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MH 729

CAN TARGET VOLUME BREATHING EXERCISES TAUGHT PREOPERATIVELY DECREASE POSTOPERATIVE PULMONARY COMPLICATIONS FOR CARDIAC SURGERY PATIENTS?

by

LEA SOL LOPEZ-FAGIN

THESIS
Presented to the Graduate Faculty of
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for the Degree of

MASTER OF SCIENCE IN NURSING

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CAN TARGET VOLUME BREATHING EXERCISES TAUGHT PREOPERATIVELY DECREASE POSTOPERATIVE PULMONARY COMPLICATIONS FOR CORONARY ARTERY BYPASS GRAFT AND VALVE REPAIR PATIENTS?

A Thesis

by

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ABSTRACT

CAN TARGET VOLUME BREATHING EXERCISES TAUGHT PREOPERATIVELY DECREASE POSTOPERATIVE PULMONARY COMPLICATIONS FOR CARDIAC SURGERY PATIENTS?

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Postoperative pulmonary complications and management are recognized as major problems following coronary artery bypass graft and valve repair surgery. Pulmonary complications include hypoxemia, reduction in air volume capacity, atelectasis, fever, tachycardia, tachypnea, and pneumonia. However, little is known about specific therapeutic interventions in nursing related to the amelioration of postoperative pulmonary complications in cardiac surgical patients. The study evaluated the outcomes of preoperative teaching of target volume breathing exercises in the prevention of hypoxemia and reduction of lung volume capacity for coronary artery bypass graft (CABG) and valve repair patients. Thirty-four patients aged 50-77 years undergoing CABG or valve repair surgery were randomly assigned to two types of preoperative teaching. A 2x2 factor, parallel group design was used in this intervention study. Arterial oxygen saturation and pulmonary function tests of forced vital capacity, forced expiratory volume in one second, and forced expiratory flow were measured preoperatively, 24 hours postextubation, and at the fifth

postoperative day. A pulse oximeter was used to measure oxygen saturation. The Collins incentive spirometer and the Respirodyne were utilized for the pulmonary function tests. Inferential statistics of *t* test and analysis of variance were used to analyze the data. Postoperatively, the experimental subjects attempted to reach 80% of their preoperative forced vital capacity on the incentive spirometer. Preoperative teaching of target volume breathing exercises resulted in statistically significant differences in percentages of oxygen saturation and forced vital capacity 24 hours postextubation for the experimental group. No significant differences were found between groups for the second and the fifth postoperative day in forced expiratory volume in one second and forced expiratory flow. The data analysis also demonstrated significant reductions in all pulmonary function tests for those patients having an internal mammary graft versus a saphenous graft. In conclusion, preoperative teaching of target volume breathing exercises may cautiously be said to provide a goal for a prescriptive therapeutic nursing intervention in the reduction of postoperative pulmonary complications in the cardiac surgical client at least during the critical 24 hours postsurgery. Further research is recommended with larger samples to validate the efficacy of target volume breathing exercises in defying the risk factors associated with postoperative pulmonary complications in CABG and valve repair patients.

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INTRODUCTION

Overview of the Problem

Postoperative pulmonary complications continue to be a prevalent problem for patients undergoing upper abdominal and thoracic surgery (Bartlett, Brennan, Gazzaniga, & Hanson, 1973; Demers & Sakland, 1976; Shapira, Zabatino, Ahmed, Murphy, Sullivan & Lemole, 1990). Despite major advances in surgical technology, anesthetic administration, and antibiotic therapy, the occurrence of postoperative pulmonary complications (PPCs) remains a challenge for health care providers. Reduction in lung capacity with consequent atelectasis, hypoxemia, fever, tachypnea, tachycardia, pneumonia, and respiratory failure are just some of the signs and symptoms of PPCs (Gass & Olsen, 1986; Hall, Tarala, Harris, Tapper, & Christiansen, 1991; Okinaka, 1967).

While PPCs are a serious and prevalent problem, there is a discrepancy in the reported incidence of PPCs in thoracic surgery. The reported incidence varies widely among studies (e.g., Hutter, Aps, Hemsi, & Williams, 1989; Mathay & Weiner-Kronish, 1989); thus, the problem is significant. The rapid improvement in thoracic surgical techniques, however, has increased the trend toward coronary revascularization (Hutter et al., 1989). Coronary artery bypass graft (CABG) surgery has been efficacious in relieving the discomfort of anginal pain and has improved patients' quality-of-life outcome (Flynn & Frantz, 1987). Currently, elderly patients are being given the benefit of CABG

surgery. Despite their age and chronic obstructive pulmonary disease (COPD), elderly patients undergo surgical procedures for serious heart malformations. In the past, these patients would have been denied surgery due to preoperative, intraoperative, and postoperative risk factors for the development of PPCs (Gass & Olsen, 1986).

The preoperative risk factors for the development of PPCs in CABG patients are age over 75 years, prior cardiac surgery, emergency status of the operation, myocardial infarction, obesity, and COPD, among others. These preoperative risk factors have been correlated to prolonged mechanical ventilation (Hammermeister, Burchfield, Johnson, & Grover, 1990). The intraoperative risk factors include use of general anesthesia, use of mechanical ventilation, length of surgery, incisional division of the sternum, use of cardiopulmonary bypass pump for extracorporeal circulation, interstitial edema of the alveoli, and pleural trauma (Bartlett et al., 1973; Berrizbeitia, Tassler, Jacobowitz, Kaplan, Budzilonicz, & Cunningham, 1989; Tulla, Takala, Alhava, Huttunen, Kari, & Manninen, 1991). The postoperative risk factors are change in breathing patterns and chest wall compliance, atelectasis, and increased incisional pain in patients with dissection of the internal mammary artery for the graft (Mathay & Weiner-Kronish, 1989; Tulla et al., 1991).

Pulmonary function tests (PFTs) have been used to predict PPCs in upper abdominal surgical patients. A decrease in forced vital capacity of 76.5% was correlated with PPCs in obese patients and patients over 50 years old by Latimer, Dickman, Clinton, Gunn, and Schmidt (1971). However, in CABG patients, PFTs are not the best predictors of PPCs and have been under scrutiny (Gass & Olsen, 1986; Gortner & Jenkins, 1990). Nevertheless, the forced expiratory flow rate has been found to be an important predictor

of patients' ability to cough and clear airway passages of accumulated secretions (Shapira et al., 1990). Paradoxically enough, PFTs have been used to predict early or late extubation based on patients' psychological traits of anxiety, hostility, depression, and positive outlook (Ingersoll & Grippi, 1991).

As stated above, PPCs such as hypoxemia, pneumonia, and decrease in total lung capacity are major problems in the recovery of CABG patients. As has been pointed out, the pathophysiology of CABG patients is different from other types of surgery. In addition, there is only limited information on the development of PPCs in CABG patients. Most studies have been focused on preoperative and postoperative psychological aspects of nursing care. Nevertheless, coronary revascularization is on the rise, despite advanced age and other risk factors. Therefore, this investigator chose to study PPCs in CABG patients in the hope of increasing the knowledge in this domain.

Need for the Study

There is a paucity of information on PPCs in CABG patients (Gass & Olsen, 1986). Most of the preoperative and postoperative nursing studies have been done on patients with upper abdominal surgery. Thus, it is generally known that, immediately after extubation, there is a high risk for development of PPCs in abdominal surgical patients (Van de Water, Watring, Linton, Murphy, & Byron, 1972). The pathophysiology of PPCs among CABG patients is different from that of patients with upper abdominal surgery (Mathay & Weiner-Kronish, 1989). The physiological lung changes after CABG surgery are directly related to surgical incision of the sternum, use of cardiopulmonary bypass, lung deflation, length of ischemic period, and mechanical manipulation

of the internal mammary artery (Given & Khan, 1991). Therefore, there is a need for further knowledge as it relates to this unique population with higher risk for development of PPCs. In addition, the increasing trend toward CABG surgery on older adults emphasizes the need for studying PPCs in older CABG patients. Older patients are more prone to develop PPCs due to the underlying risk factors. Thus, they would benefit from improved procedures in preoperative instruction and postoperative therapy. This investigation could provide needed knowledge in the area of prevention and management of PPCs such as atelectasis, hypoxemia, pneumonia, and reduction in lung capacity in this population. Furthermore, the results of this study could increase nurses' therapeutic abilities while providing postoperative nursing care for CABG patients suffering from PPCs.

Problem Statement

The needed lung air volume to prevent PPCs in abdominal surgical patients is known (Bartlett et al., 1973), but the maximal individual lung inflation needed to prevent PPCs in the CABG patient has not been determined. The establishment of a realistic target volume breathing in the incentive spirometer for CABG patients would have implications for preoperative teaching programs because CABG patients have alterations in air volume, gas exchange diffusion, carbon dioxide retention, and oxygenation postoperatively. Factors such as division of the chest wall, cross-clamping of major vessels, and use of the cardiopulmonary bypass for extracorporeal respiration have been responsible for PPCs in CABG patients up to the third postoperative month.

Purpose

The purpose of this study was to evaluate the outcomes of preoperative teaching of target volume breathing exercises for coronary artery bypass graft and valve repair patients in order to reduce postoperative pulmonary complications such as hypoxemia and reduction in lung capacity as measured by oxygen saturation and by pulmonary function tests: forced vital capacity, forced expiratory volume in one second, and forced expiratory flow.

Hypotheses

Research has indicated that decreases in lung volume and oxygen saturation are highly correlated to PPCs. Thus, the determination of a target air volume for spirometry use by CABG patients should aid in the reduction of PPCs. Hence, the hypotheses tested in this study were as follows:

1. Postoperative lung air volumes will be greater for patients receiving a structured preoperative teaching regimen including target volume breathing exercises, persuasive information, and modeling than for patients receiving only standard preoperative teaching.

2. Pulmonary function in patients receiving an internal mammary artery graft will be decreased in comparison to those receiving a saphenous graft regardless of teaching methodology.

3. Percentages of oxygen saturation measured by the pulse oximeter will not differ between the experimental and the control group.

Operational Definition of Terms

The following terms were relevant in this study:

1. Older adults, for the purpose of this study, denoted persons whose age was between 50 and 80 years.

2. Coronary artery bypass graft is a surgical bypass of a narrowed coronary artery with the saphenous vein or the internal mammary artery to improve the heart's oxygenation.

3. Standard preoperative teaching, for the purpose of this study, refers to a preoperative teaching program given by the cardiovascular nurse or a floor nurse relating information on the CABG procedure, the sensations connected with the surgery, and the techniques for coughing and deep-breathing using the incentive spirometer. The air volume to be reached in the incentive spirometer postoperatively was not individually calculated. The patient was given a booklet for further reference.

4. Target volume breathing exercises, for the purpose of this study, comprised a structured preoperative teaching program utilizing a slide/tape presentation given by the investigator the day before surgery. The patients were instructed in breathing, coughing, and the way in which to achieve sustained maximal inspiration on their own and using the incentive spirometer. They were also taught to reach 80% of preoperative vital capacity on the incentive spirometer in the postoperative period.

5. Pulmonary function tests are measurements of the amount of inspired and expired air volume of the lungs. They assess lung elasticity, diaphragm movement, and chest wall compliance. This study used forced vital capacity, forced expiratory volume in one second, and forced expiratory flow.

   a. Forced vital capacity is the largest volume of gas measured after complete expiration of a maximum inspiration with

expiration being as forcible as possible. Lower values suggest reduction in total lung capacity.

b. Forced expiratory volume in one second is the volume of gas exhaled in a second while performing forced vital capacity. Decreased values reflect airway obstruction.

c. Forced expiratory flow is the forced expiratory flow for a specific volume segment. It reflects the individual's ability to cough.

6. Oxygen saturation denotes the amount of oxygen transported to the tissues by the blood hemoglobin. It is directly related to inspired oxygen by breathing, alveolar ventilation, and hemoglobin. The normal range is between 90% and 95% at sea level.

7. Pulse oximeter is a spectrophotometric device that measures arterial oxygen saturation noninvasively. The device can be applied to a patient's fingers, toes, or nasal septum.

8. Incentive spirometer is a device used to breathe in a measured amount of air. A goal of the amount of air to breathe in can be set as an incentive.

9. Postoperative pulmonary complications comprise hypoxemia (oxygen saturation below 95 mmHg) and lung air volume reduction greater than 35% of preoperative value.

Theoretical Framework

The theoretical framework selected for this investigation was self-efficacy, a cognitive learning theory for behavioral change developed by Bandura (1977). The self-efficacy theory contends that cognitive processes are responsible for changes in behavior. Working from this premise, self-efficacy is defined as an individual's ability to gain control of and exercise control

over situations and demands placed upon the individual by the environment. Accordingly, Bandura postulates that learning is a process of cognition; individuals obtain cognitive knowledge and reinforce it by performing acts or behaviors that produce positive outcomes and benefits. Not performing those behaviors prevents them from reaching a desired consequence. Thus, a person learns from positive or negative outcome performances are correlated to consequences. Motivation, according to Bandura, has its roots in cognitive abilities that deal primarily with stimulation and repetition of behavior. That is, a person anticipates and expects a positive outcome based on a behavior that creates benefits. On the other hand, an individual avoids those behaviors that end in negative outcomes. A motivated person sets his/her own standards by which to evaluate his/her performance.

Bandura (1977) states that self-efficacy theory is rooted in performance accomplishment, vicarious experience, verbal persuasion, and emotional arousal. Through performance accomplishment, a person gains mastery of information, turning the information into a successful behavior which is manifested in performance. Self-efficacy, then, involves built-in expectations of successful performance giving a person the impetus to achieve a difficult task through continuous effort. This is a very important component of the theory.

Vicarious experience involves obtaining information through seeing others perform or through modeling of a behavior. Observing successful outcomes of a behavior in others suggests to a person a sense of being able to do the same act successfully (Bandura, 1977).

Through verbal persuasion, a behavior is changed by suggesting to a person that he/she can adjust to or learn something. The individual may, in turn, believe that a desired

goal or behavior is possible or attainable. Suggestion, exhortation, self-instruction, and interpretive treatment are some of the elements involved in verbal persuasion. Verbal persuasion may be unsuccessful if it contradicts a person's beliefs or values. However, if it is used to correct a performance to achieve mastery, it consolidates a person's energy to work harder toward self-efficacy and success (Bandura, 1977).

Emotional arousal, in Bandura's (1977) theory, refers to the possible valuable contributions to self-efficacy information gained through emotional conditions induced by fear or anxiety-provoking circumstances. According to Bandura, fear toward a perceived threat can heighten anxiety and interfere with coping abilities. Anxiety then triggers a series of physiological responses, i.e., increases in heart rate, respirations, blood pressure, ability to focus, etc. The physiological responses brought on by psychological states decreases a person's capacity to cope with a situation. Anticipatory emotional states of arousal can be decreased by role modeling and by teaching a person skills to overcome fear of a threatening situation.

Jenkins (1988) comments that Bandura's theory of self-efficacy is extremely useful to nursing because the focus is on behavior and its outcomes. A person can determine to what extent he/she wants to get involved or how much effort to put into a given behavior. Since expectations are not enough for success, performance behavior is imperative for mastery of skills and self-efficacy. According to Allen (1988), self-efficacy has been widely used as a theoretical framework in cardiac rehabilitation, smoking cessation, weight control, and other risk-reduction programs because of its emphasis on performance behavior.

Gortner and Jenkins (1990) studied the effects of self-efficacy and activity level following cardiac surgery. They

concluded that inpatient teaching and telephone follow-up at home can influence patients' learning and behavior outcomes.

