Original Article

Effectiveness of Thermotherapy in Reducing Pain in Patients with Acute Coronary Syndrome: A Quasi-Experimental Study

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Abstract

Background: Chest pain is the most common and distressing symptom experienced by patients with Acute Coronary Syndrome (ACS), often requiring rapid and effective management. While pharmacological therapies are standard, integrating non-pharmacological interventions such as thermotherapy may enhance pain control and patient comfort.
Objective: This study aimed to evaluate the effectiveness of thermotherapy in reducing pain levels among patients with ACS.
Methods: A quasi-experimental design was employed, involving 36 patients diagnosed with ACS at a hospital in Indonesia. Participants were divided equally into an intervention group (n = 18), who received thermotherapy in addition to standard care, and a control group (n = 18), who received standard care alone. Pain intensity was measured using the Numerical Rating Scale (NRS) before and after the intervention. Data were analysed using paired t-tests to compare pre- and post-intervention pain levels within each group, and independent t-tests to assess differences between groups.
Results: The intervention group showed a statistically significant reduction in pain levels after receiving thermotherapy ($p < 0.001$). In contrast, the control group showed no significant change in pain levels ($p = 0.088$). Between-group analysis using an independent t-test revealed a significant difference in post-intervention pain scores ($p < 0.001$), indicating the effectiveness of thermotherapy.
Conclusion: Thermotherapy is effective in reducing chest pain in patients with ACS and can be considered a complementary nursing intervention alongside standard care.

Keywords: Acute Coronary Syndrome, Complementary Therapies, Nursing Care, Pain Management, Thermotherapy

INTRODUCTION

Acute coronary syndrome (ACS) is one of the leading causes of mortality worldwide. According to the World Health Organization Organization (WHO), in 2023, cardiovascular disease is the main cause of death from NCDs, accounting 17.9 million deaths annually (1). According to basic health research data in 2018, the prevalence of cardiovascular disease in Indonesia reached 1.5%, equivalent to 2,784,064 cases (2). Globally, ACS results in more than 2,5 million hospital admissions yearly (3), making it a major burden on health systems.

ACS involves blood vessel narrowing due to atherosclerotic occlusion (4). It leads to sudden cardiac arrest caused by reduced coronary blood flow (5). This results in chest discomfort, which can lead to myocardial injury and infarction if untreated (6). One of the hallmark symptoms of ACS is chest pain, typically characterized as strong, tight, or squeezing feeling. It could spread to the left arm, neck, jaw, or back and can be accompanied by symptoms such as nausea, vomiting, and perspiration (3)

Effective pain management in ACS is critical, as pain intensity often correlates with the extent of myocardial damage and influences the patient's prognosis. Pain is a discomfort sensory and emotional feeling coming from actual or potential tissue injury. According to Smeltzer, pain is any bodily discomfort an individual experiences, and it exists whenever the individual states its presence (7). The pathophysiology of pain in ACS involves ischemic injury, which triggers the release of inflammatory mediators, causing the characteristic discomfort (8).

Pain management can be implemented through pharmacological and nonpharmacological interventions (9). In pharmacological therapy, analgesic medications are extensively utilized for chest pain management treatments such as nitrates and opioids. The efficacy of pain management can be enhanced by integrating pharmacological and nonpharmacological approaches. Complementary non-pharmacological methods like thermotherapy may enhance pain control and improve patient comfort (7)

Warm or thermotherapy is a therapeutic intervention that can be administered to patients experiencing pain, as recommended by the PPNI SIKI Working Group Team (10). Thermotherapy is a therapeutic modality that introduces heat to the body, rising tissue temperature, blood flow, metabolism, and connective tissue extensibility (11). By removing hazardous metabolites like histamine and bradykinin, increasing blood flow to injured and inflamed areas, and lowering sympathetic activity, thermotherapy helps to alleviate symptoms (5).

Hot packs are methods of heating the body surface (8). Hot packs are silicate gel bags submerged in hot water and used straight on the skin to generate heat to the body for 15-20 minutes (12). A prior study by Hala et al found that using a heat pack helps to raise physiological parameters and lower intensity chest pain in ACS patients (3). Similar to the study conducted by Mohammadian et al, targeted hot pack application to the posterior area of the chest can reduce pain in ACS patients (12).

Despite these findings, the use of thermotherapy in clinical practice remains limited in Indonesia, particularly as a routine non-pharmacological intervention for ACS-related pain. Therefore, this study aims to determine the effect of thermotherapy using hot packs on pain levels in patients with Acute Coronary Syndrome, thereby providing evidence for its potential application in nursing practice.

