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Biofeedback to Improve Heart Rate Variability in Patient with Coronary Artery Disease

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ABSTRACT

Background & Objective: Abstract Coronary artery disease (CAD) is a leading cause of morbidity and mortality worldwide. Patients with CAD often experience decreased heart rate variability (HRV), reflecting an imbalance in the autonomic nervous system and associated with an increased risk of cardiovascular disease. Biofeedback is a non-pharmacological intervention that helps individuals control the body's physiological responses, such as heart rate and breathing, through real-time visual or auditory feedback. The purpose of this article is to examine the role of biofeedback in improving HRV in patients with CAD. **Method:** The writing method is based on the application of biofeedback as a complementary intervention in patients with CAD, with HRV monitoring before and after the intervention. Biofeedback is performed through controlled breathing exercises and focused relaxation at a specific duration and frequency. **Result:** The results of the application showed an increase in HRV values after biofeedback, indicating improved autonomic nervous system regulatory function and a reduced stress response. **Conclusion**: Biofeedback has the potential to be an effective and safe non-pharmacological intervention to improve HRV in patients with CAD and can be recommended as a complementary therapy in nursing practice and cardiac rehabilitation.

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Introduction

Introduction Coronary artery disease (CAD) is a major global health problem and a leading cause of high morbidity and mortality (Nowbar et al., 2019). CAD occurs due to narrowing or blockage of the coronary arteries, resulting in reduced blood flow to the heart muscle. This condition not only impacts cardiovascular function but also

affects the balance of the autonomic nervous system, which plays a crucial role in heart rate regulation (Lokesh & Devendra Khurana, 2025).

One important indicator of autonomic nervous system function is heart rate variability (HRV), which is the variation in the time interval between consecutive heartbeats (Gullett et al., 2023). Low HRV in CAD patients is associated with increased sympathetic nervous activity and decreased parasympathetic activity, which contributes to an increased risk of arrhythmias, recurrent cardiovascular events, and mortality (Khan et al., 2019). Therefore, improving HRV is an important target in rehabilitation and secondary prevention efforts in CAD patients.

Management of CAD patients generally focuses on pharmacological therapy, interventional measures, and lifestyle modifications. However, non-pharmacological approaches are needed as complementary therapies to help optimize cardiovascular function and reduce stress responses. One non-pharmacological intervention that is developing and showing promising results is biofeedback. Biofeedback is a technique that allows individuals to consciously monitor and control the body's physiological responses through visual or auditory feedback, such as heart rate, breathing patterns, and heart rate variability (Kennedy & Parker, 2019).

Biofeedback, specifically heart rate variability biofeedback (HRV-BF), works by training patients to perform controlled breathing at specific resonance frequencies to increase parasympathetic nervous system activity and improve autonomic nervous system balance (Hasuo et al., 2020). Several studies have shown that biofeedback can increase HRV, decrease resting heart rate, and reduce stress and anxiety in patients with cardiovascular disorders (Carola et al., 2025; Goessl et al., 2017). This intervention is relatively safe, easy to learn, and can be performed independently after appropriate education (Weerdmeester et al., 2020).

In cardiac nursing and rehabilitation practice, biofeedback has great potential to be integrated as part of complementary interventions. However, the application of biofeedback in CAD patients still requires further scientific study to strengthen the evidence regarding its effectiveness in improving HRV. Therefore, this article aims to discuss the role of biofeedback as a non-pharmacological intervention in improving heart rate variability in patients with coronary artery disease. This is expected to support the development of evidence-based nursing care and improve patients' quality of life.

Objective

This article aims to discuss the role of biofeedback as a non-pharmacological intervention in improving heart rate variability in patients with coronary artery disease.

Method

Research Design

This study uses a case study, with the aim of in-depthly describing the application of biofeedback to improve heart rate variability (HRV) in Coronary Artery Disease (CAD) patients. The case study design was chosen to examine physiological changes and the patient's subjective response to intensive intervention.

Research Subjects

The study subjects were adult male patients with a diagnosis of CAD undergoing a cardiac rehabilitation program. Inclusion criteria included:

1. Patients with a stable CAD diagnosis.
2. Low HRV based on baseline measurements.
3. Willingness to participate in biofeedback intervention.

Exclusion criteria included: patients with severe arrhythmias, decompensated heart failure, or cognitive impairment that hindered biofeedback implementation.

Place and Time

The case study was conducted in the Dahlia 2 Ward of the Ciamis District General Hospital, West Java, during a 2-week treatment period.

Data Collection Techniques

Data were collected using:

1. HRV measurement using a biofeedback device or HRV monitor before and after the intervention.
2. Clinical observation of the patient's vital signs, physical expressions, and behavior.
3. Interviews to assess the patient's perception of stress, anxiety, and comfort.
4. Documentation study of the patient's medical records, including any pharmacological therapy received.

