THE USE OF ICE FOR PAIN ASSOCIATED WITH CHEST TUBE REMOVAL

by

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A DISSERTATION

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The purpose of this experimental study was to ascertain whether the application of ice would decrease pain before, during, and after chest tube removal (CTR) in adults who have undergone cardiothoracic surgery. Fifty postcardiac surgery patients were randomly assigned to 1 of 2 groups. Subjects in the experimental group received ice therapy (independent variable) for 10 min before CTR, while subjects in the control group received a placebo.

The Multidimensional Conceptualization of Pain Framework and the theory that ice decreases nerve conduction velocity, thereby inhibiting pain impulses, provided the supporting frameworks to guide the study. The investigator applied ice on either side of the chest tube(s) covering a 6 sq. in. area around the tube(s). The ice was applied directly over one 4 x 4 in. gauze dressing and was secured with three 10-in. strips of 3-in. cloth tape. The investigator was notified by the Nurse Practitioner (NP) or resident prior to CTR to provide time for the intervention. Pain intensity and pain distress (dependent variable) were measured on a 0-10 Numeric Rating Scale (NRS), and pain quality was measured using the McGill Pain Questionnaire-Short Form (MPQ-SF). Baseline measures of pain distress and pain intensity were taken before ice application (Time 1), ice was applied for 10 min, and pain intensity and pain distress were measured again immediately prior to CTR (Time 2). Immediately after CTR, pain intensity and pain distress...
were measured again (Time 3), and 10 min later pain intensity and pain distress were measured for the last time (Time 4). The patient was also asked to rate the quality of his or her pain during CTR using the MPQ-SF at Time 4.

The Repeated Measures Analysis of Variance (ANOVA) revealed no significant differences in pain intensity or pain distress between the experimental and control groups. A significant change in pain over time was noted in both groups with pain intensity and distress being most severe during chest tube removal. Descriptive statistics indicate that both groups used all the quality descriptors on the MPQ-SF for the sensory and affective components of pain.
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Mean pain intensity during chest tube removal
CHAPTER I

INTRODUCTION

Pain is a universal phenomenon (National Institute of Nursing Research (NINR), 1994) and is the most common medical complaint among civilized populations (Waldman, 1992), consistently ranking among the most frequently used nursing diagnoses (Kim et al., 1984; Leslie, 1981; Martin & York, 1984; Silver, Halfmann, McShane, Hunt, & Nowak, 1984; Suhayda & Kim, 1984). Millions of people experience pain each year, and with ineffective management, pain is said to be “the most frequent cause of suffering and disability for many people, significantly decreasing their quality of life” (Watt-Watson & Donovan, 1992, p. 3).

Nurses claim to be concerned with increasing quality of life for their patients. Therefore, a desire to effectively manage the pain experience should be paramount in their endeavors. Nurses have more consistent contact with patients than do any other health care providers. This gives them a unique opportunity for making a valuable contribution to the relief of pain (McCaffery & Beebe, 1989).

The focus of this study was specifically related to pain associated with chest tube removal (CTR). While several studies have been done relating to this particular pain experience, research is lacking in the area of evaluation of interventions to alleviate this problem. For this reason, the investigator has chosen to study the effects of ice application on pain associated with CTR in postoperative cardiothoracic surgery patients.
In Chapter 1 of this manuscript, the author provides a statement of the purpose of the research, a description of the problem and its significance, research hypotheses, the conceptual frameworks to be used as guidelines for conducting the research, assumptions associated with the study, and definitions of terms. Chapter 2 includes a literature review on pain management, pain associated with CTR, and ice as an intervention for pain. In Chapter 3, the author outlines the design of the study along with a description of the population and sample, procedures to be used, and statistical analyses to be employed. Chapter 4 includes a report of the findings in relation to demographics of the sample and research hypotheses. In Chapter 5, the author provides a discussion of the interpretation of results, implications, and conclusions.

Purpose

The purpose of this study was to ascertain whether the application of ice would decrease pain intensity, distress, and quality before, during, and after CTR in adult patients who have been admitted to postoperative acute and critical care areas after cardiothoracic surgery.

Significance of the Problem

Every year, more than 300,000 patients undergo cardiothoracic surgery (American Heart Association, 1997), which may include coronary artery bypass grafting (CABG), valve replacement or repair, or repair of structural defects. Each of these procedures requires placement of at least one chest tube. Removal of these chest tubes has been described as one of the worst Intensive Care Unit (ICU) experiences for these patients.
(Paiement, Boulanger, Jones, & Roy, 1979), and the pain associated with CTR has been poorly controlled (Carson, Barton, Morrison, & Tribble, 1994; Gift, Bolgiano, & Cunningham, 1991; Kinney, Kirchhoff, & Puntillo, 1995; Puntillo, 1994). Many patients receive no preprocedural pain medication (Kinney et al., 1995), and, for those who do, pain control is often not achieved (Carson et al., 1994; Gift et al., 1991; Puntillo, 1994, 1996).

Problem Statement

Will the application of ice decrease pain intensity, distress, and quality before, during, and after CTR in adult patients who have been admitted to acute and critical care areas after cardiothoracic surgery?

Conceptual Framework

Multidimensional Conceptualization of Pain

Pain is a multidimensional concept (NINR, 1994) and may be described as a complex phenomenon that involves a combination of physical and psychological events that may be affected by sociocultural phenomena. A multidisciplinary priority-expert panel was convened to review current pain management practices in order to set priorities for future research. The panel of experts established by the NINR, who were charged with studying assessment and management of the pain experience, support the use of this multidimensional model for many types of pain. The model includes six elements: physiologic, sensory, affective, cognitive, behavioral, and sociocultural. The physiologic component is pertinent to the proposed study because the application of ice affects neural conduction of pain impulses (Abramson et al., 1966; Clarke, Hellon, & Lind, 1958; Lee,
Warren, & Mason, 1978). The physiologic dimension will be explicated in the following paragraphs; however, physiologic parameters were not measured as pain is a subjective and personal experience that is best measured by the individual’s self-report of the experience (Katz & Melzack, 1999). The sensory and affective dimensions of pain were assessed in this study and will be explicated in the following paragraphs. The cognitive, behavioral, and sociocultural dimensions will be discussed briefly in this review but were not evaluated in the study. Although assessment of each dimension would present a more complete picture of the pain experience, the nature of the environment and acuity of the patients involved in this study limited the time frame for completing the pain assessment.

Physiologic dimension. Structural, functional, and biochemical aspects of the pain experience as well as the different types of pain are included in the physiologic dimension. Perception and transmission of pain by way of nociceptors along ascending and descending pathways facilitated by neurochemical mediators are important components of the physiologic mechanisms of the pain experience. Duration and pattern are also important components of this dimension (NINR, 1994). Distinctions among the different types of physiologic pain are discussed in the following paragraphs.

Fast pain, also known as brief, momentary, or transient (Melzack, 1975), sharp, pricking, acute, or electric pain that is well-localized, occurs within 1/10 s after the pain stimulus occurs and is not felt in most of the deeper tissues. Acute or fast pain may be caused by any thermal or mechanical stimulus and is transmitted by A-delta fibers with endings that secrete glutamate. If A-delta fibers are blocked by moderate compression of the nerve trunk, fast pain disappears (Guyton & Hall, 1996).
Whipple (1990) defines chronic pain, also known as slow pain, as pain that lasts for more than 6 months. Slow pain is continuous, steady, constant (Melzack, 1975), burning, aching, throbbing, nauseous, or chronic pain that is poorly localized, begins after at least 1 s of painful stimulus, and increases slowly over seconds to minutes (Guyton & Hall, 1996). Slow pain is usually associated with tissue destruction and can occur in skin, deep tissues, and organs. It may be described as excruciating, leading to prolonged and unbearable suffering. Slow or chronic pain, which may be elicited by mechanical, thermal, or chemical stimuli, is transmitted by way of C-fibers. When C-fibers are blocked by local anesthetic, chronic aching pain disappears.

According to Guyton and Hall (1996), physiologic pain is primarily a protective mechanism occurring in response to tissue damage and resulting in withdrawal from the pain stimulus. The cause may be ischemia, muscle spasm, or chemicals released as tissue damage occurs. Pain receptors are free nerve endings and are prevalent in the skin, periosteum, arterial walls, joint surfaces, and falx and tentorium of the cranial vault. Other deep tissues have significantly fewer pain receptors but can elicit painful sensations nonetheless. Unlike other sensory receptors in the body, pain receptors are nonadaptive in nature. Often, pain receptors become increasingly sensitive as the painful stimulus persists, creating a hypersensitivity or hyperalgesia. This mechanism is also protective, as it continues to remind the body that tissue damage may be occurring as long as the pain persists.

Pain receptors may be excited by mechanical, thermal, or chemical stimuli. Mechanical and thermal stimuli can elicit both acute and chronic pain, whereas chemical stimuli usually elicit only chronic pain. Substances like bradykinin, serotonin, histamine,
potassium ions, acids, acetylcholine, and proteolytic enzymes are examples of chemicals that may stimulate chronic pain. Prostaglandins and substance P are capable of enhancing sensitivity of the nerve endings; however, they do not have the ability to directly excite the pain receptors (Guyton & Hall, 1996).

As documented in Guyton and Hall (1996), two separate pathways are used for transmitting pain signals to the brain, and these pathways correspond to the types of pain. Acute or fast pain is transmitted from the periphery to the spinal cord by way of A-delta fibers and from the spinal cord to the brain by way of the neospinothalamic tract. Chronic or slow pain is transmitted from the periphery to the spinal cord by way of C fibers and from the spinal cord to the brain by way of the paleospinothalamic tract.

When excited by mechanical or thermal stimuli, pain receptors in the periphery transmit the impulses to the spinal cord by way of A-delta fibers. These fibers terminate on neurons of lamina I in the dorsal horn of the cord where they excite second-order neurons of the neospinothalamic tract. Glutamate is believed to be the neurotransmitter secreted by the A-delta nerve endings and has a rapid onset and short duration, which explains the timing of fast or acute pain. The second-order neurons give rise to long fibers, which carry the impulse over to the contralateral side of the cord and up to the brain. Some of the long fibers terminate in the reticular area of the brain stem; however, most terminate in the thalamus. From these areas, the impulse is transmitted to other areas of the brain and somatic sensory cortex where the stimulus is interpreted as pain (Guyton & Hall, 1996).

Chronic or slow pain receptors are excited by chemical stimuli and sometimes by persistent mechanical or thermal stimuli. C fibers in the periphery transmit these impulses
to the spinal cord where they terminate mostly in laminae II and III of the dorsal horn. Substance P is believed to be the neurotransmitter secreted slowly by these nerve endings, which explains the timing of slow or chronic pain. This area, known as the substantia gelatinosa, gives rise to the long fibers, which join the fibers from the fast tract and ascend to the brain in the same manner. Some long fibers do not cross to the contralateral side but proceed to the brain on the same side. Most of the neurons that transmit slow pain terminate in the brain stem, and from here the pain signals travel to the thalamus, hypothalamus, and other adjacent structures where the interpretation of pain occurs (Guyton & Hall, 1996).

Individuals respond differently to pain in part because of an internal mechanism called the analgesia system that has the ability to suppress or inhibit pain signals. This system has three basic components that are located in the pons, medulla, and the dorsal horns of the spinal cord. As pain signals descend from the brain to the spinal cord and enter the pain inhibitory complex in the dorsal horn, the signals can be blocked. There are several neurotransmitters involved in this process as well. Enkephalin and serotonin are released at various areas along the descending pathway. Serotonin stimulates the release of enkephalin, which inhibits both A-delta and C fibers and blocks calcium channels that would normally secrete transmitter to perpetuate the pain impulse, thus blocking additional pain impulses from reaching the brain (Guyton & Hall, 1996).

Physiologic responses to pain that occur as a result of sympathetic nervous system activity may include increased heart rate, blood pressure, cardiac contractility, and respiratory rate, as well as diaphoresis, pupil dilation, and pallor. Other possible manifestations include decreased intestinal motility and urinary retention. The body’s response to
stress will result in increased blood glucose, cortisol, antidiuretic hormone, and aldosterone levels (Cousins, 1989). Some of these parameters may be used for assessment of acute pain; however, subjective measures of pain assessment are more valid (Katz & Melzack, 1999).

**Sensory dimension.** According to the NINR (1994), the sensory dimension of pain refers to location, intensity, and quality. When assessing location, anatomic structures and landmarks are addressed and may assist in determining the etiology of the pain. Intensity refers to the amount or severity of pain being experienced and may be assessed using numerical pain rating scales or with word scales using terms such as mild, moderate, and severe. Factors like etiology, tolerance, and pain threshold can influence pain intensity. Quality is related to what the pain feels like and may be influenced by etiology, indicating that different types of pain may have different sensory qualities.

The McGill Pain Questionnaire (MPQ) (Katz & Melzack, 1999; Melzack, 1987) is a pain assessment tool used for evaluating the quality of pain. This multidimensional tool includes words used for assessing the sensory qualities in terms of temporal, spatial, pressure, and thermal properties. Words like throbbing, shooting, stabbing, sharp, gnawing, cramping, pulling, burning, and tingling are used to describe the sensory quality of the pain experience. These descriptors may also be related to different pain syndromes or etiologies (NINR, 1994). Somatic pain may be described as sharp or stabbing, whereas visceral pain may be described as dull or aching (Guyton & Hall, 1996).
**Affective dimension.** While emotional distress may be considered a component of pain, it may also be a consequence or cause as well as a concurrent phenomenon with entirely independent sources. The affective component of pain is the dimension that involves suffering (Craig, 1989; Loeser & Melzack, 1999; NINR, 1994) and may include emotions such as fear, depression, anxiety, anger, relief, anticipation, aggression, and personality characteristics. It may be these signs of emotional distress that enable the observer to recognize the presence of pain.

Though a number of emotions are associated with the pain experience, Peck (1986) identified anxiety as the psychological variable most related to pain. Fear of the unknown and fear of death are often associated with acute postoperative pain and trauma pain. Adequate preparation of the patient and allowing the patient to assume some control of the situation have been documented as successful methods for decreasing anxiety.

The MPQ (Katz & Melzack, 1999) includes a section containing words used for assessing the affective qualities in terms of tension, fear, and autonomic properties. Words like tiring, exhausting, sickening, fearful, punishing, cruel, and wretched are used to describe the affective or emotional quality of the pain experience. The MPQ is widely used for clinical practice and research.

Several studies have been conducted addressing the affective or emotional aspects of the pain experience (Gift et al., 1991; Puntillo, 1990, 1996). Still, it remains more elusive than the physiologic and sensory dimensions (NINR, 1994).

