

Impact of Digital Nursing Interventions on Depressive Symptoms in Patients with Mechanical Heart Valves: A Quasi-Experimental Study

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Abstract

Background Warfarin therapy remains the primary strategy to prevent thromboembolism in patients with mechanical heart valves. However, long-term use of warfarin is often associated with psychological burdens, particularly depression, which can negatively affect adherence and clinical outcomes. Recent advances in digital health have highlighted remote nursing as an effective approach to provide education, continuous monitoring, and psychosocial support for patients with chronic conditions. This study aimed to evaluate the effectiveness of digital nursing interventions on depression among these patients.

Methods This quasi-experimental study was conducted on 50 patients with mechanical heart valves referred to Seyed Al-Shohada Teaching Hospital in Urmia in 2025. Participants were selected using convenience sampling and randomly assigned to intervention ($n = 25$) and control ($n = 25$) groups. The intervention group received tele-nursing care through the Warfarin and Depression module of the Warfarin Assistant application, developed by the research team, while the control group received routine care. Depression was assessed before and 3 months after the intervention using the Beck Depression Inventory-II. Data were analyzed with SPSS version 20 using chi-square, Fisher's exact test, and independent t-test.

Results Baseline demographic and depression characteristics were comparable between groups, with no significant differences in age, gender, duration of valve replacement, or pre-intervention depression scores. Following the three-month intervention, the intervention group demonstrated significant reductions in total depression ($p = 0.01$) and anhedonia scores ($p = 0.01$), while negative self-affect showed a non-significant decrease ($p = 0.12$). These findings suggest that such telenursing interventions may be effective in alleviating depressive symptoms in these patients.

Conclusion Telenursing interventions, delivered through the Warfarin and Depression module, can significantly alleviate depressive symptoms in patients with mechanical heart valves on warfarin therapy. Healthcare administrators should consider integrating such interventions into routine cardiac care protocols to strengthen psychological support and improve clinical outcomes.

Keywords Depression, Digital health, Heart valve prosthesis, Nursing care, Telenursing, Warfarin

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1 Introduction

Heart valve diseases constitute a significant subset of cardiovascular pathologies, second only to ischemic heart diseases in terms of prevalence within clinical practice. These conditions encompass a broad spectrum of structural and functional abnormalities affecting the cardiac valves, including stenosis or regurgitation of the mitral, aortic, tricuspid, or pulmonary valves. If left untreated, such disorders can precipitate severe, life-threatening complications, including heart failure, cardiac arrhythmias, or cerebrovascular accidents (CVA).^[1,2] Mechanical heart valves are widely recognized for their exceptional durability and sustained hemodynamic performance, making them a cornerstone of surgical intervention for severe valvular heart disease. However, their implantation introduces a significant clinical challenge: the obligatory requirement for lifelong anticoagulation therapy, typically with warfarin, to mitigate the risk of thromboembolic complications, such as valve thrombosis or CVA. The necessity of anticoagulation arises from the thrombogenic potential of mechanical valves, which can predispose patients to clot formation in the absence of adequate prophylactic measures.^[3,4] While warfarin significantly improves survival and reduces thrombotic complications, its use is often associated with strict treatment adherence, dietary and drug interactions, and frequent laboratory monitoring of Prothrombin Time/International Normalized Ratio (PT/INR).^[5] The obligations associated with mechanical heart valve implantation, particularly the need for lifelong anticoagulation therapy and regular medical monitoring, impose a substantial psychological burden on patients. These demands can significantly heighten their susceptibility to mental health challenges, with depression being a particularly prevalent concern.^[6] Depression represents one of the most prevalent psychiatric comorbidities among patients with cardiovascular diseases. Meta-analyses have demonstrated that nearly half of individuals with chronic cardiac conditions experience depressive symptoms, which can significantly undermine treatment adherence and adversely affect their overall prognosis.^[6] Patients with mechanical heart valves face heightened vulnerability due to the persistent stress associated with monitoring INR levels, the fear of bleeding or clotting complications, lifestyle restrictions, and the lifelong reliance on anticoagulation therapy, all of which can profoundly diminish their psychological resilience and overall quality of life.^[7] Considering the high prevalence of depression and its detrimental effects on treatment adherence and clinical outcomes in this population, there is a critical need for targeted interventions to mitigate depressive symptoms. Depression in patients with mechanical heart valves not only diminishes their motivation to sustain treatment

but also heightens the risk of poor adherence, increased hospitalization rates, and elevated mortality.^[6,7]

In recent years, digital health solutions, such as tele-nursing, have emerged as promising strategies to address gaps in patient education, remote monitoring, and psychological support, enhancing the management of chronic conditions.^[8] Remote nursing, facilitated through mobile applications, enables continuous communication between nurses and patients, providing timely education, reminders, emotional support, and personalized guidance. Evidence suggests that such interventions can significantly alleviate depressive symptoms by enhancing patient engagement, reducing feelings of isolation, and offering immediate access to psychosocial support.^[9,10] Given the increasing accessibility of smartphones and internet services in Iran, remote nursing applications may provide an efficient and scalable approach to improving the mental health of patients receiving long-term anticoagulation therapy.