In conclusion, Bandura's (1977) theory of self-efficacy seems to be applicable to the proposed investigation of preoperative teaching of breathing exercises. Preoperative teaching, through verbal persuasion, can help patients to obtain mastery of skills in the postoperative period. Showing a slide/tape presentation on the physiology of breathing, the alterations incurred during surgery, and the way in which to prevent postoperative pulmonary complications is a form of verbal persuasion. The nurse, in this case, interprets for the patient what can happen if he/she does not breathe properly. The nurse also models (vicarious experience) to a patient by demonstrating how to achieve sustained maximum inspiration using the incentive spirometer and how to cough. Performance accomplishment, then, can be seen on return demonstration of the taught behavior. It is hoped that fear and anxiety (emotional arousal) will be ameliorated in CABG patients by teaching them how to master breathing exercises and be successful in reaching their target goal in breathing and averting postoperative pulmonary complications with faster return to self-care through self-efficacy.

Assumptions

For the purposes of this study, it was assumed that:

1. Preoperative teaching can decrease anxiety and facilitate coping by providing knowledge of postoperative performance behaviors.

2. Pulmonary function tests are reliable tools for measuring lung air volume.

Limitations

Limitations of the study were identified as follows:

1. Target volume breathing exercises have not been tested; thus, normative data were not available.

2. The clinical signs and symptoms of PPCs are too complex for all of them to be included in this study.

3. The use of pulse oximetry as a measurement of patient control over the situation has not been tested.

4. The study did not control the type of graft used because the decision as to graft usage is made in the operating room based on the patency of the blood vessel. Hence, there could have been a comparable number of patients receiving each type of surgery.

5. The sample size could have been inadequate to measure all variables.

CHAPTER 2

REVIEW OF THE LITERATURE

The literature review elucidates the pathophysiology of PPCs, general preoperative teaching, and specific preoperative teaching for CABG patients. In pursuit of this subject matter, a comprehensive search for relevant research literature was performed. Some of the studies cited in this review are old but relevant as they apply to the physiology of lung volumes and breathing patterns. Furthermore, they are seminal foundations for further research into postoperative nursing care.

Pathophysiology of Postoperative Pulmonary Complications

McCutcheon (1953), in a study of the normal breathing patterns of mammals and man, found correlations between deep inspiration and total lung capacity. In man, the frequency was 16 cycles per minute, with a deep inspiration of 500 mls of air volume three times an hour. Deep inspiration was found to be essential for gas exchange of oxygen and carbon dioxide from the lungs into the blood and vice versa.

Zikria, Spencer, Michailoff, Broell, and Kinney (1970) compared the breathing patterns of three groups of subjects. The first group was composed of volunteers with normal pulmonary function tests; the second group was composed of postoperative patients with normal preoperative pulmonary function tests; the third group was composed of critically ill patients. The normal

subjects gave five sighs per hour; the regular postoperative patients gave two or three sighs per hour. In contrast, the critically ill patients lacked sighs; their breathing was shallow and monotonous. The authors concluded that lack of sighs was responsible for PPCs.

A later study on CABG patients was carried out by Tulla et al. (1991), who found significant postoperative decreases in sighs and tidal volume whereas respiratory rate, minute ventilation, inspiratory flow, oxygen consumption, and carbon dioxide production were increased. All subjects had confirmed atelectasis. These investigators found CABG patients to be more prone to PPCs due to the complexity of respiratory changes after extubation. Carrel, Schmid, von Segesser, Vogt, and Turina (1991) report that the presence of preexisting bacterial lung infection among smokers with abnormal PFTs increased the rate of postoperative pneumonia to 30% in CABG patients. The researchers recommended preoperative sputum culture, antibiotics, coughing, and other measurements to prevent PPCs.

Relationship of Air Volume to Postoperative Pulmonary Complications

The relationship of air volume to PPCs was confirmed by Mead and Collier (1959) by measuring lung compliance after forced inflation and deflation in normal and anesthetized dogs. The researchers found no changes if the lungs were inflated to full capacity within one hour of deflation. Marked atelectasis and reduction in lung compliance resulted from failure to reach and maintain maximal lung air volume.

The importance of achieving an adequate lung air volume postoperatively to prevent the development of PPCs was

substantiated by Bartlett et al.'s (1973) classic study. A sample of 150 subjects were assigned to a control and an experimental group. The incentive spirometer was invented for this study to replicate sustained maximal inspiration obtained by yawning. Decreased air volume, shallow breathing, and atelectasis were found in the control group, the members of which performed coughing and deep-breathing activities. The experimental group, whose members used hourly incentive spirometry postoperatively, had fewer PPCs.

The benefits of incentive spirometry versus intermittent positive pressure breathing was reported by Van de Water et al. (1972). A total of 30 patients were assigned to a control and an experimental group. Radiographically, the experimental group, using incentive spirometry, had the least PPCs, but there were no differences in pulmonary function tests between the experimental and the control group.

Hall et al. (1991) compared the effects of two respiratory therapies on the prevention of PPCs. In a randomized assignment, patients performed supervised coughing and deep-breathing and received vibration therapy from a physiotherapist. Patients in the experimental group performed unsupervised incentive spirometry. The experimental treatment did not reduce the rate of atelectasis in contrast to the group receiving physiotherapy and supervised breathing exercises, who had significant decreases in PPCs.

In a comparative survey in Great Britain on the use of incentive spirometry in the prevention of PPCs, Jenkins and Soutar (1986) found a 44% use for CABG patients. These authors' findings supported the prophylactic and therapeutic use of incentive spirometry in patients with poor chest expansion and cooperation in Great Britain.

Prescriptive Air Volume in Postoperative Pulmonary Complications

Craven, Evans, Davenport, and Williams (1974) evaluated the effect of prescribed air volume in the prevention of PPCs. The variables measured were pulmonary function tests and radiological exams in 70 subjects with abdominal surgery. Experimental group subjects were prescribed to breathe 500 mls of air into the incentive spirometer during the first postoperative day, 750 mls the second day, and 1000 mls the third through fifth days. The control group received chest physiotherapy. A significant decrease in PPCs for the experimental group was confirmed through radiological findings. However, there were no differences in pulmonary function tests between the two groups.

Dekhuijzen, Folgering, and van Hervaarden (1991) studied the outcomes of target flow training of inspiratory muscles in COPD patients with pulmonary ventilation problems. The variables measured were total lung capacity, forced residual capacity, and forced expiratory volume. The authors established a target flow training of 70%, which improved the strength of inspiratory muscles and the outcome of ventilatory function tests.

Pulmonary Function Tests in Coronary Artery Bypass Graft Patients

The relationship of sternotomy to internal mammary artery grafts and saphenous vein grafts in patients was undertaken by Berrizbeitia et al. (1989). Definite reductions in pulmonary function tests were seen in both groups at six and eight weeks postoperatively. The investigators concluded that sternotomy caused greater lung impairment in patients with an internal

mammary artery graft. These findings agree with those of Shapira et al. (1990). Postoperatively, there is a 19%-35% decrease of all preoperative lung volumes, particularly the peak expiratory flow rate in CABG patients (Given & Khan, 1991). Berrizbeitia et al. (1989) also found increased atelectasis in all patients. The PFTs normalized by the third month postoperatively with the exception of a remaining lower inspiratory capacity. The investigators determined that risk factors, i.e., age, obesity, smoking history, time on the cardiopulmonary bypass machine, chest wall injury, and dissection of the internal mammary artery, were responsible for impairments in lung capacity.

Cardiopulmonary Bypass in Postoperative Pulmonary Complications

The need for oxygen perfusion to myocardial cells and other vital tissues remains crucial during CABG surgery (Balderman, 1987; Moores, 1982). During CABG surgery, the cardiopulmonary bypass (CPB) machine performs the oxygen transport and circulation normally carried out by the heart and the lungs. The CPB machine has a built-in oxygenator reservoir for blood oxygenation and a system of roller or centrifugal pumps to transport and circulate the blood flow. Deoxygenated blood returning to the right atrium by the vena cava is drained and oxygenated in the reservoir. This process is achieved by inserting a venous cannula in the right atrium, the vena cava, or the femoral vein. Then, after oxygenation, the blood is returned to the heart by a cannula inserted in the aorta or the femoral artery. The blood flow delivery is based on the commercial design of the CPB machine. There are two types: (1) the pulsatile and (2) the nonpulsatile. The pulsatile blood flow has resulted in improved cerebral

oxygenation, increased urine output, and better myocardial perfusion. The nonpulsatile blood flow has been associated with complications such as microemboli. The nonpulsatile delivery system is less expensive than the pulsatile blood flow delivery system (Reed & Stafford, 1985).

The oxygenator within the CPB machine simulates the lungs' physiological process of gas exchange, blood oxygenation, and carbon dioxide removal. There are two types of oxygenators: (1) the bubble and (2) the membrane. In the bubble oxygenator, the gas exchange takes place at the surface of the bubble. Thus, the blood comes in direct contact with the oxygen. Before the blood is sent back into circulation, the bubbles are defoamed in a filtering chamber to prevent gas embolism. The bubble oxygenator has been linked to coagulopathies due to disruption of blood cells, platelets, and clotting factors. In contrast, the gas exchange in the membrane oxygenator takes place through a thin, porous membrane which is similar to the capillary membranes of the alveoli in the lungs. The membrane oxygenator is least likely to cause complications due to its close similarity to the physiological capillary membrane of the lungs' alveoli (Given & Khan, 1991).

CPB has been linked to PPCs such as hypoxemia, reduction in air volume, atelectasis, and interstitial alveolar hemorrhage. PPCs are hypothesized to be produced by: (1) duration of CPB longer than 120-150 minutes, (2) alveolar capillary injury due to platelet aggregate and complement activation, (3) exposure of blood products to the foreign surface of the cannula, (4) blood and gas microemboli produced by bubble oxygenators, and (5) status of the lungs before surgery (Given & Khan, 1991).

There are definite physiological changes in the lungs after CABG surgery which are directly related to the CPB for

extracorporeal circulation. In addition, hypothermia, hemodilution, lung deflation, ischemic period, and capillary vasoconstriction from catecholamine release, which are associated with CPB, may cause PPCs (Given & Khan, 1991).

Preoperative Teaching

Research has demonstrated that preoperative patient teaching results in positive patient outcomes postoperatively (Lindeman, 1988). Structured preoperative teaching of the skills of coughing and deep-breathing to promote postoperative recovery and prevent PPCs resulted in significant increases in ventilatory capacity and decreases in length of hospital stay postoperatively in Lindeman and van Aernam's (1971) classic study, which was replicated by King and Tarsitano (1982). King and Tarsitano's experimental group were able to cough and deep-breathe more effectively as measured by ventilatory function tests. However, a difference in length of hospital stay was not demonstrated.

Fortin and Kirovac (1976) investigated the effectiveness of a structured preoperative teaching program in terms of postoperative comfort and physical mobility. Sixty-five patients were randomly assigned to an experimental and a control group. Data analysis led to the conclusion that the preoperative teaching increased the comfort and the physical mobility, with prompt return to work, of the experimental group.

Similar results were obtained when sensory information was added to a randomized preoperative teaching in a study conducted by Johnson, Rice, Fuller, and Endress (1978). In this study, patients were given sensory information and preoperative teaching on coughing, deep-breathing, leg exercises, and ambulation as coping strategies, using several indicators for recovery

postoperatively. A higher level of performance of activities of daily living and reduced hospital stay were manifested in patients who received sensory information.

Hinshaw, Gerber, Atwood, and Allen (1983) tested the effectiveness of a perioperative teaching program by operating room nurses based on a practice model. The model had five phases of nursing intervention according to the patient's trajectory path from the admission to the hospital (Stage 1) through the preoperative period (Stage 2), the intraoperative period (Stage 3), and the immediate postoperative period (Stage 4) to the extended postoperative period (Stage 5). The operating room nurses evaluated the outcomes of a preoperative teaching program in terms of coping, pain, anxiety, and patient recovery pattern. The operating room nurses provided the preoperative teaching and followed the patient in the intraoperative and the postoperative period. The patients evaluated the care received in terms of coping, anxiety, pain, and satisfaction with care provided by the operating room nurses. The nursing staff also evaluated the nursing care provided in terms of safety, information, and satisfaction of care. Patients exhibited less vomiting postoperatively and higher satisfaction with the hospitalization episode. Nurses reported high safety levels in patient care and higher levels of personal and professional satisfaction. The researchers concluded that perioperative teaching may be costly in terms of nurse time but that it is rewarding and safe for both patients and nurses.

A meta-analytical study of preoperative psychoeducational programs by Devine and Cook (1983) found a reduction in length of hospital stay, which decreased patient hospital cost and saved money. The investigators concluded that sufficient data are available to prove the benefits of preoperative psychoeducational

programs and that such programs should be systematically implemented.

Cardiovascular Preoperative Teaching

There is limited information on pulmonary preoperative teaching for CABG patients. Most studies have focused on psychological aspects of care and rehabilitation.

Grady, Buckley, Cisar, Fink, and Ryan (1988) determined patient perception of the value of preoperative teaching in terms of recovery using cardiovascular surgical patients. The patients ranked diet, exercise, and effects of medication(s) as most important while explanation of surgery, intensive care environment, coughing, and deep-breathing exercises were ranked second in importance regarding being helpful in postoperative recovery at home.

King (1985) postulates that preoperative teaching meets patients' information needs and may provide them with better coping strategies postoperatively. The author found evidence that, preoperatively, CABG patients actively seek for information related to changing their diet, exercise, and smoking habits. Although postoperatively these patients responded with fatigue, tension, decrease in vigor, and depression, they nevertheless considered preoperative teaching to have been extremely valuable. King contends that preoperative teaching meets patients' information needs by providing them with better coping strategies postoperatively.

Steele and Ruzicki (1987) evaluated the effectiveness of an inhospital cardiac teaching program in terms of knowledge gained and confidence of CABG patients. The authors identified a significant increase in knowledge and confidence for those

receiving inhospital preoperative teaching and following the regimen at home. The researchers concluded that inhospital preoperative teaching is effective for postoperative outcomes but that it needs to be reinforced through outpatient instruction, particularly to encourage changes in risk behavior.

Steel and Ruzicki's (1987) findings agreed with those of Marshall, Penckofer, and Llewellyn (1986), as did the findings of Gortner and Jenkins' (1990) study of inpatient and outpatient teaching of CABG patients. Gortner and Jenkins used a sample of 149 subjects divided into an experimental and a control group. Members of the experimental group were contacted by phone at specified intervals from the time of discharge till six months postdischarge. The telephone contacts enhanced patient teaching, as the experimental group reported higher levels of walking and general activity at the fourth and the eighth week postdischarge. The authors state that postdischarge telephone follow-up to inpatient preoperative teaching increases perception of self-efficacy and improves physical functional capacity.

A similar study was undertaken by Ruiz, Dibble, Gilliss, and Gortner (1992). They evaluated the effectiveness of patient teaching immediately after CABG surgery and after discharge. A total of 150 subjects were evenly randomized to an experimental and a control group. Both groups viewed a slide/tape teaching presentation on diet, exercise, and other aspects of recovery from surgery. The experimental group received in addition an enhanced educational program regarding expected changes in behavior after discharge along with postdischarge follow-up by phone. The investigators found increased self-confidence and self-efficacy among experimental group members due to the mastery of skills taught preoperatively and reinforced postoperatively.

