Effect of Cryotherapy on Pain Quality and Intensity among Patients with Thoracotomy after Chest Tube Removal

Emad A. Ahmed[1], Sahar Y. Mohammad[2], Dalia A. Abdelatief[3], Asmaa S. Ali[4]

[1]Assistant lecturer of Medical Surgical Nursing, Faculty of Nursing, Beni Sueif University, Egypt.
[2]Professor of Critical Care Nursing, Faculty of Nursing, Ain Shams University, Egypt.
[3]Assistant professor of Medical Surgical Nursing, Faculty of Nursing, Ain Shams University, Egypt.
[4]Assistant professor of Medical Surgical Nursing, Faculty of Nursing, Ain Shams University, Egypt.

Abstract

Background: Chest tubes removal (CTR) described as one of the worst feeling for critical ill patients after thoracotomy. Unrelieved pain causes undesired consequences that had adverse effects on patient quality of care. CTR pain usually managed by analgesics, but patient showed different responses to drugs and might not provide complete relaxation. **Aim:** This study aims to assess the effect of cryotherapy on pain quality and intensity among patients with thoracotomy after chest tube removal. **Methods:** Quasi-experimental design (study & control) was utilized in this study. This study conducted in the cardio-thoracic critical care units at Cardiovascular and Thoracic Academy affiliated to Ain Sham University Hospital. A purposive sample of patients undergoing thoracotomy was included in this study. They were divided into control group and study group (70 patients in each group). Data were collected using three tools; a structured interviewing questionnaire, Standardized Linear Scale for Pain Assessment and Modified McGill Pain Questionnaire-Short Form (MPQ-SF). **Results:** The results reveals that 50%, 67.1% of the control and study group patients were in age group from 51-≥60 years. 62.9 and 81.4% of the control and study group were males. 42.9% of both groups were highly educated. A statistically significant differences were found between study and control group regarding pain quality immediately and after 30 minutes of cryotherapy applied after chest tube removal in terms of sensory and affective descriptors. Also, a highly significant difference was found between study and control groups regarding pain intensity immediately and 30 minutes after cryotherapy applied after chest tube removal. **Conclusion:** cryotherapy application was useful for improving pain quality and relieving intensity of pain among patients with thoracotomy after application of cryotherapy following chest tube removal. **Recommendations:** Encourage nurses in critical care settings to make decision about applying cryotherapy as a nonpharmacological modality for reliving chest tube removal pain

Keywords: Cryotherapy, Pain, Intensity, Quality, Chest Tube Removal, patients, Thoracotomy.

Introduction

In a study entitled "Evaluation of a lateral thoracotomy implant approach for a centrifugal-flow left ventricular assist device: The LATERAL clinical trial" concluded that implantation of the left ventricular assist device through the thoracotomy was a safe and effective approach alternative to median sternotomy. ***McGee et al., (2019)***

Also, ***Yakşi and Yakşi, (2017)*** in a study "Current treatment options for post-thoracotomy pain syndrome: a review" concluded that **post-thoracotomy pain** reduced patient's quality of life and mild to severe functional and psychosocial limitations and was poorly understood and need more than one therapy to be managed.

Moreover**, *Mefire et al., (2014)*** in a study entitled "Indications and morbidity of tube thoracostomy performed for traumatic and non-traumatic free pleural effusions in a low-income setting" concluded that chest tube (tube thoracostomy) had the advantage of safety and effectiveness to drain pleural collections for patients with both traumatic and non-traumatic sources.

Also, *Mohammadi et al., (2018)* in a study entitled "Effects of Cold Application on Chest Tube Removal Pain in Heart Surgery Patients" stated that chest tube removal is considered a one of the painful procedures which may hasn't a good respond well to therapies. Patients usually report medium to severe pain during CTR and describe it as frustrating and frightening experience.

CTR is described as one of the worst feeling for critical ill patient. Uncontrolled CTR had adverse gastrointestinal, neurologic, pulmonary and cardiovascular effects leading to poor prognosis and decrease quality of patient's care, morbidity and mortality. CTR pain usually managed by analgesics, but patient showed different responses to drugs and may not provide complete relaxation *(Chary, 2020, Malik et al., 2018).*

Pharmacological management were the most usually methods that nurses provided for pain relief and called analgesia or analgesics. There were three main types of analgesia: opioids, non-opioids which non-steroidal anti-inflammatory drugs (NSAIDs) and adjuvants such as some anticonvulsants, and antidepressants. Unfortunately, it included some side effects such as respiratory distress, over-sedation, bleeding of gastrointestinal tract *(Lopez-Martinez, 2020, Matzo and Sherman, 2019, Zubrzycki et al., 2018).*

Cryotherapy was the thermal therapy including of cold modalities' application to any part of the body to relieve pain caused by surgery, injury, or medical painful procedure such as CTR. Cryotherapy could be applied by different methods such as ice pack, ice massage, cooling gel packs and cold bath. Cryotherapy was a simple, easy applied, effective, non-invasive and safe with low cost nursing intervention to relieve pain. It provided analgesic effect, increase the threshold of pain, enhance patient's autonomy and cooperation and is free from undesirable effects *(Hawk, 2017, Ravindhran et al., 2019; Tareq et al., 2020)*.

Sandhya and Jebarose (2020) in a study entitled "Effectiveness of Ice Compress Application upon the Level of Pain among Patients with Chest Drainage" concluded that application of ice pack is effective in pain relief and achieving comfort with undesirable effects.

However, *Hsieh et al. (2017)* in study entitled "Efficacy of cold application on pain during chest tube removal: a randomized controlled trial A CONSORT-compliant article" concluded that cold application is not effective intervention in reducing CTR induced pain.

