the sampling power at 0.05 significance level was found to be 99.9%. There were 24 patients who did not comply with the research data, and 11 patients did not agree to participate in the study.

Study design

This study is an open randomized controlled trial. Participants knew they would be involved in a follow-up process (for up to one month after discharge) that included breathing and medication administration. The demographic characteristics of each subject were assessed prior to randomizing the subject. Randomization was performed when all individuals meeting the inclusion criteria were 120. Interventions included:

- breaths,
- drugs,
- both app,
- hospital usual controls.

Breathing practice includes painting of an inflated balloon and training to increase lung capacity to patients. Patients were asked to open this app 3 times a day and breathe with the app for at least 10 minutes. The drug app was prepared by the researchers according to the frequency of use of the drugs by the patients. The images of the drugs were uploaded to the app, and during the reminder the patients were reminded of the drugs. During the hospital follow-up phase, the existing training was applied to the patients, and they received counselling from the physician regarding the symptoms they experienced in the hospital at the frequency of follow-up.

The app, which will provide mobile-based respiratory and drug control, could not be developed by the researchers due to lack of project support. A selection was made from the app that will provide respiratory and medication control that can be downloaded via the Google play store and App store. During this selection, attention was paid to the features of the app being easy to understand, free to download, sharing the data with the researcher, and sending reminders to the patient. A separate app was selected for respiratory and medication, which included these features, and symptom control was achieved with these apps. Two different apps were selected, and the companies that developed these apps were different from each other.

Measures

The patients who met the sampling criteria were interviewed at the hospital the day before the surgery, and the introductory features questionnaire, Morisky drug compliance and symptom interpretation scale were administered by the researchers. In this interview, the patients were presented with an envelope that chose which group to be included by introducing the study. Respiratory and drug apps were introduced to the researchers and uploaded to their phones according to the envelopes that individuals chose voluntarily. Compliance of the whole group with the mobile app was provided in the hospital, and the patients were given consultancy on the app for a month after discharge. At the hospital controls one month later, the Morisky and symptom interpretation scales were repeated to the patients. Qualitative interviews were conducted with patients using mobile apps at this stage. The patients were collected with a form containing 8 ques-

tions including sociodemographic characteristics (age, gender, educational status, etc.).

Morisky Questionnaire – self-reported measure of adherence

The Morisky Questionnaire – self-reported measure of adherence (MQ) is validity study was carried out by Donald E. Morisky in 1986, and its Cronbach α value was stated as 0.61 [12]. The validity and reliability study of Turkey Hacıhasanoğlu *et al*. and the Cronbach α value was reported as 0.79 [13]. The Morisky Medication Compliance Scale is a self-assessment scale that measures drug-taking behaviour. The scale consists of 8 items. The questions in the scale are answered as yes and no; "yes = 0" and "no = 1". If the score obtained from the scale is less than 6, it indicates low compliance, between 6–8 is medium level, and 8 points and above indicates a high level of compliance. The reliability of the questionnaire in this study was confirmed with a Cronbach's α of 0.81.

Symptom Interpretation Questionnaire

For the Symptom Interpretation Questionnaire (SQ) developed by Robbins and Kirmayer, the Cronbach α value was 0.86 for the psychological subtest, 0.71 for the somatic subtest, and 0.81 for the normalizing subtest [14]. The Turkish validity and reliability study was conducted by Güleç and Sayar, and the Cronbach α values of the psychological, somatic, and normalizing subscales were 0.82, 0.76, and 0.82, respectively [15]. It is a scale that evaluates the attribution used by individuals in the interpretation of common somatic symptoms. The interpretation of 13 somatic symptoms due to a physical illness (somatic), spiritual causes (psychological), or a situational sensation due to normal environmental stimuli (normalizing) is determined by severity grading. The scale is a four-point Likert type scale. The questions are coded as "not much = 1", "sometimes = 2", "often = 3", and "very often = 4". The scale is evaluated according to its sub-dimensions, and the score increase in the somatic and psychological sub-dimensions is negative; a score increase in the normalizing sub-dimension is considered positive. The reliability of the questionnaire in this study was confirmed with a Cronbach's α of 0.89.

Data analysis

The data obtained from the study were analysed using SPSS (Statistical Package for Social Sciences) 25.0 software. The percentage, *U* Mann-Whitney, Kruskal-Wallis variance analysis, significance of the difference between 2 means in dependent independent groups, one-way analysis of variance, and correlation test were used to evaluate the data. The compatibility of the data for normal distribution was determined by using the Kolmogorov-Smirnov test. The data obtained were evaluated at 95% confidence interval and 5% significance level.