Summary

Coronary artery bypass graft surgery is a lifesaving surgical procedure. More and more elderly patients are being given a second chance for survival following CABG surgery. However, the postoperative course of CABG is still associated with pulmonary complications ranging from atelectasis and pneumonia to disturbances in pulmonary capacity persisting up to three to four months after surgery. Surgical division of the sternum, duration of the CPB procedure, and lung trauma decrease in air volume due to shallow breathing and lack of sighs have been linked to PPCs in CABG patients.

The benefits of preoperative teaching programs include improved pulmonary capacity, ability to perform breathing exercise effectively, decreased vomiting, greater mobility, and enhanced functional capacity. Furthermore, patients and nurses are more satisfied with the care provided. Preoperative teaching also reduces the cost of hospitalization by decreasing length of hospital stay and increases patients' self-confidence and self-efficacy through compliance with instructions. In addition, preoperative teaching can be maintained and strengthened by phone contact and continuing instruction in the outpatient setting.

The extensive literature review did not uncover any studies addressing the specific air volume needed to prevent PPCs in CABG patients. Specific information as to the optimal level of air volume needed on an individual basis could reverse lung impairments caused by decreased air volume in the lungs. In addition, such knowledge should foster quicker recovery of CABG patients by decreasing PPCs. Finally, patient and nurse outcomes of preoperative teaching could be measured quantitatively to see

if indeed preoperative patient teaching does make a difference despite preoperative risk factors.

CHAPTER 3

METHODOLOGY

Design for Data Collection

The study utilized an experimental 2x2 factorial parallel group design with pretest and posttest. The subjects in the study were randomized to the control or the experimental group following a parallel group design with random permutations of blocks of four (Dempsey & Dempsey, 1992; Fleiss, 1986). Working with this method, the statistician generated the tables containing the randomized assignment to the treatment groups and sealed them to assure confidentiality (see Appendix A). The investigator was given an envelope with the sealed randomized numbers, which were opened one by one only after a subject signed the informed consent form.

In this study, the patients having CABG or valve replacement surgery were recruited from the operating room surgery schedule. At that point, they had had a complete clinical evaluation by the cardiothoracic surgeon and their pulmonary function had been measured by the Pulmonary Department personnel and recorded on their charts. In addition, each patient had had his daily caloric intake, his ideal body weight, and his percentage above ideal body weight calculated by the dietitian.

Each patient's chart was carefully reviewed to see if he met the inclusion criteria. Those patients meeting the criteria were invited to participate in the study by the investigator. At that time, the purpose and the nature of the study were explained in

full. Those patients agreeing to participate and who met the inclusion criteria then signed the informed consent. A copy of the consent was given to the patient, and the original was placed with the new subject's chart. Following this, the subject opened his sealed randomized number for group assignment to the control or the experimental group.

The independent variable was the preoperative teaching intervention for the experimental group:

1. The experimental group members were taught breathing exercises through a 15-minute videotape detailing basic lung anatomy, atelectasis and pneumonia formation, techniques for coughing, and proper use of the incentive spirometer. The subjects were instructed to use the incentive spirometer at a minimal volume of 1000 mls 10 times in a row at hourly intervals for approximately 15 hours following extubation. Then the interval was lengthened to every two hours during the daytime and every four hours during the nighttime on the second and the third postoperative day. On the fourth and the fifth postoperative day, the subjects were instructed to use the incentive spirometer every four hours.

2. The subjects were also taught individualized target volume breathing exercises for the incentive spirometer. The calculated volume was 80% of their actual achieved forced vital capacity (not the ideally predicted volume), which was to be reached as quickly as possible postoperatively.

The dependent variables were (1) the levels of oxygen saturation measured by the pulse oximeter and (2) the lung air volume measured by pulmonary function tests: forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), and forced expiratory flow (FEF).

Setting

The study was conducted in the Cardiovascular Intensive Care Unit (CVICU) and the step-down unit for cardiac surgical patients at a 650-bed Veterans Affairs hospital in South Texas. The hospital is affiliated with a university; thus, it functions as a teaching institution.

The Cardiovascular Intensive Care Unit has a four-bed capacity designed for the acute care of CABG patients immediately postanesthesia. It is staffed by experienced critical care registered nurses who alternate between the adjacent Surgical Intensive Care Unit (SICU) and the CVICU. The CPB machine used during CABG surgery was the Cobe Optima Halobir Reverse Phase. The blood flow is delivered through a nonpulsatile centrifugal pump. It uses a membrane oxygenator for gas exchange. The monthly average for CABG surgery is 12 patients, and the average length of stay in the CVICU post-CABG is 72-hours. Most CABG patients are discharged home seven days after surgery.

Sampling and Sample

A power analysis determined the minimal sample size of 36 subjects was needed to detect the variables under investigation, but, since some attrition was expected, a total of 40 patients was sought to be evenly divided between the control and the experimental group (Hines, 1980; Munro, Visintainer, & Page, 1986; Nieswiadomy, 1993; Roberts & Burke, 1989). A total of 40 patients, mean age 65, met the following inclusion criteria and volunteered to participate:

1. Aged 50 to 80 years old.

2. Admitted for elective coronary artery bypass graft surgery or valve replacement surgery.

3. Forced vital capacity above 65% of predicted norm.

4. Weight not greater than 30% above ideal weight.

5. No previous history of cardiac or lung surgery.

6. Comprehension of spoken English.

The following exclusion criteria were utilized in the removal of subjects from the study following surgery:

1. Development of cardiac arrest during surgery or postoperatively.

2. Return to the operating room for surgical review of graft.

3. Reintubation and mechanical ventilation immediately or within 24 hours postextubation.

4. Mechanical ventilation for more than 24 hours due to pulmonary edema and fluid overload.

Protection of Human Rights and Ethics

The study was reviewed and approved by the Institutional Review Board of the University of the Incarnate Word in San Antonio, Texas, and the Institutional Review Board of the University of Texas Health Science Center in San Antonio, Texas. In addition, the study was approved by the Research and Development Committee and the Subcommittee on Human Studies at the federal institution prior to its implementation (see Appendix B). Furthermore, the informed consent followed the guidelines specified by all involved institutions.

The day prior to surgery, potential subjects were identified from the operating room surgical schedule as undergoing coronary artery bypass graft or valve replacement procedure. The

investigator gave each patient who qualified for inclusion in the study a careful verbal explanation of the purpose, the risks, and the demands of the study before asking him to sign the informed consent (see Appendix C). The subjects were assured confidentiality at all times. This was accomplished by the data-collection sheet identifying subjects not by name but rather by the random number provided by the statistician. Subjects were also informed that the study would not offer monetary or other remuneration for their participation.

The risks involved were minimal according to the review of the literature and the expertise of the cardiothoracic surgeon, Dr. L. Miller, and the pulmonary consultant, Dr. A. Anzueto (refer to Appendix B). However, the subjects were warned about the possibility of some lightheadedness and/or incisional pain or discomfort while doing the breathing exercises. The subjects experiencing incisional pain were medicated with an analgesic such as Tylenol #3 with codeine, and, prior to their pulmonary function tests, the subjects were evaluated for any discomfort or need for further pain medication.

All subjects were hemodynamically monitored throughout their CVICU stay. In the step-down unit, they continued to be monitored for cardiac dysrrhythmias by the floor telemetry unit. The researcher visited all the patients in the control and the experimental group daily to assure proper follow-up. Upon completion of the study, the researcher advised the control group regarding the members' optimum target volume breathing exercises for the incentive spirometer. In addition, these patients were encouraged to do breathing exercises at least four times a day for the next three months.

Instruments

The measurements of inspired and expired air volume from the lung, assessing the elasticity of the lungs, the diaphragm movement, and the chest wall compliance, were determined by pulmonary function tests using the Collins spirometer and the Respirodyne, a portable spirometer. The Collins spirometer was located in the pulmonary laboratory and was utilized to obtain the preoperative and the predischarge measurements of FVC, FEV_1, and FEF. The Respirodyne was used for bedside measurements of FVC, FEV_1, and FEF 24 hours after extubation. The Collins spirometer was calibrated daily by Respiratory Therapy personnel using a three-liter Hans Rudolph syringe according to standards. The Respirodyne was also calibrated daily with a three-liter syringe at room temperature by the Respiratory Therapy personnel (Ruppel, 1986).

In this study, the PFTs were obtained by the respiratory therapist, who was unaware of the subjects' group assignment. It was felt that this method would prevent bias in the therapist while he/she was coaxing the subjects to inhale and exhale as much air as possible. When performing the PFTs, the research subjects were seated in an upright position. The best out of three trials was recorded for each subject for statistical analysis.

The norms used to predict and compare the research subjects' PFT values on the Collins spirometer were derived from Morris, Koski, and Johnson's (1971) article, "Spirometric Standards for Healthy Nonsmoking Adults." This study measured lung volumes in 988 healthy nonsmoking adults, aged 20 to 84 years old, with limited exposure to air pollution.

Another biophysiological instrument used in the study to measure oxygen saturation was the pulse oximeter. The pulse

oximeter, a noninvasive spectrometric instrument, provides a continuous read-out of oxygen saturation. The accuracy and precision for oxygen saturation measurements ranges between 70% and 100%, with a variance of 3 mmHg to 5 mmHg; 95% is considered normal. The pulse oximeter has a r=.98 correlation when compared to oxygen saturation values obtained using arterial blood gases analysis (Peters, Caulfield, Schultz, Miller, & Larson, 1990; Yashiya, Shimada, & Tanaka, 1980; Yelderman & New, 1983). The instrument is calibrated at the factory. However, a display of three asterisks in the monitor must be present at all times. The asterisks indicate how well the light is transmitted and reflected. The finger probe or the ear clip of the pulse oximeter was repositioned if the three asterisks were not present or the fail alarm went off. In addition, the Biomedical Department checked the pulse oximeter for proper sensitivity and functioning.

Based on knowledge from the review of the research literature, the investigator conceptualized and developed a 15-minute videotape providing instruction on preoperative breathing exercises. Since preoperative teaching at this level was not available at the institution, she utilized two nurses in the step-down medical-surgical unit. One of them assisted with the artistic graphics and slides, and the other helped with the computer format and the level of education, which was simplified to a fourth-grade reading level. Then the videotape was revised and approved by an expert panel of nurses on the Nursing Education Committee at the federal facility. Furthermore, the videotape was submitted to a pilot study and evaluated for clarity, overall understanding, and clearness of explanation for coughing exercises, use of incentive spirometer, and percentage of oxygen saturation by pulse oximeter. The pilot study utilized 10

surgical patients in the postoperative period while in the surgical intensive care unit.

The evaluation results were very encouraging. The SICU staff nurses reported the patients' self-motivation in coughing and proper use of the incentive spirometer to a maximum level without the nurses' encouragement to do the breathing exercises. In addition, their oxygen saturation on the monitor was seen to remain at 95% to 100%. Patients were observed to work hard if their oxygen saturation level went below 95% as instructed by the researcher during the preoperative teaching and the return demonstration the day before surgery. The patients' comments reflected that the teaching had helped them to understand the importance of performing the breathing exercises following surgery in order to prevent the complications of pneumonia and other conditions.

Once the preoperative teaching was approved, the researcher gave a series of inservices to the surgical intensive care nurses (N=35) in the research setting about the nature of the study: the pathogenesis of atelectasis, the proper techniques to utilize, and the minimal volumes to be reached on the incentive spirometer postoperatively. At the end of the presentation, the critical care nurses were invited to collaborate in the data collection as research assistants. A good deal of enthusiasm was generated since the nurses would be given credit for research participation on their yearly proficiency evaluation.

Data-Collection Procedure

After obtaining the name of the patients scheduled for coronary artery bypass graft or valve replacement procedure from the surgery schedule and determining those who met the inclusion

criteria, the researcher approached the patients one by one and solicited their participation in the study. Once a patient had agreed to participate in the study, the researcher began to fill out the data-collection instruments (see Appendix D), the first of which was divided into five parts: (1) subject demographics, (2) preoperative data, (3) perioperative data, (4) postoperative data, and (5) oxygen saturation level 24 hours after extubation.

Preoperatively, both groups received the Patient Handbook on Cardiac Surgery, which offers a brief explanation of the anatomy of the heart and the pathophysiology of coronary artery disease, angina, etc. It also describes the feelings and sensations before and after CABG/valve replacement surgery, the intubation procedure, the SICU environment, the length of hospital stay, etc. However, the handbook contains very little information on breathing exercises.

The researcher instructed the members of both groups to request pain medication when needed to reduce pain or discomfort while doing their breathing exercises. At this federal institution, all cardiac surgical patients receive 40% oxygen by face mask immediately after extubation. Then they are placed on three liters of oxygen by nasal cannula while eating or doing breathing exercises. If a patient's oxygen saturation is greater than 95%, he/she remains on three liters of oxygen by nasal cannula. Patients are allowed to get out of bed and sit in a chair as much as tolerated.

Specific preoperative teaching for the two groups (control and experimental) included the following. The control group received the institution's standard preoperative teaching, which included the Patient Handbook on Cardiac Surgery. The control subjects were expected to read the book on their own. However, some subjects were motivated to read their books while others were

not. In addition, based on the nurse's expertise and workload, some subjects may or may not have received further training in breathing exercises: coughing, deep-breathing, and proper use of the Voldyne (disposable incentive spirometer). The subjects were not informed of the minimum target air volume to be achieved on the incentive spirometer postoperatively.

After extubation, each control subject was asked to take 10 breaths on the incentive spirometer at whatever volume he was able to reach. The breathing exercises were on an hourly basis during the daytime and every two hours during the night the first 24 hours after extubation. After transfer to the step-down unit, the subjects followed the instructions given by their physician, which included hourly incentive spirometry while awake. Compliance with the regimen was not always achieved by all the control patients.

A structured preoperative teaching on target volume breathing exercises was given to the experimental group. The night before surgery, the subjects viewed a 15-minute videotape presentation on the breathing process with instruction on target volume breathing of at least 1000 cc on the incentive spirometer (vicarious experience). In agreement with Bandura's (1977) theory, the videotape, using the cognitive process, offered verbal persuasion and role-modeling. The experimental subjects learned how to:

1. Cough at least three times, splinting the sternum with a pillow. The patients were instructed to cough postoperatively only if they felt that they had secretions.

2. Achieve sustained maximal inspiration (SMI), 10 times each time, by making a maximal inspiratory effort through the mouth, holding the air in for at least three seconds, and then releasing the air slowly through pursed lips.

3. Use the incentive spirometer to the highest air volume (2400 cc to 4500 cc). The subjects practiced the way to achieve 80% of their preoperative FVC. This volume was calculated in accordance with Latimer et al.'s (1971) correlations that an 88.1% preoperative FVC coincided with normal patients who prevented PPCs. Dekhuijzen et al. (1991) trained COPD patients to reach a 70% maximum inspiratory effort, which resulted in a significant improvement in their inspiratory effort. Thus, CABG patients were individually informed of the need and trained to reach 80% of their preoperative FVC in the postoperative period. Furthermore, the subjects were taught to observe and maintain an oxygen saturation greater than 95 mmHg on the monitor by using the incentive spirometer or performing SMIs.

4. Return demonstration of breathing exercises and exhibit performance accomplishment of behaviors at the end of the presentation. The investigator enhanced and reinforced the learned behaviors by monitoring the practice performance of coughing and obtaining sustained maximum inspiration preoperatively and postoperatively. It was hoped that the teaching program would decrease fear and anxiety (emotional arousal) and promote self-confidence and self-efficacy.