Critical care nurse played a great importance in the management of CTR pain because they were the person who expended the most time taking care of the patient. Critical care nurses were responsible for providing a safe, healing and caring atmosphere for critically ill patient. They should be able to deal with any change that occurred to the patient. CCN should be aware of skills and knowledge about the latest advanced methods for pain management *(Mona, 2018, Munkombwe et al., 2020).*

Significance of the Study:

Patients after thoracotomy hat at least one chest tube to maintain heart and lung functioning unfortunately removing chest tube was a painful procedures with more consumption of pharmacological interventions. Cold application was recommended to relive CTR pain, in study that conducted to assess using of superficial cooling to relive CTR pain among patients with thoracotomy in Alexandria, Egypt, revealing that, majority of group (92%) without superficial cooling expressed severe pain, but 8% of them expressed mild to moderate pain. However, about third (32%) of experimental group expressed mild to moderate pain and the remaining of them didn't complain of pain. Besides, after ten minutes following chest tube removal, majority of experimental groups (96%) were free of pain, but the two thirds of the control group complained of severe pain (60%) and about third of them complained moderate pain (32%) *El-Hady, (2007).*

Also, another study in Shebin AL Khom, Egypt is conducted to evaluate the cold application and breathing exercises on decreasing pain and anxiety after CRT and found that, cold application group showed a significant decrease in pain intensity with comparison to the control group *(EL Mokadem & Ibraheem, 2017).*

Cryotherapy was simple, low cost and easy applicable with fewer or no side effects. It could be used as a non-pharmacologic methods to relieve pain related to CTR. So this current study is an attempt to enhance the evidence of the effectiveness of cryotherapy in reducing the pain intensity and improving pain quality among patients with after CTR.

Aim of the study:

The present study aimed to assess the effect of cryotherapy on pain quality and intensity among patients with thoracotomy after chest tube removal through assessment of pain quality and intensity for patient immediately and 30 minutes after chest tube removal.

Research Hypothesis:

The study hypothesizes that patients who exposed to cryotherapy after chest tube removal will experience improvement in pain quality and reduce pain intensity compared to controls.

Subjects and Methods
A. Research design:

Quasi-experimental design (study & control) was utilized in this study to assess using cryotherapy on pain among patients with thoracotomy after chest tube removal immediately after chest tube removal (time one) and 30 minutes after chest tube removal (time two).

Quasi-experiment Design is an empirical interventional study used to estimate the causal impact of an intervention on target population without random assignment *(Singh, 2019).*

Variables:
Independent variable: cryotherapy
Dependent variable: pain quality, pain intensity.

B. Research Setting:

The study conducted in the cardio-thoracic critical care units at Cardiovascular and Thoracic Academy affiliated to Ain Sham University Hospital, Cairo. The academy provide outpatients clinics and inpatients' services, interventional cardiology, emergency, blood bank and laboratory services, and cardiorespiratory rehabilitation centers for millions of patients free of charge or at low cost. It is also an education and research center for Cardiovascular and thoracic research. This ICU prepared to provide intensive care for patients with thoracotomy immediately after surgery. It sited in the floor number eight and the total capacity was ten beds.

C. Subjects:

A purposive sample of 140 patients divided into control group and study group (70 patients in each group) of both genders. Power analysis was used to statistically calculate the sample size with consideration of the total number of patients admitted to the cardio-thoracic critical care units at Cardiovascular and Thoracic Academy affiliated to Ain Sham University after thoracotomy.

Study subjects include a representative of total patients in cases of cardio-thoracic surgery at Ain Shams University Hospital (total n=285) who were hospitalized during the period 2018. Based on sample size equation 140 patients will be participated in the study.

So, the sample size was calculated by adjusting the power of the test to 80% and the confidence interval of 95% with margin of error accepted adjusted to 5% and a known total population of 140 patients using the following equation:

$$n = \frac{N \times p(1-p)}{\left[\left[N-1 \times \left(d^2 \div z^2\right)\right] + p(1-p)\right]}$$

Nxp(1-p)   =(285*(0.5*(1-0.5)))/

N-1 $=(285-1)*$
d^2/z^2 $=0.0025 / 3.8416+$
$p(1-p)$ $=0.5*(1-0.5)$
N $=140$

N= Community size

z= Class standard corresponding to the level of significance equal to 0.95 and 1.96

d= the error rate is equal to 0.05

p= Ratio provides a neutral property = 0.5.

(Chow, Shao & Wang, 2007)

Inclusion criteria:
• Patients with thoracotomy.
• Having one chest tube at minimum immediately after surgery
• Conscious.
• Having the ability to communicate.
•Not on pain killer immediately (one hour) before tube removal.
• Hemodynamically stable.

Exclusion criteria:
• Patients are complaining of hemiparesis, peripheral neuropathy or hypothyroidism.

Tools of data collection:

1. A structured interviewing questionnaire

The researcher designed this tool to assess the patients' demographic data such as (age, gender, level of education, marital status, occupation), present history such as (medical diagnosis, type of current surgery, site and size of chest tube that will be removed, length of chest tube stay, numbers of mediastinal chest tubes, numbers of pleural chest tubes, postoperative pain medications, last 24 hours pain medication dose (before chest tube removal), presence of invasive devices) and past history (past surgical history and previous chest tube removal experience).

Modified McGill Pain Questionnaire-Short Form (MPQ-SF)

It was developed by Melzack, 1987. It was in English language questionnaire form to assess pain quality immediately and 30 minutes after chest tube removal. This tool included two parts: sensory pain descriptors and affective pain descriptors.

It adopted from *Elsharkawy, (1991); Sauls, (2002)*.