**Cognitive dimension.** Cognition has been defined as "awareness with perception, reasoning, judgement, intuition, and memory; the mental processes by which knowledge
is acquired” (Thomas, 1997, p. 411). The cognitive dimension of pain involves the individual’s perception of self; the meaning of pain, knowledge, attitude, and belief about pain and pain therapy; and personal preferences and coping strategies. Also included in this dimension are the level and quality of cognition of the individual as they relate to his or her ability to self-report pain. Individuals with limited or impaired cognitive function, such as infants, those with learning disabilities, confused patients, or those with dementia, may lack the ability to report their pain adequately. The few studies regarding the cognitive dimension of pain fail to provide a comprehensive understanding of this dimension (NINR, 1994), as the emphasis for most is on altering the way in which individuals view their pain experiences. Although the nature of the success remains unclear, cognitive aspects of pain have been shown to be significant in the perception and management of pain (Weisenberg, 1989).

Cognitive strategies that have been used to alter pain perception are: (a) imagery that is incompatible with the pain experience; (b) imaginative transformation, wherein the subject must interpret the feeling as something other than pain; (c) changing the setting of the painful stimulus; (d) attention diversion (counting ceiling tiles); (e) doing mental arithmetic; and (f) somatisation, which involves focusing on the painful part in a detached manner. Each of these strategies has been found to be successful in altering pain perception in some patients (Weisenberg, 1989).

Behavioral dimension. Behavioral aspects of pain include those observable actions exhibited by individuals that indicate pain is being experienced, or the actions may be attempts to alleviate pain. Behaviors like moaning, groaning, facial grimacing, and
limping may be indicators of pain, whereas actions like lying down, splinting, physical activity or inactivity, massage, use of medication, and seeking of health care are displays of efforts to alleviate pain (Loeser & Melzack, 1999; NINR, 1994). Behaviors like sleep, rest, or fatigue that are related to the pain phenomenon may also be observed (NINR, 1994).

The behavioral aspects of pain are very important assessment parameters for individuals who may be unable to report their pain, such as infants, children, or adults who are unable to communicate due to confusion, altered levels of consciousness, or insufficient command of language (Katz & Melzack, 1999; NINR, 1994). The combination of self-report and observed behaviors may result in a more complete assessment. However, behavioral observations should not replace self-reporting, which is considered to be the most valid measure of the pain experience (Katz & Melzack, 1999). Also of importance is that, even when incongruent with pain behaviors, self-reports should be the primary validation of the person's experience.

**Sociocultural dimension.** The sociocultural dimension of pain involves those aspects of pain intrinsic to the individual's perception as related to demographics, ethnicity, spirituality, culture, religion, and social factors. Individuals' perceptions of and responses to pain are certainly influenced by the beliefs and teachings of family members as well as their ability to afford health care. Important areas to assess include family and social history, home and work environment, and attitudes and beliefs about pain. Not only are these sociocultural variables pertinent to sufferers but also the sociocultural variables
related to providers will influence their assessment and management of the pain experience, as the perceptions of the sufferer and the providers may differ (NINR, 1994). Although much of the research regarding the six dimensions of pain is descriptive in nature, the support for pain as a multidimensional concept is strong. It is evident that pain is unique to the sufferer and is defined as a subjective experience. Knowledge about the extent, nature, significance, and interaction of the six dimensions remains incomplete, yet this multidimensional framework enhances the understanding of pain as a multifaceted concept (NINR, 1994).

**Cold and Nerve Conduction Velocity**

While the multidimensional conceptualization of pain provides a framework for guiding the definition and measurement of the pain experience, the notion that cold decreases nerve conduction velocity, thus inhibiting painful impulses, provides the support for the intervention, which is the use of ice for decreasing pain associated with chest tube removal.

Clarke et al. (1958) noted that cooling not only decreased the rate of impulse transmission along the neuron but also caused failure of conduction at approximately 27 °C. Temperatures less than 20 °C created a decreased production of acetylcholine and decreased the conduction velocity along cooled neurons, thereby creating asynchronous conduction of impulses. These mechanisms of action seem to be responsible for the analgesic effects of cold. Abramson et al. (1966) found similar results when he studied the change in motor conduction velocity of the ulnar and median nerves during exposure of the human forearm to histamine by ion transfer, short-wave diathermy, and a variety of
different bath temperatures. He found a significant decrease in nerve conduction velocity with both rapid and slow cooling of the skin on the forearm of 29 normal adults. Also noted was a significant drop in temperature of the skin and subcutaneous tissues (including muscle).

Further validation of this theory occurred when Lee et al. (1978) investigated the effects of ice application on nerve conduction velocity of the ulnar nerve of the human forearm in 10 healthy young adults. Electrical stimulation was used for painful stimulation, and the Medelec Electromyograph MS6 was used to measure nerve conduction velocity. The investigators found a statistically significant decrease in motor nerve conduction velocity ($p = .005$) with a 24-min application of ice to the flexor carpi ulnaris muscle in the forearm and with a 20-min application of ice to the medial aspect of the elbow ($p = .001$). A greater decrease in conduction velocity was noted at the medial aspect of the elbow (29.4% decrease) than at the flexor carpi ulnaris muscle (11.6% decrease), suggesting a more dramatic decline at the superficial or subcutaneous level. Six subjects in the control group showed nonsignificant changes in nerve conduction velocity during the entire test period. No correlation was found between body fat and nerve conduction velocity. Skin temperature and conduction velocity correlated significantly with ice application on the elbow.

**Hypotheses**

Based on the physiologic, sensory, and affective dimensions of pain and the results of studies regarding cold and nerve conduction velocity, the following hypotheses were established.
1. Adults with chest tubes who receive application of ice will have a lower pain intensity score on the Numeric Rating Scale (NRS) before, during, and after CTR than a similar population who does not receive application of ice.

2. Adults with chest tubes who receive application of ice will have a lower pain distress score on the NRS before, during, and after CTR than a similar population who does not receive application of ice.

3. Adults with chest tubes who receive application of ice will have lower scores on the descriptors on the MPQ-SF during CTR than a similar population who does not receive application of ice.

Assumptions

The following assumptions were made.

1. Pain can be quantified and described by using a reliable and valid instrument.

2. Patients did honestly and accurately report pain intensity, distress, and quality.

3. The investigator did remain neutral in terms of outcome of the study.

Definitions

The following definitions were used in the study.

**Cold** refers to “the abstraction of heat, the substance by means of which such abstraction is effected, and to the sensation created by such abstraction” (Bierman, 1955, p. 1189). When water is used as an intervention, it is said to be very cold at temperatures less than 55 °F. Ice is operationally defined as the solid form of water formed in response to the application of cold.
Pain refers to “whatever the experiencing person says it is and exists whenever he says it does” (McCaffery, 1972, p. 8); “an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage” (International Association for the Study of Pain Subcommittee on Taxonomy, 1979, p. 250). Pain intensity, distress, and quality were measured.

Pain intensity refers to “a quantitative estimate of the severity of felt pain” (Jensen & Karoly, 1992, p. 137). The 10-point NRS with the anchors 0 (no pain) to 10 (worst possible pain) was used to measure pain intensity.

Pain distress refers to pain dimension that relates to negative emotional response (Johnson, 1973; NINR, 1994). The 10-point NRS with the anchors 0 (no distress) to 10 (worst possible distress) was used to measure pain distress.

Pain quality refers to “words used to describe feelings and sensations” (Melzack & Katz, 1992, p. 155). The MPQ-SF was used to measure sensory and affective qualities of pain. The instrument includes 15 descriptive words, each measured on a 4-point scale with the anchors 0 (none) to 3 (severe).

Chest tube refers to “a drain inserted into the pleural space or mediastinal space to restore normal physiological intrapleural pressure by allowing drainage of fluid out of the space into a collection chamber below the chest level” (Ingatavicius, Workman, & Mishler, 1999, p. 743).

Adult refers to any man or woman more than 18 years of age.

Coronary artery bypass graft (CABG) refers to “myocardial revascularization that involves the use of a conduit or channel designed to bypass an occluded coronary artery” (Thelan, Davie, & Urden, 1990, p. 308). This surgical procedure requires opening of the
chest cavity for direct access to the heart. Upon completion of the graft procedure, the surgeon places a hollow chest tube inside the chest cavity to promote drainage of fluids into a collection chamber. The nurse monitors and measures the drainage hourly, reporting drainage in excess of 100-150 ml/hr to the surgeon. Once the drainage reaches an acceptable level, usually from 24-48 hr postoperatively, the chest tube is removed.

Valve replacement (or repair) refers to surgical replacement with a biologic (tissue) or prosthetic (synthetic) valve that may be performed in order to improve the prognosis of valvular heart disease. In some cases, the valve may simply be repaired by reconstruction (Ignatavicius et al., 1999). The same procedure is followed with chest tube insertion and removal as is described with CABG.

Structural defect refers to a congenital abnormality of the heart that results in abnormal communication between chambers of the heart, such as atrial septal defect and ventricular septal defect (Porth, 1998).

Pericardiectomy refers to partial or complete excision of the pericardium (Ignatavicius et al., 1999); requires mediastinotomy with insertion and removal of chest tube as described with CABG.

The purpose of the proposed research, a description of the problem and its significance, research hypotheses, a description of the conceptual frameworks, related assumptions associated with research, and definitions of terms have been presented in Chapter 1. Chapter 2 will include a review of literature on pain management, pain and CTR, and ice as an intervention for pain.
CHAPTER 2

REVIEW OF LITERATURE

Chapter 2 of this manuscript includes a review of the literature related to pain management, pain and CTR, and ice used as an intervention for pain management.

Pain Management

Pain is a problem that nurses encounter daily, and it requires accurate assessment and prompt intervention for quality care and patient comfort. Although it has been documented that pain consistently ranks among the most used nursing diagnoses (Kim et al., 1984; Leslie, 1981; Martin & York, 1984; Silver et al., 1984; Suhayda & Kim, 1984), the literature reveals that pain is poorly managed in a variety of patient populations. Gujol (1994) conducted a descriptive study to explore the concerns of 71 critical care nurses about use of narcotics in pain management. Factors like concerns about addiction, tolerance, physical dependence, and respiratory depression were documented as reasons that nurses fail to effectively implement adequate pain control measures. A review of pain management practices is discussed in the following paragraphs.

In a survey done by Warfield and Kahn (1995), 500 randomly selected adults across the country having had surgery in the previous 5 years were questioned regarding their primary concern prior to surgery. Results of the study indicated that 57% of the participants admitted that pain after surgery was their major concern, and 77% reported having pain postoperatively, of which 49% reported moderate pain, 23% reported severe
pain, and 8% reported extreme pain. Of the 71% of patients who had received medication for pain relief, 71% admitted experiencing pain after their first dose of analgesic.

In the same study, 300 randomly selected hospitals across the country were surveyed regarding pain management programs established or planned. Only 42% of the hospitals surveyed had active pain management programs. Additionally, 13% had plans for implementing such programs. Although the study involved survey research, the large sample size and random sampling lends credibility to the results, which are consistent with information published by the Acute Pain Management Guideline Panel (1992) that indicates many surgical patients do not obtain adequate pain relief postoperatively.

Another study of ICU patients by Puntillo (1990) revealed that more than 70% of her sample reported having had moderate to severe pain. Although this study involved a small sample (N = 24) and was descriptive in nature, many of the participants were able to describe their pain experiences vividly.

A descriptive study of 101 postcardiac-surgery patients (Meehan, McRae, Rourke, Eisenring, & Imperial, 1995) showed that, despite administration of analgesics, many patients continued to experience moderate pain. The participants identified other problems associated with pain, such as limited mobility and difficulty sleeping and resting. A descriptive study by Tittle and McMillan (1994) using 44 postoperative patients revealed similar findings in that many patients continued to experience pain despite intervention. Also noted in this study were the facts that many nurses did not administer as much analgesic as was ordered and that frequency of pain assessment was inadequate. Results also revealed almost no use of nonpharmacologic pain management strategies. A descriptive study done by Puntillo and Weiss (1994) involving 75 postoperative
cardiovascular surgical patients showed similar results in that the amount of analgesic administered was not sufficient to relieve pain.

Carroll et al. (1999) completed a descriptive, correlational study using 213 patients in 13 hospitals to examine individual and institutional approaches to pain management. These investigators found that 64% of patients in ICUs were often in moderate-to-severe pain and had to wait for long periods to receive pain medication. Also noted was that only 54% of the patients had a numeric pain rating in the first 24 hr after surgery, and only 33% of the patients had documentation of the use of nonpharmacological pain interventions. Despite these findings, many patients reported satisfaction with pain management practices. In a study done by Van Kooten (1999) to assess the effectiveness of nonpharmacologic pain control methods in 20 postoperative CABG patients, massage, deep breathing, distraction, and repositioning were used frequently. Eight other alternatives were rarely used. The patients who used these nonpharmacologic adjuncts reported greater relief from pain than those who did not use the alternative methods.

Summary

Although physicians prescribe analgesics, nurses ultimately deliver the intervention. From the studies reviewed, it is clearly evident that nurses do not manage pain effectively. A serious examination is needed to determine what the role of nursing should be in managing patients' pain. As the health care providers who spend more time at the bedside than any others, nurses can make a profound impact regarding the alleviation of pain. In the next section, the author will provide a review of the literature relating pain and CTR.
Pain and Chest Tube Removal

The focus of this study is specifically related to pain associated with CTR, which is addressed in only a few studies. Kinney et al. (1995) surveyed 553 critical care nurses to explore CTR practices in the United States and discovered considerable inconsistencies, particularly in regard to pain management. Only 50% of the nurses surveyed admitted to being notified in advance of CTR in order to provide patient preparation, while only 16.3% reported routine availability of an order for preprocedural pain medication. Nurses reported that administration of pain medication was more likely if the nurse removed the chest tube than if the physician removed the chest tube. Also reported was that pain was only monitored in 78.5% of the patients having chest tubes removed.

In one descriptive study, a purposive sample of 24 adults recovering from critical illnesses was interviewed by Puntillo (1990) about their experiences while in the ICU. Twenty-three of the patients were able to provide vivid descriptions of the memories of their experiences. The second most often reported memory was pain. Seventy percent of the sample reported having pain while in ICU; two thirds of the subjects said the pain was moderate to severe. One woman reported her experience with CTR as follows: “When my chest tubes were removed, it felt like they were pulling my guts out” (Puntillo, 1990, p. 529). In a descriptive study of postoperative patients with chest tubes (Gift et al., 1991), the sensations reported during CTR were burning, pain or hurting, pulling, yanking, and pressure. Burning was the most frequently reported sensation, with a mean intensity of 51 mm on a visual analog scale (VAS) of 0-100 mm, while pain was the second most reported sensation, with a mean intensity of 62 mm on the same scale. Of the 36
subjects in the study, only 50% received some type of analgesic prior to chest tube removal.