Ethical approval

Ethical approval was given by the Ethics Committee of the Scientific Research Faculty of Medicine (No. 24237859/570-571). Institutional permission and the written consent of patients were obtained. Before collecting the data, the researcher informed the patients about the purpose, method, and scope of the scientific research, and their consent was obtained.

Limitations

The subject to be researched was determined as the most frequent subjects. Since there is no project within this scope, different apps were downloaded to the phone and followed in order to manage every problem. It was difficult for both the researcher and the patients to control these two practices. On the other hand, the greater improvement in the group using both apps may be due to the warnings of these two apps at different times. Another limitation of the study was that it did not contain data on other possible problems. Due to the fact that the mobile app to be used in the initiative of the study was not developed, a separate app was used for each symptom and controlled by the patients. The limitation of the study is that the mobile app is not used for other symptoms, because only 2 symptoms are preferred after the surgery.

Implications for nursing

The use of mobile apps positively contributes to the management of the 2 most common symptoms after heart surgery.

The mobile app is an effective tool to support the use of TriFlo after surgery and to allow patients to breathe comfortably.

Although drug use is a major postoperative problem for patients, the mobile app offers ease of use. Since the use of separate mobile apps for all symptoms complicates the situation, it is important to develop mobile apps specific to the disease.

The data produced during this study is not open to data sharing because it contains patient data.

Results

Patient↑↓s' age, gender, education level, TriFlo level, number of drugs used, and Morisky and symptom in-

terpretation scale sub-dimensions were homogeneously included in the study. It was found that all parameters were not different between groups at the first measurement (Tab. 1).

In the last measurement, significant changes were observed in the MQ and SQ scale scores in all of the groups using mobile-based care support. On the other hand, it was found that the change in the control group was not significant. A significant increase in TriFlo level was determined in all app-loaded groups ($p < 0.05$). The increase in MQ of patients who loaded both apps was found to be higher than those who loaded only drug app ($p < 0.05$). There was a decrease in SQ-psychological and SQ-somatic values, and the value was lower than the control group. While the highest increase SQ-normalization was in individuals who installed both apps, it was seen that it decreased slightly in the control group ($p < 0.05$). The Morisky Questionnaire – self-report measure of adherence last measurement mean scores were found to be highest in the drug group and lowest in the control group. It was determined that the mean scores of the scales between the groups and the difference between the first and last measurement showed a significant change ($p < 0.05$) (Tab. 2).

In the last measurement, the Morisky, symptom interpretation scale, somatic, and normalizing sub-dimen-

Table 1. Characteristics of patients in the groups ($n = 120$)