This tool consisted of 2 parts:

Part I: Sensory Pain descriptors

It consisted of characteristics to evaluate sensory pain, such as throbbing, cramping, gnawing, aching, burning, tender, stabbing/ sharp, dull, heavy, splitting or no pain.

Part II: Affective Pain descriptors

This part included 4 characteristics to assess affective pain such as tiring/exhausting, cruel/punishing, chocking, and fearful.

3. Standardized Linear Pain Assessment Scale

It was developed by **McCaffery, 1982** and adopted by the researcher to assess pain intensity immediately and 30 minutes of applying cryotherapy after chest tube removal. This tool was written in English language.

It consisted of 10 points numerical scale with "0" representing no pain, "1-3" representing mild pain, "4-6" representing moderate pain, "7-9" representing severe pain and "10" representing unbearable pain.

2) Operational Design:
The operational design consist of preparatory phase, content validity, pilot study and field work.

A) Preparatory phase:
It included reviewing of related literature and theoretical knowledge of various aspects of the study using books, articles and internet's periodicals and journals to develop tools for data collection.

B) Tool validity and reliability:
• **Validity:**

The revision of the tools was done by a panel of seven experts from Medical-Surgical and Critical Care Nursing academic staff. The content of tools were reviewed for the accuracy, clarity, comprehensiveness and relevance and the modifications done accordingly.

• **Reliability*:***

Alpha Cronbach's model which is a model of internal consistency used to test the reliability of the tools. The results of Standardized Linear Scale for Pain Assessment was 0.95 and Modified McGill Pain Questionnaire-Short Form (MPQ-SF) was 0.60.

C) A pilot study:

A pilot study carried out on 14 patients (10%) of sample size to assess feasibility of the research process, clarity, applicability and efficiency of the tools. After conducting pilot study, there was no modification done so the patients who were involved in the pilot study were included to the a main sample

D) Field work:

Assessment for all patients with thoracotomy admitted to intensive care unit was done for meeting the inclusion criteria. Explanation of the aim of the study for the patients who enrolled in the study before data collection after obtaining a written consent. The work of the current study started from beginning of April to the end of October (2021) completed within six months. The researcher collected data three days per week, at morning and afternoon shifts.

Researcher followed the preventive measures included wearing personal protective equipment and hand washing to minimize the risk of transmissions of coronavirus.

Cryotherapy intervention was conducted through cold packs (ice bags) filled two thirds with ice cubes with size: 15×12 cm with zip lock (clamp); a stop watch to measure the cold packs' duration after the applications of and disposable towel or sterile gauze to wrap cold packs.

Patients divided into two groups; G1 (control group), G2 (study group), each of group was 70 patients after thoracotomy who undergoing chest tube removal. Study group included patients who received cryotherapy (ice packs) while, the control group received the routine hospital care for CTR pain .

The First Interview: For both groups (control and study) an assessment of the patients' demographic data and health relevant data were done from the patients and using the structured interview questionnaire

During the first interview at the beginning of the morning shift pain measurement times (immediately and 30 minute after chest tube removal) are explained to the patients.

For study group: The investigator was notified by the nurse of intensive care unit staff) about the patient's readiness CTR after physician decision. The researcher brought ice packs from the freezer of refrigerator and disinfection by 70% alcohol to prevent infection.

Immediately after CTR by physician and the close of insertion port with sutures, disinfection and covered with sterile dressing, patients received cryotherapy by ice bags on either side of chest tube insertion port covering (15 cm) around the chest tube port using a measuring tape (applying one layer of sterile gauze or towel to wrap ice bag and act as a barrier between patient skin and the ice bag). Evaluation of pain intensity and quality measured for patients using Standardized Linear Pain Assessment Scale and Modified McGill Pain Questionnaire-Short Form immediately after applying cryotherapy following chest tube removal (time one measurement).

The researcher kept the patients in position without change and stayed beside to keep ice packs in place for the next 30 minute. After 30 minutes from CTR, pain quality and

intensity were measured (time two measurement). It was observed that no patient complained of side-effects related ice application. After the procedure that lasting about 30 minutes, the patient was assisted to return to comfortable position.

The Control Group: Control group received the routine care of CTR pain without the researcher's interference. Immediately and thirty minute after CTR, pain intensity and quality measured for patients using the same study tools (time one and two measurement).

Evaluation phase: The effect of pain intensity and quality determined through comparison between the study group and control group findings.

3-Administrative design:
Submission of official letters issued from the dean of faculty of nursing, Ain shams University to the director of Ain shams University hospitals and the Director of Cardiovascular and Thoracic Academy to obtain Official permission. The title, aim, main data items and the expected outcomes of the study were explained.

Ethical consideration:
The research approval from the Faculty of Nursing ethical committee was obtained before beginning of the study. Objectives and aim of the study were explained to patients included in the study before starting by researcher. The anonymity and confidentiality of the patients included in the study assured. The researcher informed the patients under study that they had the choice to participate or not in the study and they were allowed to withdraw from the study at any time.

4) Statistical Design:
Analysis of data was done using SPSS program version 25. Presentation of Quantitative data were as mean and standard deviation. Presentation of Qualitative data were as frequencies and percentages. Comparison between quantitative data and two independent groups was done by Independent samples t test

(Student t test). Comparison between qualitative data and different groups was done by using Chi square test (or Fisher Exact test). $P. > 0.05$ was considered insignificance (No difference), $P. \leq 0.05$ was considered significance difference and $P. \leq 0.001$ was considered highly significance difference.

Results:

Table (1): shows that, 67.1% of study subject and 50% of the control group were aged between 51- $\geq$ 60 Years. Concerning, gender, 81.4% of the study (cryotherapy) group and 62.9% of the control subject were males. In relation to level of education, 42.9% of the studied subjects were highly educated. Regarding marital status, 95.7% of the study (cryotherapy) group and 88.6% of controls (without cryotherapy) group were married. Moreover, 50% of the study subject and 44.3% of the control subject were workers. Moreover, non-statistically significant differences were revealed between both groups except for their gender and occupation.