In yet another study on procedural pain, Puntillo (1994) discovered pain intensity associated with CTR ($M = 6.6$ on a 0 to 10 NRS) to be greater than pain associated with endotracheal suctioning ($M = 4.9$). This descriptive correlational study involving 45 patients with endotracheal tubes and 35 patients with chest tubes showed that patients received insignificant amounts of premedication analgesic and that the correlation between amount of analgesic given and pain intensity was not significant.

A more recent study by Puntillo (1996) showed pain intensity associated with CTR to be of moderate to severe intensity irregardless of the intervention. This experimental study involved the use of intrapleural bupivacaine for control of pain associated with CTR. Forty-one postoperative CABG patients were randomly assigned to one of two groups. The patients in Group 1 received injections of intrapleural bupivacaine, while patients in Group 2 received a placebo (normal saline). No significant difference was noted between the two groups with regard to pain intensity, distress, sensation, or affect scores. Although not a part of the study design, results indicated that those patients who received Ketorolac (Torodol) prior to CTR had significantly lower pain intensity scores ($M = 2.8$ on a 0 to 10 NRS) than those who did not receive the drug ($M = 5.4$). Also noted was a nonsignificant difference when comparing patients who received morphine sulfate with patients who did not receive morphine sulfate.

Another experimental study comparing different analgesic regimens for management of pain associated with CTR was done by Carson et al. (1994) with 80 adults who had heart surgery requiring chest tube placement. The patients were randomly assigned to
one of four test groups. Patients in Group 1 received intravenous morphine sulfate. Patients in Group 2 received intravenous morphine sulfate and subfascial angiocatheter lidocaine hydrochloride. Patients in Group 3 received intravenous morphine and subfascial angiocatheter normal saline solution. Patients in Group 4 received only subfascial angiocatheter lidocaine. Results indicated no significant difference in pain scores among the four groups. All groups reported mild to moderate pain intensity on a 0 to 100 mm VAS and were rated as follows: Group 1 had a mean pain score of 43.7, Group 2 had a mean pain score of 40.9, Group 3 had a mean pain score of 36.4, and Group 4 had a mean pain score of 38.1.

Broscious (1999) conducted a study to examine the effects of music on pain associated with CTR after cardiothoracic surgery. One hundred fifty-six subjects were randomly assigned to one of three groups. Subjects in Group 1 received standard care, subjects in Group 2 listened to a prerecorded tape of white noise for 10 min, and subjects in Group 3 listened to music of their choice for 10 min prior to CTR. Study findings indicated no significant difference in pain intensity scores, using an 11-point NRS, among the three groups during and after CTR. Results also indicated that there was no significant difference in self-reported pain between subjects who received analgesics within 4 hr of CTR and those who received analgesics more than 4 hr before CTR.

Summary

Of the seven studies reviewed, a significant number of patients admitted to having pain regardless of any intervention that was used for pain control. Again, results of these studies indicate a lack of adequate pain control measures for patients undergoing CTR.

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Despite these findings, little research has been done to test different pain management practices to find an effective intervention for pain associated with CTR. In the following paragraphs, the author will provide a literature review on the use of cold for pain control.

Cold for Pain

Although analgesic administration is probably the most common intervention that nurses provide for pain management (Mobily, Herr, & Nicholson, 1994; Whipple, 1987), cutaneous stimulation in the form of cold application can be an effective alternative or adjunct to pain management. A simple and inexpensive therapy, cold application has been accepted for decades as an effective nonpharmacologic intervention for pain management (Beare & Myers, 1998; Bierman, 1955; DeCrosta, 1984; Ingatavicius et al., 1999; Lewis, Collier, & Heitkemper, 1996; McCaffery, 1972, 1980, 1990; McCaffery & Beebe, 1989; McMaster, Liddle, & Waugh, 1978; Mobily et al., 1994; Romyn, 1992; Whipple, 1987). Several authors have documented empirical clinical evidence indicating success with the use of cold in pain control (Aronoff, 1985; Faint, 1971; Harbert, 1989; Logan & Martin, 1993; Mehus, 1981; Wing, 1976), yet very little scientific evidence exists to validate its effectiveness. After an extensive review of the literature, the author found no studies testing ice for effectiveness in alleviating pain associated with CTR. However, several studies were located that evaluated ice as a therapeutic intervention for pain associated with orthopedic procedures, abdominal procedures, and gynecologic procedures. Also included in the review are studies regarding the physiologic effects of cold.

A study by Benson and Copp (1974) was conducted to compare therapeutic effects of heat and cold, in the form of diathermy and ice, on pain threshold of the normal
shoulder in 12 physical therapy students. An algesimeter was the stimulus as well as the measure for pain. The subjects were divided into three groups, and each group received diathermy on one occasion and ice on another occasion. Both between and within subjects, comparisons were conducted using repeated measures analysis of variance (ANOVA). Findings indicated that, though both interventions were effective in increasing the pain threshold, cold was significantly more effective than heat, with maximum effect immediately following treatment. With both interventions, however, effects lasted only up to 30 min.

Although the study by Benson and Copp (1974) revealed some interesting findings, the small sample, homogeneity of subjects, and lack of randomization make generalizability difficult. Also, failure to document an alpha coefficient, which would allow us to surmise whether the effect is indeed a result of the intervention or if it occurred only by chance, prevents the determination of the likelihood of a Type I error. Reliability of the instruments used for the study was documented, yielding greater internal validity for the study. In a similar study by Miller and Weber (1990), who investigated the effects of ice massage on pain tolerance to electrical stimulation of 21 female physical therapy students, ice massage prior to electrical stimulation was shown to significantly increase pain tolerance to electrical stimulation (p < .05). This study was well controlled, with random assignment to groups and documented instrument reliability. However, the small sample limited the power and generalizability of the results.

Findings in a study by Bugaj (1975), conducted to assess the cooling, analgesic, and rewarming effects of a 10-min application of cold to the skin on 16 healthy adults, further validate the theory of cold and analgesia supported by Lehmann and DeLateur.
Each subject participated in the experimental and control groups, acting as his or her own control. The experimental group received ice, while the control group received a placebo. The lowest mean skin temperature was 5.8 °C, occurring during the first 10 min of the ice application, and was 26.6 °C less than the mean pretreatment temperature (most rapid cooling occurred in the first 2 min). There was no significant change in temperature of the contralateral extremity.

Bugaj (1975) discovered that cooling occurred at a rate of 2.7 °C/min. Warming occurred at a rate of 1.9 °C/min during the first 10 min of the rewarming phase. Analgesic effects began at 1 min 45 s (temperature 13.6 °C) after ice application and ended 2 min 57 s after discontinuation of therapy. Results indicated that ice at 2 °C was effective in achieving analgesia during administration and for approximately 3 min after the application ceased (p = .001). No significant change in temperature was noted with the placebo treatment and no analgesia occurred. The major limitation of this study is the small sample size of healthy adults, which limits generalizability of the findings. Reliability and validity of the instruments was not well documented, which may also limit the internal validity of the study.

A study by Waylonis (1967) to investigate the physiologic effects of ice massage on blood pressure, pulse, response to pain, and temperature in 12 adults revealed no significant change in blood pressure or pulse. However, a dramatic drop in skin temperature for each of the three groups was noted. The subjects in Group 1, who had ice applied to one thigh for 5 min, showed a decrease of 19.2 °C. The subjects in Group 2, who had ice applied to one thigh for 10 min, showed a temperature drop of 18.2 °C. The subjects in Group 3, who had ice applied to one calf for 5 min, showed a decrease of
17.2 °C. The temperature of subcutaneous tissue, which was measured at depths of 0.5 cm, 1.0 cm, 2.0 cm, 3.0 cm, and 4.0 cm, decreased an average of 12.5 °C, with the temperature change being less with increasing depth of tissue. A noted drop in temperature of 1.3 - 2.2 °C at 3 and 4 cm approximately 10 min after discontinuation of therapy indicates some delay in deep muscle cooling.

Comparison of Groups 1 and 2, in which time was the variable, revealed significantly greater drops in temperature for Group 2 in a majority of the observations (p = .000002). However, no significant difference was noted between Groups 1 and 3, in which location was the variable. These results indicate that (a) cooling for longer periods of time may provide some added benefits, and (b) site of application may not make a difference. In regard to pain response, numbness was detected 4 min to 4 ½ min after application of the ice lasting from 30 min up to 3 hr (at least 1 hr for the majority of the subjects). No adverse reactions were documented. Although findings of this study are significant and of major importance, the lack of documentation regarding reliability and validity of the instruments and the small sample limit internal validity and generalizability.

Several studies regarding effectiveness of cold applications were reviewed. In a study by Cohn, Draeger, and Jackson (1989), 54 patients having anterior cruciate ligament (ACL) reconstruction were used to compare postoperative pain between two groups: an experimental group using the Hot/Ice Thermal Blanket (50 °F) as cold therapy (in continuous use after discharge from recovery until discharge home) and a control group (use of ice bag in recovery room only) without the therapy. Results showed that the experimental group used an average of 5.2 mg/kg of Demerol, while the control group used an average of 11.22 mg/kg, significant at p < .05. Fifty percent of the patients in the
experimental group were taking oral narcotics the second postoperative day, while only 30% of the patients in the control group were in this category. Further, patients receiving cold therapy progressed more rapidly with independent ambulation and stair climbing.

The findings of Cohn et al. (1989) suggest that cold therapy is effective in decreasing the amount of narcotics used in postoperative pain management of the patients in this sample. However, using McCaffery’s (1972) definition of pain, “whatever the experiencing person says it is and exists whenever he says it does” (p. 80), an additional subjective measure of pain beyond narcotic use would be helpful in documenting pain intensity. Numerous other studies (Gujol, 1994; Meehan et al., 1995; Puntillo, 1994; Puntillo & Weiss, 1994; Tittle & McMillan, 1994; Warfield & Kahn, 1995) have shown narcotic use to be incongruent with actual pain experienced. Although patients in the Cohn et al. (1989) study may have been instructed to request narcotics for a certain level of pain, no documentation of such was found. Also, use of an ice bag in the recovery room for the control group was not mentioned initially as part of the therapy, and no time limit was assigned to this intervention. One patient in the control group suffered from temporary nerve palsy, which the investigators attributed to placement of the ice bag for a 40-min period. No other adverse reactions were documented.

A similar study by Konrath, Lock, Goitz, and Scheidler (1996) was conducted to assess the effectiveness of cold therapy, using the Polar Care device, in 100 postoperative patients having ACL reconstruction. Patients were randomly assigned to one of four groups: Group 1 received a Polar Care device filled with ice water (40 to 50 °F), Group 2 received a Polar Care Device filled with tap water, Group 3 received a bag of crushed ice, and Group 4 received no cold therapy. Findings indicate no difference in skin

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temperature of the patients using the Polar Care device and the patients using ice nor were any differences noted between patients using tap water and patients using no therapy. No significant differences between any of the groups in regard to temperature, drainage output, range of motion, length of stay, or amount of pain medication used were found ($p > .01$). Again, no subjective measure of pain was used, raising questions about the validity of the results. Also, the authors failed to document length of time for application of the device, although continuous application was implied.

Results similar to these were found by Edwards, Rimmer, and Keene (1996), who conducted a study to assess the effectiveness of cold therapy for 36 hr using the Cryo/Cuff device (applied over the dressing) in relieving postoperative pain in 71 patients having ACL reconstruction. No significant differences were found in amounts of narcotics used, pain scores on a VAS, blood loss, or range of motion between subjects who were randomly assigned to one of three groups: Group 1, who received cold therapy; Group 2, who received tap water; and Group 3, who received no Cryo/Cuff at all. The major limitation of this study was that pain was only measured once per day, and there was no documentation of the level of significance. Although this was a double-blind study, control was lacking in that the intervention was altered after the first nine patients. In the first nine subjects, orthopedic wool was placed over the wound closure. The investigators determined that this procedure may decrease the effectiveness of the intervention; therefore, the remaining 62 patients had a sterile compression stocking applied, covered by the Cryo/Cuff. The alteration in the intervention places the internal validity of the study in question. No adverse reactions were documented.
Dervin, Taylor, and Keene (1998) also conducted a study using the Cryo/Cuff to ascertain whether the alleged benefits of the device are a result of the compressive effect as opposed to the application of cold. Seventy-eight patients having ACL reconstruction were randomized into one of two groups: Group 1 received the Cryo/Cuff with continuous circulating ice water, while Group 2 received the Cryo/Cuff with room-temperature water. No significant difference was found between the two groups regarding length of stay, drainage, narcotic use, or pain scores on a VAS. No adverse reactions were noted.

Finan et al. (1993) conducted a study to determine the effect of cold therapy using the Hot/Ice Thermal Blanket continuously for 72 hr (temperature of 52 °F), on postoperative pain in 27 females undergoing exploratory laparotomy. Patients were randomly assigned to one of two groups. The experimental group had the blanket placed beneath the surgical dressing, while the control group had no blanket. The investigators found that the experimental group used more Morphine Sulfate on the first postoperative day (0.529 mg/kg/day) than the control group (0.363 mg/kg/day) (p < .05). No significant difference in the use of Morphine was noted on the second postoperative day. No adverse reactions were documented. The study was terminated after data were collected on 27 patients due to the discomfort and inconvenience of the blanket. Also, subjective data for VAS scores were not reported due to the "subjectivity and variability involved in these measurements in such a small number of patients" (Finan et al., p. 543). With pain being a subjective experience, it seems that the data from the VAS scores would be of great importance in establishing a difference between the two groups, as use of analgesics is not always consistent with amount of pain experienced. Also, the small sample size severely limits the power of the study.
Levy and Marmar (1993) found contrary results in a study they conducted to evaluate the role of cold compression dressing in the postoperative management of 90 total knee arthroplasty (TKA) patients. Eighty of these patients having unilateral TKA were randomly assigned to one of two groups: patients in the experimental group received the cold compression dressing, while patients in the control group received the standard compressive dressing. Ten patients who had bilateral TKA had the standard dressing placed on the first operative knee and the cold compressive dressing on the second operative knee. The unilateral and bilateral groups were combined for analysis. Results indicated that patients who had cold therapy in the form of Aircast Cryo/Cuff used 0.33 mg/kg Morphine Sulfate over 48 hr, while those without Cryo/Cuff used 0.69 mg/kg, which was a statistically significant difference (p < .05). Subjective reports of pain were documented using a VAS. The experimental group had significantly higher pain ratings than the control group prior to surgery. The difference was not significant on postoperative Day 1. On postoperative Days 2 and 3, the experimental group's pain ratings were significantly less. The fact that patients in the experimental group had higher pain ratings on the VAS prior to surgery than patients in the control group could increase the significance of the results.

The study done by Levy and Marmar (1993) was a well-controlled study with random assignment and a thorough description of the intervention. Analyzing the data on each group (unilateral and bilateral) independently and then presenting a comparison of the two would increase clarity of the study. One knee in the experimental group and two in the control group developed a superficial wound necrosis, while one patient in the
experimental group and two in the control group developed deep vein thrombosis. These complications were not attributed to the cold application.