Accordingly, this study was designed to rigorously evaluate the effectiveness of the WarDep module of the Warfarin Assistant application in reducing depressive symptoms among patients with mechanical heart valves undergoing warfarin therapy.

2 Methods

Study Population

The study population consisted of individuals with mechanical heart valves undergoing warfarin therapy, who were referred to Seyyed al-Shohada Teaching Hospital in Urmia in 2025.

Sample Size and Sampling

Based on the study by Li et al.^[11] the required sample size was determined using the mean and standard deviation of depression scores following the intervention. Assuming a significance level of 5% ($\alpha = 0.05$), a 95% confidence interval, and a statistical power of 90% ($1 - \beta = 0.90$), the calculation indicated that 21 participants per group were necessary. To accommodate an anticipated dropout rate of 20%, the sample size was increased to 25 participants per group, yielding a total of 50 participants. Eligible patients were initially recruited through convenience sampling and subsequently randomized to either the intervention group ($n = 25$) or the control group ($n = 25$) using a random-number table.

$$1. N = \frac{(z_{1-\frac{\alpha}{2}} + z_{1-\beta})^2 \times (S_1^2 + S_2^2)}{(n_1 - n_2) \times 2}$$

$$2. n = \frac{(1.96 + 1.28)^2 \times (11.3^2 + 9.2^2)}{(44.1 - 33.8)^2} \sim 21$$

Inclusion and Exclusion Criteria

Participants were included if they had a mechanical heart valve, were at least 6 months post-surgery, had no

psychiatric or cognitive disorders, had internet access, and provided informed consent. They were excluded if they failed to complete questionnaires or died during the study.

Study Design and Procedure

Module Design and Development

The development of the WarDep module proceeded in three stages. First, a needs assessment was conducted through interviews with 10 patients to identify their care requirements, followed by consultations with nurses, cardiologists, and psychologists. Key themes were extracted, and the module content was designed based on a comprehensive literature review, with expert validation ensuring content accuracy and relevance. Second, the module prototype was developed for the Android platform, with identified issues addressed during iterative testing. Finally, user evaluation was performed by assessing satisfaction using the Questionnaire for User Interaction Satisfaction (QUIS) in five non-study patients over a three-day period, and their feedback was incorporated into the final version of the module.

Intervention

This study used a quasi-experimental design with a pre-test and post-test. Following approval from the institutional ethics committee (IR.UMSU.REC.1403.328), eligible patients were provided with detailed information regarding the study objectives, procedures, potential risks, and benefits, and written informed consent was obtained from all participants. A total of fifty patients who met the inclusion criteria were randomly assigned to either the intervention or control group, with 25 participants in each group.

The control group received standard nursing care, which included comprehensive education on warfarin therapy, its potential interactions, and complications.

The intervention group had access to the WarDep module for 3 months. The module provided multifaceted support for patient self-management, including educational content on warfarin therapy, information on its interactions, medication reminders, psychological counseling, and 24-hour patient support, as well as timely responses to patient inquiries.

Post-intervention data were collected immediately following the 3-month period to evaluate the effectiveness of the WarDep module in improving patient knowledge and overall management of warfarin therapy.

Outcome Measure: Depression

Beck Depression Inventory-II (BDI-II), short form (13 items)

The 13-item short form of the Beck Depression Inventory was selected to minimize respondent burden while

maintaining psychometric validity, which is particularly important in vulnerable clinical populations. The BDI-II assesses emotional, cognitive, motivational, and physiological symptoms of depression. Items are scored 0–3; total scores range 0–39.

- Negative affect toward self: Items 1, 2, 3, 4, 5, 6, 7, 10

- Anhedonia: Items 7, 8, 9, 11, 12, 13

* Item 7 is included in both subscales.