Postoperatively, immediately after extubation, the subjects in the experimental group were asked to cough. Then, with the oxygen face mask on, they performed 10 SMIs in a row. One hour after extubation, the subjects started using the incentive spirometer, utilizing it 10 consecutive times every hour during the daytime and every two hours during the nighttime for the first 24 hours after extubation. The air volume goal was set at 1000 mls on the incentive spirometer. Subjects were encouraged to reach this goal or higher, if tolerated. It was up to each

subject's tolerance to increase his/her goal toward the predicted 80% of preoperative FVC.

The second and the third day postextubation, the subjects used the incentive spirometer every two hours during the daytime and every four hours during the nighttime. On the third through the fifth postoperative day, the subjects used the incentive spirometer four times a day and at night when awake. The breathing exercises were performed in a seated position with the knees flexed to avoid discomfort. While in the CVICU, the investigator or a research associate provided guidance on the performance of the desired exercises according to protocol. In the step-down ward, subject, family, and nurse were responsible for following the written instructions as to when to perform the target volume breathing exercises.

The pulmonary function tests of forced vital capacity, forced expiratory volume in one second, and forced expiratory flow were obtained preoperatively at the pulmonary testing center. Then, the 24-hour postextubation PFTs were obtained at the patients' bedside by the respiratory therapist using the Respirodyne. The final PFT measurements were obtained on the fourth or the fifth postoperative day. Originally, all measurements were planned for the fifth day. However, this was altered for two reasons: First, some patients were ready for discharge on the fourth day and there was no reason to keep them in the hospital any longer, particularly on a weekend. Second, the study facility's pulmonary laboratory is closed on Saturdays and Sundays. For the purposes of this study, however, the term fifth postoperative day was utilized.

Arterial oxygen saturation percentage was obtained preoperatively and predischarge by the respiratory therapist in the pulmonary laboratory. Hourly measurements postextubation were

obtained from the monitor by the critical care nurse (research associate). The values were obtained before and 30 seconds after using the incentive spirometer 10 times. To insure accuracy and precision of the instrument, the oxygen saturation values obtained by the pulse oximeter were compared to those obtained by arterial blood gases (ABGs) analysis (DeKeyser & Pugh, 1991). A set of ABGs was routinely sent to Anesthesia for all cardiac surgical patients 30 minutes past extubation. A difference of 3% in oxygen saturation was considered acceptable in accordance with the review of the literature (Peters et al., 1990; Yashiya et al., 1980; Yelderman & New, 1983).

The type of graft used, i.e., internal mammary artery, saphenous vein, or both, was obtained from the subject's operating room record. This variable was difficult to randomize because the decision as to which blood vessel to use was made based on the patency of the blood vessel during surgery.

Subject demographics (age, sex, weight, percentage above ideal body weight [added], height [added], race, smoking history [last time smoked and number of cigarettes smoked per day) were obtained. A brief medical and surgical history was also obtained.

Preoperative data included information on the subjects' ejection fraction, oxygen saturation, and study group (control or experimental). The values of the subjects' predicted FVC, FEV_1, and FEF were recorded. The patients' actual achieved PFTs and percentage from the normal obtained were automatically calculated by the Collins spirometer.

Perioperative data collected included date and type of cardiac surgery, graft used, length of surgery, bypass time, and cross-clamping time for the major blood vessels. Postoperative data collected included 24-hour postoperative measurements of PFTs

using the Respirodyne and percentages of preoperative values achieved, which were calculated by Respiratory Therapy personnel.

An additional data-collection record (refer to Appendix D) was used to record the incentive spirometry volumes achieved by both groups during the first 24 hours following surgery and extubation. During the daytime, the subjects were scheduled for hourly incentive spirometry for approximately 15 hours, and, during the nighttime, every two hours. The same data-collection record included the oxygen saturation measurements before and after incentive spirometry.

A high level of coordination and cooperation was established between the Chief of the Pulmonary Department and the Chief of Respiratory Therapy and the researcher for obtaining the PFT measurements with the portable Respirodyne 24 hours postextubation and 96 hours following surgery. A consultation was sent to Respiratory Therapy specifying the dates and the type of measurements to be obtained on each research subject.

Analysis of Data

Statistical analysis of the data was accomplished using a two-way analysis of variance (ANOVA) for a 2x2 factorial parallel group design. The type of data was nominal and interval. Factor A, preoperative teaching, had two levels; (1) the control group receiving the standard preoperative teaching and (2) the experimental group receiving preoperative teaching on breathing exercises and on target air volume breathing exercises. Factor B was the graft type: (1) a saphenous vein or graft or (2) an internal mammary artery graft.

The effects of the independent variable, which was breathing exercises and target volume breathing exercises, were examined to

determine the differences between and within groups and to discern the interactions between groups (Fleiss, 1986). The level of significance for alpha was set at 0.05 while beta was set at the 0.20 level (Polit & Hungler, 1991; Roberts & Burke, 1989).

A power analysis was carried out to calculate the needed statistically significant level for differences between the lung volumes and the type of graft. The power analysis for oxygen saturation as a measurement of preoperative teaching was limited because the direction of change was unknown at that time. The ANOVA simultaneously determined if there were statistically significant differences between the control and the experimental group in terms of forced vital capacity, forced expiratory volume in one second, forced expiratory flow, and oxygen saturation. In addition, the ANOVA tested the variability within the groups by graft type and oxygen saturation.

CHAPTER 4

ANALYSIS OF DATA

This chapter discusses the findings of the data analysis. The independent variable in this investigation was the teaching of target volume breathing exercises to patients undergoing coronary artery bypass graft or valve replacement surgery. The aim of the study was to determine whether or not the teaching of target volume breathing exercises had any effect on the dependent variables of oxygen saturation and pulmonary function test results. The pulmonary function tests measured were forced vital capacity, forced expiratory volume in one second, and forced expiratory flow. The results of the data analysis are presented and limited to the effects on these variables. The findings of the study are addressed according to each hypothesis.

Description of the Sample

The characteristics of the sample included a 70% or greater occlusion of major coronary arteries or malfunctioning valves as a result of arteriosclerosis. All the sample members were victims of the effects of coronary artery disease and had developed symptoms such as angina, shortness of breath, and, to some extent, hypertension and chronic obstructive pulmonary disease as a result of their long history of smoking tobacco. The main reason for having coronary artery bypass graft or valve replacement surgery is to relieve the discomfort of angina and reduce the potential

for morbidity and mortality associated with coronary artery disease.

A total of 40 patients were enrolled in the study, but only 34 subjects completed the protocol. The demographic characteristics of the sample are shown in Table 1. Six of the subjects did not complete the study for the following reasons: One of them was returned to the operating room for exploration of a bleeding graft, a second patient had a stroke, and the third patient remained in a daze for several days and was unable to follow any directions. A fourth patient became very agitated and confused, requiring a high level of sedation, which prevented him from performing any type of breathing exercises. The fifth patient was discharged without his last set of PFTs. (It was to prevent this incident from recurring that the tests were changed to the fourth day.) The sixth patient's data were not completed at the time of the data analysis.

The control and the experimental group were found to be homogeneously distributed (according to a statistical t-test analysis) on the following parameters: The average age was 65 years old with a 32% higher incidence of surgery in the elderly, aged 71-77 years. The race distribution by group (control and experimental) is depicted in Table 2. The smoking history of the veterans ranged from nonsmoking to light and heavy smoking (20-100 cigarettes a day) The average weight was 179.9 pounds, with an even distribution in the 30% above ideal body weight. The height and ejection fraction were equivalent in both the control and the experimental group.

The specific preoperative dependent variable of oxygen saturation averaged 94.9% (N=34, SD=2.05, range: 93%-98%). The other preoperative dependent variable was the pulmonary function tests, which included forced vital capacity, forced expiratory

Table 1

Demographic Characteristics of Sample (N=34)

Characteristic	Number	Percent	Range	Mean	SD
Sex					
Male	34	100.0			
Female	0	0.0			
Age			50-77 years	65 years	8.330
50-55 years	6	17.6			
56-60 years	4	11.8			
61-65 years	7	20.6			
66-70 years	6	17.6			
71-77 years	11	32.4			
Smokers			20-100 cigarettes	2.5 packs/day	
Nonsmokers	7	20.0			
Smokers	27	47.0			
Smoked preoperative day	7	20.0			
Weight			130-259 pounds	179.9 pounds	19.094
Height				68 inches	
Ejection fraction			21%-75%	56.53%	18.460
Race					
Non-Hispanic White	15	50.0			
Hispanic	11	37.0			
Black	4	13.0			

Table 2

Race/Ethnic Distribution by Group

Group	Non-Hispanic White		Hispanic		Black		Total
	Number	Percent	Number	Percent	Number	Percent	
Control	8	57.14	4	28.57	2	14.29	14
Experimental	7	43.75	7	43.75	2	12.50	16
Total	15		11		4		30

flow in one second, and forced expiratory flow (see Table 3). All pulmonary functions tests--FVC, FEV_1, and FEF--were similar in both groups.

The majority of the sample (88%) had a coronary artery bypass graft versus a small number (11%) who had valve replacement surgery. See Table 4 for type of surgery and number of grafts used. Most of the CABG grafts utilized both the internal mammary artery and the saphenous vein as a graft conduit (n=22, 64%). There was a limited but equal percentage of subjects who had an internal mammary artery graft or a saphenous vein graft exclusively. The most frequent number of coronary artery blood vessels grafted was three (n=13, 38%).

The length of surgery averaged 4.35 hours, and, on the average, subjects stayed in extracorporeal circulation using the cardiopulmonary pump for 1 hour 80 seconds. The cross-clamping and ischemic time ranged from 38 to 171 minutes. The subjects' average length of time in the CVICU was 48 hours after surgery. Then they were transferred to telemetry in the step-down unit.

Findings

The purpose of this investigation was to determine whether or not preoperative teaching of individualized target volume breathing exercises is effective in decreasing postoperative pulmonary complications of lung air volume reduction and hypoxemia in coronary artery bypass graft/valve repair surgical patients. The data analysis was performed by a statistician utilizing the Statistical Analysis System (SAS 6.1).

A two-way factor analysis of variance (ANOVA) was used to test the three hypotheses in order to determine if target volume breathing exercises were more effective than the standard

Table 3

Preoperative Dependent Variables of Forced Vital Capacity, Forced Expiratory Volume in One Second, and Forced Expiratory Flow

Mean Volume Predicted Norm	Mean Achieved Volume	Percent Volume from Predicted Norm	SD
FVC=4.24 liters	4.70 liters	86%	12.30
FEV_1=2.91 liters	2.62 liters	90%	4.23
FEF=8.49 liters	7.54 liters	88%	25.40

preoperative teaching as a means of reducing postoperative pulmonary complications as evidenced by examining the differences obtained in forced vital capacity, forced expiratory volume in one second, and forced expiratory flow. In addition, the ANOVA measured the effects of the interaction of the independent variable at other levels, such as graft site and oxygen saturation. The levels of significance were set for alpha = 0.05 and beta = 0.20.

Hypothesis 1: Preoperative lung air volumes will be greater for patients receiving a structured preoperative teaching regimen including target volume breathing exercises, persuasive information, and modeling than for patients receiving only standard preoperative teaching.

The lung air volumes for FVC, FEV_1, and FEF were measured with the Collins incentive spirometer and the Respirodyne 24 hours extubation and on the fourth/fifth postoperative day. The best effort of three trials was recorded by the respiratory therapist. The measurements of forced vital capacity preoperatively, 24 hours postoperatively, and 5 days postoperatively are listed in Table 5 and graphically depicted in Figure 1. There was a statistically significant difference 24 hours postextubation in the mean percentage of predicted FVC=17.59%: (SD=12.37) (F[1,45]=5.18, P=0.0267). The measurements on the fifth day postoperatively showed a difference of 6.95% from the original preoperative mean difference of 4.18, which was not statistically significant (P=0.1575). However, clinically, the experimental patients felt better (see Discussion of Findings below).

Table 6 and Figure 2 depict the overall effects of target volume breathing exercises on forced expiratory volume in one second preoperatively, 24 hours postextubation, and 5 days postoperatively. The effects of target volume breathing exercises

Table 5

Mean Differences of Forced Vital Capacity Preoperatively, 24 Hours Postoperatively, and 5 Days Postoperatively for Control and Experimental Group

	Control (N=16)		Experimental (N=18)			
Forced Vital Capacity	Achieved	Percent Predicted	Achieved	Percent Predicted	Percent Mean Difference	p
Preoperatively	3.47	82.68	3.70	86.86	4.18	0.5274
24 hours post-operatively	1.31	31.34	2.01	48.93	17.59	0.0267
Mean difference	2.16	51.34	1.69	38.93		
5 days post-operatively	2.14	51.09	2.48	58.04	6.95	0.1575
Total difference	1.33	31.59	0.22	18.82		