Another study using the Cryo/Cuff (Scheffler, Sheital, & Lipton, 1992) was performed to ascertain whether the cuff would reduce postoperative pain and edema in 25 patients having bilateral foot surgery. Although the investigators reported that 80% of the experimental group had less pain on the first and second postoperative day than those in the control group, several weaknesses and study limitations are apparent. Patients provided their own therapy at home after discharge, and the data were collected from self-reports on postoperative follow-up visits. There was no report of the pain intensity scores derived from the VASs, which were used for subjective pain measurement, nor was there a comparison of the groups regarding the VAS scores. And finally, there was no discussion of the statistical procedures used. At best, this study provides data regarding patient satisfaction with the equipment.

In a similar study, Scarcella and Cohn (1995) examined the effects of cold therapy using a thermal blanket during the postoperative course of patients having TKA or total hip arthroplasty (THA), using random assignment with both groups. No significant differences were noted in narcotic use between the experimental (use of cold therapy) group and the control (no use of cold therapy) group ($p > .05$). However, approximately one third of the patients complained about the equipment being cumbersome. Most of the patients who complained of this problem were in the control group, perhaps indicating a lack of tolerance of the machine due to the temperature of the solution ($70 \, ^\circ F$) as opposed to the temperature of the actual therapy ($50 \, ^\circ F$). The investigators also addressed the issue of the inability to maintain cool enough temperatures, especially with the THA.
patients, because of difficulty in keeping the device properly placed. This problem with
the intervention raises a question of internal validity. The homogeneity of subjects and
relatively small sample prevents generalizability to other populations.

Ross and Soltes (1995) studied the effects of ice application on pain and hemato­
toma formation in 70 healthy adults receiving subcutaneous Heparin injections. Subjects
acting as their own controls experienced a significant difference in pain intensity between
the injection with ice and the injection without ice ($p = .01$), but no significant differences
in hematoma formation. Although the sample size was adequate, generalizability is lim­
ited due to the homogenous sample of healthy adults.

Ebner (1996) found no significant difference in pain intensity when he looked at
the use of cold for decreasing the perceived pain associated with intramuscular injections
in 40 children aged 10-18 years. However, mean overall pain scores for both the experi­
mental and the control groups (with random assignment) were 4 or less on an NRS of 1 to
10. Other factors that potentially added bias were the need for other painful procedures,
such as suturing, in some of the children and the expertise of various technicians admin­
istering the injections. Similar results were revealed in a study done by Amin-Hanjani,
Corcoran, and Chatwani (1992) to evaluate the efficacy of cold therapy, using the Dual
Temp Unit (temperature 43 °F) continuously for 48 hr, in controlling postoperative pain
in 62 women who underwent cesarean section. Pain was measured by the amount of nar­
cotics used, and the investigators found no significant difference in the group that had the
intervention and the group that did not. However, no alpha coefficient was documented,
precluding the knowledge of Type I error; no discussion of statistical techniques was
noted; and no subjective measure of pain was found. Also, the authors noted that direct
application of the cooling device over the incision, as opposed to application over the surgical dressing, could have made a difference in the outcome.

Several studies regarding modalities of cold application were also reviewed. Bierman (1955) defined cold as “abstraction of heat, the substance by means of which such abstraction is effected, and to the sensation created by such abstraction” (p. 1189). An individual feels the sensation of cold when the temperature of the application is less than that of the body part to which it is applied. The skin temperature on the torso is regarded as the neutral point and is approximately 93 °F (33.9 °C). In using water as an intervention, it is considered tepid at a temperature of 80-93 °F (26.7-33.9 °C), cool at a temperature of 65-80 °F (18.3-26.7 °C), cold at a temperature of 55-65 °F (12.8-18.3 °C), and very cold at a temperature below 55 °F (12.8 °C). Most of the studies reviewed in this document included investigations using temperatures considered to be very cold.

Bierman (1955) identified three basic forms of application: solid, liquid, and gas. Various cooling techniques have been noted in this literature review: chipped ice, the Cryo/Cuff, the thermal blanket, the Hot/Ice Thermal Blanket, the Dual Temp Unit, ice cubes, gel packs, chemical ice envelope, and refrigerant-inflated bladders. Most techniques have been evaluated with some formalized method, with the Cryo/Cuff and ice packs being noted most often in the research literature. A review of the findings of these investigations follows.

A study by McMaster et al. (1978) conducted to evaluate the effectiveness of four different cooling modalities (chipped ice, frozen gel, chemical ice envelope, and refrigerant inflated bladder) in lowering muscle temperature in two canines revealed that, while no ill effects were noted as a result of the application, only the ice chips (11.3 °C) and gel...
packs (8.4 °C) were satisfactory in reducing temperature over 1 hr in a linear fashion. Ice chips performed the most effectively overall, while the gel packs were also satisfactory. However, the refrigerant produced only a decrease of 2 °C over the 1-hr observation, while the chemical ice produced a drop of 3.5 °C. Reliability and validity of the thermometer probes used for measurement were documented, adding internal validity to the study; however, the use of canines as subjects prohibits generalizability to humans. The study was well controlled, with a 4 x 4 matrix design which allowed all therapies on both dogs alternating four limbs, which provided 16 observations for each modality.

Whitelaw, DeMuth, Demos, Schepsis, and Jacques (1996) conducted a study to compare the effectiveness of the Cryo/Cuff and ice with elastic bandage for postoperative pain relief in 102 human subjects (randomly assigned) undergoing knee arthroscopy. Results indicated that subjects using the Cryo/Cuff used significantly less analgesia than patients using ice with elastic bandage (p < .05). However, no significant difference was noted in the subjective degree of pain reported using a VAS. These findings reveal interesting results; however, all data were obtained at follow-up visits using diaries that each patient kept after discharge. All patients were discharged within 6 hr of the operative procedure, meaning that all therapy was performed at home by the patient, decreasing the control of extraneous variables and leaving the validity of the findings in question. Also, pain ratings were assessed using the VAS and then converted to an NRS. The initial use of the NRS would have provided greater validity and been less work for the investigator.

Adverse reactions to cold were also included in the review of literature. According to Lehmann and DeLateur (1982), severe adverse reactions to cold applications are rare. Some people suffer hypersensitivity reactions to cold with the typical allergy type.
symptoms, which can progress to anaphylaxis unless intervention occurs. The most frequent complications that have been documented are frostbite and nerve palsy (Swenson, Sward, & Karlsson, 1996). In a series of studies done by Lake (1917), findings indicated that true frostbite only occurs at temperatures below -6 °C. Frostbite may be prevented by avoiding direct application of ice to the skin for prolonged periods (longer than 45 min), and nerve palsy may also be prevented by limiting ice application to 30 min or less (Swenson et al., 1996).

Although many of the modalities evaluated in this literature review were utilized for longer periods than has just been recommended, only one subject was noted to suffer from temporary nerve palsy secondary to continuous application of an ice bag for 40 min. No other adverse reactions to cold were noted in any of the investigations. Waylonis (1967) concluded that ice is safe even in inexperienced hands. Frequent observation and good use of common sense on the part of the nurse should prevent most adverse reactions.

Summary

Although a number of authors have documented the consistent use of cold over several decades for treating various painful phenomena, scientific inquiry has produced controversial findings on its true efficacy. Although empirical documentation of the clinical efficacy of cold exists and a number of nursing texts recommend cold as an intervention for pain management, very little nursing research has been done to validate the efficacy of using cold for pain management. A majority of the studies found by this author related specifically to orthopedic procedures. In the studies reviewed, scientific rigor is
often lacking, which leaves the validity of the findings in question and indicates a need for further investigation into the use of cold for relief of pain. As responsible caregivers, nurses must take the initiative to validate such interventions with a variety of pain experiences with well-controlled scientific investigations.

The literature clearly indicates that pain associated with CTR has not been managed effectively. Pain control measures for this patient population must be evaluated in order to determine the most effective pain-management strategy. Although McCaffery and Beebe (1989) recommended ice as a nonpharmacologic pain control measure for CTR and other procedures of short duration (less than 10 min), the intervention has never been scientifically tested in this patient population. However, Bugaj (1975) found ice to be effective in producing analgesia when applied for 10 min. Puntillo (1996) noted that patients undergoing CTR who received Ketorolac (Torodol) had significantly less pain than patients who did not receive this drug. Ketorolac is an antiinflammatory drug often used for postoperative pain. As ice is said to be a nonpharmacologic anti-inflammatory agent (Bierman, 1955), it is suggested that, by cooling the tissue around the CTR site, possible analgesia can occur. The use of ice is also supported by the theory that ice decreases nerve conduction velocity and increases the pain threshold. Although other findings are controversial, there is enough evidence available to suggest ice as a potential solution for a painful and frequently performed clinical procedure.

Chapter 2 provided a review of the literature on pain management, pain and CTR, and ice as an intervention for pain. Methodology for this study is outlined in Chapter 3.
CHAPTER 3
METHODOLOGY

Chapter 3 provides an outline of the methodology used for this study, including a description of the design, setting, population and sample, protection of human subjects, instruments, procedures, pilot studies, data analysis, and limitations.

Design

This experimental pretest and posttest study involving one treatment group and one control group was intended to evaluate the effects of ice as an intervention for pain intensity, pain distress, and the quality of pain experienced by postcardiothoracic surgery patients undergoing CTR. The experimental group received the cold intervention, and the control group received a placebo.

Setting

The study site was a surgical intensive care unit (SICU), a coronary intensive care unit (CCU), a medical intensive care unit (MICU), and two acute postoperative units in a large regional tertiary-care teaching hospital where approximately 700 adult patients undergo cardiothoracic surgery every year. The nurse practitioner or cardiothoracic surgery resident associated with the cardiac surgeon was responsible for discontinuation of all chest tubes using a standardized procedure (see Appendix A).
Population and Sample

A convenience sample of 50 adult patients, 25 per group, was randomly assigned to either the experimental or control group just prior to CTR and after completion of the informed consent (Appendix B) to participate in the study. A lack of previous studies to establish power and effect size limited the ability to establish an accurate sample size for this study. Therefore, the sample size was based on recommendations by Polit and Hungler (1995) for experimental studies including more than one group and other intervention studies relating pain and CTR (Carson et al., 1994; Puntillo, 1996).

Eligible participants included those patients who had cardiothoracic surgery, were English speaking and able to verbally self-report their pain, and were having a chest tube removed. Exclusionary criteria included patient refusal and the inability to speak or interpret English.

Protection of Human Subjects

Protection of human subjects was granted by the Institutional Review Boards both at the study site and at the University of Alabama at Birmingham (UAB) (Appendix C). Participation was voluntary. No names appear on the data collection instruments. Medical record numbers were recorded for retrieval of records if necessary, and each subject was assigned a code number for data entry purposes. A separate document was developed including names, medical record numbers, and the correct code. All data are stored under double lock and key in the office of the investigator to further maintain confidentiality of all subjects. One year after completion of the study and dissemination of results, all raw data collected will be destroyed.
Instruments

Demographics

The following demographic information was collected for each participant: age, gender, ethnicity, primary diagnosis, type and number of chest tubes, mediastinal or pleural, previous cardiac surgery, previous chest tubes, and details of postoperative pain medication (Appendix D).

Pain Intensity

Participants self-reported their pain intensity using a 10-point NRS of 0 (no pain) to 10 (worst possible pain) (Appendix E). This instrument has been used successfully with critically ill patients for reporting postoperative and procedural pain (Puntillo, 1994, 1996; Puntillo & Weiss, 1994). Reliability and construct validity of the NRS have been previously established through factor analysis (Downie et al., 1978; Jensen, Karoly, & Braver, 1986; Jensen, Karoly, O’Riordan, Bland, & Burns, 1989).

Concurrent validity of the NRS and the VAS was established in a study of critically ill cardiovascular surgery patients (Puntillo & Weiss, 1994). Downie et al. (1978) established concurrent validity among simple descriptive scales, NRS, VAS, and intensity word scales in a study of 100 patients with a variety of rheumatic diseases. This study also provided evidence that the 11-point NRS performed better than the 4-point simple descriptive scale and the VAS.

Jensen et al. (1986) compared six different methods for measuring chronic pain in 75 patients. The VAS, NRS, Box Scale, Behavioral Rating Scale, 4-point Verbal Rating Scale, and 5-point Verbal Rating Scale were compared for rates of correct response and
construct validity. Results indicated that some incorrect responding occurred with each scale, but the difference in incorrect responses was not significant, indicating consistency of incorrect response across all scales. It is important to note that the only scale where age was related to incorrect response was the VAS, where an increased age was correlated to more incorrect responses. The investigators concluded that all six scales are useful for measuring pain, and there was a high correlation of all six scales for construct validity. The VAS was found to be more difficult for older patients to understand. The NRS has several advantages over the other tools in that it is very simple to administer and score and may be given in written or verbal form, whereas the VAS must be done in writing and takes two steps to score. Also, the VAS may be invalid if care is not taken in photocopying.

Another study by Jensen et al. (1989) that evaluated eight tools for measuring pain intensity and two tools for measuring pain distress in 69 postoperative patients showed all the measures of pain intensity to have construct validity. The tools evaluated by these authors for intensity were the 11- and 15-point Verbal Rating Scales, the 10-cm VAS, the 11-point Box Scale, the 4- and 5-point VRSs, the 101-point NRS for intensity, and a 6-point Behavior Rating Scales. The authors also evaluated two VRSs for the affective dimension of pain. Findings suggested the necessity for further research for validation of the affective measures because patients in this study could not differentiate intensity and affect with the tools that were evaluated for this purpose.
Pain Distress

Pain distress, which is the dimension of pain associated with emotional response (Craig, 1989; Johnson, 1973; Loeser & Melzack, 1999; NINR, 1994), was also measured using a 0 (no distress) to 10 (worst possible distress) NRS (Appendix F). Although pain distress scales have been used to test for effectiveness of interventions for clinical (Puntillo, 1996) and experimental (Johnson & Rice, 1974) pain, reliability and validity are not clear (McGuire, 1984).

Pain Quality

The MPQ-SF (Appendix G) was utilized to measure the magnitude of the sensory and affective components of pain quality during CTR. Response to these words is measured on a 0 (none) to 3 (severe) scale. Reliability and validity have been established previously for this tool (Chapman et al., 1985; Wilke, Savedra, Holzemer, Tesler, & Paul, 1990), and concurrent validity between the McGill Pain Questionnaire-Long Form (MPQ-LF) and the MPQ-SF has also been established (Melzack, 1987).

