Review Article

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The Effect of Cold Therapy in Reducing Pain among Coronary Artery Bypass Graft (CABG) Patients: A Systematic Literature Review

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ABSTRACT

Background: Postoperative pain following Coronary Artery Bypass Graft (CABG) surgery can influence patients' adaptive responses across multiple domains, including physiological function, role performance, self-concept, interdependence, and overall quality of life. It indicates that postoperative pain must be addressed immediately. Cold therapy is a nursing intervention that is safe, cost-effective, and easy to perform, and is considered to reduce post-CABG surgery pain. However, the duration and other procedural measures still need to be discussed. **Objectives:** This study aimed to review the effect of cold therapy on pain intensity among patients post CABG surgery. **Methods:** This study used a systematic review method. Articles were taken from four databases, such as ProQuest, ScienceDirect, PubMed, and Sage Journal. The process of searching and selecting articles followed PRISMA guidelines starting from identification and screening and including articles in the study. The selection criteria for the included articles required that the study population consist of postoperative Coronary Artery Bypass Graft (CABG) patients, the intervention involve the use of cold therapy or cold compresses, and the reported outcomes measure patients' pain levels. Only studies published in English or Indonesian were considered. Article assessment was carried out using JBI (Joanna Briggs Institute, critical appraisal checklists) so that eight articles were reviewed. **Results:** Eight out of 5556 articles were selected based on a defined process and criteria. Of the eight articles analysed, the results showed that there is a significant effect of cold therapy interventions on pain in patients post-CABG. Cold therapy involves using ice packs for 10 to 20 minutes, applied to the chest area with a cloth bandage at temperatures ranging from -5°C to 5°C. **Conclusions:** Cold therapy is effective for reducing pain based on the eight articles that have been analysed and recommended to be carried out as a nursing therapeutic intervention.

Keywords: Cold Therapy; Coronary Artery Bypass; Cryotherapies; Pain

INTRODUCTION

Coronary Heart Disease (CHD) is a condition where there is a blockage in one or more coronary arteries that disrupts blood flow to the heart muscle (Black & Hawks, 2014; Rahayu *et al*., 2021). CHD is a cardiovascular disease that is a common cause of death worldwide (Seymour *et al*., 2025). In 2022, coronary heart disease accounted for approximately 371,506 deaths. The incidence of CHD among adults aged 20 years and older is estimated at 20.1 million, with approximately one in ten deaths among individuals under 65 years of age attributed to CHD (National Center for Health Statistics, 2024; Tsao *et al*., 2023). CHD in Indonesia accounts for 1.5% of the population of all ages. The study shows that among 100 people of all ages, 15 people suffer from heart disease (Tampubolon *et al*., 2023). Coronary Artery Bypass Graft (CABG) is one of the medical interventions that can be performed on patients with CHD.

CABG is a surgical procedure in which a blood vessel is grafted to a blocked coronary artery so that blood can flow around the occlusion (Hinkle *et al*., 2018; Pamungkas *et al.*, 2023). It is the most common surgical procedure performed worldwide. Globally, this procedure is performed on an average of 44 per 100,000 individuals (Pamungkas *et al.*, 2024). CABG operations amounting to about 400,000, are performed annually, making it the most frequently performed major surgical procedure in the United States (US) (Bachar & Manna,

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2023; Collins & Goldberg, 2020). The average incidence rate of CABG is 62 per 100,000 population in Western European countries (Melly *et al*. 2018). Meanwhile, the incidence of CABG in Indonesia has continued to increase over the past 4 years. In 2020, the incidence of CABG was 458 cases. The number increased to 634 cases in 2021. The increase in the incidence of CABG was repeated in 2022 with 671 cases. In 2023, the incidence of CABG increased to 1010 cases (National Cardiovascular Center Harapan Kita, 2024). The high incidence of CABG is not the only problem that must be addressed.