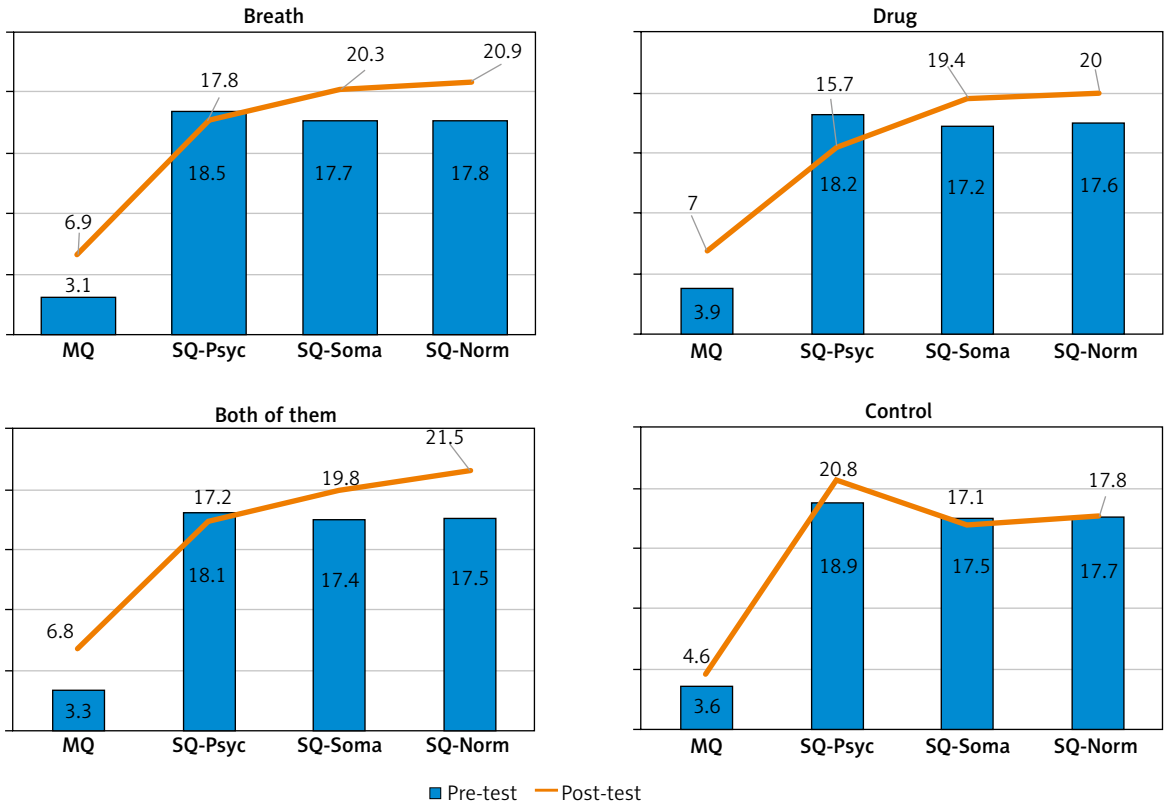
Characteristic	Breathing $n = 30$	Drug $n = 30$	Both $n = 30$	Control $n = 30$	*p*-value
Age [years]*	56.1 (11.3)	57.2 (11.1)	57.3 (11.7)	56.3 (11.8)	0.98
Gender**					
Woman	12 (40.0)	12 (40.0)	12 (40.0)	12 (40.0)	1.00
Man	18 (60.0)	18 (60.0)	18 (60.0)	18 (60.0)	
Education level**					
Primary school	14 (46.7)	14 (46.7)	14 (46.7)	14 (46.7)	1.00
Second school	7 (23.3)	7 (23.3)	7 (23.3)	7 (23.3)	
High school	4 (13.3)	4 (13.3)	4 (13.3)	4 (13.3)	
University	5 (16.7)	5 (16.7)	5 (16.7)	5 (16.7)	
TriFlo class**					
I	23 (76.7)	23 (76.7)	23 (76.7)	23 (76.7)	1.00
II	4 (13.3)	4 (13.3)	4 (13.3)	4 (13.3)	
III	3 (10.0)	3 (10.0)	3 (10.0)	3 (10.0)	
Medicine number*	3.9 (2.6)	3.8 (2.4)	3.7 (2.6)	3.8 (2.5)	0.99
MQ**					
< 6	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	1.00
6–8	–	–	–	–	
8	–	–	–	–	
SQ*					
Psychological	18.5 (6.3)	18.2 (6.2)	18.1 (6.1)	18.9 (6.0)	0.92
Somatic	17.7 (3.8)	17.4 (3.4)	17.4 (3.9)	17.5 (3.7)	0.95
Normalizing	17.6 (3.4)	17.6 (3.8)	17.5 (3.6)	17.7 (3.6)	0.99

*MQ – Morisky Questionnaire – self-report measure of adherence, n – number of patients, SQ –Symptom Interpretation Questionnaire, * mean (standard deviation), ** n (%), p – statistical significance*

Table 2. Findings in the groups between the first and last follow-up decrease or increase rate ($n = 120$)

Variable	Breathing ($n = 30$)	Drug ($n = 30$)	Both ($n = 30$)	Control ($n = 30$)	*p*-value
TriFlo class	1.3 ↑	1.3 ↑	1.3 ↑	0.9 ↑	0.01
MQ	3.1 ↑	3.5 ↑	3.8 ↑	0.1 ↑	< 0.0001
SQ-psychological	0.7 ↓	0.9 ↓	2.4 ↓	2.1 ↑	0.03
SQ-somatic	1.2 ↓	1.1 ↓	1.4 ↓	2.3 ↑	0.04
SQ-normalizing	3.3 ↑	2.4 ↑	3.9 ↑	0.1 ↓	0.03

MQ – Morisky Questionnaire – self-report measure of adherence, SQ – Symptom Interpretation Questionnaire



MQ – Morisky's Questions- self- report measure of adherence, SQ –Symptom Interpretation Questionnaire

Fig. 1. According to measurement frequencies groups values of scale scores

sions of the patients who were offered a mobile-based care support system increased, while a decrease in the psychological sub-dimension was detected. In the control group, a decrease in the psychological and somatic sub-dimensions and an increase in the Morisky and normalizing sub-dimensions were determined (Fig. 1).