Procedure

Informed consent (Appendix B) was obtained by the investigator after preoperative teaching. All subjects who agreed to participate in the study were randomly assigned to either the experimental or the control group. The investigator was notified by the nurse practitioner, a member of the unit staff, of the readiness for CTR according to established protocol (see Appendix A). The investigator then provided the intervention for the participants in the experimental group or the placebo for subjects in the control group. The
investigator or the research assistant assessed the participants' pain at the appropriate times for both groups.

Ten research assistants, who were also employed by the study institution, were educated in the use of the assessment tools. In order to increase the consistency of data collection, a script was written directly on each instrument (see Appendices E, F, and G) so that the data collector could simply read the questions to the participants. The original procedure required an RA to complete pain assessment. However, as data collection progressed, it became evident that an RA was not always available to complete the process. The investigator was required to complete the pain assessment of many of the participants, which could introduce bias and decrease the validity of the study. The investigator felt that completing data collection was preferable to recruiting a nurse who had not been adequately educated in the use of the instruments, which could decrease interrator reliability.

The investigator applied ice, in the form of ice chips in a zip-lock bag, which was determined to be the most effective form of application in a study by McMaster et al. (1978), on either side of the chest tube(s) covering a 6 sq. in. area around the tube(s). The same amount of ice, enough to fill a 6-oz cup, was used in each bag to maintain consistency of the intervention. The ice was applied directly over one 4 x 4 in. gauze dressing and was secured with three 10-in. strips of 3-in. cloth tape. Patients in the control group received a placebo in the form of a zip-lock bag filled with tepid tap water. The same amount of tap water, enough to fill a 6-oz cup, was used in each bag to maintain consistency of the placebo. The temperature of every third bag of tap water was measured to
maintain consistency. The mean temperature was 84 °F, with a range of 82 to 86 °F. A 6 ½ x 4 ½ in. zip-lock bag was used for the ice and the placebo.

Results of a pilot study conducted by the investigator (Appendix H) using four baccalaureate nursing students indicated that one 4 x 4 in. gauze dressing allowed cooling of the skin while causing little or no discomfort. After the treatment was applied, the investigator remained in the room to monitor the subject for discomfort with the intervention and to ensure that the participant had the opportunity to terminate participation in the study at any time.

Routine postoperative pain management was not altered because research has shown that pain associated with CTR is different than typical postoperative pain from cardiothoracic surgery (Puntillo, 1994; Puntillo & Weiss, 1994); therefore, any pain medication administered for expected postoperative pain should not be considered as a confounding variable. Also, randomization should provide for equal distribution of types and amounts of pain medications given among the patients.

Pain intensity and pain distress (dependent variable) were measured using a 0 to 10 NRS, and pain quality was measured using the MPQ-SF. Baseline measures of pain distress and pain intensity were taken before ice application (Time 1). The intervention was applied for 10 min, then pain intensity and pain distress were measured again immediately prior to CTR (Time 2). Immediately after CTR, pain intensity and pain distress were measured again (Time 3). Pain intensity and pain distress were measured again 10 min later (Time 4), and the patient was asked to rate the quality of his or her pain during CTR using the MPQ-SF. Skin assessment for possible complications after removal of ice indicated no redness, blistering, or edema for any of the participants.
Participants in this study were instructed in the use of the NRS for reporting pain intensity as outlined in Appendix E. Participants were asked to verbally report their pain intensity scores numerically. The same procedure was used for measuring pain distress (see Appendix F). The MPQ-SF was used for measuring pain quality. Participants were asked to respond to a list containing 11 sensory words (for example, sharp, stabbing, burning) and 4 affective responses (for example, sickening, punishing-cruel, fearful) at the time of the last measurement of pain intensity and distress. Response to these words was measured on a 0 (none) to 3 (severe) scale.

Pilot Study 1

The pilot study was conducted after human subjects approval by the Institutional Review Board at Middle Tennessee State University and at the University of Alabama at Birmingham (Appendix H). The purpose of this pilot study was to test the comfort level and use of ice with four levels of gauze dressings: one gauze dressing, two gauze dressings, three gauze dressings, and four gauze dressings.

A convenience sample of eight students in a baccalaureate nursing program was selected from the investigator's place of employment. They were told that participation was strictly voluntary and was not part of their course work in any way nor would participation or lack of participation affect their grades in any way. The first eight students to volunteer were selected and asked to sign the consent form. Four students had the ice applied and four students collected the data on comfort and onset of cold feelings.

Each subject had one gauze dressing placed on the right lower extremity for 10 min, two gauze dressings placed on the left lower extremity for 10 min, three gauze
dressings placed on the right lower extremity for 10 min, and four gauze dressings placed on the left lower extremity for 10 min. An ice bag was placed on top of the dressings at each site for 10 min. Using a 10-point NRS of 0 (no pain) to 10 (worst possible pain), each subject was asked to rate her level of discomfort for each of the applications. Information was also obtained regarding time of onset of feelings of cold for each of the different sites for each subject.

The mean time for onset of cold feelings for one gauze was 135 s (2.25 min), with a mean level of discomfort at 2.5 on the NRS. For two gauze dressings, mean time for onset of cold feelings was 221 s (3.69 min), with a mean level of discomfort at 2.0 on the NRS. For three gauze dressings, onset of cold feelings began at 1,360 s (5.66 min), with a mean level of discomfort at 0.5 on the NRS. The mean time for onset of cold feelings for four gauze dressings was 1,260 s (5.25 min), with a mean level of discomfort at 0.25 on the NRS.

The information gained from the results of this pilot study was used to determine the number of gauze dressings to use for the greatest comfort and most rapid onset of cooling with ice application for the participants in the proposed study. As a result of the findings of the pilot, the investigator determined that one gauze dressing allowed for the most rapid onset of cooling while producing minimal discomfort.

Pilot Study 2

This pilot study was conducted after protection of human subjects approval by the Institutional Review Board at Vanderbilt University and at the University of Alabama at Birmingham (Appendix C). It involved a small-scale version of the planned experiment.
The purpose of this pilot study was to test the instruments to be used and to identify potential problems with data collection.

A convenience sample of four patients was selected from the study site. After signing the informed consent (Appendix B), each participant received the ice treatment in preparation for CTR. All participants answered the questions related to pain using the NRS for intensity and distress and the MPQ-SF without difficulty. None of the participants complained of discomfort from the ice. It was determined that participants with two chest tubes would require three zip-lock bags of ice and that participants with more than two chest tubes would require four zip-lock bags of ice in order to cover the area around the tubes adequately. Also, 3-in. wide silk tape was found to be more practical for securing the bags of ice than 2-in. silk tape. The process for the intervention was standardized as a result of these findings.

Data Analysis

Data were entered into the Statistical Package for the Social Sciences (SPSS, Inc., 1997) statistical software package from the original data-collection instruments. Descriptive statistics for age, ethnicity, gender, previous chest tubes, number of chest tube(s), type of chest tube(s), and type of surgery were obtained. Two repeated measures ANOVAs were used to analyze the data—one for pain intensity and one for pain distress—with an alpha level of 0.05. The repeated measures ANOVA has one between-subject factor (TREATMENT) with two levels (with treatment and without treatment) and one within subject factor (TIME) with four levels (Times 1, 2, 3, 4). This specific analysis tested the main effect for each independent variable, time and treatment, and the interaction effect.
of the independent variables. Testing the interaction effect ascertained whether the change in the dependent variables (PAIN) was the same for each group. The significance of the interaction determined further statistical analyses that were done. Descriptive statistics were used to determine the frequency of descriptors used on the MPQ-SF. An independent-samples t test was used to ascertain whether a difference existed between the two groups regarding level of severity for each descriptor.

Limitations

There were numerous extraneous variables in this study that could not be controlled by research design. Although CTR practices are standardized at the study site, there were seven different individuals with different levels of expertise who performed CTR. The subjects who participated in the study were scattered over five different acute/critical care areas. Those who were in the SICU were in semiprivate rooms with three to four other patients. Noise, lights, other treatments, and procedures occurring in the same room; the presence of multiple health care providers; and the presence of other patients in the room are all distractions created by the research setting that could not be controlled by the investigator. The patients in the other areas were all in private rooms with fewer distractions. Also, the investigator completed many of the pain assessments because of the unavailability of trained Research Assistants. This presents a potential bias of study findings.
Summary

In Chapter 3, the author described the design of the study, the population and sample, instruments used for measurement of the dependent variables, the procedure for data collection and analysis, and limitations of the study.
CHAPTER 4
FINDINGS

This chapter includes a report of the findings from statistical analyses used to address the three research hypotheses posed in this study. A description of the sample is included along with comparisons of the two groups related to effects of the intervention and a summary of findings.

The sample consisted of 50 patients who had cardiothoracic surgery in a large tertiary-care facility in middle Tennessee. Of the 50 patients who completed the study, 7 participants (14%) had undergone cardiothoracic surgery that included placement of chest tubes in the past. Forty-one patients (82%) underwent CABG procedure, 7 patients (14%) had valve procedures, 1 (2%) had atrial septal defect repair, and 1 (2%) had a partial pericardiectomy. Thirty-four of these participants (68%) had two mediastinal chest tubes placed, 10 (20%) had two mediastinal tubes and one pleural tube for a total of three tubes, and 6 participants (12%) had only one mediastinal tube placed. The average age of the participants was 59.70 years (SD = 13.06). The age range was from 21 to 85 years. Forty-five participants (90%) were Caucasian, and five (10%) were African American. The study included 35 (70%) males and 15 (30%) females. Tables 1 and 2 provide detailed demographic characteristics of the sample.
Table 1

**Age by Group**

<table>
<thead>
<tr>
<th>Group</th>
<th>Range (years)</th>
<th>Mean (years)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental (ice)</td>
<td>24 – 85</td>
<td>58.96</td>
<td>12.92</td>
</tr>
<tr>
<td>Control (placebo)</td>
<td>21 – 77</td>
<td>60.44</td>
<td>13.43</td>
</tr>
<tr>
<td>Total</td>
<td>21 – 85</td>
<td>59.70</td>
<td>13.06</td>
</tr>
</tbody>
</table>

**Hypothesis 1**

A repeated measures ANOVA was used to ascertain whether adults with chest tubes who received applications of ice would have a lower pain intensity score on the NRS before, during, and after CTR than a similar population who received a placebo (tap water). The means and standard deviations for pain intensity scores are reported in Table 3. The interaction of time (before, during, and after the intervention) and group (ice, placebo) was not shown to be significant, $F (3, 144) = 0.42$, MSE = 3.57, $p > .05$, nor was the comparison between groups, $F (1, 48) = 0.027$, MSE = 0.36, $p > .05$. Significant overall differences were found in the level of pain intensity over time during the progress of the study, $F (3, 144) = 69.65$, MSE = 3.57, $p < .05$. Because sphericity is often violated, the Greenhouse-Geisser adjusted probability value was used for the test involving time.

Marginal pairwise comparisons for time were conducted, and the familywise alpha on all possible pairwise comparisons was controlled to .05 using Dunn’s procedure;
Table 2

Demographic Characteristics of the Sample by Group

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Experimental</th>
<th>Control</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 25</td>
<td>n = 25</td>
<td>N = 50</td>
</tr>
<tr>
<td>Gender</td>
<td>f</td>
<td>%</td>
<td>f</td>
</tr>
<tr>
<td>Female</td>
<td>5</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Male</td>
<td>20</td>
<td>80</td>
<td>15</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>f</td>
<td>%</td>
<td>f</td>
</tr>
<tr>
<td>Caucasian</td>
<td>22</td>
<td>88</td>
<td>23</td>
</tr>
<tr>
<td>African American</td>
<td>3</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Type of surgery</td>
<td>f</td>
<td>%</td>
<td>f</td>
</tr>
<tr>
<td>CABG</td>
<td>22</td>
<td>88</td>
<td>19</td>
</tr>
<tr>
<td>Valve</td>
<td>2</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Previous CT surgery/CT*</td>
<td>3</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Number of CT</td>
<td>f</td>
<td>%</td>
<td>f</td>
</tr>
<tr>
<td>One</td>
<td>3</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Two</td>
<td>18</td>
<td>72</td>
<td>16</td>
</tr>
<tr>
<td>Three</td>
<td>4</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Type of CT</td>
<td>f</td>
<td>%</td>
<td>f</td>
</tr>
<tr>
<td>Mediastinal</td>
<td>22</td>
<td>88</td>
<td>20</td>
</tr>
<tr>
<td>Mediastinal and pleural</td>
<td>3</td>
<td>12</td>
<td>5</td>
</tr>
</tbody>
</table>

Note. CABG = coronary artery bypass grafting; CT = chest tube.

*Previous CT Surgery/CT indicates previous cardiothoracic surgery requiring CT.
Table 3

Means and Standard Deviations for Pain Intensity Over Time

<table>
<thead>
<tr>
<th>Group</th>
<th>Time 1 M</th>
<th>SD</th>
<th>Time 2 M</th>
<th>SD</th>
<th>Time 3 M</th>
<th>SD</th>
<th>Time 4 M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>2.48</td>
<td>3.06</td>
<td>1.18</td>
<td>2.19</td>
<td>5.86</td>
<td>2.82</td>
<td>1.68</td>
<td>2.30</td>
</tr>
<tr>
<td>Control</td>
<td>2.22</td>
<td>2.46</td>
<td>1.04</td>
<td>1.60</td>
<td>6.34</td>
<td>2.52</td>
<td>1.94</td>
<td>2.39</td>
</tr>
</tbody>
</table>

Note. n = 25 per group.

therefore, the percomparison alpha was set to 0.0083. Pairwise comparisons, using two-correlated sample $t$ tests, revealed that subjects who had the ice applications had significantly lower pain intensity scores after the ice applications for 10 min than before the ice, $t(24) = 3.28, p = .003$, before ice than during CTR, $t(24) = 4.94, p = .000$, after ice than during CTR, $t(24) = 8.13, p = .000$, and 10 min after CTR than during CTR, $t(24) = 7.17, p = .000$. No significant differences were found in pain intensity before ice and 10 min after CTR, $t(24) = 1.28, p = .213$, nor after ice and 10 min after CTR, $t(24) = 1.37, p = .185$.

Pairwise comparisons, using two-correlated sample $t$ tests, revealed that subjects who received the placebo treatment (tap water) had significantly lower pain intensity scores after the placebo than before the placebo, $t(24) = 3.12, p = .005$, before the placebo than during CTR, $t(24) = 6.81, p = .000$, after the placebo than during CTR, $t(24) = 10.62, p = .000$, and 10 min after CTR than during CTR, $t(24) = 8.00, p = .000$. No significant difference in pain intensity was noted before the placebo and 10 min after CTR, $t(24) = .48, p = .638$, nor after the placebo and 10 min after CTR, $t(24) = 2.03, p = .054$.  