Table (2): shows that, regarding medical diagnosis 90% of patients had cardiac diseases. In relation to type of current surgery 67.1% of the study (experimental) group and 57.1% of the control group had coronary artery bypass graft (CABG). Concerning site of chest tube that will be removed, mediastinum represents 55.7% of the experimental group and 54.3% of the control subject. Regarding, size of chest tube that will be removed, 28 - 40 F represents 91.4% of the experimental group and 98.6% of the control subject. As regards, length of chest tube stay 62.9% of experimental group compared to 47.1% of the controls had 4-7 day.

Concerning, numbers of mediastinal chest tubes 40 % of experimental group and

48.6 % of control subject had one tube. Regarding numbers of pleural chest tubes, 60% of experimental group and 67.1% of the control subject had one tube. As regards, postoperative pain medications, 65.7 % of experimental group and 52.9% of control subject received opioids. Concerning last 24 hours pain medication dose before CTR, 50% of study subject and 44.3% of the control subject had analgesic between 4-<8 hours before chest tube removal. Regarding presence of invasive devices 100% of patients had intravenous line & urinary catheterization. Regarding past surgical history other than the current surgery 55.7% of experimental group had no previous surgical history compared to 50% of control subject. Concerning previous chest tube removal experience 92.9% of experimental group did not experience CTR before compared to 90% control subject. There were non-significant differences between both groups regarding all their medical history except for number of pleural chest tubes.

Table (3): reveals that**, regarding time one (Immediately after CTR)** there was statistically significant difference regarding sensory descriptors of chest tube removal pain among the studied groups at p value = 0.02 as well as, 12.9% of the study group didn't experience any **sensory** descriptors of pain. **Regarding the time two (30 minutes after CTR),** there was highly statistically difference regarding

sensory descriptors of chest tube removal pain among the studied groups at p. value <0.001 besides, 5.7% of the control study compared to 75.7% of the study group didn't experience any sensory descriptors of pain.

Table (4): reveals highly statistically significant differences regarding affective descriptors of chest tube removal pain among the studied groups at p value P. < 0.001 immediately and 30 minutes after CTR. 12.9% of the study group didn't experience any affective descriptors of pain immediately after CTR meanwhile, 5.7% of the control study compared to 77.1% of the study group didn't experience any affective descriptors of pain 30 minutes after CTR.

Table (5): reveals highly statistically significant differences of pain intensity scores between study and control groups at p value <0.001 immediately and 30 minutes after CTR.

Table (6): reveals highly statistically significant differences regarding pain intensity score between study and control groups at P. < 0.001. In addition to that, the Mean ± SD of pain intensity score for study group was 3.00 ± 1.75 and 0.63± 1.12 immediately after CTR after 30 minute of cryotherapy application respectively. On the other hand, regarding the control group, Mean ± SD were 6.06± 2.14 and 3.31 ± 1.74 immediately and after 30 minute of CTR respectively.

Table (1): Comparison of Sociodemographic Characteristics between study and control Groups (n=140).

Sociodemographic characteristics		Groups				Chi square Test	p. value
		Control group (n = 70)		Study group (n = 70)			
		No.	%	No.	%		
Age	18 – 35 Years	6	8.6	5	7.1	**4.42**	**0.11 NS**
	36 – 50 Years	29	41.4	18	25.7		
	51- ≥ 60 Years	35	**50**	47	**67.1**		
Gender	Male	44	**62.9**	57	**81.4**	**6.01**	**0.01 HS**
	Female	26	37.1	13	18.6		
Level of education	Can't read and write	11	15.7	8	11.4	**4.03**	**0.25 NS**
	Reading and writing	0	0	0	0		
	Primary	5	7.1	1	1.4		
	Secondary	24	34.3	31	44.3		
	Highly educated.	30	**42.9**	30	**42.9**		
Marital Status	Married	62	**88.6**	67	**95.7**	**3.73 FE**	**0.22 NS**
	Single	6	8.6	1	1.4		
	Divorced	0	0	0	0		
	Widow	2	2.9	2	2.9		
Occupation	Employee	14	20	14	20	**10.84**	**0.01 HS**
	Worker	31	**44.3**	35	**50**		
	Retirement	4	5.7	13	18.6		
	House wife	21	30.0	8	11.4		

Non-Significant (NS) = P. > 0.05   High significant (HS) = P. < 0.001

Table (2): Comparison of Medical Health History between study and control Groups (n=140).