Discussion

Managing the problems of patients with mobile health app increases the quality of service. Our research evaluates the TriFlo level and symptom interpretation status with mobile apps for breathing and drug compliance, which are the most common problems that patients undergoing cardiac surgery may experience.

Compliance of the drugs and respiratory support with the mobile app and respiratory function results of the patients after cardiac surgery were compared with the control group. In the first measurement, it was observed that there was no significant difference between the study and control group patients in terms of introductory characteristics, gender, education level, TriFlo level, number of drugs used, and Morisky and symptom interpretation scale scores. These results show that the study and control group patients were homogeneous in terms of both introductory features and the measurements used in the study. In a tele-rehabilitation study in which patients with open heart surgery were followed at home, it was stated that telephone consultation sessions with a health monitoring-based program had a positive effect on the health of the patients [16]. The mobile app initiative of the research does not include problem management, and it draws attention to the successful results of the intervention applied to a similar patient group.

It was found that the TriFlo level of the mobile app users made a significant difference compared to the non-users, and this difference was similar in both mobile apps. While the highest MQ level was in the group using both apps, a significant difference was observed in the group using both drugs and both apps compared to the control group. In a study conducted with chronic lung patients, it was stated that the use of mobile apps was effective and created significant changes in patients' medication and oxygen saturation follow-up [17]. In a systematic analysis examining mobile apps aiming to change health behaviour, it is pointed out that a mobile app is an effective tool in the management of problems [18]. It was seen that the mobile app used in the research had a positive effect on TriFlo and drug use.

It was determined that Morisky scale scores were low in the first measurement and high in the last mea-

surement, and the difference between groups was significant in the last measurement. Since no mobile application research supporting drug use could be found, the results of the research were compared with different drug interventions. In a study conducted by Griffo *et al*., it was found that the mean scores of the Morsiky drug compliance scale of the patients after CABG surgery were low [19]. In a study in which a drug compliance plan was applied, it was noted that the mean Morisky score of the patients in the intervention group was significantly higher than in the control group [20]. In another study, it was noted that patients with myocardial infarction had medium Morsiky scale scores, and high scale scores were created in individuals who were treated with quality health behaviours [21]. The results of the research show that intervention is necessary to improve drug adherence and that the mobile app is effective in drug adherence.

When the symptom comments of the individuals in the drug and respiratory groups within the scope of the study were examined, it was found that the individuals with high normalizing sub-dimension scores were from the respiratory group. While it was observed that individuals who were positively affected psychologically were mostly in the drug group, all variables were more positively affected in the group in which both apps were loaded. It was stated in a study that the problems experienced cannot be associated with psychological problems, and that patients who have had heart surgery may experience anxiety, depression and stress a year later [22, 23]. In a study conducted using a similar measurement tool with patients with myocardial infarction, it was noted that the high normalizing evaluations of somatic evaluation were low [24]. Since the symptom interpretation scale is mostly used in the definition of psychological diseases, the data related to the research were discussed limited. However, the fact that all scale parameters were higher in individuals who were loaded with both apps compared to other applied groups may indicate that it is an effective parameter in controlling symptoms.

Conclusions

Individuals who have undergone heart surgery have problems in post-operative symptom management and feel inadequate to cope with these problems. The search for new methods continues to cope with the aforementioned problems and accelerate recovery. It is a popular topic to use mobile technologies to control this situation. Today, mobile apps make our lives easier with different options besides their use in daily life. It is seen that patients who have heart surgery have effective results both in providing drug controls and in increasing their lung capacity. Mobile apps are used in many disease processes in the world. The results of these studies contribute to the limited information presenting results regarding drug compliance and lung capacity in patients with bypass between mobile apps.

Acknowledgements

The authors would like to thank all the participants in this study.

The authors declare no conflict of interest.