METHODS

Research Design

This study employed a quantitative design with a Quasi-Experimental approach, utilizing the "Pre-Test and Post-Test with Control Design" methodology.

Setting

The research was conducted from January to February 2024 in the Intensive Cardiac Care Unit (ICCU) at Raden Mattaher Jambi Hospital.

Population and Sample

All ACS diagnosed patients admitted to the ICCU throughout the study period formed the study population. The sample size was calculated using the Federer formula, suitable for experimental research with two or more treatment groups. Based on this formula, a minimum of 36 respondents was required, with 18 individuals assigned to the intervention group and 18 to the control group. Inclusion criteria for the research sample selection encompassed patients with a medical diagnosis of ACS, adult patients aged over 19 years, patients with a compos mentis level of consciousness, patients experiencing moderate pain (4-6 on the NRS), patients receiving isosorbide dinitrate (ISDN) analgesic therapy, patients without speech impediments, and patients who consented to participate in the study. Exclusion criteria comprised patients with altered consciousness, psychological disorders, infectious diseases, and patients presenting with wounds, abrasions, or erythema on the chest.

Participants were selected using a consecutive sampling technique. Every eligible patient who met the inclusion criteria and was admitted to the ICCU during the study period was assessed and

invited to participate until the required sample size was reached.

Due to the nature of the intervention (thermotherapy using hot packs), blinding participants was not feasible. However, standardized procedures were implemented to reduce assessment bias, including consistent timing of pain assessments and the use of a validated instrument (NRS).

Intervention Protocol

A pre-test assessment of the pain scale was conducted 30 minutes before administering thermotherapy intervention using the NRS instrument. Subsequently, thermotherapy intervention was administered following these procedures: positioning the patient's body in a comfortable state, ensuring that the patient was relaxed, heating the hot pack in water for 10 minutes to achieve a temperature of 50º C as measured by a glass thermometer, wrapping the hot pack in a dry towel to maintain temperature and protect the patient's skin from burns, and applying the hot pack to the patient's left anterior chest. The hot pack was left in place for 20 minutes. Thermotherapy was administered to the patient twice per 12-hour period. The researcher conducted a post-test pain scale assessment 30 minutes after the second thermotherapy intervention using the NRS instrument.

Instruments

The Numeric Rating Scale (NRS) was used to examine the pain scale. A glass thermometer and a silicate-gel-based hot pack were also used in this research.

Data Analysis

The Paired Sample T-test and independent Sample T-test were used to analyze the data. Additionally, the study assessed effect size using the Hedge's correction.

Ethical Consideration

Ethical clearance was conducted with approval from the Health Research Ethics Commission of Raden Mattaher Jambi Hospital by established procedures under the ethical approval number S.114 / SPE / 1/2024. The study was conducted by ethical standards, including ensuring participant confidentiality and voluntary participation. Participants were recruited from the hospital's Intensive Coronary Care Unit (ICCU). Every qualified patient got a thorough description of the goals, methods, possible advantages, and hazards of the study. Written informed consent was obtained from each participant before enrollment, confirming their voluntary agreement to participate after understanding the information provided.

RESULTS

The demographic profile of the intervention and control group respondents is shown in Table 1. Patients with ACS in both groups mostly ranged in age from 46 to 55. Regarding sex distribution, the intervention group was mostly male whereas the control group was mostly female. Most of the intervention and control groups were elementary schools in terms of educational attainment. Most in the both groups were self-employed and jobless according to profession.

Table 1. Frequency Distribution of Respondents According to Respondent Characteristics (n=36)

Characteristics		Intervention Group		Control Group	
		f	%	f	%
Age	17-25	0	0	1	6
	26-35	0	0	0	0
	36-45	1	6	1	6
	46-55	8	44	5	28
	56-65	7	39	7	39
	>65	2	11	4	22
Sex	Man	11	61	7	39
	Woman	7	39	11	61
Education	Primary School	8	44	7	39
	Junior High School	1	6	3	17
	Senior High School	6	33	5	28
	University	3	17	3	17
Occupation	Civil Servant	2	11	1	6
	Private Sector Employee	0	0	1	6
	Self-employed/Entrepreneur	6	33	4	22
	Farmer	5	28	2	11
	Unemployed	5	28	10	56

Table. 2 reveals a notable difference between the pre-test and post-test scores in the intervention group. Ranging from 4 to 6, the intervention group's mean pre-test score was 5.06 (SD = ±0.87); the mean post-test score dropped dramatically to 1.83 (SD = ± 1.25), with a range from 0 to 4. With a substantial effect size (Hedges' correction = 2.329), a paired-sample t-test showed that this decrease was statistically significant $p < 0.001$, suggesting a considerable influence of the intervention.