FIGURE 1. **Effect of Training on FVC**

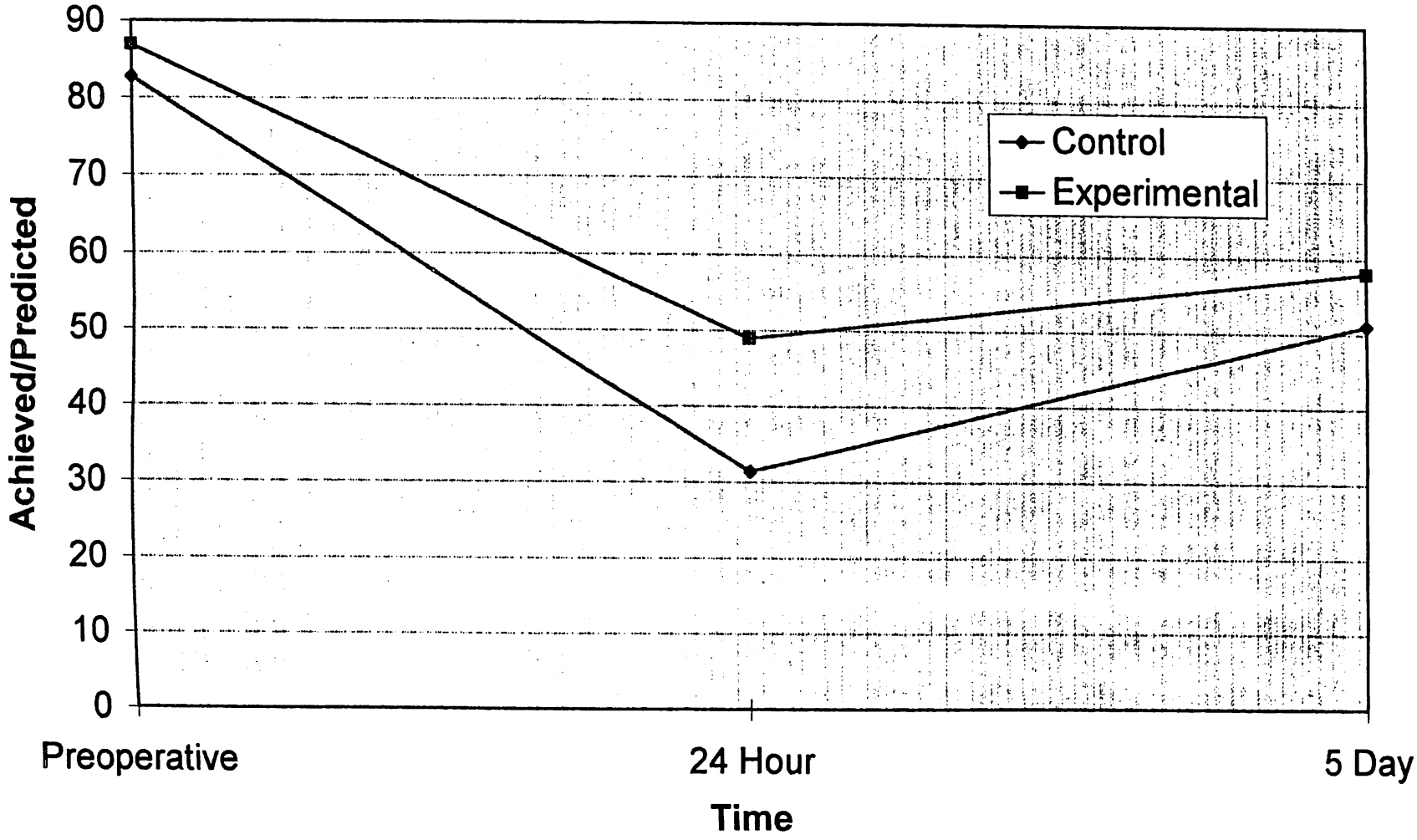
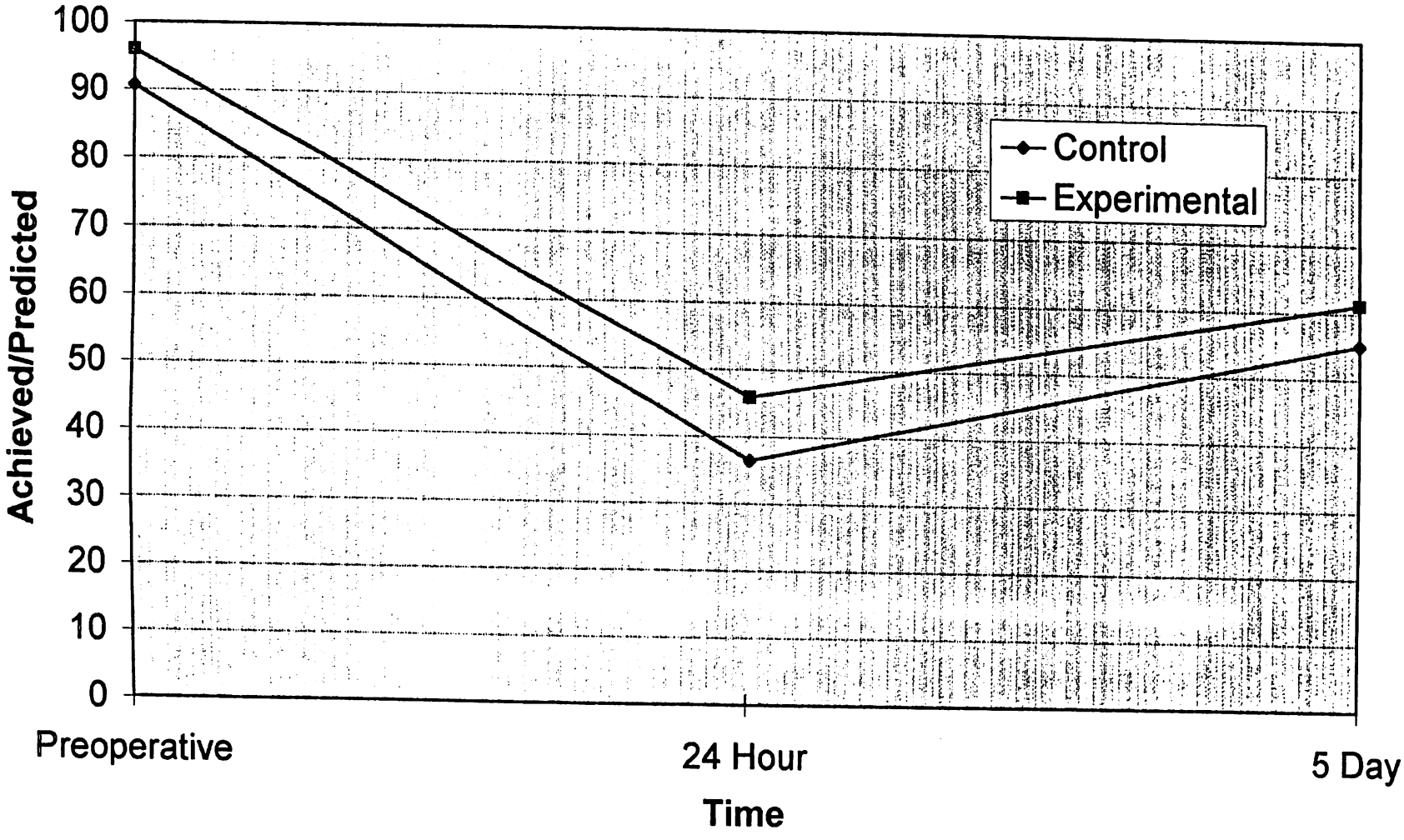


Table 6

Forced Expiratory Volume in One Second Mean Differences Preoperatively, 24 hours Postoperatively, and 5 Days Postoperatively for Control and Experimental Group

Forced Expiratory Volume In One Second	Control (N=16)		Experimental (N=18)			
	Achieved	Percent Predicted	Achieved	Percent Predicted	Percent Mean Difference	p
Preoperatively	2.62	90.65	3.70	86.86	3.79	0.4141
24 hours post-operatively	1.05	36.42	1.3	45.90	9.48	0.1832
Mean difference	1.57	54.23	2.39	40.96		
5 days post-operatively	1.59	55.19	1.77	61.20	6.01	0.4905
Total difference	1.03	45.46	1.93	25.66	-2.22	

FIGURE 2. **Effect of Training on FEV_1**



on forced expiratory volume in one second 24 hours postextubation was not statistically significant. The mean difference was 9.48% (percent FEV_1 predicted = 45.9%, SD=18.94, [F(1,57), F=1.82, P=0.1832]). On the fifth day postoperatively, the differences were not statistically significant (F[1,57], F=0.48, P=0.49), as shown in Table 6 and Figure 2.

The last component of the PFT analysis was the mean forced expiratory flow. The preoperative values were compared to those values obtained 24 hours postextubation and 5 days postoperatively. These findings are summarized in Table 7 and graphically depicted in Figure 3. The ANOVA 24 hours postextubation showed a mean difference of 13.91% (mean percent FVC=74.93%, SD=32.79) (F[1,56], F=1.73, P=0.19), which was not statistically significant. At the fifth day postoperatively, the experimental group had a mean difference of 3.93% from 2.13% preoperatively (F[1,56] = 0.07, P>0.79). Figure 3 illustrates a spring-like effect for the experimental group 24 hours postextubation which continued to the fifth day postoperatively.

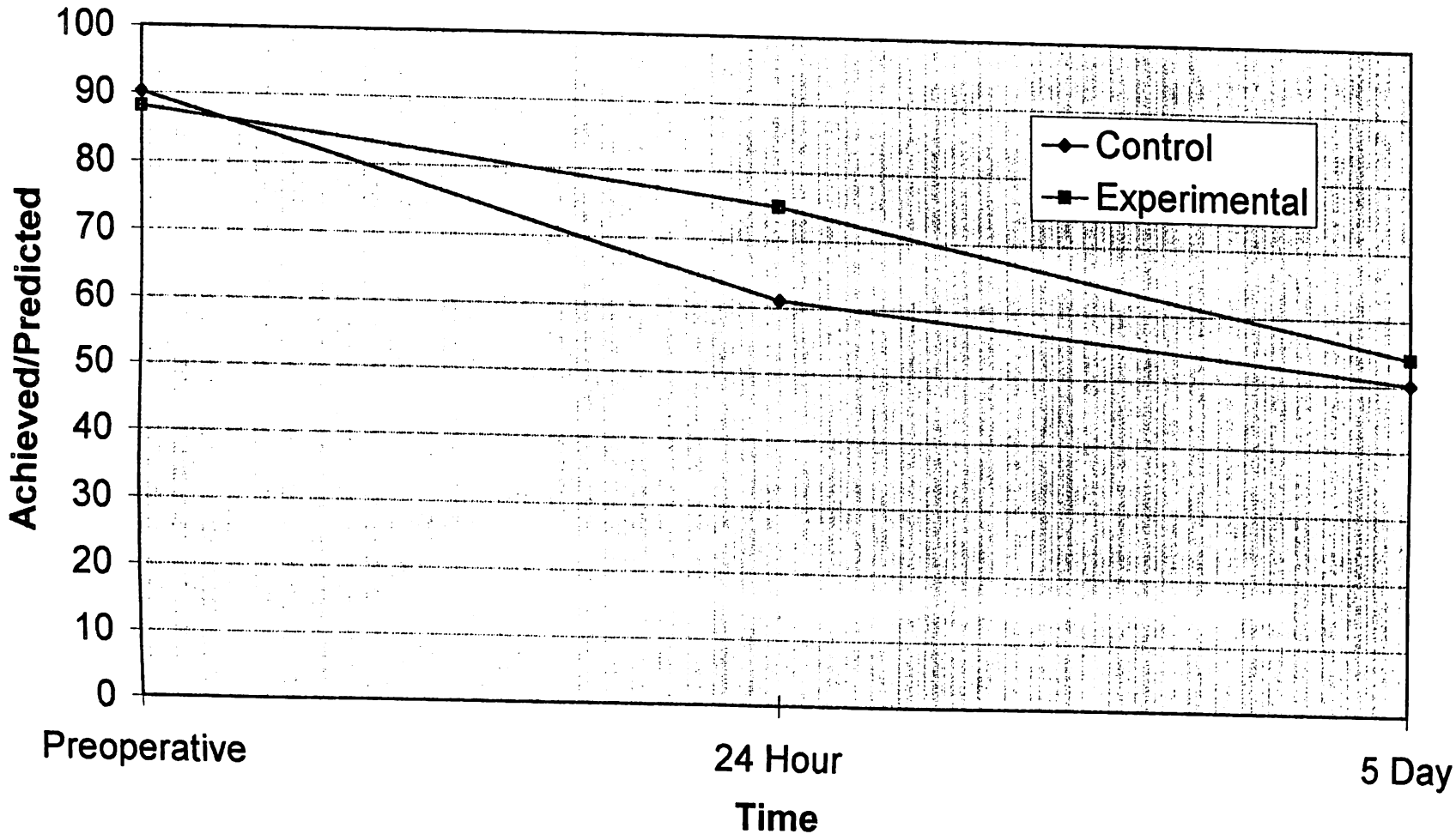
After a careful analysis of the quantitative data, hypothesis #1 was supported by the findings 24 hours postextubation, but the data reported on the fifth day postoperatively were not significant. The hypothesis states that postoperative lung air volumes will be greater for patients receiving structured preoperative teaching including target volume breathing exercises, persuasive information, and modeling than for patients receiving only standard preoperative teaching. The members of experimental group receiving the teaching of target volume breathing exercises were able to expand and inflate their lung volume at a higher capacity 24 hours after extubation. Overall, the experimental group exhibited a difference of 18.82%

Table 7

Forced Expiratory Flow Mean Differences Preoperatively, 24 Hours Postoperatively, and 5 Days Postoperatively for Control and Experimental Group

Forced Expiratory Flow	Control (N=16) Achieved	Control (N=16) Percent Predicted	Experimental (N=18) Achieved	Experimental (N=18) Percent Predicted	Mean Percent Difference	p
Preoperatively	7.51	90.15	7.54	88.02	2.13	0.8295
24 hours post-operatively	5.06	61.02	6.32	74.93	13.91	0.1938
Mean difference	2.45	29.13	1.22	13.09		
5 days post-operatively	4.14	50.17	4.68	54.10	3.93	0.7989
Total difference	3.37	39.98	2.86	23.92		

FIGURE 3. **Effect of Training on FEF**



less baseline reduction versus a 31.59% higher reduction for the control group on the fifth postoperative day.

Hypothesis #2: Pulmonary function in patients receiving an internal mammary artery graft will be decreased in comparison to those receiving a saphenous graft regardless of teaching methodology.

The pulmonary functions test scores of FVC, FEV1, and FEF of patients receiving an internal mammary artery graft were measured preoperatively, 24 hours postextubation, and 5 days postoperatively. The 24 hours extubation FEV_1 measurement showed a dramatic reduction for internal mammary artery graft patients (n=5)(F[a,26], F=5.84, P=0.02), which was greater and statistically significant when compared to the saphenous vein graft patients (n=5) (F[1,26], F=4.01, P=0.05). Both groups seemed to stabilize at the fifth day postoperatively, with total reductions in FEV_1 (F[2,49], F=0.10, P=0.90) for the internal mammary artery graft patients and (F[2,49], F=0.46, P=0.63) for the saphenous vein graft patients. These findings were not statistically significant at the fifth day. However, the hypothesis that the pulmonary function in patients receiving an internal mammary artery graft would be decreased in comparison to those receiving a saphenous vein graft regardless of teaching methodology was supported.

Hypothesis #3: Percentages of oxygen saturation measured by the pulse oximeter will not differ between the experimental and the control group.

The percentages of oxygen saturation (SaO_2) were measured by the pulse oximeter preoperatively. Postextubation measurements were hourly before and after 10 rows of deep-breathing in the incentive spirometer for the first 17 hours. At night, the measurements were done every two hours while the patients were on

3 liters of oxygen by nasal cannula until they were transferred to the ward (see Table 8 and Figure 4 for overall mean differences). There was a statistically significant difference for the experimental group before incentive spirometry: SaO_2 = 96.09 (F[1,79], F=4.05, P=0.0475) during the first 24 hours postextubation. This means that the control group patients had a lower percentage of oxygen saturation while the experimental group patients significantly improved their percentage of oxygen saturation during the first 24 hours postextubation. The experimental group saturation level remained constant. Both groups returned to their preoperative baseline oxygen saturation level, which was slightly below 95%. The null hypothesis #3, which stated that the percentages of oxygen saturation measured by the pulse oximeter would not differ between the experimental and the control group, was rejected during the first 24 hours, meaning that the teaching method made a difference by improving the level of oxygen saturation for the experimental group. However, both groups returned to their baseline oxygen saturation at the fifth postoperative day.

Additional Findings

The effects of self-efficacy in performing target volume breathing exercises was analyzed in terms of volumes reached on the incentive spirometer (IS) during the first 24 hours postextubation to see if there were any differences between groups. The control group achieved IS=1067 mls of air (SD=357.47, range: 250-2500) while the experimental group volume reached IS=1293.01 mls (SD=562.16, range: 500-3000 mls). The mean difference between groups was 208.69 mls IS volume (F[16,15), F=2.53, P=0.07).