Pain is one of the challenges and experiences felt by patients after CABG (Ahmad *et al.*, 2021; Khoiriyati *et al*., 2021). This is supported by Mentari and Rahayu (2022), which states that pain is still a symptom reported by patients after CABG. Other studies have also shown that most patients (more than 50%) experience moderate to severe pain after CABG surgery, making pain a significant postoperative problem (Elmas & Aksüt, 2025). Sternotomy performed in open heart surgery is the main cause of postoperative pain. Surgical trauma, tissue damage, and release of inflammatory mediators cause pain in patients after CABG. Chest pain after CABG can be very distressing and affect the patient's quality of life. One-third of post-CABG patients report chronic chest pain during movement, and 17% report it at rest. Pain may persist for months, reducing quality of life and impairing adaptive behaviours in physiologic, role function, self-concept, and interdependence modes (Dağcan *et al.*, 2024; Gimpel *et al*., 2019). Pain management is essential, as the ability to effectively alleviate pain reflects the quality of nursing care provided.

Nursing services to reduce post-CABG pain need to be carried out. It included nursing therapeutic interventions (non-pharmacology) and collaboration (pharmacological). The combination of pharmacological and non-pharmacological interventions shows better results in CABG (El-Naggar & Mohamed, 2020). One therapy that can be given is cold therapy. Cold therapy has become a dominant therapy in the domain of manipulative and body-based practice. It activates inhibitors to limit nerves originating from the posterior horn in the grey matter of the spinal cord (Ariawan *et al.*, 2022).

Cold therapy is one of the simple nursing interventions that can contribute to the patient's healing process by reducing pain with low cost and risk (Pishkarmofrad *et al*., 2016; Zencir & Eser, 2016). This has led to a need for more nursing education on the effective use of cold therapy, along with new research revealing the effectiveness of cold applications for pain control (Zencir & Eser, 2016). This recommendation is supported by El-Naggar and Mohamed (2020), who recommend further research to discuss cold therapy in terms of duration and other procedural actions. This study was conducted to review the effect of cold therapy on pain levels in patients after undergoing CABG.

METHODOLOGY

Design

This study was conducted using a systematic review method to discuss the effect of cold therapy intervention on pain levels in post-CABG patients. This method begins with the preparation of PICO. The PICO framework was developed to identify how cold therapy can address pain in post-CABG patients, which was arranged as follows:

Table 1: Preparation of PICO

Component	Terms	MeSH Terms
Problem/Population	Coronary Artery Bypass Graft	Coronary Artery Bypass
Intervention	Cold Therapy Cryotherapy	Cold Therapy Cryotherapy
Outcome	Pain Level Pain Score	Pain

Search Methods

A literature search in this research using Boolean operators (AND, OR, NOT) and MeSH Terms based on clinical questions was conducted. This article search refers to the PRISMA flow chart. This is depicted in Figure 1. The PRISMA flowchart was developed following latest guidelines. The preparation has been carried out through the following stages:

Stage 1

Articles were collected by two authors through four databases, namely ProQuest, ScienceDirect, Sage Journals, and PubMed. Searches were conducted using predefined keywords. Searching the ProQuest database resulted in 1,385 research articles, ScienceDirect resulted in 3,166 research articles, Sage Journal resulted in 924 research articles, and PubMed resulted in 81 research articles. The collected articles were downloaded using the BibTex format and entered into the reference manager. The results obtained were 5556 articles from all four databases. However, several articles were found to be duplicates, unavailable in full text, or inaccessible; therefore, a total of 2,587 articles were subsequently screened based on their titles and abstracts.

Stage 2

This stage was carried out by screening 2587 articles through titles and abstracts were. A total of 2577 articles were not continued to the next stage based on discrepancies in the titles and abstracts. Ten selected articles were then included in the next stage.

Stage 3

This stage was carried out by screening ten full-text articles were conducted. Two articles were excluded from the process because the population was not suitable.

Stage 4

Eight selected articles were assessed using the JBI (Joanna Briggs Institute) critical appraisal tools for randomised controlled trials and systematic reviews.

Stage 5

Eight articles that have been assessed are then analysed, and data extraction is carried out in the table attached.