References

1. Alkan A, Selçuk T, Tekinalp M. The segmentation of the coronary arteries based decision support system Kahramanmaraş Sütçü İmam University. J Eng Sci 2016; 19: 99-103.
2. McMurray JJ, Adamopoulos S, et al. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2012: the task force for the diagnosis and treatment of acute and chronic heart failure 2012 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association (HFA) of the ESC. Eur Heart J 2012; 14: 803-869.
3. Yavuz D. Comparison of symptoms and self-efficacy experienced at home by patients with coronary artery bypass graft and heart valve surgery. Maltepe University, Graduate Education Institute 2019.
4. Yılmaz M, Ciftçi S. A model for determining home care needs of individuals who have undergone open heart surgery: Functional health patterns. Turk Gogus Heart Checkers 2010; 18: 183-189.
5. İlkeli E, Duzgun AC. The mortality ratio and the validity of the original EuroSCORE in patients over the age of 70 undergoing cardiovascular surgery. Pielęg Chir Angiol 2021; 3: 130-134.
6. Erkuş, B. Possible complications after cardiac surgery and nursing care. Available from: http://www.acibademhemsirelik.com/e-dergi.
7. Direk F, Şenol Çelik S. Postoperative problems experienced by patients undergoing coronary artery bypass graft surgery and their self-care ability after discharge. Türk Göğüs Kalp Damar Cerrahisi Dergisi 2012; 20: 530-535.
8. Fernandes A, Barros L, Barreira L, et al. Effects of different processing technologies on chemical and antioxidant parameters of Macrolepiota procera wild mushroom. LWT Food Sci Technol 2013; 54: 493-499.
9. Lyles CR, López A, Pasick R, Sarkar U. 5 mins of uncomfyness is better than dealing with cancer 4 a lifetime: an exploratory qualitative analysis of cervical and breast cancer screening dialogue on Twitter. J Cancer Edu 2013; 28: 127-133.
10. Krebs P, Duncan D. Health app use among US mobile phone owners: a national survey. JMIR mHealth uHealth 2015; 3: 101.
11. Stoyanov SR, Hides L, Kavanagh DJ, et al. Mobile app rating scale: a new tool for assessing the quality of health mobile apps. JMIR mHealth and uHealth 2015; 3: 1-10.
12. Morisky DE, Ang A, Krousel-Wood M, Ward H. Predictive validity of a medication adherence measure in an outpatient setting. J Clin Hypertens (Greenwich) 2008; 10: 348-354.
13. Hacıhasanoğlu Aşılar R, Gözüm S, Çapık C, Morisky DE. Validity and reliability of the Turkish version of the eight-item Morisky drug compliance scale in hypertensive patients. Anatolian J Cardiol 2014; 14: 692-700.
14. Robbins J, Kirmayer L. Attributions of common somatic symptoms. Psychol Med 1991; 21: 1029-1045.
15. Güleç H, Sayar K. Validity and reliability of the Turkish Form of Symptom Interpretation Questionnaire. J Clin Psychiatr 2005; 8: 31-36.

16. Ding EY, Erskine N, Stut W, et al. MI-PACE home-based cardiac telerehabilitation program for heart attack survivors: usability study. JMIR Hum Factors 2021; 8: e18130.
17. Hardinge M, Rutter H, Velardo C, et al. Using a mobile health application to support self-management in chronic obstructive pulmonary disease: a six-month cohort study. BMC Med Inform Decis Mak 2015; 15: 46.
18. Free C, Phillips G, Galli L, et al. The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. PLoS Med 2013; 10: e1001362.
19. Griffo R, Ambrosetti M, Tramarin R, et al. Effective secondary prevention through cardiac rehabilitation after coronary revascularization and predictors of poor adherence to lifestyle modification and medication. Results of the ICAROS Survey. Intern J Cardiol 2013; 167: 1390-1395.
20. Bahramnezhad F, Sanaie N, Jackson AC, Shariati E, Atashzadeh-Shoorideh F. The of effect of partnership-based education on adherence to the treatment plans in open heart surgery. J Edu Health Prom 2021; 10: 353.
21. Lee YM, Kim RB, Lee HJ, et al. Relationships among medication adherence, lifestyle modification, and health-related quality of life in patients with acute myocardial infarction: a cross-sectional study. Health and Qual Life Outcomes 2018; 16: 100.
22. Rosson S, Monaco F, Miola A, et al. Longitudinal course of depressive, anxiety, and posttraumatic stress disorder symptoms after heart surgery: a meta-analysis of 94 studies. Psychosom Med 2021; 83: 85-93.
23. Keskin G. Neurocognitive dysfunction after cardiac surgery process. Pielęg Chir Angiol 2021; 15: 68-73.
24. Zhang W, An Y, Xiu H, et al. Applying a psychological nursing care quality evaluation index in hospitalized patients: a pilot study. Nur Forum 2022; 57: 26-33.