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Hypothesis 2

A repeated measures ANOVA was used to ascertain whether adults with chest tubes who received application of ice would have lower pain distress scores on the NRS before, during, and after CTR than a similar population who received a placebo (tap water). The means and standard deviations for pain distress scores are reported in Table 4. The interaction of time (before, during, and after intervention) and group (ice, placebo) was not shown to be significant, $F (3,144) = 0.18$, MSE = 3.91, $p > .05$, nor was the comparison between groups, $F (1,48) = 0.11$, MSE = 2.00, $p > .05$. Significant overall differences were found in the level of pain distress over time, $F (3, 144) = 39.23$, MSE = 3.92, $p < .05$. Because sphericity is often violated, the Greenhouse-Geisser adjusted probability value was used for the tests involving time.

Table 4

Means and Standard Deviations for Pain Distress Over Time

<table>
<thead>
<tr>
<th></th>
<th>Time 1</th>
<th></th>
<th>Time 2</th>
<th></th>
<th>Time 3</th>
<th></th>
<th>Time 4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>SD</td>
<td>$M$</td>
<td>SD</td>
<td>$M$</td>
<td>SD</td>
<td>$M$</td>
<td>SD</td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>2.70</td>
<td>2.91</td>
<td>2.04</td>
<td>2.79</td>
<td>5.68</td>
<td>2.90</td>
<td>1.58</td>
<td>2.51</td>
</tr>
<tr>
<td>Control</td>
<td>2.34</td>
<td>2.78</td>
<td>1.92</td>
<td>2.42</td>
<td>5.26</td>
<td>3.29</td>
<td>1.68</td>
<td>2.29</td>
</tr>
</tbody>
</table>

Note, $n = 25$ per group.

Marginal pairwise comparisons for time were conducted, and familywise alpha on all possible pairwise comparisons was controlled to .05 using Dunn's procedure; therefore, the percomparison alpha was set to .0083. Pairwise comparisons, using
two-correlated sample $t$ tests, revealed that subjects who had the ice application had significantly lower pain distress scores before ice than during CTR, $t (24) = 4.59, p = .000$, after ice than during CTR, $t (24) = 5.17, p = .000$, and 10 min after CTR than during CTR, $t (24) = 6.89, p = .000$. No significant differences were found in pain distress before ice and after ice, $t (24) = 1.59, p = .126$, before ice and 10 min after CTR, $t (24) = 2.39, p = .025$, nor after ice and 10 min after CTR, $t (24) = 0.95, p = .335$.

Pairwise comparisons, using two-correlated sample $t$ tests, revealed that subjects who received the tap water had significantly lower pain distress scores before the tap water than during CTR, $t (24) = 3.92, p = .001$, after the tap water than during CTR, $t (24) = 5.97, p = .000$, and 10 min after CTR than during CTR, $t (24) = 5.77, p = .000$. No significant difference in pain distress was noted before the tap water and after the tap water, $t (24) = 1.03, p = .312$, before the tap water and 10 min after CTR, $t (24) = 1.91, p = .245$, nor after the tap water and 10 min after CTR, $t (24) = .51, p = .613$.

**Hypothesis 3**

A frequency distribution of the two groups and an independent-samples $t$ test were used to ascertain whether adults with chest tubes who receive application of ice would use fewer descriptors on the MPQ-SF during CTR than a similar population who did not receive application of ice. There was no significant difference between the two groups regarding the level of severity for each descriptor. A detailed description of the means and significance is reported in Table 5. In the experimental group, all 15 descriptors were used, with cramping, gnawing, and splitting being used most often, in
descending order. See Table 6 for an inclusive list of the descriptors used by the subjects who received the ice.

Subjects in the control group also used all 15 descriptors, with gnawing, cramping, aching, and heavy being used most often, in descending order; heavy and aching were used an equal number of times. See Table 5 for an inclusive list of the descriptors used by the subjects who received the tap water and for significance.

**Findings Relevant to Demographic Variables**

Forty-six patients were premedicated within 2 hr of CTR. Four patients were not premedicated at all. The Aspin-Welch-Satterthwite t test used for unequal samples sizes and the computed value of the Mann-Whitney test both revealed no significant difference in pain intensity (Table 7) at Time 1 ($t = 0.32, p > .05$), Time 2 ($t = 0.47, p > .05$), Time 3 ($t = 0.35, p > .05$), or Time 4 ($t = 0.82, p > .05$) or pain distress (Table 8) at Time 1 ($t = 0.26, p > .05$), Time 2 ($t = 0.34, p > .05$), Time 3 ($t = 0.14, p > .05$), or Time 4 ($t = 0.43, p > .05$) between the patients who were premedicated and those who were not.

A finding worth noting is that participants who had three chest tubes had much greater pain intensity levels during CTR than those with one or two chest tube(s) in the ice group. Descriptive statistics are outlined in Table 9. A two-independent-samples t test showed no significant difference; however, the small sample size limits the power of the analysis. Figure 1 provides a graphic representation of the difference in mean pain intensity during CTR when comparing participants with one, two, and three tube(s).
Table 5

**Descriptive Statistics and Comparisons for MPO Descriptors**

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Group</th>
<th>t</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throbbing</td>
<td>Ice</td>
<td>0.41</td>
<td>1.00</td>
<td>0.96</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td></td>
<td>0.88</td>
<td>1.13</td>
</tr>
<tr>
<td>Shooting</td>
<td>Ice</td>
<td>0.37</td>
<td>1.04</td>
<td>1.24</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td></td>
<td>0.92</td>
<td>1.08</td>
</tr>
<tr>
<td>Stabbing</td>
<td>Ice</td>
<td>0.24</td>
<td>1.08</td>
<td>1.04</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td></td>
<td>1.16</td>
<td>1.31</td>
</tr>
<tr>
<td>Sharp</td>
<td>Ice</td>
<td>0.35</td>
<td>1.80</td>
<td>1.26</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td></td>
<td>1.68</td>
<td>1.14</td>
</tr>
<tr>
<td>Cramping</td>
<td>Ice</td>
<td>0.00</td>
<td>0.48</td>
<td>0.77</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td></td>
<td>0.48</td>
<td>0.92</td>
</tr>
<tr>
<td>Gnawing</td>
<td>Ice</td>
<td>1.99</td>
<td>0.80</td>
<td>1.08</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td></td>
<td>0.28</td>
<td>0.74</td>
</tr>
<tr>
<td>Hot-burning</td>
<td>Ice</td>
<td>0.26</td>
<td>1.16</td>
<td>1.07</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td></td>
<td>1.24</td>
<td>1.24</td>
</tr>
<tr>
<td>Aching</td>
<td>Ice</td>
<td>0.71</td>
<td>1.00</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td></td>
<td>0.80</td>
<td>1.12</td>
</tr>
<tr>
<td>Heavy</td>
<td>Ice</td>
<td>0.90</td>
<td>0.94</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td></td>
<td>0.68</td>
<td>0.99</td>
</tr>
</tbody>
</table>
### Table 5 (Continued)

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Group</th>
<th>t</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tender</td>
<td>Ice</td>
<td>1.32</td>
<td>1.52</td>
<td>1.26</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td>1.96</td>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td>Splitting</td>
<td>Ice</td>
<td>0.88</td>
<td>1.00</td>
<td>1.22</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td>0.72</td>
<td>1.02</td>
<td></td>
</tr>
<tr>
<td>Tiring</td>
<td>Ice</td>
<td>1.31</td>
<td>1.38</td>
<td>1.22</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td>0.92</td>
<td>1.26</td>
<td></td>
</tr>
<tr>
<td>Sickening</td>
<td>Ice</td>
<td>0.68</td>
<td>0.80</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td>0.60</td>
<td>0.91</td>
<td></td>
</tr>
<tr>
<td>Fearful</td>
<td>Ice</td>
<td>0.77</td>
<td>1.52</td>
<td>1.29</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td>1.24</td>
<td>1.27</td>
<td></td>
</tr>
<tr>
<td>Punishing-cruel</td>
<td>Ice</td>
<td>0.39</td>
<td>0.56</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td>0.46</td>
<td>0.96</td>
<td></td>
</tr>
</tbody>
</table>

*Note. n = 25 per group (ice, no ice). MPQ = McGill Pain Questionnaire. df = 48.*

*p > .05.

### Summary of Findings

Sixty-seven people were approached regarding participation in the study. Fifty completed the study, 6 refused to participate, 4 consented but did not complete the study because the investigator was not notified of CTR, and 7 agreed to participate but did not have surgery during the data collection period.
Table 6

Frequency of MPO Descriptors Used by Groups

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Experimental n = 25</th>
<th>Control n = 25</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>f</td>
<td>%</td>
</tr>
<tr>
<td>Throbbing</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>Shooting</td>
<td>13</td>
<td>52</td>
</tr>
<tr>
<td>Stabbing</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>Sharp</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>Cramping</td>
<td>17</td>
<td>68</td>
</tr>
<tr>
<td>Gnawing</td>
<td>14</td>
<td>56</td>
</tr>
<tr>
<td>Hot-burning</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>Aching</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>Heavy</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>Tender</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>Splitting</td>
<td>14</td>
<td>56</td>
</tr>
<tr>
<td>Tiring--exhausting</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>Sickening</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>Fearful</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>Punishing--cruel</td>
<td>16</td>
<td>64</td>
</tr>
</tbody>
</table>

Note. MPQ = McGill Pain Questionnaire.
Table 7
Premedication and Mean Pain Intensity Scores Over Time

<table>
<thead>
<tr>
<th></th>
<th>Intensity 1</th>
<th></th>
<th>Intensity 2</th>
<th></th>
<th>Intensity 3</th>
<th></th>
<th>Intensity 4</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Premedicated</td>
<td>46</td>
<td>2.44</td>
<td>2.77</td>
<td>1.17</td>
<td>1.96</td>
<td>6.20</td>
<td>2.69</td>
<td>1.78</td>
</tr>
<tr>
<td>Not premedicated</td>
<td>4</td>
<td>1.25</td>
<td>2.50</td>
<td>0.38</td>
<td>0.75</td>
<td>5.00</td>
<td>2.16</td>
<td>2.13</td>
</tr>
</tbody>
</table>

Table 8
Premedication and Mean Pain Distress Scores Over Time

<table>
<thead>
<tr>
<th></th>
<th>Distress 1</th>
<th></th>
<th>Distress 2</th>
<th></th>
<th>Distress 3</th>
<th></th>
<th>Distress 4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Premedicated</td>
<td>46</td>
<td>2.63</td>
<td>2.85</td>
<td>2.07</td>
<td>2.64</td>
<td>5.66</td>
<td>3.06</td>
<td>1.72</td>
</tr>
<tr>
<td>Not premedicated</td>
<td>4</td>
<td>1.25</td>
<td>2.50</td>
<td>1.00</td>
<td>2.00</td>
<td>3.25</td>
<td>2.75</td>
<td>1.63</td>
</tr>
</tbody>
</table>

Analyses revealed that subjects who received ice had similar pain intensity and pain distress scores to those patients who received tap water. A change in pain over time was noted in both groups, with pain during CTR being the most severe—an expected outcome. Both groups used all descriptors on the MPQ-SF to describe the quality of their pain. There was no significant difference in level of severity for any descriptor between the two groups. Pain intensity and distress were not significantly different between those
Table 9

Descriptive Statistics for PainIntensity During CTR for Number of CT

<table>
<thead>
<tr>
<th>Number of CT</th>
<th>Group</th>
<th>n</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>Ice</td>
<td>3</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td>3</td>
<td>6.33</td>
<td>2.08</td>
</tr>
<tr>
<td>Two</td>
<td>Ice</td>
<td>18</td>
<td>5.56</td>
<td>2.45</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td>16</td>
<td>6.41</td>
<td>2.69</td>
</tr>
<tr>
<td>Three</td>
<td>Ice</td>
<td>4</td>
<td>7.88</td>
<td>2.46</td>
</tr>
<tr>
<td></td>
<td>No ice</td>
<td>6</td>
<td>6.17</td>
<td>2.64</td>
</tr>
</tbody>
</table>

Note. CTR = chest tube removal. CT = chest tube.

who were premedicated and those who were not. Those participants who had three chest tubes suffered greater pain intensity during CTR than those who had two tubes and those who had one tube.

In summary, among 50 cardiothoracic surgery patients who had chest tubes removed, a repeated measures ANOVA showed no significant difference in the pain intensity or pain distress between the patients who had the ice application and the patients who had the placebo, neither was there any difference in the number of quality descriptors used by these two groups.
Figure 1. Mean pain intensity during chest tube removal.
CHAPTER 5

DISCUSSION, CONCLUSIONS, IMPLICATIONS,
AND RECOMMENDATIONS

The purpose of this experimental study was to ascertain whether the application of ice versus tap water would be followed by a significant decrease in pain intensity and pain distress as well as use of fewer quality descriptors of pain. The sample included 50 patients who had cardiothoracic surgery in a large tertiary-care facility in middle Tennessee. The instruments used in this study were the NRS for pain intensity and pain distress and the MPQ-SF. The multidimensional conceptualization of pain theory and the theory of ice and conduction velocity provided the supporting frameworks for the study. Descriptive statistics, repeated measures ANOVA, and the AWS t tests under the SPSS Release 9.0 program were used to analyze the data and test the hypotheses for this study.

This chapter includes a discussion of the findings as related to the three research hypotheses; their relationship to the conceptual frameworks; and a discussion of the conclusions, implications, and recommendations.

Research Hypothesis 1

Research Hypothesis 1 states that adults with chest tubes who receive application of ice will have a lower pain intensity score on the NRS before, during, and after CTR than a similar population who does not receive application of ice.
Mean pain intensity scores at Time 1 (preintervention) were in the mild range for both the ice group ($M = 2.48$) and the tap water group ($M = 2.22$). A statistically significant decrease in pain intensity was noted at Time 2 (postintervention) for both groups, with a slightly greater decrease in the ice group ($M = 1.18$) as opposed to the tap water group ($M = 1.04$). Pain intensity was the greatest, with a significant increase at Time 3 (postintervention), during CTR for both the ice group ($M = 5.86$) and the tap water group ($M = 6.34$), which is an expected outcome. Although the pain intensity is slightly higher in the control group, the difference is not statistically significant. Pain intensity returned to the mild range at Time 4, with a significant decrease for both the ice group ($M = 1.68$) and the tap water group ($M = 1.94$), which is also expected as 10 min should provide recovery time from the pain associated with the CTR. The pain intensity was slightly higher in the control group at Time 4, but not significantly higher.