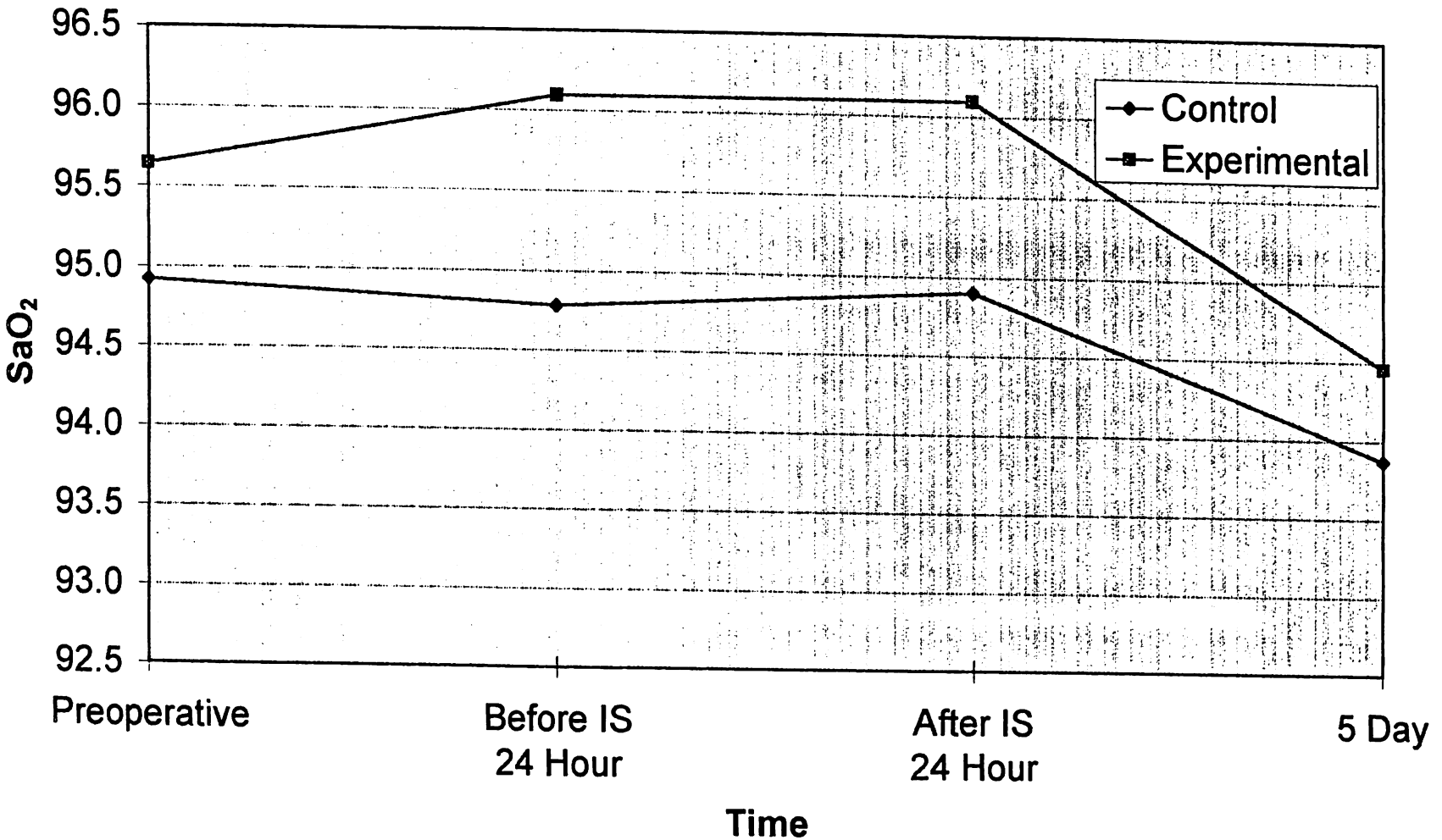
Table 8

Percentage Oxygen Saturation before and after 10 Rows of Incentive Spirometry

Time	Control (N=16)	Experimental (N=18)	p
Preoperative	SaO_2=94.92%	SaO_2=95.46%	0.3639
Postoperative extubation	Pre-IS=94.70%	Pre-IS=96.09%	0.0475
24 hours post-operatively	Post-IS=94.90%	Post-IS=99.09%	0.1260
5 days post-operatively	Post-PFTs=93.75%	Post-PFTs=93.98%	0.8697

SaO_2--Oxygen saturation
IS--Incentive spirometer
PFT--Pulmonary function test

FIGURE 4. **Effect of Training on Oxygen Saturation**



Although not statistically significant, the experimental group was able to achieve a volume of 208.69 mls higher on the incentive spirometer than the control group during the 24 hours postoperatively. Figure 5 depicts the deep breath volumes reached on the incentive spirometer. The large drop at the eighteenth postoperative hour coincided with sleep times (11:00 p.m. to 5:00 a.m.) in both groups while the high range volumes on the incentive spirometer coincided with high levels of oxygen saturation in the experimental group (refer to Table 8).

Another interesting finding was the combined utilization of internal mammary artery and saphenous vein for coronary artery bypass graft in the veteran population (see Table 9). The percentage was equally divided between control and experimental group. The overall total reduction for FVC from the preoperative period to the fifth day postoperatively for the control group was higher (31.58%) versus a lower reduction rate (18.81%) for the experimental group. The FEV_1 level was similar for both groups (C=35.57% versus E=34.74%). The FEF was higher for the control group (39.98% versus E=33.91), which was discussed under clinical findings.

An analysis of the effects of target volume breathing in the experimental group demonstrated a maximal improvement in the percentage of FVC reduction to 3% versus a 19-33% reduction reported in the literature (Berrizbeitia et al., 1989). This was due primarily to subject #7, who was a 75-year-old male undergoing four grafts using both the internal mammary artery and the saphenous vein, was considered a high risk due to his reduced preoperative FVC of 67%. His PFT score on the fifth day postoperatively was 64%. The experimental group had a 17% (n=6) reduction below the 20% preoperative FVC. The range of reductions was 3% to 48%. The control group had a minimal improvement of

FIGURE 5. **Effect of Training on Incentive Spirometry Volume Achieved**

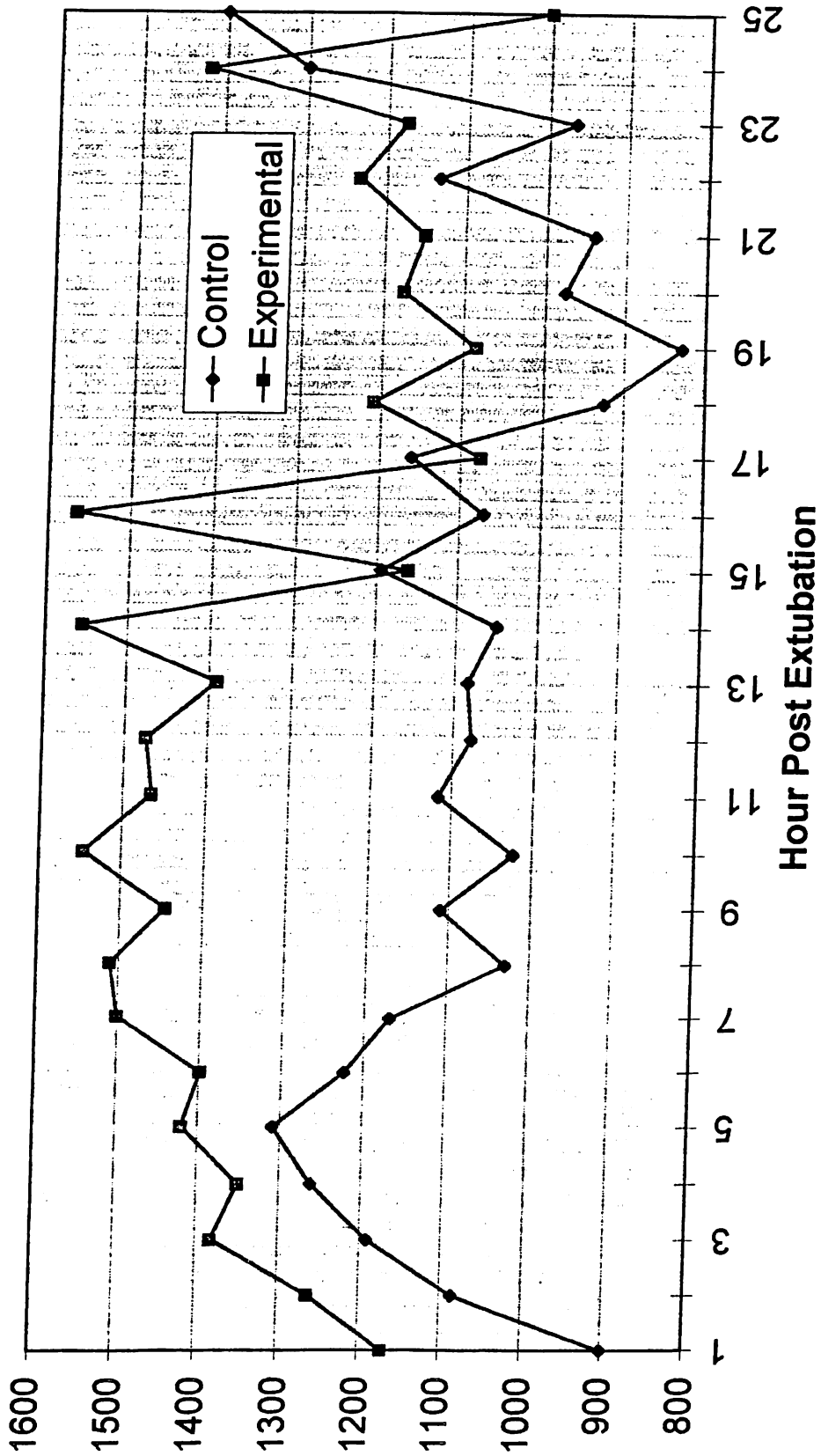


Table 9

Combined Use of Internal Mammary Artery and Saphenous Vein for Grafts

Time	Control (N=22)			Experimental (N=22)		
	Percent			Percent		
	FVC	FEV_1	FEF	FVC	FEV_1	FEF
Preoperatively	82.68	90.66	90.16	86.86	95.94	88.02
24 hours post-operatively	31.35	36.42	61.02	48.93	45.90	61.20
Mean difference	51.33	54.24	20.14	37.93	50.04	26.82
5 days post-operatively	51.1	55.09	50.18	58.05	61.20	54.11
Total difference from preoperative score	31.58	35.57	39.98	18.81	34.74	33.91

FVC--Forced vital capacity
FEV_1--Forced expiratory volume in one second
FEF--Forced expiratory flow

only 2.9% (n=3) below the 20% FVC. The range of reduction fluctuated from 14% to 61%, higher than that for the experimental group. The experimental group had a 15% rate of postoperative PPCs versus a 28% rate of PPCs for the control group.

Summary of Findings

Based on the analysis of data, the findings are summarized in the following expressions (see Table 10):

Hypothesis #1--Postoperative lung air volumes will be greater for patients receiving a structured preoperative teaching regimen including target volume breathing exercises, persuasive information, and modeling than for patients receiving only standard preoperative teaching--was statistically significant at 24 hours postextubation but not significant at the fifth day postoperatively.

Hypothesis #2--Pulmonary function in patients receiving an internal mammary artery graft will be decreased in comparison to those receiving a saphenous graft regardless of teaching methodology--was supported by the results of the study.

Hypothesis #3--Percentage of oxygen saturation measured by the pulse oximeter will not differ between the experimental and the control group--was rejected by the data collected at 24 hours postextubation. However, it was supported by the data collected on the fifth day postoperatively.

Table 10

Summary of Anlysis of Variance for Variables: FVC, FEV_1, FEF, and SaO_2

Item	Percent Mean	NDF	DDF	F	p
FEV					
Preoperatively	86.86	16	15	1.39	0.5274
24 hours post-operatively	17.59	1	56	5.18	0.0267
5 days post-operatively	6.95	1	56	2.05	0.1575
FEV_1					
Preoperatively	90.0	1	57	0.68	0.4141
24 hours post-operatively	36.0	1	57	1.82	0.1832
5 days post-operatively	51.0	1	57	0.48	0.4905
FEF					
Preoperatively	90.15	1	56	0.05	0.82
24 hous post-operatively	74.93	1	56	1.73	0.19
5 days post-operatively	54.10	1	56	0.07	0.79
SaO_2					
Preoperatively	94.92	1	79	0.83	0.3637
24 hours post-operatively	96.09	1	79	4.05	0.0475
5 days post-operatively	94.46	1	79	0.03	0.8697
IS volume	1293.01 mls	16	15	2.53	0.0700

FEV--Forced vital capacity
FEV_1--Forced expiratory volume in one second
FEF--Forced expiratory flow
SaO_2--Oxygen saturation
IS--Incentive spirometer

CHAPTER 5

CONCLUSION

Discussion of Findings

The results of this study describe the effects of teaching target volume breathing exercises preoperatively as a means of reducing postoperative pulmonary complications in patients undergoing coronary artery bypass graft or valve replacement surgery. The sample was composed of 34 males aged 50 to 79 years old who had CABG/valve repair surgery at the South Texas federal institution at which the study took place. The research design was experimental, and the subjects were randomly assigned to the control or the experimental group following a two factorial parallel group design.

The lung air volume capacity was measured by the pulmonary function tests of forced vital capacity, forced expiratory volume in one second, and forced expiratory flow preoperatively, 24 hours postextubation, and 5 days postoperatively. The level of hypoxemia was determined by measurement of oxygen saturation using a pulse oximeter. The scores were obtained preoperatively on room air, at hourly intervals over a 24-hour period postextubation before and after taking 10 deep breaths using the Voldyne incentive spirometer to a maximal full capacity while on 3 liters of oxygen by nasal cannula, and on the fifth day postoperatively on room air.

The sample had all the risk factors related to postoperative pulmonary complications in patients undergoing coronary artery

bypass graft/valve replacement surgery, which are age, chronic obstructive pulmonary disease, obesity, surgical division of the sternum, mechanical bisection of the internal mammary artery, lung deflation, use of the cardiopulmonary bypass machine, and ischemic time (Mathay & Weiner-Kronish, 1989). The literature provides information on the drastic physiological changes leading to PPCs after this type of surgery. However, there is a limited knowledge of specific methods for preventing or ameliorating PPCs in this population.

The experimental group patients viewed a videotape on the basics of lung anatomy, atelectasis formation, and decrease in the lung's inflating capacity. They were taught how to decrease these problems by sustained maximal inspiration using the incentive spirometer. The subjects were also taught to achieve their highest possible volume. Finally, they practiced how to achieve a minimum of 1000 mls to a maximum of 80% of their predicted preoperative FVC on the incentive spirometer.

The experimental group receiving preoperative teaching of target volume breathing exercises performed better than the control group receiving the standard preoperative teaching. During the first 24 hours, the experimental group subjects obtained the largest volume of gas at a maximum inspiratory and expiratory effort. This fact was particularly important during the first crucial 24 hours postsurgery, when a great many PPCs are known to develop (Shapira et al., 1989). The effectiveness of this nursing intervention was also generalized to the statistically significant improvements in oxygen saturation for the experimental group during the immediate 24 hours postextubation. Hypoxemia is known to be existent in the immediate postoperative period (Berrizbeitia et al., 1989). Thus, the teaching was beneficial since the subjects in the experimental

group were able to oxygenate better than the subjects in the control group during the first 24 hours postoperatively.

The nonstatistical significance of the volume reached on the incentive spirometer during the first 24 hours (P=0.07)) may reflect periods when the patients had fallen asleep or the acuity of care had intensified in the SICU and recordkeeping of IS volumes may not have been well documented. Nevertheless, Figure 5 above approximates the high levels of oxygen saturation and the high volumes reached on the incentive spirometer by the experimental group.

The study also validated previous findings that elucidated the significant reductions of PFTs to 19%-33% for most patients having a sternotomy and involvement of the internal mammary artery. This finding corroborates the contention that these reductions are expected and are true regardless of the teaching method. The impact of this finding is seen in the fact that both groups had the same reduced ability to exhale air as rapidly as possible in one second (FEV_1). These changes were expected and were related to the effects of the sternotomy and the use of the internal mammary artery on 64% of the subjects (Berrizbeitia et al., 1989).