By comparison, the control group saw a fairly little shift. Ranging from 4 to 6, the mean pre-test score was 5.11 (SD = ±0.90); the post-test mean was somewhat lower at 4.67 (SD = ±0.91), ranging from 3 to 6. With a modest to medium effect size (Hedges' adjustment = 0.417), the paired-sample t-test for the control group showed that this difference was not statistically significant p-value = 0.088.

Table 2. Differences In Pain Scale Pre-Test and Post-Test Between the Intervention Group and The Control Group in Patients with Acute Coronary Syndrome.

Variable	Mean (St. Deviation)	Min-Max	t	df	p-value	Effect Size
Pre-test (Intervention Group)	5.06 (± 0.87)	4-6	10.10	17	<0.001	2.329
Post-test (Intervention Group)	1.83 (±1,25)	0-4				
Pre-test (Control Group)	5.11 (± 0,90)	4-6	1.81	17	0.088	0.417
Post-test (Control Group)	4.67 (± 0,91)	3-6				

Table. 3 shows the post-test results between the intervention group and the control group, which show a statistically significant difference. The intervention group had a mean post-test score of 1.83 (SD = ±1.25), with scores ranging from 0 to 4. In comparison, the control group had a higher mean post-test score of 4.67 (SD = ±0.91), with scores ranging from 3 to 6.

An independent samples t-test revealed that this difference was statistically significant, $p < 0.001$, indicating a meaningful effect of the intervention. However, the reported effect size was relatively small (Hedges' correction = 0.254), suggesting that while the difference is statistically significant, the magnitude between groups is modest.

Table 3. Differences In Pain Scale Post-Test Between the Intervention Group and The Control Group in Patients Acute Coronary Syndrome

Variable	Mean (St. Deviation)	Min-Max	t	df	p-value	Effect Size
Post-test (Intervention Group)	1.83 (± 1.25)	0-4	-7.78	34	<0.001	0.254
Post-test (Control Group)	4.67 (± 0.91)	3-6				

DISCUSSION

Based on the study findings, it can be concluded that the effect of thermotherapy of pain scale after the administration of thermotherapy. There is a significant decrease in the pain scale in the intervention group. Meanwhile, there is only a slight decrease in the pain scale in the control group after giving thermotherapy. Our findings are consistent with prior studies showing significant pain reduction through local heat application in ACS patients. (5)

Demographic analysis revealed that most intervention group participants were 46–55 years (44%), while those in the control group were mostly aged 56–65 years (39%). These findings are consistent with Pratiwi et al. (2024), who reported a higher prevalence of ACS in individuals over the age of 46 due to age-related vascular changes that impair cardiac function. (13)

Regarding gender distribution, the majority of participants in the intervention group were male (61%). Meanwhile the majority respondents in the control group were female (61%). In the control group control, the majority respondents were women (55%) (14). However, prospective multinational registry studies have shown no significant sex-based differences in obstructive coronary artery disease rates, suggesting other underlying factors may also contribute (15). Men are at risk of ACS due to bad lifestyle, like smoking and drinking alcohol. However, women may develop ACS after menopause or because of increased blood lipid levels. It is due to the protective mechanism of estrogen in premenopausal women (13)

Based on the level of education in both groups, the majority respondents had elementary school education, whereas the intervention group at 44% and the control group 39%. This study aligns with the results of study conducted by Degano et al, which showed 58% of respondents had low education (16). Naomi's study also showed that respondents had higher education than those with lower educational levels. People with higher levels education tend to have better health awareness, hence lowering their risk of ACS. Education has an impact on individual's health. It will influence healthy living behavior, improve working condition, and access better health services. Increasing the level of education will enhance the individual's awareness of healthy lifestyle and dietary choices (14)

Based on the type of employment in intervention group, the majority of professionals was self-employed (35%). Meanwhile, in the control group, the majority were unemployed (56%). A study conducted by Naomi et al showed no association between occupation with ACS (14). However, work-related tension or stress can contribute to an increased incidence of ACS (17)

This study showed a significant effect of thermotherapy on the pain scale in the intervention group, whereas no such effect was observed in the control group among patients with ACS. Based on the study results, the subjects experienced a significant reduction in pain, which can be attributed to the selection criteria of ACS patients with a moderate pain scale (4-6 in NRS). When administered with non-pharmacological pain management, these patients exhibited a more rapid transition to a mild pain scale.