Inclusion and Exclusion Criteria

The inclusion criteria for this study specified that participants must be post–CABG patients, the intervention implemented should involve cold therapy or cold compress application, and the measured outcome must be the patient's reported pain level. These criteria were established to align with the study's predetermined objectives. Only articles published in Indonesian and English were included, consistent with the authors' language proficiency, to minimise potential misinterpretation during data extraction.

Data Extraction

Data extraction was performed and presented as a table, including the author, year of publication, sample size, research aims, research method, intervention, and results.

Quality Appraisal

The authors extracted the required information and determined the quality of the study using the JBI (Joanna Briggs Institute) instrument. After assessing each article's eligibility, eight articles were obtained. Selected articles must have a score of at least 70%.

Data Analysis

All studies included in this research are primary and original, with a quantitative approach and experimental methods, namely randomised controlled trials. Data analysis is carried out by identifying and presenting data that has been extracted by the author and presented in a table. The data that has been presented is then analysed and explained for each study. This focuses on cold therapy interventions to reduce pain felt by post-CABG patients. The procedure applied included five components, such as type of ice used, temperature, layer, location, and duration of application.

RESULTS

The section discusses overview of the included study, the comparison of findings, the summary of findings,

and trends. Besides that, the matrix of included articles consists of six sections of results, namely author, year, and country, aim, sample or respondent, design, intervention and result.

Overview of Included Study

Eight articles were included in this research. Quality appraisal was conducted by three experts who are competent in cardiovascular nursing. Of the eight articles, all scored more than 70%, so the authors determined that all eight articles could be included and extracted into this study. This systematic review shows that the research design used by all articles is a randomised controlled trial (RCT). The total number of respondents used in this study was 633 people. All articles state that there is a significant effect between cold therapy and the value of pain felt by patients after CABG. From the eight articles, there are some common characteristics of the respondents, such as being an adult (over 18 years old), having first-time surgery, having no cognitive limitations to understanding the pain instrument, and having no use of sleeping pills, drugs, and alcohol.

Comparison of Findings

In all studies, cold therapy was performed by applying an ice or gel pack to the patient's surgical area (compress). This study extracted five important components that need to be considered when performing cold therapy: the type of ice used, temperature, layer, location, and length of time. In the type of ice used, two articles used ice packs in performing cold therapy (Pishkarmofrad *et al.,* 2016; Yarahmadi *et al*., 2018), and five other articles used gel packs (Gorji *et al*., 2014; Seweid *et al.*, 2021; Zencir & Eser, 2016; Çelik & Özer, 2021; Khalkhali *et al.*, 2014). One article did not specify the type of ice used (Hatefi *et al.*, 2023). Three articles used a temperature of 0°C (Gorji *et al.*, 2014; Pishkarmofrad *et al*., 2016; Çelik & Özer, 2021), two articles used a temperature of 0°C - 5°C (Khalkhali *et al*., 2014; Zencir & Eser, 2016), two articles used a temperature of -5°C (Yarahmadi *et al.*, 2018; Hatefi *et al.*, 2023), and one article stated that the gel pack used was stored in the refrigerator for 30 - 45 minutes (Seweid *et al*., 2021). In its implementation, four articles used gauze (Gorji *et al*., 2014; Pishkarmofrad *et al.,* 2016; Yarahmadi *et al*., 2018; Hatefi *et al.*, 2023), one article used a washcloth or towel (Seweid *et al*., 2021), two articles used a cotton bag or cotton cloth (Khalkhali *et al*., 2014; Çelik & Özer, 2021), and one article did not state this. The majority of articles performed cold therapy on the midline sternotomy area (Khalkhali *et al*., 2014; Pishkarmofrad *et al*., 2016; Seweid *et al*., 2021; Zencir & Eser, 2016; Celik & Ozer, 2021), and three articles stated near the chest tube (Gorji *et al*., 2014; Pishkarmofrad *et al*., 2016; Hatefi *et al*., 2023). The duration of cold therapy was in the range of 10-20 minutes. Two articles performed cold therapy for 10 minutes (Gorji *et al*., 2014; Pishkarmofrad *et al.*, 2016), three articles performed cold therapy for 20 minutes (Seweid *et al*., 2021; Yarahmadi *et al.*, 2018; Zencir & Eser, 2016), and three articles performed it for 15 minutes (Hatefi *et al*., 2023; Khalkhali *et al*., 2014; Çelik & Özer, 2021).