Items		Control group (n = 70)		Study group (n = 70)		Chi Square Test	P. value
		No.	%	No.	%		
Medical Diagnosis	Cardiac	63	**90**	63	**90**	**0**	**1.00 NS**
	Non- cardiac	7	10	7	10		
Type of current surgery	CABG	40	**57.1**	47	**67.1**	**1.82**	**0.40 NS**
	MVR	23	32.9	16	22.9		
	Lobectomy	7	10	7	10		
Site of chest tube that will be removed	Pleura	32	45.7	31	44.3	**0.03**	**0.87 NS**
	Mediastinum	38	**54.3**	39	**55.7**		
Size of chest tube that will be removed	12-24 F	1	1.4	6	8.6	**3.76**	**0.12 NS**
	28 - 40 F	69	**98.6**	64	**91.4**	**FE**	
Length of chest tube stay	1-3 day	37	**52.9**	26	37.1	**3.49**	**0.06 NS**
	4 -7 day	33	47.1	44	**62.9**		
	> 7 day	0	0	0	0		
Numbers of mediastinal chest tubes	0	18	25.7	28	**40**		
	1	34	**48.6**	28	**40**	**3.26**	**0.20 NS**
	2	18	25.7	14	20		
Numbers of pleural chest tubes	0	19	27.1	14	20		
	1	47	**67.1**	42	**60**	**6.59**	**0.04 S**
	2	4	5.7	14	20		
Post-operative pain medications	Opioids	37	**52.9**	46	**65.7**		
	Non opioids	33	47.1	24	34.3	**2.40**	**0.12 NS**
	Adjuvant	0	0.0	0	0		
Last 24 hours pain medication dose before CTR)	Non	0	0	0	0		
	< 1 hour	0	0	0	0		
	1-<4 hours	27	38.6	25	35.7	**0.50**	**0.78 NS**
	4 - < 8 hours	31	**44.3**	35	**50**		
	>8hours	12	17.1	10	14.3		
Presence of invasive devices	I.V. line & Urinary catheter	70	**100**	70	**100**	**-**	**-**
Past surgical history Other than the current surgery	Yes	35	**50**	31	44.3		
	No	35	50	39	**55.7**	**0.46**	**0.50 NS**
Previous chest tube removal experience	Yes	7	10	5	7.1	**0.37**	**0.55 NS**
	No	63	**90**	65	**92.9**		

Significant (S) p< 0.05 Non-Significant (NS) = P. > 0.05

MVR: Mitral valve replacement CABG: coronary artery bypass graft CTR: chest tube removal pain

Table (3): Comparison between study and control groups regarding their sensory descriptors of pain immediately and after 30 minutes of cryotherapy application (n=140).

Sensory descriptors		Immediately after CTR				30 minutes after CTR			
		Control Group	Study Group	Chi Square Test	P. value	Control group	Study group	Chi Square Test	P. value
Absent	No.	0	9			4	53		
	%	0	**12.9**			**5.7**	**75.7**		
Throbbing	No.	2	3			0	0		
	%	2.9	4.3			0	0		
Cramping	No.	0	0			5	0		
	%	0	0			7.1	0		
Gnawing	No.	10	9			1	0		
	%	**14.3**	12.9			1.4	0		
Aching	No.	1	1			2	0		
	%	1.4	1.4			2.9%	0		
Burning	No.	20	26	18.4	0.02 S	18	4	83.54	<0.001 HS
	%	**28.6**	**37.1**			**25.7**	5.7		
Tender	No.	6	3			19	5		
	%	8.6	4.3			**27.1**	7.1		
Stabbing/Sharp	No.	14	13			6	6		
	%	**20**	**18.6**			8.6	**8.6**		
Dull	No.	1	1			7	1		
	%	1.4	1.4			10	1.4		
Heavy	No.	4	1			8	1		
	%	5.7	1.4			11.4	1.4		
Splitting	No.	12	4			0	0		
	%	**17.1**	5.7			0	0		

Significant (S) p< 0. 05   High significant (HS) = P. > 0.05   CTR: chest tube removal pain

Table (4): Comparison between study and control groups regarding their affective descriptors of pain immediately and after 30 minutes of cryotherapy application (n=140).

Affective pain descriptors		Immediately after CTR				30 minutes after CTR			
		Control Group	Study Group	Chi Square Test	p.value	CONTROL GROUP	STUDY GROUP	Chi Square Test	p.value
Absent	No.	0	9			4	54		
	%	0	**12.9**			**5.7**	**77.1**		
Tiring / Exhausting	No.	23	13			6	0		
	%	**32.9**	18.6			8.6	0		
Cruel / Punishing	No.	25	17	15.16	0.004 HS	12	0	77.10	<0.001 HS
	%	**35.7**	**24.3**			17.1	0		
Chocking	No.	11	13			15	5		
	%	**15.7**	18.6			**21.4**	**7.1**		
Fearful	No.	11	18			33	11		
	%	**15.7**	**25.7**			**47.1**	**15.7**		

High significant (HS) = P. < 0.001   CTR: chest tube removal pain

Table (5): Comparison between study and control groups regarding their pain intensity immediately and after 30 minutes of cryotherapy application (n=140).

Pain intensity grade		Immediately after CTR				30 minutes after CTR			
		Control group	Study group	Chi Square Test	P. value	Control group	Study group	Chi Square Test	P. value
No pain	No.	0	8			4	52		
	%	0	11.4			5.7	74.3		
Mild pain	No.	4	38			34	18		
	%	5.7	54.3			48.6	25.4		
Moderate pain	No.	34	24	69.25	<0.001 HS	32	0	78.07	<0.001 HS
	%	48.6	34.3			45.7	0		
Severe pain	No.	32	0			0	0		
	%	45.7	0			0	0		
Unbearable pain	No.	0	0			0	0		
	%	0	0			0	0		

High significant (HS) = P. < 0.001   CTR: chest tube removal pain

Table (6): Comparison between Study Group and Control Group Regarding Pain Intensity mean Score (n=140).

Pain intensity score	Group				Student t test	P value
	Control group		Study group			
	Mean	SD	Mean	SD		
Immediately after CTR	6.06	2.14	3.00	1.75	9.25	<0.001 HS
30 min. after CTR	3.31	1.74	0.63	1.12	10.86	<0.001 HS

High significant (HS) = P. < 0.001 CTR: chest tube removal pain

Discussion:

Patients always described chest tube removal as one of the worst, painful and frightening intensive care unit experiences. Patients who undergoing chest tube removal experience moderate to severe pain. This pain results from the chest endothelial tissue which is adhered to the tube tip and at the time of tube removal the pulling force will shear this adhesion causing severe pain **(EL Mokadem & Ibraheem, 2017).**

The present study aimed to assess the effect of cryotherapy on pain quality and intensity among patients with thoracotomy after chest tube removal through assessment of pain quality and intensity for patient immediately and 30 minutes after chest tube removal.