The fact that pain intensity decreased in the control group after the placebo intervention (from Time 1 to Time 2) suggests a positive placebo effect. Numerous studies of various populations and settings have demonstrated a placebo effect (Amanzio & Benedetti, 1999; Kumar, Aevaro, Julka, & Marshall, 1998; Roghani, Duperon, & Barcohana, 1999; Staats, Hekmat, & Staats, 1998; Verdugo & Ochoa, 1998). Wall (1993) suggests that there is not a fixed percentage of the population that responds to placebos. Evans (1974) found that 36% of subjects who received a placebo injection for pain relief the day following abdominal surgery reported relief, which was confirmed by Goodwin, Goodwin, and Vogel (1979). These findings indicated that placebos can be effective in relieving pain associated with a known physical etiology. Clearly, placebo effect is a documented phenomenon; however, the underlying physiology is yet to be discovered.
Although several theories have been enumerated, such as anxiety reduction, faith, endorphin release, and operant conditioning (Grevert, Albert, & Goldstein, 1983; Levine, Gordon, & Fields, 1978; Richardson, 1994), none have been validated.

The findings of this study do not support the original hypothesis, although two participants who received ice that had had prior cardiac surgery requiring CTR stated that their pain was less with the ice. The fact that pain intensity scores were in the mild range after the intervention in both groups and in the moderate range during CTR for both groups does not support the claim that ice increases the pain threshold, as tap water had the same effect on pain intensity.

**Research Hypothesis 2**

Research Hypothesis 2 states that adults with chest tubes who receive application of ice will have a lower pain distress score on the NRS before, during, and after CTR than a similar population who does not receive application of ice.

Mean pain distress scores at Time 1 (preintervention) were in the mild range for both the ice group ($M = 2.70$) and the tap water group ($M = 2.34$). Insignificant changes were noted from Time 1 to Time 2 (postintervention) for both groups, with a slightly greater decrease in the ice group ($M = 2.04$) as opposed to the tap water group ($M = 1.92$). Pain distress was the greatest, with a significant increase at Time 3 (postintervention), during CTR for both the ice group ($M = 5.68$) and the tap water group ($M = 5.26$), which is an expected outcome. Although the pain distress is slightly higher in the ice group, the difference is not statistically significant. Pain intensity returned to the mild range at Time 4 with a significant decrease for both the ice group ($M = 1.58$) and the tap
water group ($M = 1.68$), which is also expected as 10 min should provide recovery time from the pain associated with the CTR. The pain distress was slightly higher in the tap water group at Time 4, but not significantly higher.

These findings do not support the original hypothesis. The fact that pain distress scores varied in the same pattern as pain intensity scores supports the claim that the emotional or affective component of the pain experience is congruent with the sensory component, yet the cause and effect relationship remains unclear. The presence of the investigator could be a confounding variable. The investigator remained in the room during the intervention, which provided an opportunity for the participants to ask questions about the procedure. The investigator, who was the only nurse present during the intervention, provided information and explanation about the procedure, as it proved difficult, if not impossible, not to interact with the participants during this time.

Research Hypothesis 3

Research Hypothesis 3 states that adults with chest tubes who receive application of ice will use fewer descriptors on the MPQ-SF during CTR than a similar population who does not receive application of ice.

Both groups used all 15 quality descriptors on the MPQ-SF to describe their pain during CTR. There was no significant difference in the level of severity of each descriptor when comparing the two groups.
Findings Relevant to the Conceptual Frameworks

The Multidimensional Conceptualization of Pain

The conceptual framework for pain assessment was based on the Multidimensional Conceptualization of Pain Theory designed by the NINR (1994). Pain is defined as a multidimensional concept involving physical, psychological, and sociocultural components. The model includes six dimensions: physiologic, sensory, affective, cognitive, behavioral, and sociocultural. Findings of the study are applicable to three of the dimensions—the physiologic, sensory, and affective components. The physiologic component is relevant to the intervention and will be addressed in reference to the supporting framework of ice, conduction velocity, and pain threshold. Due to limited resources, the cognitive, behavioral, and sociocultural dimensions of the framework were not addressed in this study.

The sensory component of pain involves location, intensity, and quality. The focus of the study was pain at the site of chest tube insertion before, during, and after removal of the tube. Level of pain intensity was evaluated using an NRS, and quality was evaluated using the MPQ-SF. Participants were able to self-report their pain intensity using the NRS without difficulty. Pain intensity was greatest during the actual tube removal, with a return to baseline in approximately 10 min.

The MPQ-SF contains 11 words that may be used to describe the sensory dimension: throbbing, shooting, stabbing, sharp, gnawing, cramping, hot-burning, aching, heavy, tender, and splitting (Katz & Melzack, 1999; Melzack, 1987). In terms of quality, participants who received ice used all the descriptors relating to sensory qualities; however, cramping, gnawing, and splitting were used most often, in descending order.
Participants who received tap water also used all the descriptors relating to sensory qualities, with gnawing, cramping, aching, and heavy being used most often, in descending order; heavy and aching were used an equal number of times.

The affective component of pain involves those emotions that are experienced by the sufferer. This component was evaluated using an NRS for pain distress and the MPQ-SF for describing affective qualities that are part of the pain experience. The participants were able to quantify their level of pain distress without difficulty. The MPQ-SF contains four words that may be used for describing affective qualities: tiring-exhausting, sickening, fearful, and punishing-cruel. Participants who received ice used all the descriptors relating to affective qualities; however, punishing and sickening were used most often, in descending order. Participants who received tap water also used all the descriptors relating to affective qualities, with punishing and sickening being used most often, in descending order.

These findings support the multidimensional conceptualization of pain as the participants in the study were able to quantify and describe both sensory and affective components of their pain experience using the NRS for intensity and distress and the MPQ-SF for describing sensory and affective qualities of their pain experience.

**Cold and Pain**

Several authors (Abramson et al., 1966; Benson & Copp, 1974; Bugaj, 1975; Clarke et al., 1958; Lee et al., 1978; Miller & Weber, 1990; Waylonis, 1967) support the theory that cold application decreases nerve conduction velocity, thereby providing analgesia. Findings of the study do not support that claim. Pain intensity scores and pain
distress scores were not significantly different between the participants who received ice
and the ones who received tap water. A 10-min application of ice resulted in subcutaneous
tissue cooling and analgesia in several studies (Bugaj, 1975; Waylonis, 1967); however, Lee et al. (1978) used a 20-min application of ice to achieve the desired analgesia.
Two participants in the current study stated that they never felt the ice, although their skin
felt cold to the touch. Several other participants stated that the ice should be left in place
longer than 10 min. Perhaps a 20-min application of ice would yield significant results.
Also noted is the fact that all previous studies were conducted in a laboratory setting with
healthy adults or canines.

Conclusions

On the basis of the findings of this study, the following conclusions were drawn, subject to the limitations previously cited.

1. There was no significant difference in pain intensity scores before (immediate
postintervention), during (approximately 5 min postintervention), and after (more than 10
min postintervention) CTR between those participants who received ice treatment and
those who received the placebo.

2. There was no significant difference in pain distress scores before (immediate
postintervention), during (approximately 5 min postintervention), and after (more than 10
min postintervention) CTR between those participants who received ice and those who
received tap water.

3. There was a change in pain intensity over time for both the ice and tap water
groups, with maximum intensity occurring during CTR.
4. There was a change in pain distress over time for both the ice and tap water groups, with maximum distress occurring during CTR.

5. Both groups used all 15 descriptors to delineate sensory and affective qualities experienced during CTR.

6. No significant differences were noted in pain intensity and pain distress between the participants who were given pain medication prior to the procedure and those who were not.

7. Those subjects who had three chest tubes suffered more pain than those who had two tubes and those who had one tube.

Implications

The results of this study have implications for both nursing practice and nursing research. Implications for each of these areas will be discussed.

Nursing Service

Nurses care for patients in pain on a daily basis. Searching for valid pain management techniques is a responsibility not to be taken lightly. Accurate assessment is essential in determining the effectiveness of the interventions that are used for pain control. It is also important to recognize that the distress component of pain is closely coupled with the sensory component. It is the responsibility of the nurse to manage as many aspects of the pain experience as possible in providing holistic care.
Nursing Research

Additional research is needed in evaluating interventions for managing pain associated with CTR in the clinical setting. The studies that have been done indicate that no effective intervention has been found for managing this pain experience that has been identified as one of the worst experiences for these patients. Nurse researchers must collaborate with clinical nurses in order to discover a successful resolution for this challenging problem.

A replication of this study using a longer period of time for ice application may yield significant findings. Also, a replication of the study using three groups—one with ice, one with a placebo, and one with only customary treatment—may reveal whether the presence of the nurse providing a physical intervention serves to decrease pain, as opposed to the intervention itself, or whether the placebo has its own effect. Also, use of other populations, such as those with pleural tubes as opposed to mediastinal tubes, would provide useful information. Other studies evaluating the pain medications used prior to CTR are in order, as the drugs used for patients in this study (Morphine, Percocet, Dilaudid) were not shown to be effective. Further study regarding number of chest tubes and pain intensity is warranted, with a larger sample size, in order to validate the findings in the current study.

Recommendations

The following recommendations are made as a result of this study.
1. The current study should be replicated to further validate the findings. Other health care settings with different patient populations as well as different methodologies and different designs may be used for comparison purposes.

2. Other studies should be conducted to evaluate the current methods that are used for managing pain associated with CTR.

3. Studies should be conducted to evaluate new and innovative methods for managing pain associated with CTR.

4. Studies should be conducted in the clinical setting to evaluate ice application time and effectiveness.

5. A replication of the study using three groups should be conducted to ascertain whether the actual physical intervention is making the difference or the presence of the nurse giving information is the difference.

6. A replication of the study using a treatment group with ice and a no-treatment group to eliminate the placebo effect in order to establish treatment effect would be beneficial.

7. A similar study could be conducted addressing other or all dimensions of the concept of pain.
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2, 557-563.

velocity. Physiotherapy, 64, 2-6.


Nursing, 81, 1012.

The Lancet, 2, 654-657.

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search, 297, 174-178.


APPENDIX A

PROCEDURE FOR CHEST TUBE REMOVAL
Chest Tube Removal Criteria:

General guidelines for removal of chest tubes after cardiac surgery are as follows:

- The drainage has decreased to less than 100 ml in the past 8 hours.
- An air leak is not evident.
- Equal bilateral breath sounds are present with auscultation.
- The patient has been weaned from the ventilator.
- Results of pulse oximetry and arterial blood gas analyses are within normal limits.
- Chest radiographs show that the lung has re-expanded and that no other abnormalities are present.
- Results of coagulation studies, if any were ordered, are normal.
- The physician has ordered the chest tube removed.

<table>
<thead>
<tr>
<th>PROCEDURE FOR CHEST TUBE REMOVAL</th>
<th>Date</th>
<th>Initial</th>
<th>Date</th>
<th>Initial</th>
<th>Date</th>
<th>Initial</th>
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</thead>
<tbody>
<tr>
<td>1. Verify physician’s order for chest tube removal.</td>
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<td>2. Inform nurse of the procedure and verify patient has received analgesia.</td>
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<td>3. Place chux under chest tubes to protect patient.</td>
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<td>4. Place drainage system in red biohazard bag.</td>
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<td>5. Discontinue suction from chest drainage system and check for air leakage in water-seal chamber.</td>
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<td>6. Determine type of suture that secures each chest tube and clip appropriately.</td>
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<td>7. Cleanse thoroughly around site with betadine (alcohol, if allergic).</td>
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<td>8. Clamp each tube to be removed.</td>
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<tr>
<td>9. Obtain an air-occlusive dressing if no purse string suture is available.</td>
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<td>10. Pull out these chest tubes individually, each one while patient is in full inspiration while assistant maintains pressure over site with appropriate dressing.</td>
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<td>11. Tie suture securely with three (3) knots while assistant maintains occlusive pressure on the site.</td>
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<td>12. Applies occlusive dressing.</td>
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<td>13. Examine each chest tube to verify that all of the tubes has been removed.</td>
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<td>14. Assess the patient after the procedure and compare the results with those of previous assessment.</td>
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<td>15. Order chest x-ray to rule out pneumothorax.</td>
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</tbody>
</table>
APPENDIX B

INFORMED CONSENT
Institutional Review Board

Consent Form

PI: Jenny Sauls                        March 10, 1999
Title of Study: The Use of Ice for Pain Associated with Chest Tube Removal
Institution/Hospital: Vanderbilt University Medical Center

This consent form applies to: adults

Name of subject_________________________ Age_______

The following information is provided to inform you about the research project and your participation in it. Please read this form carefully. Please feel free to ask any questions you may have about this study and the information given below. You will be given an opportunity to ask questions, and your questions will be answered. You will be given a copy of this consent form.

1. Purpose of the study.
   You are being asked to participate in a study designed to determine whether or not application of an ice bag to the area surrounding the chest tube helps to ease any discomfort associated with removal of the tube.

2. Description of the procedures to be followed and approximate duration of the study.
   Participation in this study will not change anything else about your treatment. For example, the pain medications that you would normally receive during chest tube removal will not be changed, and all usual procedures will be followed.

   You will be randomly placed (like the flip of a coin) in one of two groups for the purposes of this study. One group will receive the ice bag treatment and the second will have a small bag of tap water placed on the chest tube area. You will not be told which treatment you will receive.

   A small plastic bag of crushed ice or the same size bag of tap water will be placed around your chest tube for ten minutes before the nurse practitioner removes the tube. These bags will not be placed on the skin but on top of guaze pads to protect your skin from direct contact with cold. This will remain in place for 10 minutes. Just after the ice bag (or tap water bag) is removed, the nurse practitioner will remove the chest tube.

   Your level of comfort/discomfort will be evaluated 4 times during this whole procedure: (1) just before ice bag (or tap water bag) placement, (2) just after the ice bag (or tap water bag) is removed, (3) just after the chest tube is removed, and (4) ten minutes after the chest tube is removed. You will be asked to report your level of discomfort using a numeric pain scale that is routinely used at this hospital to measure the pain of all patients who have had surgery.

Consent Form 1

IRB Forms(10/29/96)

UAB-IRB

Consent Form Approved 06-02-99
Expiration Date 03-10-2000

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Institutional Review Board
Consent Form

PI: Jenny Sauls March 10, 1999
Title of Study: The Use of Ice for Pain Associated with Chest Tube Removal
Institution/Hospital: Vanderbilt University Medical Center

If you decide you want to stop your participation in this study, you may do so at any time. The investigator will remain close by during the ice bag (or tap water bag) application in case you decide to have it removed before the ten minutes elapse.

There will be no cost to you from participation in the ice application study, nor will you be paid for participation in this study.

3. Description of the discomforts, inconveniences, and/or risks that can be reasonably expected as a result of participation in this study.

Adverse reactions to cold are rare. The two side effects that have been reported with the use of ice are frostbite and nerve paralysis. True frostbite only happens in temperatures less than -6 degrees Celsius (21.2 degrees Fahrenheit), and nerve paralysis only occurs when ice is left in place longer than 40 minutes. The temperature of your ice bag will be greater than 0 degrees Celsius (32 degrees Fahrenheit), and the ice bag will only be left in place for ten minutes. This will minimize the chances of any adverse reactions. Some people find application of ice to be uncomfortable. If any adverse reactions are noted, the ice application will be stopped immediately, and the Nurse Practitioner will be notified.