Summary of Findings

Findings from the eight reviewed studies demonstrate a significant relationship between the application of cold therapy and pain reduction in post-CABG patients. According to Pishkarmofrad *et al*. (2016), cold therapy decreases nerve conduction velocity, thereby activating the pain gate control mechanism and diminishing pain perception. Similarly, Seweid *et al.* (2021) reported that the reduction in sensory and motor nerve conduction velocity induced by cold application produces an immediate analgesic effect. Furthermore, the stimulation of cutaneous cold receptors inhibits and blocks pain signal transmission. Overall, cold therapy represents a simple yet effective nursing intervention that facilitates the healing process by alleviating postoperative pain (Gorji *et al.*, 2014; Yarahmadi *et al*., 2018; Zencir & Eser, 2016).

Patterns and Trends

Gaps in the selected articles have been identified. It was found that the implementation was carried out in one ICU room in one geographical area, so the results cannot be generalised, and the sample size does not represent the entire population. The study was conducted with a small sample size, so the results cannot be generalised. Further research with a larger sample size is recommended. There is also concern that interventions conducted with different nurses will affect the results of the study.

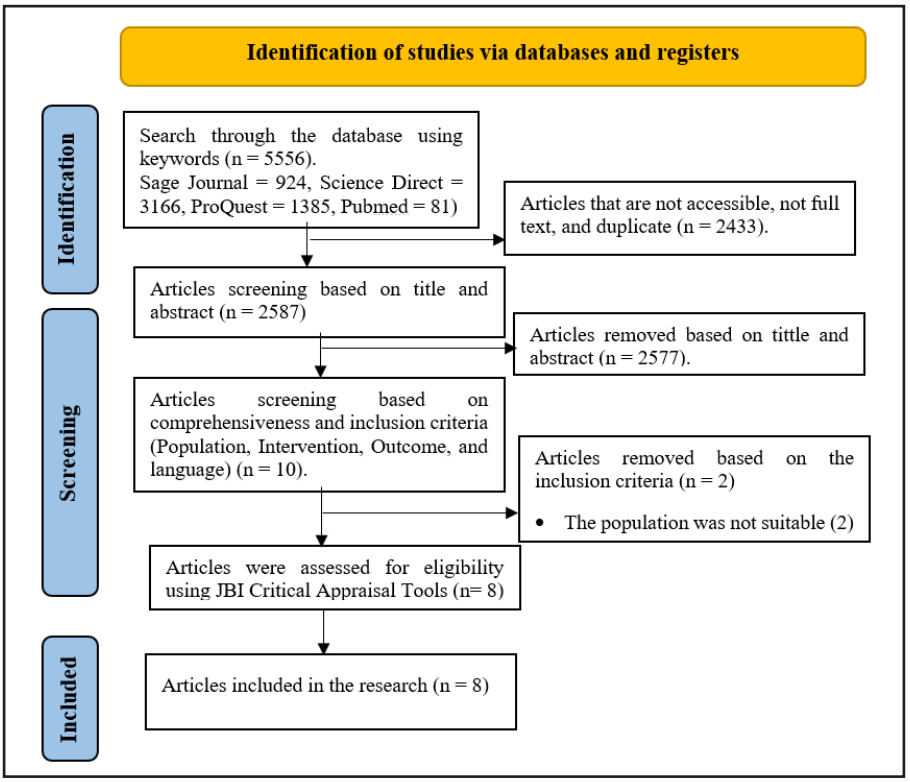


***Figure 1: PRISMA Flow* Diagram**

Table 1: Data Extraction

Sl. No.	Author, Year, and Country	Aim	Sample or Respondent	Design	Interventions	Results
1	Pishkarmofrad *et al*. (2016) Iran	This study aims to evaluate the effect of local cryotherapy on the severity of chest pain in patients undergoing coronary artery bypass grafting (CABG).	50 respondents	RCT	• Type of ice used: Ice pack • Temperature: 0°C • Layer: Two layers of gauze and adhesive • Location: Sternum Dressing • Duration of application: 10 minutes	Mean score before intervention: • Intervention Group: 60.16 ± 13.45 • Control Group 58.64 ± 14.42 Mean score after intervention: • Intervention Group: 45.16 ± 15.25 • Control Group: 58.60 ± 14.40
2	Seweid *et al* (2021) Egypt	This study aims to determine the effect of cold application on incisional pain associated with incentive spirometry after coronary artery bypass graft surgery.	60 Respondents	Crossover study design	• Type ice used: Cold gel pack • Layer: Washcloth or towel • Location: Median sternotomy incision • Duration of application: 20 minutes	Mean difference score on the 1st day: • Intervention Group: 1 ± 0.7 • Control Group: 3.1 ± 0.6 Mean difference score on the 2nd day: • Intervention Group: 0.5 ± 0.5 • Control Group: 2.5 ± 0.5