The lack of statistically significant differences on the fifth day postoperatively for FVC and FEV_1 could have been attributable to the research design, which lengthened the interval between breathing exercises. The experimental group was asked to use the Voldyne every two hours during the day and every four hours at night on the second and the third postoperative day and every four hours throughout thereafter, as recommended by Craven et al., 1974). The control group was instructed to use the incentive spirometer every hour while awake. Two possible events could have happened regarding the control subjects: First,

perhaps they started to feel better and tried harder on their breathing exercises. In addition, physiologically speaking, the lungs may have started to expand better as the days passed. Second, it was noted toward the end of the study that, preoperatively, the health care team stressed the use of the incentive spirometer more. The floor nurses were more aware that a study measuring the patients' ability to deep-breathe was underway. In the meantime, the experimental group members may have reduced their volume capacity from their original head start of 37.95% reduction 24 hours postsurgery (control group reduction of 51.33%). This particular factor is explained by Mead and Collier's (1959) studies on anesthetized dogs, which developed reduction in compliance if their lungs were not inflated for periods longer than two hours. Although the patients were told to do their breathing exercises as often as possible, the majority followed their prescribed scheduled times.

The lack of statistical significance of FEF at 24 hours postextubation and on the fifth day postoperatively could be related to the fact that coughing was not stressed as a therapy. Coughing is an expiratory maneuver that deflates the alveoli; the subjects were taught to focus on achieving a high volume to overcome the shallow, monotonous breathing prevalent in critical care surgical patients (Zikria et al., 1970).

Study-Related Complications and Observations

The following observations were made by the investigator while the study subjects were in the intensive care unit. It was noted that a good number of patients in the control group developed atrial fibrillation. Some of the experimental patients also developed atrial fibrillation, but these subjects found it

much easier to revert, particularly if they resumed aggressive use of the incentive spirometer. Unfortunately, the investigator did not keep a record of the number of these interesting observations.

A post hoc review of the literature cited the development of atrial fibrillation after cardiovascular surgery as a frequent complication linked to increased age, presence of COPD, increased cross-clamp time, etc. The incidence of atrial fibrillation is 31.9% for those patients having coronary artery bypass graft and 63.6% for those undergoing combined procedures of mitral valve replacement and CABG (Creswell, Schuessler, Rosenbloom, Cox, 1993). The major problem of atrial fibrillation is the risk for postoperative stroke after a successful cardiac surgery (Creswell et al., 1993; Gentili, Giordano, Alois, Massa, & Bianconi, 1992). This, in turn, increases functional disability, length of stay in the intensive care unit, and hospitalization in general. Gentili et al.'s (1992) method of treatment was drug therapy. It would be intriguing to follow up on the relationship, if any, of increased target volume breathing versus reduction of atrial fibrillation.

Some of the control patients desaturated to 83% and were not able to be weaned off the facial mask at 40% concentration for a day longer than usual. At times, they were kept in the SICU one day longer (or a third day) to work on their pulmonary status.

Two patients, one in each group, developed sternal wound infections requiring more surgical intervention. Both patients had a 24 hours postextubation FVC below 25%, which was a reduction of 51% below preoperative FVC. Three patients developed lung collapse (two in the control and one in the experimental group)., requiring the insertion of chest tubes to help them expand their lung. The experimental subject continued to work fervently with his incentive spirometer, and his chest tube was removed on the third day versus five days for the control group patient.

Another interesting observation concerned the comments of experimental subjects, who described their chest as being "dry" or "clear" and had a white liquid expectorate, if any. On auscultation, they had clear breath sounds. On the other hand, the control subjects had a thick yellow expectorate and felt the need to cough more often. They were greatly encouraged to cough by the health care team.

Observations on Self-Efficacy Activities and Study-Related Complications

During the preoperative teaching, the investigator utilized persuasion and role modeling to empower the experimental group patients and their families to perform self-efficacy behaviors (Bandura, 1977). These interventions were designed to help the subjects achieve their highest volume capacity on the incentive spirometer and to maintain their oxygen saturation above the 95% range while observing their SaO_2 display on the monitor. The researcher suggested that the experimental patients could go home earlier if they worked hard on their breathing exercises.

The nurses in the CVICU commented on the patients' self-motivated compliance in doing their breathing exercises without being reminded to do them. They also noticed that these patients looked at the monitor more often to observe their SaO_2 level and that some of them used the incentive spirometer more often if they saw that their SaO_2 percentage was coming down or was below 95%. The subjects smiled a great deal when other nurses praised them for a 100% in SaO_2 and seemed genuinely pleased with themselves for their accomplishment.

In the step-down unit, the nurses assisted the patients by reminding them to perform and record their breathing exercises at

the specific times established by the protocol. Otherwise, the patients themselves were responsible for following the scheduled times for breathing exercises and for filling in their achieved volume on their bedside flow sheet. The nurses in the ward allowed these patients to be as independent as possible. Some of them commented on the high level of confidence and the ability of the experimental patients to move in and out of bed at ease.

Overall, the experimental patients and their families displayed a high level of collaboration, pride, and zealousness at times in complying with their written "agendum" of scheduled exercises. The subjects also noticed and reinforced corrective behaviors on themselves if their incentive spirometer volume was lower than previously reached. The experimental patients reported sleeping better at night since the breathing exercises were used every four hours by the third night. In the morning, they seemed rested and eager to restart their prescribed regimen of target volume breathing exercises.

Four experimental patients were documented as going home on the fourth day while none of the control subjects went home on the fourth day. Most of the control patients were discharged between the fifth and the eighth day or longer, particularly if they developed a PPC, such as pneumonia. The length of hospital stay was not part of the study; thus, the overall length of hospitalization for each subject was not carefully recorded. At present, due to the subject randomization, it is difficult to retrieve this information. The length of hospital stay was not part of this study outcome measurement because the length of hospitalization for older veterans varies according to different factors, such as living arrangements, distance to the nearest veteran health care facility, and family dynamics.

Conclusions

The following conclusions are drawn from the study:

1. The teaching of target volume breathing exercises and self-efficacy behaviors and the percentage of calculated volumes statistically significantly reduced the rate of postoperative pulmonary complications for coronary artery bypass graft and valve replacement surgical patients for the first 24 hours postsurgery as measured by the subjects' FVC and oxygen saturation level.

2. The preoperative teaching of target volume breathing exercises to coronary artery bypass graft and valve repair surgical patients was associated with significant improvements in the patients' ability to expand their lungs to a maximal capacity and achieve a higher air volume capacity at 24 hours postextubation.

3. All coronary artery bypass graft patients having an internal mammary artery for graft experienced a significantly higher reduction on their pulmonary function tests versus those who had a saphenous vein graft.

4. Target volume breathing may be significantly beneficial in ameliorating the degree of postoperative pulmonary complications in CABG/valve replacement patients related to their graft site.

5. The target volume breathing exercises were tested and provided some normative data for a therapeutic, prescriptive range to be reached on the incentive spirometer with CABG/valve repair surgical patients.

6. The target volume breathing exercises showed significant relationship of maximal inspiratory capacity to higher ranges on the incentive spirometer and the oxygen saturation of CABG/valve repair patients to immediate recovery.

7. The pulse oximeter measuring oxygen saturation was a precise instrument and evaluated the effects of teaching target volume breathing as a therapeutic nursing intervention and the patients' self-efficacy control over their situation.

8. The teaching and performance of target volume breathing exercises on the incentive spirometer at 80% of preoperative FVC was associated with decreased PPCs in the elderly and middle-aged veterans who were smokers, had COPD, or were 30% heavier than their ideal body weight who are experiencing lengthy surgery time or increased cross-clamping time.

This study sample was randomized and may provide a representation of the veteran population afflicted with coronary artery disease in the United States. The research findings are relevant and applicable to the elderly veteran and, with caution, to those who are nonveterans.

Nursing Implications

Postoperative pulmonary complications continue to be a significant problem and a first research priority for clinical practice research in critical care nursing (American Association of Critical Care Nurses, 1993). Critical care nurses can make a significant difference in reducing PPCs, length of hospital stay, and cost of health care. Preoperative teaching programs for these patients need to emphasize prescriptive air volumes that promote maximal alveolar inflation and oxygenation as a therapeutic intervention.

Cardiac surgical patients have the right to know about the breathing changes which they will experience as a result of surgery. They need to be taught the specific target volume range to be reached postoperatively if they are to reduce PPCs. Nurses

have the professional responsibility to teach their patients how to achieve the performance of sustained maximal inspiration and coughing only if necessary to decrease PPCs.

Nurses can be self-efficacy agents of change by engaging not only their patients but also the patients' families in self-efficacy behaviors in the early stages of pulmonary cardiac rehabilitation. The cardiopulmonary-compromised elderly and/or obese patient could perhaps be given a better chance to bounce back quickly to activities of daily living as a result of teaching self-efficacy behaviors in the reduction of PPCs. In summary, these research findings have other related nursing implications for the development of preventive wellness programs by the federal government.

Recommendations

Further research and replication of the study are recommended using larger samples to evaluate lasting effects of the teaching over a longer time period. Some changes are suggested.

First, a future study should continue with hourly target volume breathing exercises during the daytime and every two hours at night for at least the first 48 hours and progress to every two hours at least up to the fifth day postsurgery. According to Mead and Collier (1959), the lungs need to be reexpanded at least every two hours. Failure to reexpand the lungs results in reduced compliance and difficulty in reexpanding the lungs to full capacity. Thus, for further efficacy, at the patient's or the nurse's discretion, the frequency could be increased to every four hours day and night up to the first three months postsurgery, when

the lungs are known to resume normal expansion (Berrizbeitia et al., 1989).

Second, the study should be replicated using subjects with an FVC of 65% or lower to determine the effects on a group with high morbidity and at risk for longer mechanical ventilation.

Third, in a future study, the ideal body weight criterion should be increased to 50% to determine the effects on patients who are obese. This criterion could provide needed information on ways in which to reduce complications in this population, who constitute a large percentage of CABG patients.

Fourth, in measuring the effects of teaching target volume breathing exercises, this investigator recommends using the FVC and the pulse oximeter as the most sensitive measurements of lung volume inflation and oxygen saturation. The other two measurements, those of FEV_1 and FEF, may not be proper indicators of the nurse's therapeutic ability in CABG/valve repair patients.

Finally, in future studies, it is recommended that the criteria for measurement of FVC be redesigned. It would perhaps be cost effective to use the patient's preoperative maximal capacity achieved on the disposable incentive spirometer and calculate a target goal of 80% of this measurement, teaching the patient how to use the device according to the protocol with the exact or a modified frequency. The literature review questioned the validity of using PFTs as predictors of PPCs in CABG patients because these patients reduce their PFTs independently from their preoperative pulmonary function test. Thus, the replication of this study in this manner could reduce the cost of the study initially and lead to a cost-effective method of calculating target volumes for breathing exercises while providing an effective preoperative teaching intervention.

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APPENDIX A

STATISTICAL PROTOCOL FOR SUBJECT ASSIGNMENT

Plans for data analysis, including justification of sample size.

This protocol is being planned as a 2x2 factorial, parallel groups study. Since it is impossible to blind the investigator in this study, as patients are enrolled they will be assigned to either the treatment or control group using randomly permuted blocks of size four. The information indicating which group an individual will be assigned to will not be made known to the investigator until that subject has actually been enrolled. Every effort will be made to blind the person testing the patients' respiratory functions. To prevent a treatment subject from possibly "contaminating" a control patient, there will be only a single person on a unit participating in the protocol at any one time. (Because the decision concerning where the graft will be obtained is made during surgery, this factor obviously is incapable of being randomly applied and will be treated as a classificatory factor.)

A two factor ANOVA will be used to test the three hypotheses. The respiratory variables of primary interest in this study are FVC and FEV1. For the purposes of this experiment, we have set a=0.05 and B=0.20.

The table below gives the mean percentage of pre-op FVC and FEV1 seen two days post-op in a similar study[1] as well as the standard deviations of these percentages. These are the values we anticipate seeing in the control group. The treated column in the table indicates the mean percentage of pre-op FVC and FEV1 at two days post-op we would consider meaningful improvements. (Based on previous studies examining the effect of graft site we will be testing to see if similar differences, i.e. >20%, exist between patients with different graft types.)

RESPIRATORY MECHANIC	CONTROL	STD	TREATED
FVC	44.6	15.0	65 .0
FEV1	43.9	21.0	65.0

Therefore, the effect size, f, for FVC is 0.7 and for FEV1 is 0.5. This is true for both the treatment factor and the graft factor (assuming we have nearly equal number of graft types.)

The table below gives the numer of patients required in each group to detect this effect size with the power specified above.

FVC

Source	f	a	Power	n (per group)
Treatment	0.70	0.05	0.80	5
Graft	0.70	0.05	0.80	5
TxG	0.61	0.10	0.80	5

FEV1

Source	f	a	Power	n (per group)
Treatment	0.50	0.05	0.80	9
Graft	0.50	0.05	0.80	9
TxG	0.44	0.10	0.80	9

Therefore, to have the desired power, we will need to have 36 patients complete the study.

APPENDIX B

DOCUMENTATION OF AUTHORIZATION FOR STUDY

INCARNATE WORD COLLEGE

March 21, 1994 (Date) — Nursing (Major)

To: Dean of Division

I submit for approval the following thesis proposal:

Tentative title: [Be concise and state clearly the nature of the proposed research.]

CAN TARGET VOLUME BREATHING EXERCISES TAUGHT PREOPERATIVELY DECREASE POSTOPERATIVE PULMONARY COMPLICATIONS FOR CORONARY ARTERY BYPASS GRAFT PATIENTS?

On attached sheets, present concise information covering the following:

1. PROBLEM STATEMENT.
2. PRESENT STATUS OF THE QUESTION. Summarize the previous research in this information area citing any gaps which the study may help to fill. Include definite citations in your summary.
3. PROCEDURE. Indicate clearly the methods you will use in gathering and analyzing data to accomplish the objectives.

[The proposal should not normally exceed 10 pages].

.....

THESIS APPROVAL RECOMMENDED:

Katherine S. Ballin
Thesis Committee Chairperson

Brenda S. Jackson
Committee Member

Barbara Ashby
Committee Member

B. Bob Connelly
~~(optional)~~ Member
IRB CHAIR

Jane M Cardea
Division Dean

Lea S Fagin
Signature of Student

Lea Sol Lopez-Fagin
Student's Name (Print or Type)

90832
Student's Permanent Number

418 Crestwind, San Antonio, TX 78239
Mailing Address

Dean of Graduate Studies

White - File copy Yellow - Chairperson Pink - Student

The University of Texas
Health Science Center at San Antonio
7703 Floyd Curl Drive
San Antonio, Texas 78284-7830

Institutional Review Board
(Multiple Assurance #1403)

(210) 567-2351
FAX: (210) 567-2360

June 13, 1994

Lea S. Lopez-Fagin, R.N.C.
Surgical Intensive Care Unit (SICU)
Audie Murphy Memorial Veterans Hospital

Dear Ms. Lopez-Fagin:

Re: IRB Protocol #**934-0023-422** **Can Target Volume Breathing Exercises Taught Preoperatively Decrease Postoperative Pulmonary Complications For Coronary Artery Bypass Graft Patients? (Audie Murphy Veterans Hospital)**

This protocol was approved as submitted on June 13, 1994, under DHHS Regulation **46.101(b)(1)** for exempt review, **46.110(3)** for **EXPEDITED** review: 46.101(b)(1) Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula or classroom management methods. 46.110(3) Recording of data from subjects 18 years of age or older using noninvasive procedures routinely employed in clinical practice.