Intervention Procedure

Biofeedback was administered as a non-pharmacological intervention with the following procedures:

1. The patient sat or lay in a comfortable position.
2. The patient used a biofeedback device to monitor heart rate and HRV in real time.
3. Patients perform controlled breathing at a resonant frequency (typically 5–6 breaths per minute) while focusing on their breathing patterns and biofeedback responses.
4. Biofeedback sessions are conducted for 15–20 minutes per session, once or twice daily throughout the intervention period.
5. Patients are asked to record subjective experiences, such as feelings of calmness, relaxation, or perceptions of pain and anxiety.

Evaluation

Evaluation is conducted by comparing HRV values before and after the intervention. The patient's subjective responses to stress and comfort levels are also recorded. Increases in HRV and improved autonomic nervous system balance are indicators of intervention success.

Data Analysis

Data are analyzed using descriptive narrative analysis, emphasizing changes in HRV, vital signs, and the patient's subjective responses during the case study period.

Research Ethics

This study adheres to ethical research principles, including:

1. Obtaining written informed consent from the patient.
2. Maintaining patient confidentiality.
3. Ensure the intervention is safe and does not harm the patient (beneficence and non-maleficence).

Results

Subject Overview

The case study subject is a 58-year-old female patient diagnosed with stable coronary artery disease (CAD). The patient had low heart rate variability (HRV) values at baseline. The patient reported mild symptoms of stress and anxiety that affected his sleep and daily well-being.

HRV Changes Before and After Biofeedback

The following table shows the results of HRV measurements using a biofeedback device during the intervention period:

TABLE 1. Measurements using a Biofeedback during intervention period

	1st Session	**2nd Session**	**3rd Session**
Heart Rate	96-88 bpm	92-84 bpm	88-74 bpm
Respiratory Rate (Rr)	24-20 times/ minutes	22-18 times/ minutes	16-12 times/ minutes
Heart Rate Variability (Hrv)	18-25 ms	20-35 ms	25-40 ms
Patient Progress	The patient said "calmer but still having difficulty adjusting to deep breathing".	Patient starts to enjoy the session, looks relaxe.	Patients were able to follow visual feedback without repeated instructions and reported reduced anxiety.

TABLE 2. HRV Changes Before and after Biofeedback

Parameter	**Before**	**After**	**Change**
HR	96 bpm	74 bpm	↓ 22 bpm
RR	24 times/ minute	18 times/ minute	↓ 6 times/ minute
HRV	18 ms	40 ms	↑ 22 ms

Discussion

The results of this case study demonstrate that biofeedback has a positive impact on improving heart rate variability (HRV) in patients with Coronary Artery Disease (CAD). Consistent increases in HRV values after each biofeedback session indicate improved autonomic nervous system balance, specifically increased parasympathetic activity and decreased sympathetic nervous system dominance.

In patients with CAD, low HRV is often associated with chronic stress, anxiety, and autonomic regulatory dysfunction resulting from cardiovascular disease (Valenza,

2023). Biofeedback, specifically HRV biofeedback, works by training patients to perform controlled breathing at an optimal resonance frequency. This mechanism increases vagal tone and improves the baroreceptor reflex, thereby improving heart rate variability. The results of this case study support this theory, demonstrated by the increase in SDNN HRV values and a decrease in heart rate after the intervention.

In addition to physiological changes, this case study also demonstrated improvements in the patient's psychological responses. The patient reported decreased anxiety levels, feelings of greater relaxation, and improved sleep quality. A more stable psychological state contributed to reduced sympathetic nervous system activation, which indirectly supported the improvement in HRV. These findings align with previous research indicating that biofeedback is effective in reducing stress and improving emotional regulation in patients with heart disease.

In the context of nursing practice and cardiac rehabilitation, biofeedback has the advantage of being a safe, easy-to-learn, non-pharmacological intervention that can be independently implemented by patients after education. Nurses play a crucial role in guiding patients during biofeedback exercises, monitoring physiological responses, and providing support to improve patient adherence to the exercises (Elavally et al., 2020). Integrating biofeedback into cardiac rehabilitation programs can help improve clinical outcomes and quality of life in patients with CAD.

However, this case study has limitations because it involved only one subject, so the results cannot be broadly generalized. Other factors such as pharmacological therapy, physical activity level, and the patient's psychosocial condition can also influence HRV. Therefore, further research with experimental designs and larger sample sizes is needed to strengthen the evidence regarding the effectiveness of biofeedback in improving HRV in patients with CAD.

Conclusion

This case study concludes that biofeedback can improve heart rate variability (HRV) and reduce heart rate in patients with coronary artery disease (CAD) by enhancing autonomic nervous system balance, while also providing psychological benefits such as reduced stress and anxiety and improved relaxation. Although limited to a single patient, the findings suggest that biofeedback is a safe, simple, non-pharmacological intervention with potential application in nursing practice and cardiac rehabilitation, warranting further research with larger sample sizes to confirm its effectiveness.

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