3	Gorji *et al*. (2014) Iran	This study aims to compare the effects of cold therapy and relaxation on pain in CABG patients.	80 Respondents	RCT	• Type ice used: Cooling gel pack • Temperature: 0°C • Layers: Twisted in gauze • Location: Centre (Near chest tube) • Duration of application: 10 minutes and until the temperature reached 13°C.	Mean score before intervention: • Cold Application Group. 0.85 ± 0.57 • Relaxation Group: 0.84 ± 0.57 • Control Group 0.89 ± 0.56 • *p*-value 0.84 Mean score immediately after intervention: • Cold Application Group: 2.4 ± 0.52 • Relaxation Group: 2.3 ± 0.35 • Control Group: 4.6 ± 0.66 • *p*-value 0.001 Mean score 15 minutes after intervention: • Cold Application Group: 0.42 ± 0.31 • Relaxation Group: 0.5 ± 0.39 • Control Group: 0.64± 0.47 • *p*-value 0.01
4.	Zencir & Eser (2016) Turkey	This study was conducted to investigate the effect of cold therapy on pain associated with sternotomy patients after cardiac surgery.	34 Respondents	Crossover Design	• Type ice used: Gel pack • Temperature: 0°C - 5°C • Location: Incision line dressing • Duration of application: 20 minutes	Mean score on the 1st day before the intervention: • Intervention Group: 4.09 ± 2.57 • Control Group: 3.51 ± 257 Mean score on the 1st day after the intervention: • Intervention Group: 4. 63 ± 2.46 • Control Group: 4.95 ± 2.76 Mean score on the 2nd day before the intervention: • Intervention Group: 3.17 ± 2.39 • Control Group: • 2.87± 2.83 Mean score on the 2nd day after the intervention: • Intervention Group: 3.53 ± 2.59 • Control Group: 4.17± 3.22
5	Yarahmadi *et al*., (2018) Iran	This study aimed to test the effects of cold and music therapy individually, as well as the combination of these interventions in reducing pain after chest tube removal.	180 Respondents	RCT	• Type ice used: 9-inch ice pack • Temperature: -5°C • Layer: Sterile gauze • Location: Near chest tube • Length of time: 20 minutes	Mean score before intervention: • Cold Application Group: 2.23±1.02 • Music Group: 2.07± 1.14 • Cold and Music Group: 1.84 ± 0.75 • Control Group: 1.91± 1.21 Mean score immediately after intervention: • Cold Application Group: 3.58 ± 1.09 • Music Group: 4.93± 1.06