It will take approximately five extra minutes for you to answer the questions about the quality of the discomfort you feel during the time your chest tube is removed.

[Note: Immediate necessary care will be provided without charge by Vanderbilt University if you are injured because of participation in this research project. You will not be charged for this care if the injury would not have been expected from standard treatment or would not have occurred if you were not taking part in this research. However, there is no provision for the costs of further long-term medical care or for monetary compensation for such injury.]

4A. Anticipated benefits resulting from this study:

Your participation in this study may or may not result in greater comfort during your chest tube removal than if you did not have the ice applied. However, your participation in the study will allow us to collect information, which may result in future help to other patients experiencing chest tube removal.

4B. Potential benefits for participation:

None
Institutional Review Board

Consent Form

PI: Jenny Sauls

Consent Form 3

March 10, 1999

Title of Study: The Use of Ice for Pain Associated with Chest Tube Removal

Institution/Hospital: Vanderbilt University Medical Center

5. Alternative procedures

It is customary for you to receive pain medication before you have your chest tube removed. Even if you participate in this study, you will still receive pain medication before you have your chest tube removed. You will also receive the ice or the tap water. Those who do not participate in the study will receive customary treatment, which does not include ice.

6. Contact information.

If you have any questions about the research, either Jenny Sauls at [redacted] or Nancy Wells at [redacted] will be glad to answer them. If you have any questions about your rights as a research participant, you may call the IRB office at [redacted] or Ms. Sheila Moore, Director of the Office of the Institutional Review Board for Human Use (IRB) at [redacted] 9 or [redacted].

Your rights as a volunteer:

Your participation in this study is voluntary. You may choose not to participate and receive alternative treatment without affecting your health care/services or other rights. You are also free to withdraw from this study at any time. Withdrawal or refusal to participate will not prejudice your health care.

In the event new information becomes available that may affect the risks or benefits associated with this study or your willingness to participate in it, you will be notified so that you can make an informed decision whether or not to continue your participation in this study.

Your rights of privacy will be maintained in the following manner. All information obtained about you during the study will be kept as confidential as legally possible and will be accessible only to the investigators and the sponsor of the study and any appropriate government agency. Research records, just like any other hospital record, may be inspected by federal regulatory authorities, including the Food and Drug Administration (FDA), state regulatory authorities, and legally authorized parties. Should the result of this study be published, neither your name nor any information from which you may be identified will be included.
Institutional Review Board
Consent Form

PI: Jenny Sauls March 10, 1999
Title of Study: The Use of Ice for Pain Associated with Chest Tube Removal
Institution/Hospital: Vanderbilt University Medical Center

STATEMENT BY PERSON AGREEING TO PARTICIPATE IN THIS STUDY
[ ] I have read this consent form. All my questions have been answered, and I freely and voluntarily choose to participate. I understand that I may withdraw at any time.
[ ] The material contained in this consent form has been explained to me verbally. All my questions have been answered, and I freely and voluntarily choose to participate. I understand that I may withdraw at any time.

__________________________________________
Date Signature of patient/volunteer

Consent obtained by:

__________________________________________
Signature Printed Name and Title

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INFORMED CONSENT - ICE APPLICATION: COMFORT AND ONSET OF COOLING

Investigator: Jenny Sauls

Explanation of Procedures

You are being asked to participate in a study designed to evaluate the rate and amount of cooling that you experience when ice is applied to your skin on top of different numbers of gauze dressings. One gauze dressing will be placed on your right thigh with chipped ice in a zip-lock bag placed on top of that. The ice will be applied for approximately ten minutes. Your level of comfort or discomfort will be measured at the end of the ten minutes using a 10-point Numeric Rating Scale where “0” means “no pain” and “10” means the “worst possible pain”. This process will be repeated three more times using 2 gauze dressings on the left thigh, then 3 gauze dressings on the right thigh, and finally, 4 gauze dressings on the left thigh. The whole procedure should take a little more than 40 minutes.

If you decide to participate, a research assistant will place the ice bag on each of the four sites. The ice will be taped in place each time for ten minutes. You may decide at any time in this process to withdraw from the study. If you remain in the study, you will be asked to report your level of discomfort on the ten-point scale, and to report the time of the onset of cooling for each site.

Risks and Discomforts

Side effects have only been reported with temperatures less than 0 degrees Celsius for periods longer than 40 minutes. Neither of these conditions exists in this study.

Benefits

Your participation in this study will assist in determining how many gauze dressings to use for ice application to provide the greatest comfort and the most timely cooling. This information may not benefit you directly at all but the results of the study may be used to benefit patients in the future.

Confidentiality

The information gathered during this study will be kept confidential as far as the law allows. The results of the treatment may be published for scientific purposes, however, your identity will not be revealed.

Withdrawal without Prejudice

You are free to withdraw your consent and to discontinue participation in this project at any time without prejudice against present or future education you may receive at this institution.

Costs to Subject from Participation in Research

There will be no cost to you from participation in the research.

UAB-IRB

Consent Form Approved 3/8/99
Expiration Date 3/24/2000

Participants Initials ______
Payment for Participation in the Research
You will not be paid for participation in this study.

Questions
If you have any questions about the research, Jenny Sauls will be glad to answer them. Mrs. Sauls telephone number is [REDACTED]. If you have any questions about your rights as a research subject, Susan Seager, chairperson of the Institutional Review Board at Middle Tennessee State University, will answer them. Her number is [REDACTED].

Legal Rights and Signatures
You will receive a copy of this informed consent. You are not waiving any of your legal rights by signing this consent form. Your signature below indicates that you agree to participate in this study.

_____________________________  _______________________
Signature of Participant        Date

_____________________________  _______________________
Signature of Investigator       Date

_____________________________  _______________________
Signature of Witness           Date
APPENDIX C

INSTITUTIONAL REVIEW BOARD APPROVAL
The Institutional Review Board for Human Use (IRB) has an approved Multiple Project Assurance with the Department of Health and Human Services and is in compliance with 21 CFR Parts 50 and 56 and ICH GCP Guidelines. The Assurance became effective on January 1, 1999 and the approval period is for five years. The Assurance number is M-1149, identification number 01.

Principal Investigator: SAULS, JENNY
Protocol Number: F990223009
Protocol Title: The Use of Ice for Pain Associated with Chest Tube Removal

The IRB reviewed and approved the above named project on 3/10/99. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This Project will be subject to Annual continuing review as provided in that Assurance.

This project received FULL COMMITTEE review.

IRB Approval Date: 3/10/99
Date IRB Approval Issued: 02-02-99

Ferdinand Urthaler, M.D.
Chairman of the Institutional Review Board for Human Use (IRB)

Investigators please note:

- The IRB approved consent form used in the study must contain the IRB approval date and expiration date.
- IRB approval is given for one year unless otherwise noted. For projects subject to annual review research activities may not continue past the one year anniversary of the IRB approval date.
- Any modifications in the study methodology, protocol and/or consent form must be submitted for review and approval to the IRB prior to implementation.
- Adverse Events and/or unanticipated risks to subjects or others at UAB or other participating institutions must be reported promptly to the IRB.
May 28, 1999

Jenny Sauls

RE: IRB# 990083/Standard, “The Use of Ice for Pain Associated with Chest Tube Removal” (None)

Dear Ms. Sauls:

At its meeting on March 24, 1999, the Institutional Review Board-Health Sciences reviewed the protocol and the consent forms for the research proposal identified above. The Committee determined that the study poses minimal risk to subjects. The recommendations of the Committee have been satisfactorily answered and final approval is extended on May 28, 1999.

Please note that approval is for a 12-month period only. Any further changes to the protocol and/or consent form should be presented to the Committee for approval before implementation of the changes.

Please be reminded that any serious and/or unexpected adverse reactions are to be reported to the Committee in writing within 10 days of their occurrence if Vanderbilt related, and 30 days if at other institution(s). Any safety reports from the sponsor must also be submitted to the Institutional Review board within 30 days of your having received them.

Please be reminded also that you are required to promptly report to the study sponsor and/or the FDA any adverse event that may be reasonably regarded as caused by or probably caused by the drug/device. If the adverse event is alarming, you are required to report the event immediately.

FINAL APPROVAL: May 28, 1999
EXPIRATION DATE: May 27, 2000

Sincerely,

Richard Hoover, Ph.D., Chair,
Institutional Review Board – Health Sciences

RH/Vfw

(th: Sauls.FAL990083.Standard.052799.HS)
## DEMOGRAPHIC DATA

ID Code _____ MR number __________ Experimental or Control Group (circle one)

Admitting Diagnosis __________________________

Age ______ Ht ______ Wt ______

Gender ______

Ethnicity ____________

Previous Cardiac Surgery: Type _______________________ Date ______________________

Number & Type (Mediastinal or pleural) of Chest Tubes ___________________________

Previous Chest Tube/s ______

Pain Medication (that which was administered within six hours of CTR). *Also list other drugs such as sedatives that may affect outcome.*

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<thead>
<tr>
<th>Name</th>
<th>Amount</th>
<th>Route</th>
<th>Time</th>
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NUMERIC RATING SCALE—PAIN INTENSITY

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<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<tbody>
<tr>
<td>No Pain</td>
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<tr>
<td>Worst Possible Pain</td>
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**Directions to Patients:**

**Time 1**
Before ICE

"Using a 0-10 scale, where 0 = no pain and 10 = worst possible pain, how intense is your pain now, where your chest tube is inserted, when you are lying still?" *Patient Response* ___________

**Time 2**
Before CTR

"Using a 0-10 scale, where 0 = no pain and 10 = worst possible pain, how intense is your pain now, where your chest tube is inserted, when you are lying still?" *Patient Response* ___________

**Time 3**
During CTR

"Using a 0-10 scale, where 0 = no pain and 10 = worst possible pain, how intense was your pain during chest tube removal?" *Patient Response* ___________

**Time 4**
10 min. AFTER CTR

"Using a 0-10 scale, where 0 = no pain and 10 = worst possible pain, how intense is your pain now when you are lying still?" *Patient Response* ___________

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APPENDIX F

NUMERIC RATING SCALE-PAIN DISTRESS
Numeric Rating Scale - Pain Distress

**I.D. CODE**

0 1 2 3 4 5 6 7 8 9 10

**No Distress**

**Worst Possible Distress**

**Directions to Patients:**

**Time 1 Before ICE**

"Using a 0-10 scale, where 0 = no distress and 10 = worst possible distress, how distressful is your pain now, where your chest tube is inserted when you are lying still?"  **Patient Response**

**Directions to Patients:**

**TIME 2 Before CTR**

"Using a 0-10 scale, where 0 = no distress and 10 = worst possible distress, how distressful is your pain now, where your chest tube is inserted, when you are lying still?"  **Patient Response**

**Directions to Patients:**

**TIME 3 During CTR**

"Using a 0-10 scale, where 0 = no distress and 10 = worst possible distress, how distressful was your pain during chest tube removal?"  **Patient Response**

**Directions to Patients:**

**TIME 4 10 min. AFTER CTR**

"Using a 0-10 scale, where 0 = no distress and 10 = worst possible distress, how distressful is your pain now when you are lying still?"  **Patient Response**
APPENDIX G

McGILL PAIN QUESTIONNAIRE-SHORT FORM (MPQ-SF)
SHORT-FORM McGILL PAIN QUESTIONNAIRE (MPQ-SF)

I.D. CODE_____
Also to be assessed at Time 4 but refers to the pain experienced DURING CTR.

Say to the subject: “Now I am going to say 15 different words that may be descriptive of the pain you experienced during your chest tube removal. I would like for you to rate each of these words on a scale of 0 to 3 with 0 being “NONE,” 1 being “MILD,” 2 being “MODERATE,” and 3 being “SEVERE.”

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<tr>
<th>Word</th>
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<th>2</th>
<th>3</th>
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<tbody>
<tr>
<td>THROBBING</td>
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<tr>
<td>SHOOTING</td>
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<tr>
<td>STABBING</td>
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<td>SHARP</td>
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<td>HOT-BURNING</td>
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<td>SPLITTING</td>
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<td>TIRING-EXHAUSTING</td>
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<tr>
<td>SICKENING</td>
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<tr>
<td>FEARFUL</td>
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<tr>
<td>PUNISHING-CRUEL</td>
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The Institutional Review Board for Human Use (IRB) has an approved Multiple Project Assurance with the Department of Health and Human Services. The Assurance became effective on February 1, 1994 and the approval period is for five years. The Assurance number is M-1149.

Principal Investigator: JENNY SAULS
Protocol Number: X990204002
Protocol Title: Ice Application: Comfort Levels and Onset of Cooling

The IRB reviewed and approved the above named project on 2/24/99. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This Project will be subject to Annual continuing review as provided in that Assurance.

This project received EXPEDITED review.
Date: 2/24/99

Marilyn Doss, M.A.
Vice Chair of the Institutional Review Board for Human Use (IRB)

Investigators please note:

The IRB approved consent form used in the study must contain the IRB approval date and expiration date.

IRB approval is given for one year unless otherwise noted. For projects subject to annual review research activities may not continue past the one year anniversary of the IRB approval date.

Any modifications in the study methodology, protocol and/or consent form must be submitted for review and approval to the IRB prior to implementation.

Adverse Events and/or unanticipated risks to subjects or others at UAB or other participating institutions must be reported promptly to the IRB.
To: Jenny Sauls  
School of Nursing  
MTSU  
Box 81  

From: Susan R. Seager, Ed.D., R.N.  
Chair, Institutional Review Board  

Re: “Comfort Level and Onset of Cooling  
(IRB Protocol Number: 99-073 )  

Date: November 10, 1998  

The above named human subjects research proposal has been reviewed and approved. This approval is for one year only. Should the project extend beyond one year or should you desire to change the research protocol in any way, you must submit a memo describing the proposed changes or reasons for extension to your college’s IRB representative for review. Best of luck in the successful completion of your research.
Name of Candidate _______ Jenny L. Sauls ________________________________

Major Subject __________ Educator of Nursing ____________________________

Title of Dissertation _______ The Use of Ice for Pain Associated With Chest Tube __________
Removal ________________________________________________________________

I certify that I have read this document and examined the student regarding its content. In my opinion, this dissertation conforms to acceptable standards of scholarly presentation and is adequate in scope and quality, and the attainments of this student are such that she may be recommended for the degree of Doctor of Science in Nursing.

Dissertation Committee:

Name

__________________________  Dr. Gail Hill  _______________ Chair  __________________________

__________________________  Dr. Dorothy Gauthier  __________________________

__________________________  Dr. Myra Smith  __________________________

__________________________  Dr. Alfred Bartolucci  __________________________

__________________________  Dr. Stephen Krau  __________________________

Signature

Director of Graduate Program

Dean, UAB Graduate School

Date ________________