Two matched groups were recruited for this study as there were no statistically significant difference between the two group regarding their sociodemographic characteristics and their medical health history except for gender, occupation and number of pleural chest tubes inserted.

These findings were in agreement with **Aktaş et al. (2020)** in a study conducted to assess the effect of cold therapy (CT) on pain and physiological parameters following spine surgery and stated that no statistical difference significant difference was found between patients in the two groups regarding their demographic characteristics (marital status and educational level). Although, they disagreed with the current study that no statistical significant difference was found between patients in the two groups regarding their demographic characteristic (gender).

Meanwhile, these findings disagreed with **Hatami et al. (2018)** in a study entitled "The Effect of Cold Compresses on the Comfort of the Patients during Chest Drainage Tube Removal after Cardiac Surgery: A Randomized Clinical Trial", who stated that there was no

statistically significant difference among the studied groups regarding demographic data (occupation and gender).

These findings were in the same line with **Elmetwaly and El Sayed, (2020)** in a study entitled "Chest Tube Removal: Efficacy of Cold Application and Breathing Exercise on Pain and Anxiety Level" and found that there were no statistically significant difference among studied group regarding medical health variables (type of surgery, previous surgeries and duration of chest tube placement).

As well as **Sajedi-Monfared et al. (2021)** in a study to assess using of cold application and respiratory relaxation exercise to reduce pain and anxiety following CTR and stated that there was no statistically significant difference among studied group regarding medical health variables (number of days with chest tube).

Meanwhile, these results disagreed with **Sauls, (2002)** in a study to evaluate usage of ice for pain associated with CTR reported that there was no significant difference between the experimental and control groups regarding medical health history including numbers of pleural chest tubes.

Concerning comparison between study and control groups regarding their affective and descriptive descriptors of pain immediately and after 30 minutes of cryotherapy application. The current study revealed statistically significant difference and highly statistically difference regarding sensory descriptors immediately and 30 minutes after CTR respectively. In addition to that, there were highly statistically significant differences regarding affective descriptors of chest tube removal pain among the studied groups.

As well as, about one sixth of the study group didn't experience any sensory and affective descriptors of pain immediately after CTR. Meanwhile, 5.7% of the control study compared to three quarters of the study group

didn't experience any sensory and affective descriptors of pain30 minutes after CTR).

These findings of the present study illustrated that pain descriptors and pain quality significantly different and improved with cryotherapy application after CTR. These results support the study hypothesizes that patients who exposed to cryotherapy after CTR would experience improvement in pain quality. This **might be due** to cryotherapy application elevated pain threshold because its effect on reduction nerve sensitivity to pain. As pain is subjective and only the patient can accurately expressed the pain who experienced using pain descriptors. Therefore, it was logical that pain descriptors were affected and changed with the degree of pain level.

In addition, these findings agreed with **Küçükakça Çelik and Ozer, (2020)** in a study entitled "Effect of Cold Application on Chest Incision Pain Due to Deep Breathing and Cough Exercises" who stated that there were statistically significant difference regarding pain quality (sensory and affective descriptors) that experienced by the patients.

Also, these findings were in the same line with **Ebrahimi-Rigi et al. (2016)** in a study "Effect of cold therapy on the pain of deep-breathing and coughing in patients after coronary artery bypass grafting" who stated that there were statistically significant difference regarding pain quality (sensory descriptors) that experienced by the patients. Although, it was reported that cold therapy had no effect regarding affective pain.

Meanwhile, these findings were incongruent with **Mazloum et al. (2018)** in a study to examine the effect of ice on improvement of quality of pain related to CTR among patients after cardiac surgery and found that there were no significant differences were observed with regard to sensory and affective items of SF-MPQ among cold therapy group, placebo and control group.

Concerning comparison of pain intensity scores among the studied groups throughout chest tube removal pain assessment times, the current study reveals that there was highly statistically significant difference of pain intensity scores among the studied groups after application of cryotherapy at the time of chest tube removal. These results support the present study hypothesizes that patients who exposed to cryotherapy after chest tube removal would experience reduce pain intensity compared to controls.

This might be related to decrease of sensory and motor nerve conduction velocities with cryotherapy application which was defined as the direct analgesic effect of cold application. Moreover, cold application played a vital role in stimulation cold receptors on the skin that lead to inhibit and block of pain signals which called the indirect analgesic effect of cryotherapy **(Lister et al., 2020, Mohammadi et al., 2018).**

These findings were in the same line with **EL Mokadem and Ibraheem, (2017),** who found that there was a statistically significant decrease in pain intensity attained at the three measurement points (immediately, 15 and 30 minutes) following CTR in the studied groups compared to the control group.

Also, these findings agreed with **Kunter and Gezer, (2019)** in their study entitled "The Effect of Cold Application before Breathing Exercises on Sternotomy Pain" they found that cold application with breathing exercise was effective to reduce pain intensity with statistically significant difference between study and control groups.

Although, these findings were incongruent with **Hsieh et al. (2017)** in study to assess the efficacy of cold application on pain during chest tube removal showed that, although the mean pain score in the experimental group after CTR was lower than that in the sham group, there was no statistically difference regarding pain intensity scores among the studied groups and that revealed that cold application was not more effective in reducing pain than sham treatment.

This discrepancy with the current study might explained that in the previous study was small sample (N=30) for each group, cold application lasted only for 10 minute that not enough to get its effect as well as pain was a subjective feeling, it was very difficult to exclude the placebo effect even in the study group, so the results could be controversial.