						• Cold and Music Group: 2.05 ± 0.95 • Control Group: • 4.73 ± 1.08 Mean score 15 minutes after intervention: • Cold Application Group: 0.72 ± 0.79 • Music Group: 1.07± 0.66 • Cold and Music Group. 0.63 ± 0.87 • Control Group: 0.89 0.97
6	Khalkhali *et al*., (2014) Iran	This study aimed to determine the effect of cold gel compresses on pain during deep breathing and coughing in cardiac surgery patients.	50 respondents	RCT	• Type ice used: Gel pack with weighed 320 g and measured 25 cm by 10 cm. • Temperature: -5°C - 0°C • Layer: Cotton bag • Location: Sternal wound dressing • Length of time: 15 minutes	• Average mean score in group started with gel pack: 3.81/10 • Average mean score in group started without gel pack: 6.18/10
7	Hatefi *et al* (2023) Iran	This study aimed to compare the effects of cold compress, Transcutaneous Electrical Nerve Stimulation (TENS), and combined cold compress-TENS on CTR-associated pain among patients with Coronary Artery Bypass Grafting (CABG)	120 respondents	RCT	• Type ice used: Not Sure • Temperature: -5°C • Layer: A sterile gauze • Location: Chest tube insertion site • Length of time: 15 minutes	Mean score before CTR: • Placebo. 0.03 ± 0.18 • TENS: 0.00 ± 0.00 • Cold compress: 0.03 ± 0.18 • Combined: 0.00 ± 0.00 Mean score during CTR: • Placebo: 4,21 ± 1,18 • TENS. 2.92 ± 0.80 • Cold compress: 2.60± 0.77 • Combined: 2.23 ± 0.76 Mean score immediately after CTR: • Placebo: 3.83 ± 1.07 • TENS: 2.27 ± 0.78 • Cold compress: 2.03± 1.0 • Combined: 1.27 ± 1.08 Mean score 15 minutes after CTR: • Placebo: 1.62 ± 0.77 • TENS. 0.85 ± 0.67 • Cold compress. 0.53 ± 0.73 • Combined. 0.38 ± 0.57
8	Çelik & Özer (2021) Turkey	To investigate effect of cold application on sternotomy incision pain after CABG	59 respondents	RCT	• Type ice used: Gel pack • Temperature: 0°C • Layer: Cotton cloth • Location: Sternum incision site • Length of time: 15 minutes	Average mean of Evaluative Total Pain Intensity (ETPI) before exercise: • Intervention group: 1.15 ± 0.93 • Control Group: 1.5 ± 1.06 Average mean of pain immediately after exercise: • Intervention group: 2.58 ± 1.01 • Control Group: 3.52 ± 0.97 Average mean of pain five minutes after exercise: • Intervention group: 1.46 ± 0.77 • Control Group: 1.79± 0.88

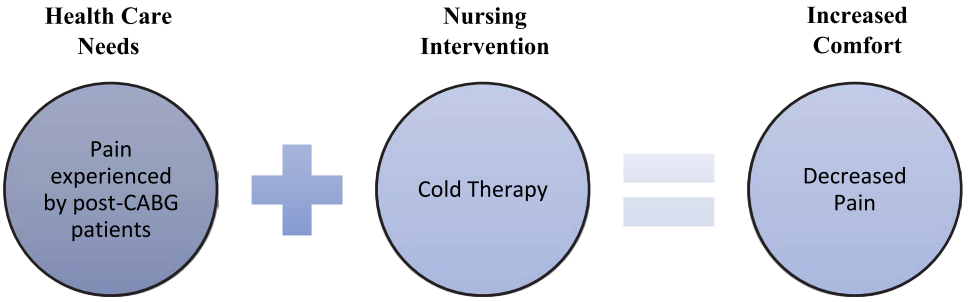
DISCUSSION

Mechanism of Cold Therapy in Pain Reduction

Cold therapy has a significant effect on the level of pain in patients post-CABG (Gorji *et al.*, 2014; Hatefi *et al*., 2023; Khalkhali *et al.*, 2014; Celik & Ozer, 2021; Pishkarmofrad *et al*., 2016; Seweid *et al.,* 2021; Yarahmadi *et al*., 2018; Zencir & Eser, 2016). The interventions involved the application of cold packs or ice packs. The duration of application is 10 - 20 minutes with a temperature of -5°C to 5°C. Ice packs are placed on the chest area with a cloth bandage so that they do not come into direct contact with the patient's skin. The recommended time for a local cryotherapy application is at least 20 minutes to obtain the desired physiological effect. It should also be noted that local cryotherapy for more than 20 minutes has been reported to cause reflexive vasodilation (Gorji *et al*., 2014).