Scoring involves summing responses. If multiple options are marked, only the highest score is counted. Content, face, and criterion validity of BDI-II have been confirmed in previous studies. Cronbach's alpha was above 0.7.^[12,13]

Data Analysis

All collected data were systematically coded and entered into SPSS version 20 for statistical analysis. Descriptive statistics, including means, standard deviations, and frequency distributions, were used to summarize the demographic and clinical characteristics of the study participants. The normality of the data distribution was assessed using the Kolmogorov–Smirnov test, which indicated that the data were normally distributed (Table 1). Analytical statistics were applied to evaluate the effects of the intervention on depression scores. Therefore, Parametric tests were employed to compare outcomes within groups (pre-test versus post-test) and between groups (intervention versus control). Statistical significance was set at $p < 0.05$.

Table 1 Normality assessment of data distribution

Variable	Before intervention		After intervention	
	Control	Intervention	Control	Intervention
Depression	K-S = 0.128	K-S = 0.153	K-S = 0.159	K-S = 0.125
	*p = 0.20	*p = 0.13	*p = 0.10	*p = 0.20

* Kolmogorov–Smirnov test

3 Results

The demographic characteristics of the participants in the control and intervention groups are presented in Table 2. Quantitative analysis showed that the mean age of participants in the control group was 46.12 years (SD = 13.61), while the intervention group had a mean age of 43.72 years (SD = 11.45). The mean duration of heart valve replacement was 73.64 months (SD = 54.92) in the control group and 68.80 months (SD = 61.99) in the intervention group. Independent t-tests revealed no statistically significant differences between the groups in age ($p = 0.50$) or history of heart valve replacement ($p = 0.77$), indicating comparable baseline quantitative characteristics.

In the control group, 32% of participants were male and 68% female, while the intervention group included 40% males and 60% females ($p = 0.55$). No statistically

Table 2 Comparison of demographic characteristics of the patients in the study groups

Variables	Groups		Sig.
	Control N (percentage)	Intervention N (percentage)	
Sex	Men	8 (32)	$\chi^2 = 0.34$ *p = 0.55
	Women	17 (68)	
Age	Control	Intervention	t = 0.67 **p = 0.50
	Mean $\pm$ SD	Mean $\pm$ SD	
	46.12 $\pm$ 13.61	43.72 $\pm$ 11.45	
History of heart valve replacement (months)	73.64 $\pm$ 54.92	68.80 $\pm$ 61.99	t = 0.29 **p = 0.77

* Chi-squared test and Fisher's exact test ** Independent sample t-test

significant difference was observed between the groups for gender ($p > 0.05$). These results suggest that the control and intervention groups were comparable in terms of baseline demographic characteristics.

Depression Scores

Before the intervention, no significant differences were observed between the groups in negative self-affect, anhedonia, or total depression scores. Specifically, the mean negative self-affect score was 4.80 (SD = 4.39) in the control group and 4.52 (SD = 4.52) in the intervention group ($p = 0.82$). For anhedonia, the control group had a mean score of 4.80 (SD = 3.13) compared to 4.88 (SD = 2.89) in the intervention group ($p = 0.92$). The total depression score was 8.96 (SD = 6.02) in the control group and 8.80 (SD = 5.83) in the intervention group ($p = 0.92$). These results indicate that baseline depression levels were comparable between groups.

Following the 3-month intervention using the WarDep module, significant reductions in depression scores were observed in the intervention group. The negative self-affect score decreased to 2.96 (SD = 2.79) in the intervention group compared to 4.60 (SD = 4.37) in the control group, showing a trend toward significance ($p = 0.12$). Anhedonia scores significantly improved in the intervention group, with a mean of 1.56 (SD = 2.88) versus 4.72 (SD = 3.11) in the control group ($p = 0.01$). The total depression score also showed a significant reduction in the intervention group, reaching 5.32 (SD = 3.21) compared to 8.68 (SD = 5.94) in the control group ($p = 0.01$) (Table 3).

4 Discussion

The present study investigated the effect of the WarDep module on depression among patients with mechanical heart valves on warfarin therapy. The findings demonstrated that, while baseline depression scores were comparable between the intervention and control groups, the 3-month intervention led to significant reductions in total depression and anhedonia scores in the intervention group. Although the decrease in negative self-affect showed a trend toward improvement, it did not reach statistical significance. These results highlight the potential of structured remote nursing programs to address psychological vulnerability in this high-risk population.