In addition, these findings were contradicted **Sajedi-Monfared et al. (2021),** who found that pain intensity score in experimental group was lower than in the control immediately and 15 min after CTR in experimental but this reduction was not statistically significant so cold therapy was not effective in relieving pain.

Also, these findings were in the same line with **Sandhya and Jebarose, (2020)** who found posttest mean pain scores and standard deviation in the control group (M = 2, SD = 0.51) and ice pack group (M = 1.8, SD = 1.11) by numerical rating revealed a statistically significant difference.

Conclusion:

Based on the findings of the current study, it could be concluded that, there was statistically significant difference and highly statistically difference regarding sensory and affective descriptors of chest tube removal pain among the studied groups at time one (immediately after CTR) and time two (30 minutes after CTR) respectively besides, these findings of the present study illustrated that pain descriptors and pain quality improved with cryotherapy application after CTR. These results support the study hypothesis that patients who exposed to cryotherapy after CTR would experience improvement in pain quality.

In addition, there was highly statistically significant difference of pain intensity scores among the studied groups with accepting the study hypothesis.

Recommendations:

Based on the findings of the current study, the following recommendations were suggested:

- Develop a simplified and comprehensive booklet for critical care nurses including basic knowledge and practices regarding application of cryotherapy for relieving pain associated CTR after thoracotomy .
- Applying cryotherapy as a care protocol for reducing pain associated CTR after thoracotomy as a safe, low cost and effective pain management technique.
- Written guidelines should be available with periodic meeting, workshops and conferences with teams in critical care units regarding chest tube removal pain management after thoracotomy with cryotherapy
- Conducting a comparative study to examine the effectiveness of different modes of cryotherapy (e.g. cold spray, ice towel, ice pack, ice chip and ice massage) and different non-pharmacological therapeutic methods for managing pain after CTR.

References:

Aktaş, Y.Y., Durgun, H., & Durhan, R. (2020): Cold Therapy and the Effect on Pain and Physiological Parameters in Patients Recovering from Spine Surgery: A Randomized Prospective Study. Complementary Medicine Research, 1–9. Doi: 10.1159/ 000508029

Chary, S. (2020). What Do We Need to Consider for Pain Management? Intech Open, DOI: 10.5772/ intechopen. 93640.

Chow, S.C., Shao, J., & Wang, H. (2007): Sample size calculation in clinical research, 2nded. Chapman and Hall/ CRC Biostatistics Series, P.P. (389-405).

Demir, Y. & Khorshid, L. (2010). "The Effect of Cold Application in Combination with Standard Analgesic Administration on Pain and Anxiety during Chest Tube Removal: A SingleBlinded, Randomized, Double-Controlled Study;Pain Management Nursing,

Vol 11, No 3 (September), 2010: pp 186-196. Doi:10.1016/j.pmn. 2009.09.002.

Ebrahimi-Rigi, H., Feizi, A., Abdollahimohammad, A., Ebrahimi-Rigi, Z., & Salehi-Ardabili, S. (2016): Effect of cold therapy on the pain of deep-breathing and coughing in patients after coronary artery bypass grafting. Der Pharmacia Lettre, 8(10), 201-205.

EL Mokadem, N. M. & Ibraheem, S. E. (2017): Cold Application and Breathing Exercises to Reduce Pain and Anxiety during Chest Tube Removal. American Journal of Nursing Science. Vol. 6, No. 4, 2017, pp. 285-292. Doi: 10.11648/j.ajns. 20170604.12.

EL-Hady, M. M., Ibrahim, Y. M., & El-Soussi, A. H. (2007). Effect of Superficial Cooling on Pain Associated with Chest Tube Removal after Thoracotomy. *Journal of High Institute of Public Health*, *36*(2), 387-404. DOI: 10.21608/ jhiph.2006.158136.

Elmetwaly, R., & El Sayed, R. (2020). Chest Tube Removal: Efficacy of Cold Application and Breathing Exercise on Pain and Anxiety Level. Evidence-Based Nursing Research, 2(4), 12. Doi.org/10.47104/ ebnrojs3. v2i4.159.

Elsharkawy, F.M. (1991): Determination of the Patient's Pain Intensity In Terms Of the Patient's Perception of His Pain and Nurses Assessment of This Pain. Unpublished doctoral dissertate; Faculty of Nursing, University of Alexandria.

Hatami, M. M., Oshvandi, K., Vardanajni, M. M., Mohamadi, Y., & Shamas, A. (2018): The Effect of Cold Compresses on the Comfort of the Patients During Chest Drainage Tube Removal After Cardiac Surgery: a Randomized Clinical Trial.Scientific Journal of Hamadan Nursing & Midwifery Faculty - ISSN 2008-2819.2018; 26 (1): 57 - 62.DOI:10.30699/ sjhnmf. 26.1.57.

Hawk, C. (2017): The Praeger Handbook of Chiropractic Health Care: Evidence-Based Practices.Other chiropactic service.Cryotherapy.CH.5.PP.(96-97).

Hsieh, L. Y., Chen, Y. R., & Lu, M. C. (2017): Efficacy of cold application on pain during chest tube removal: a randomized controlled

trial: A CONSORT-compliant article. Medicine, 96(46), e8642.Doi.org/ 10.1097/ MD.0000000000008642

Küçükakça Çelik, G., & Özer, N. (2020): Effect of Cold Application on Chest Incision Pain Due to Deep Breathing and Cough Exercises. Pain Management Nursing. Doi:10.1016 /j.pmn.2020.02.002

Kunter, D, Gezer, N. (2019): The Effect of Cold Application Before Breathing Exercises on Sternotomy Pain: A Quasi-Experimental Study. ADYÜ Sağlık Bilimleri Derg. 2019; 5(3): 1776-1787. Doi.org/ 10.30569/adiyamansaglik.623953.