Pain experienced by post-CABG patients is primarily attributed to surgical trauma involving tissues and organs, as well as the presence of surgical incisions and wounds. It typically manifests after the effects of intraoperatively administered analgesic agents have subsided. Pain decreases from day to day with the healing of organic tissues and skin for less or more than 10 days, but it can also persist for up to three months. Tissue damage causes neurogenic inflammation at the site of trauma. The injured area becomes inflamed, appearing swollen, red, and tender. These reactions occur due to the release of potassium ions, bradykinin, prostanoids, and various inflammatory mediators—including substance P, serotonin, histamine, cytokines, and leukotrienes—from the affected cells. This process causes changes in the properties and sensitivity of primary afferent nerve terminals (peripheral sensitisation) (Zubrzycki *et al*., 2018).

Pain can influence various aspects of patient well-being, including their perceived comfort. Patient comfort is achieved when their pain management needs are adequately addressed. The intervention provided causes the pain to subside so that the patient feels relieved. The emphasis on comfort lies in the psychological well-being of the patient; because of the reduced pain, the patient becomes more comfortable (Kolcaba, 2003; Shafiq & Uzma, 2024). Interventions for comfort are nursing actions and are aimed at achieving the comfort needs of care recipients, which include physiological, psychological, and physical interventions (Alligood & Tomey, 2014). One of the interventions that can be done is cold therapy, which is also a complementary nursing therapy.



Scheme 2. Theoretical Conceptual Framework of Comfort

Adapted from Kolcaba (2003); Alligood and Tomey (2014); Shafiq & Uzma (2024)

Cold therapy is effective in reducing postoperative pain after cardiac surgery. It activates inhibitory neurones to limit the nerves originating from the posterior horn of the grey matter in the spinal cord, resulting in lower pain transmission activity. Cold therapy also decreases nerve conduction velocity, local blood circulation, and cell metabolism.

This therapy alleviates pain by activating descending inhibitory neurons, which suppress ascending nociceptive signals from the substantia gelatinosa and decrease the production of inflammatory mediators (Ariawan *et al.*, 2022).

Clinical Implications

Cold therapy may be considered as a nursing therapeutic intervention. This is because cold therapy is an

intervention that is easy to perform, effective, not costly, and safe. Nursing services may implement cold therapy as their evidence-based practice.

Limitations

This study presents findings solely from a research perspective and does not incorporate clinical expertise or patient preferences. Therefore, further investigation is necessary to integrate these perspectives for the development of evidence-based nursing practices in routine care. Additionally, one of the inclusion criteria was the use of Indonesian and English to minimize misinterpretation during data extraction, which could otherwise lead to the exclusion of relevant studies.

CONCLUSION

Cold therapy may be considered for post-CABG patients to alleviate pain. It activates inhibitory nerves, thereby suppressing nociceptive impulses and reducing pain transmission. This study may serve as a reference for healthcare services in developing standard operating procedures for pain management in post-CABG patients. Cold therapy may be incorporated into evidence-based nursing interventions for managing post-CABG pain. Nonetheless, additional research is required to develop and validate standardised clinical protocols.

Recommendation

Nursing services must implement evidence-based practice by applying cold therapy to reduce the pain of post-CABG patients. This maybe be accompanied by consideration of healthcare resources and patient preferences. The result can be disseminated so that it becomes Standard Operating Procedure (SOP) in health services.

Conflict of Interest

The authors declare that they have no competing interests.

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