These results are consistent with previous studies highlighting the positive impact of telehealth and remote nursing interventions on psychological outcomes in cardiac patients. For instance, studies by Zheng et al. and Pogossova et al. reported that structured remote support programs can effectively reduce depressive symptoms and improve emotional well-being among patients with chronic cardiac conditions.^[14,15] Similarly, Hayati et al. found that remote nursing interventions enhanced patients' adherence to treatment and reduced psychological distress, aligning with the improvements observed in anhedonia and overall depression scores in our study.^[16] Collectively, these studies support the notion that remote, continuous, and interactive care can mitigate psychosocial stressors associated with chronic cardiac disease.

Table 3 The mean score of depression and its dimensions in participants

Variable	Groups					Sig.
	Before intervention		Sig.	After intervention		
	Control Mean ± SD	Intervention Mean ± SD		Control Mean ± SD	Intervention Mean ± SD	
Negative self-affect	4.80 ± 4.39	4.52 ± 4.52	t = 0.22 *p = 0.82	4.60 ± 4.37	2.96 ± 2.79	t = 1.57 *p = 0.12
Anhedonia	4.80 ± 3.13	4.88 ± 2.89	t = -0.09 *p = 0.92	4.72 ± 3.11	2.88 ± 1.56	t = 2.63 *p = 0.01
Total depression scores	8.96 ± 6.02	8.80 ± 5.83	t = 0.09 *p = 0.92	8.68 ± 5.94	5.32 ± 3.21	t = 2.48 *p = 0.01

* Independent sample t-test

The observed reduction in anhedonia and total depression scores may be attributed to multiple factors inherent to the WarDep module. The program provided regular education, medication reminders, nutritional guidance, and psychological support, which together likely contributed to improved emotional regulation and perceived support.^[17] By facilitating ongoing engagement and immediate access to psychosocial resources, the module may have strengthened patients' coping strategies, self-efficacy, and sense of control over their treatment. These findings echo the work of Keshavaraz et al., who emphasized that multi-component telehealth interventions combining education, monitoring, and psychological support are more effective in alleviating depressive symptoms than standard care.^[18]

Notably, the modest change in negative self-affect suggests that certain emotional dimensions may require longer or more intensive interventions to achieve significant improvement.^[19] This aligns with prior research indicating that entrenched negative self-perceptions in chronic cardiac patients may be less responsive to short-term interventions.^[20]

Overall, the current findings underscore the value of remote nursing interventions in improving psychological outcomes for patients with mechanical heart valves, complementing prior evidence on telehealth effectiveness in chronic disease management. The study not only reinforces the clinical utility of digital health platforms for mental health support but also provides a practical framework for integrating remote nursing into standard cardiac care. However, this study has some limitations, including a small sample size, a single-center design, and a short duration of intervention. Future research should address these limitations to further validate and extend these findings. Future studies could explore longer follow-up periods, integration of cognitive-behavioral components, and larger sample sizes to further enhance the efficacy of remote nursing programs for depression management.

5 Conclusion

The present study demonstrates that the WarDep module is effective in reducing depression symptoms among patients with mechanical heart valves taking warfarin. Significant improvements were observed in both negative self-affect and anhedonia dimensions, as well as total depression scores, in the intervention group compared to the control group. These findings highlight the potential of remote nursing interventions to enhance psychological well-being and improve the overall quality of life in cardiac patients. Implementing such telehealth programs could serve as a valuable adjunct to standard care, offering continuous support, education, and monitoring

for patients at risk of depression. Healthcare authorities are recommended to integrate telehealth programs such as WarDep into healthcare systems to better support cardiac patients at risk of depression. Key strategies include investing in professional training to ensure the effective delivery of remote interventions, allocating sufficient funding and infrastructure to improve accessibility, particularly in underserved areas, and promoting ongoing research to assess long-term outcomes. Implementing these measures can substantially enhance mental health, alleviate the burden of depression, and ultimately improve the overall quality of life among cardiac patients.

Declarations

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Artificial Intelligence Disclosure

An AI-based language tool was used only for grammar checking and correction of typographical errors. The authors take full responsibility for the final content of the manuscript.

Authors' Contributions

All authors contributed to the study concept, design, data collection, and preparation of the manuscript. The final version was reviewed and approved by all authors, and there were no disagreements regarding any part of the paper.

Availability of Data and Materials

The data that support the findings of this study are available on request from the corresponding author.

Conflict of Interest

The authors declared no conflict of interest.

Consent for Publication

Not applicable.

Ethical Considerations

This study was conducted after receiving ethical approval from the Ethics Committee of Urmia University of Medical Sciences under the Code of Ethics IR.UMSU.REC.1403.328.

Considering the positive outcomes of the study and in adherence to the principle of justice in healthcare, the WarDep module was provided to the control group after the completion of the intervention.

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