The results of this study indicated that patients frequently reported chest pain characterized by heaviness, tightness, pressure or choking. The pain radiated to left arm, neck, jaw, shoulder or epigastrium, nausea, vomiting, and sweating (18). Chest pain associated with ACS is typically severe and may occur intermittently or persistent (>20 min). The clinical manifestation of ACS is marked by chest pain symptoms referred to as angina pectoris, which occurs due to myocardial ischemia stemming from an imbalance of oxygen supply and demand caused by atherosclerosis (19)

This study supports Pomalango et al which indicated that thermotherapy effectively reduce pain levels in acute myocardial infarction

patients, showing an average pain intensity decrease from 6.40 before thermotherapy to 2.40 after the intervention (20). A study conducted by Mujhana also showed a decresase in pain scale from mean 2.87 to 2.17 (19). Moreover, this research aligns with Mohammadian et al that local heat therapy is effective in minimizing the chest pain in patients with ACS with a decrease of pain scale from moderate to mild (12).

The using of hot packs can have therapeutic effects (21). In this study, thermotherapy was administered at a temperature of 50 °C. The application of thermotherapy under 44ºC does not contribute to therapeutic effect (8). This research aligns with the study of Handhyani et al (22), which showed that the application of thermotherapy on the patient's chest area for 15-20 minutes, repeated twice or every 12 hours with a temperature of 50°C, can reduce pain in patients with ACS. The research was conducted by Moradkhani et al in a randomized controlled clinical trial involving 50 patients with ACS (5). Patients in the experimental group received thermotherapy at a temperature of 50ºC, while the placebo group received thermotherapy at 37ºC for 23 minutes. The results showed that systolic blood pressure increased ($p<0.001$), respiration rate increased ($p=0.027$), and oxygen saturation increased significantly ($p=0.003$) in the experimental group compared with the control group. It highlights the physiological benefits of properly applied thermotherapy.

Non-pharmacological pain management techniques demonstrate greater efficacy in cases of mild to moderate pain intensity while exhibiting reduced effectiveness when administered to patients experiencing severe pain intensity who are concurrently receiving pharmacological therapy (23). The findings of this study align with the gate control theory, which posits that warm therapy or warm compresses can attenuate pain by stimulating non-pain receptors in the skin, thereby inhibiting the pain pathway ((8). The generated heat can enhance the activity of degradative enzymes such as collagenase and accelerate the rate of catabolism(24). Potter and Perry assert that warm compresses also elicit physiological effects on the body, specifically vasodilatory effects, increased cellular metabolism, and muscle relaxation, consequently reducing perceived pain (25).

Nonpharmacological interventions, such as thermotherapy or warm therapy, are among the measures that can be utilized to enhance coronary blood flow supply and mitigate acute pain associated with ischemia in cardiac tissue (12). The application of thermotherapy can lead to vasodilation of coronary arteries, increase myocardial perfusion, and provide patient comfort (20,26,27). Our findings are consistent with prior studies showing significant pain reduction through local heat application in ACS patients. The proposed mechanism may involve vasodilation, improved perfusion, and activation of thermoreceptors that modulate pain pathways (3,8).

From a nursing perspective, thermotherapy presents a safe, cost-effective, and easily administered non-pharmacological intervention for managing pain in ACS patients. Nurses play a critical role in implementing evidence-based practices, and incorporating thermotherapy can enhance patient outcomes and comfort.

Limitations and Future Research

This study has limitations, including a small sample size and being conducted at a single healthcare facility, which restricts the generalizability of the findings. Additionally, variations in baseline characteristics and the subjective nature of pain reporting may influence outcomes. Future research should involve multicenter trials with larger, more diverse populations to validate these findings. Comparative studies assessing thermotherapy in combination with pharmacological treatments could further inform best practices in comprehensive pain management for ACS patients.

CONCLUSION

There is a significant effect of thermotherapy on the pain scale in patients with ACS. Thermotherapy represents a cost-effective, non-invasive nursing intervention that can be integrated into clinical practice to reduce pain and improve patient comfort. This intervention is particularly relevant for nurses, as it offers a practical approach to non-pharmacological pain management in ACS care. The generalizability of the results, however, should be read with care given the small sample size and single-center character of this investigation. Future multicenter studies with bigger and more varied populations are advised to confirm these findings and support the evidence base for more broad therapeutic use.

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Author Contributions
GG: Conceptualization, data collection, intervention implementation, manuscript writing.
NN: Study design, statistical analysis, interpretation of results, manuscript review.
YO: Literature review, methodological supervision, final manuscript revision, and approval of the version to be published.

Conflict of Interest Disclosure
The authors declare that there are no competing financial or non-financial interests related to this study.

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Data Availability Statement
The datasets generated and analyzed during the current study are not publicly available due to patient confidentiality policies but are available from the corresponding author upon reasonable request and with institutional approval.

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