Lister, S., Grafton, H. & Hofland, J. (2020): The Royal Marsden Manual of Clinical Nursing Procedures. Pain assessment and management. CH.10.pp. (450-452).

Lopez-Martinez, D. (2020): Machine Learning for Pain Assessment and Management. Submitted to the Harvard-MIT Health Sciences & Technology in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Medical Engineering and Medical Physics at the Massachusetts Institute Of Technology February 2020."

Malik, V., Kiran, U., Chauhan, S., & Makhija, N. (2018): Transcutaneous nerve stimulation for pain relief during chest tube removal following cardiac surgery. Journal of anaesthesiology, clinical pharmacology, 34(2), 216–220.Doi: 10.4103/joacp. JOACP_336_ 15PMID:30104832; PMCID: PMC606 6881.

Matzo, M. & Sherman, D.W. (2019): Palliative Care Nursing. Physical Health: Symptom Management. Pain: Assessment And Treatment Using a Multimodal Approach.5thed. Section IV .pp. (467-496)

Mazloum, S., Gandomkar, F., & Tashnizi, M. (2018): The Impact of Using Ice on Quality of Pain Associated with Chest Drain Removal in Post cardiac Surgery Patients: An Evidence-Based Care. Cross ref DOI link: https://doi.org/ 10.2174/187443 4601812 010264 Published: 2018-12-31 .pp.264-271".

McCaffery, M. (1999) : Pain management: Problems and progress, 2nded. St. Louis: Mosby Co, 1999; 1-14.

McGee, E., Danter, M., Strueber, M., Mahr, C., Mokadam, N. A., Wieselthaler, G., ... & Cheung, A. (2019): Evaluation of a lateral thoracotomy implant approach for a centrifugal-flow left ventricular assist device: The LATERAL clinical trial. The Journal of Heart and Lung Transplantation, 38(4), 344-351. Doi.org/10.1016/ j.healun. 2019.02.002.

Mefire, A. C., Fokou, M., & Dika, L. D. (2014): Indications and morbidity of tube thoracostomy performed for traumatic and non-traumatic free pleural effusions in a low-income setting. Pan African Medical Journal,18, 256.Doi:10.11604/ pamj. 2014.18.256.3963.

Mohammadi, N., Pooria, A., Yarahmadi, S.,Tarrahi, M. J., Najafizadeh, H., Abbasi, P., & Moradi, B. (2018): "Effects of Cold Application on Chest Tube Removal Pain in Heart Surgery Patients. Tanaffos 2018; 17(1): 29-36.ISSN: 1735-0344. PMID: 30116276. PMCID: PMC6087532.

Mona, M. (2018). 30 Major Duties and Responsibilities of an ICU Nurse. retrived on march,14, 2021 from http: //nursing exercise.com/icu-nurse-duties-responsibilities.

Munkombwe, W. M., Petersson, K., & Elgán, C. (2020). Nurses' experiences of providing non-pharmacological pain management in palliative care: A qualitative study. Journal of Clinical Nursing. Doi:10.1111/jocn.15232

Puntillo, K., Ley, S. J. (2004): Appropriately timed analgesics control pain due to chest tube removal. American Journal of Critical Care. 2004 Jul;13(4):292-301; discussion 302; quiz 303-4. PMID: 15293581.Doi.org/10.4037/ajcc2004.13.4.2 92.

Ravindhran, B., Rajan, S., Balachandran,G., & Mohan, L. N. (2019): Do Ice Packs Reduce Postoperative Midline Incision Pain, NSAID or Narcotic Use?World Journal of Surgery: 43:2651–2657 .Doi.org/10.1007/s00268-019-05129-1.

Sajedi-Monfared, Z., Rooddehghan, Z., Haghani, H., Bakhshandeh, A. R., Monfared, L.S. (2021): Cold therapy and respiratory relaxation exercise on pain and anxiety related to chest tube removal: A

clinical trial. Iranian Journal of Nursing and Midwifery Research 2021;26:54-9 Doi:10.4103/ ijnmr. IJNMR_228_19.

Sandhya, R., & Jebarose, S. (2020): Effectiveness of Ice Compress Application upon the Level of Pain among Patients with Chest Drainage.Pondicherry Journal of Nursing, Volume 13 Issue 1.Doi: 10.5005/jp-journals-10084-12153.

Sauls, J. (2002): The use of ice for pain associated with chest tube removal. Pain Management Nursing, 3(2), 44–52. Doi:10.1053/jpmn.2002.123017 .

Singh, S. (2019): Advanced Technology-Assisted Problem Solving in Engineering Education .spur gesr design and analysis ATAPS package. Ch.5; pp. (152-153).

Tareq, Z., Morshed, A.T., Rahman, M., & Hoque, R. (2020). Effects Of Cold Presentation On Pain & Anxiety During Chest Tube Removal Among Post-Operative Cardiac Surgery Adult Patients: A Study In (Nicvd), Dhaka, Bangladesh.European Journal of Pharmaceutical and Medical Research.2020,7(8), 207-211.ISSN 2394-3211.

Yakşi, E., Yakşi, O. (2017): Current treatment options for post-thoracotomy pain syndrome: a review. Curr Thorac Surg. 2017; 2(3): 103-110. Doi.org/10. 26663/cts.2017.0020.

Zubrzycki, M., Liebold, A., Skrabal, C., Reinelt, H., Ziegler, M., Perdas, E., & Zubrzycka,M. (2018): Assessment and pathophysiology of pain in cardiac surgery. Journal of Pain Research, Volume 11, 1599–1611. Doi: 10.2147/ jpr.s162067