This approval will be endorsed by the full Board and recorded in the minutes at the next convened IRB meeting on June 14, 1994.

RESPONSIBILITIES OF PRINCIPAL INVESTIGATOR:

(1) report **immediately** to the IRB all deaths of subjects, regardless of cause;

(2) report **immediately** to the IRB any severe adverse reaction or serious problem, whether anticipated or unanticipated;

(3) report any significant findings that become known in the course of the research that might affect the willingness of subjects to continue to take part;

(4) insure that only formally designated investigators (as approved by the IRB) enroll subjects;

(5) submit for review and approval by the IRB all modifications to the protocol or consent form(s) prior to the implementation of the change;

(6) submit a **Progress Report** for continuing review by the IRB. Federal regulations require IRB review of on-going projects no less than once a year (a Progress Report will be sent to you in 10 months); and

(7) notify the IRB when the study has been completed and prepare a final report.

NEXT IRB REVIEW: April 1995

(Note: Approval may need to be obtained from the appropriate hospital committee(s) prior to the implementation of this study.)

Wayne P. Pierson, Ph.D., Director, IRB

The University of Texas Health Science Center at San Antonio
7703 Floyd Curl Drive
San Antonio, Texas 78284-7830

Institutional Review Board
(Multiple Assurance #1403)

(210) 567-2351
FAX: (210) 567-2360

TO: Lea S. Lopez-Fagin, RNC
VA SICU

DATE: February 10, 1995

FROM: **Institutional Review Board**

SUBJ: IRB Protocol #934-0023-422 **Can Target Volume Breathing Exercises Taught Preoperatively Decrease Pulmonary Complications Postoperatively for Coronary Artery Bypass Graft Valve Patients? (AMVAH)** *Formerly* "Can Target Volume Breathing Exercises Taught Preoperatively Decrease Postoperative Pulmonary Complication for Coronary Artery Bypass Graft Patients?"

REQUESTS:

__X__ Revised Consent Form(s)

__X__ Protocol Modification/Addendum

_____ Change in Title

_____ Addition/Deletion of Investigator

_____ Spanish Translation of Consent Form(s)

_____ Conditions Met

_____ Other

ADMINISTRATIVE ACTION:

__X__ Approve

_____ Clarification Required

_____ Disapprove

COMMENTS: This is in reference to your request dated February 10, 1995.

Approval was given on February 10, 1995, to the protocol modification, change in the title of the study, and to the revised consent form.

DATE OF NEXT IRB REVIEW: April 1995

Wayne P. Pierson

Wayne P. Pierson, Ph.D., Director, IRB

The University of Texas
Health Science Center at San Antonio
7703 Floyd Curl Drive
San Antonio, Texas 78284-7830

Institutional Review Board
(Multiple Assurance #1403)

(210) 567-2351
FAX: (210) 567-2360

May 9, 1995

Lea S. Lopez-Fagin, RNC
SICU
VAH

Dear Dr. Lopez-Fagin:

CONTINUING REVIEW - IRB Protocol #934-0023-422 Can Target Volume Breathing Exercises Taught Preoperatively Decrease Pulmonary Complications Postoperatively for Coronary Artery Bypass Graft Valve Patients? (AMVAH) *Formerly* "Can Target Volume Breathing Exercises Taught Preoperatively Decrease Postoperative Pulmonary Complication for Coronary Artery Bypass Graft Patients?"

In accordance with Federal regulations for continuing review, the Institutional Review Board reapproved the above referenced protocol at a convened meeting on May 9, 1995.

RESPONSIBILITIES OF PRINCIPAL INVESTIGATOR FOR ONGOING PROTOCOLS:

(1) report **immediately** to the IRB all deaths of subjects, regardless of cause;

(2) report **immediately** to the IRB any severe adverse reaction or serious problem, whether anticipated or unanticipated;

(3) report any significant findings that become known in the course of the research that might affect the willingness of subjects to continue to take part;

(4) insure that only persons formally approved by the IRB enroll subjects;

(5) submit for review and approval by the IRB all modifications to the protocol or consent form(s) prior to the implementation of the change;

(6) submit a **Progress Report** for continuing review by the IRB. Federal regulations require IRB review of on-going projects no less than once a year (a Progress Report will be sent to you in 10 months); and

(7) notify the IRB when the study has been completed and prepare a final report.

Sincerely,

Stephen Ryan, M.D.
Subcommittee Chair
Institutional Review Board

DATE OF NEXT IRB REVIEW: March 1996

Request to Review Research Proposal

1. **Principal Investigator/Program Director:** Lopez-Fagin (Last) Lea (First) S. (MI) BSN (Degree)

2. **SS No:** 454 - 19 - 5741 **3. Telephone:** *(Office/Lab)* Ext. 4573 **4. Mail Code:** 118

5. **VA Appointment:** X Full-Time ___Part-Time ___WOC ___Consultant ___Contract *(Check one)*

6. **Status of PI in Proposal:** 01 *(Enter Code)* *(01 = Awardee or Initiator 02 = Not Awardee; eg, Participant in VA Co-Op Study)*

7. **Type of Submission:** X New ___Renewal of Active Project *(Check one)*
If Renewal, complete a and b: a) Enter 4-digit number of active project _____ b) Has title changed? [ ] Yes [ ] No

8. **Project Title:** Can Target Volume Breathing Exercises Taught Preoperatively Decrease Postoperative Pulmonary Complications for Coronary Artery Bypass Graft Patients?
(Maximum length: 142 characters, including spaces)

9. **Co-Principal Investigators:** *(Enter Only if Study is Funded. Must have a VA appointment and must be designated a Co-PI in application.)*

N/A _____ [ ] Check if at another VAMC
(Last name, first name, MI, Degree) *(Social Security Number)*

_____ _____ [ ] Check if at another VAMC
(Last name, first name, MI, Degree) *(Social Security Number)*

10. **Anticipated Starting Date:** 07 / 11 / 94 *(mm/dd/yy)*

11. **Funding Source and Fund Administration:** *(Codes are on back of instruction sheet)*

Source Code (4-digits)	Name if Funding Source Code ends in "99"	Admin Code (2-digits)	Name if Admin Code is "08"
0000			

12. **Project Uses:** *(Mark each item and submit completed forms. If Animal Subjects is Yes, Complete Item 15.)*

Human Subjects [X] Yes [ ] No Investigational Drugs [ ] Yes [X] No Radioisotopes [ ] Yes [X] No
Animal Subjects [ ] Yes [X] No Investigational Devices [ ] Yes [X] No Biohazards [ ] Yes [X] No

13. **Research Focus:** *(Mark each item.*

Agent Orange [ ] Yes [X] No Females [ ] Yes [X] No Prisoners of War [ ] Yes [X] No

14. **Key Words:** *(Minimum 3, maximum 6. Use MeSH terms only. Enter one term per line)*

1 Coronary artery bypass graft
2 Incentive spirometry
3 Forced vital capacity test
4 Forced expiratory volume in 1 second
5 Peak expiratory flow
6 Breathing exercises

15. **Animal Subjects Used:** *(Species and, if applicable, strain. Enter one species and its strain per line.)*

1 _____ 5 _____
2 _____ 6 _____
3 _____ 7 _____
4 _____ 8 _____

16. **Abstract:** *(Submit on separate sheet; see instructions)*

17. **Institutional Support:** *(Mark each item. *If Yes, a letter of support/collaboration must be attached to this form.)*

Laboratory*	[ ] Yes [X] No	Medicine*	[ ] Yes [X] No	Pharmacy*	[ ] Yes [X] No
Radiology*	[ ] Yes [X] No	Nuclear Medicine*	[ ] Yes [X] No	Nursing*	[X] Yes [ ] No
Psychiatry*	[ ] Yes [X] No	Out-patient*	[ ] Yes [X] No	Surgery*	[X] Yes [ ] No
Other*	[ ] Yes [X] No	If Yes, Specify:			
Lab Space	[ ] Yes [X] No	If Yes, Bldg and Room			
Budget Page	[ ] Yes [X] No	Must be included with all submissions (except Funding Source Code 0000)			

18. **Institutional Approvals:** *(Signatures as appropriate)*

Section Chief V. Kathryn Mick 6-10-94
Signature Date

Service Chief Bruce A. Fagan 6/10/94
Signature Date

Other _____ _____
Signature Date

19. **Additional Information:**

Duration of Study: One year

Number Subjects at this Hospital: Forty-four

Number Non-veteran Subjects at this Hospital: Zero

Number Visits for Research Purposes Only: N/A

Number & Type Procedures in Excess of Routine Care: One; pulmonary function tests 24 hours postextubation.

Comments:

Principal Investigator Lea S. Lopez-Fagin RNC June 10, 1994
Signature Date

(If this is the First Research Proposal submitted at this Medical Center, also submit an Investigator Data Sheet (Page 18).

Office use only:

Date Received: _____

Item check: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 VAF 10-5368

Date Returned: _____ *Reason:* _____

Date Entered: _____

Department of Veterans Affairs

Memorandum

Date: August 1, 1994

From: Chairman, Research and Development Committee (151)

Subj: Review of Research Proposal

To: Lea S. Lopez-Fagin, B.S.N.

Proposal: "Can Target Volume Breathing Exercises Taught Preoperatively Decrease Postop Pulmonary Complications for Coronary Artery Bypass Graft Patients"

1. The above proposal was approved by the Research and Development Committee on July 28, 1994.

2. Any changes in proposals or investigators must be reported to the Research and Development Committee. Changes in studies involving human subjects must also be reported to the Institutional Review Board (IRB).

VALawrence MD

VALERIE LAWRENCE, M.D.

April 14, 1993

O. Lawayne Miller, M.D.
Chief, Cardiothoracic Surgery
Audie L. Murphy Memorial
Veterans Affairs Hospital

Dear Dr. Miller:

I am currently enrolled in the graduate program at Incarnate Word College School of Nursing in San Antonio. As we have previously discussed, I have developed a research proposal entitled "Can Target Volume Breathing Exercises Taught Preoperatively Decrease Pulmonary Complications Postoperatively for Coronary Artery Bypass Graft Patients?"

The literature points out that older patients are at higher risk for postoperative pulmonary complications after heart surgery. Thus, it is hoped that older patients can benefit from the proposed structured preoperative teaching program by experiencing a decrease in postoperative pulmonary complications such as atelectasis, pneumonia, and changes in the lungs' ventilatory capacity.

The proposed study will have an experimental design with a control and an experimental group. The control group will receive the standard preoperative teaching while the experimental group will receive an enhanced preoperative teaching format combining the standard teaching content and the viewing of a slide/tape showing an overview of the lungs, the mechanics of coughing, and the way in which to achieve sustained maximal inspiration on one's own and using the incentive spirometer. Also, an individual target volume on the incentive spirometer of 80% of preoperative predicted forced vital capacity will be set for these patients.

A schedule of breathing exercises will be given to the experimental group. Assessment of the patients' response to the breathing exercises will be effected by measurement of forced vital capacity, forced expiratory volume in one second, and peak expiratory flow 24 hours after extubation and prior to discharge on the fifth to seventh day postoperatively. These values will be compared to the preoperative values in both groups. In addition, the patients' arterial oxygen saturation will be measured by pulse oximeter to assess alveolar ventilation.

Presently, I am requesting your permission to approach these patients the day before surgery, after they have had their routine pulmonary function tests, to request their participation in the proposed study. Your time and effort in the consideration of this

request are extremely important. My school requires a written reply to include in the study report; thus, I am asking you to kindly furnish a written reply. If you need more information about the proposed study, I will be available at your convenience. Furthermore, when the study is completed, I will provide you with a copy of the abstract for your information.

Looking forward to your reply, I remain

Yours sincerely,

Lea S. Fagin R.N.C.

Lea S. Fagin, R.N.C.
Surgical Intensive Care Unit

Audie L. Murphy
Memorial Veterans
Hospital

7400 Merton Minter
Boulevard
San Antonio TX 78284

Veterans
Administration

In Reply Refer To:epte

Lea S. Fagin
418 Crestwind
San Antonio, Texas 78239

Dear Mrs. Fagin:

As requested in your letter, I am giving you permission to enroll CABG patients in your research study "Can Targetted Volume Breathing Exercises Taught Preoperatively Decrease Pulmonary Complications Postoperatively for Coronary Bypass Graft Patients?"

The need for the study was clearly demonstrated through your review of literature. I do agree that the benefits of Targetted Volume Breathing Exercises need to be further explored through research.

I do not foresee any major problems since the risk to patients seems to be minimal. Furthermore, I will be able to collaborate in this study by providing guidance and assistance if needed during the course of the investigation.

Sincerely,

O. LAWAYNE MILLER, M.D.
Chief, Cardiothoracic Surgery
Audie L. Murphy VAMC

September 9, 1993

Thelma Shanks, R.N.
Cardiovascular Liaison Nurse
Audie L. Murphy Memorial
Veterans Affairs Hospital

Dear Ms. Shanks:

I am currently enrolled in the graduate program at Incarnate Word College School of Nursing in San Antonio. As we have previously discussed, I have developed a research proposal entitled "Can Target Volume Breathing Exercises Taught Preoperatively Decrease Pulmonary Complications Postoperatively for Coronary Artery Bypass Graft Patients?"

The proposed study will have an experimental design with a control and an experimental group. The control group will receive the standard preoperative teaching provided by the cardiovascular nurse. The experimental group will receive the standard preoperative teaching plus the experimental teaching being provided by the nurse investigator. Also, an individual target volume on the incentive spirometer will be set for these patients.

I am asking your permission to use your booklet on cardiac surgery in the proposed study. This booklet will be given to both groups to provide them with knowledge about their surgery, the procedures involved, the sensations to expect, and the breathing exercises to be done after surgery.

Your time and effort in consideration of this request are extremely important. I am requesting a written reply regarding your collaboration during this investigation. Furthermore, I am enclosing a copy of the letter of approval to conduct this study received from Dr. O. Miller, Chief of Cardiothoracic Surgery.

Looking forward to your reply, I remain

Yours sincerely,

Lea S Fagin RN

Lea Fagin
Critical Care Nurse
Surgical Intensive Care Unit

Audie L. Murphy
Memorial Veterans
Hospital

7400 Merton Minter
Boulevard
San Antonio TX 78284

Veterans
Administration

SEP 1 6 1982

In Reply Refer To: epte

Lea S. Fagin
418 Crestwind
San Antonio, Texas 78239

Dear Mrs. Fagin:

As requested in your letter, I am giving you permission to use my booklet "Patient Handbook on Cardiac Surgery" in your study "Can Targetted Volume Breathing Exercises Taught Preoperatively Decrease Pulmonary Complications Postoperatively for Coronary Bypass Graft Patients?"

Sincerely,

Thelma Shank RN

THELMA SHANK, RN, CCRN
Cardiovascular Nurse

April 5, 1993

Lea S. Fagin
418 Crestwind
San Antonio, Texas 78239

Dear Mrs. Fagin:

I will be happy to collaborate in your research study entitled "Can Target Volume Breathing Exercises Taught Preoperatively Decrease Pulmonary Complications Postoperatively for Coronary Artery Bypass Graft Patients?" I agree that this is a very important aspect of postoperative patient management which needs to be addressed.

We will be happy to have available a portable spirometer in order to obtain the parameters described in your study proposal. We also can designate a finger oximeter to be used for these patients.

I am looking forward to collaborating with you.

Sincerely,

Antonio Anzueto, M.D.
Staff Pulmonologist

The University of Texas
Health Science Center at San Antonio
7703 Floyd Curl Drive
San Antonio, Texas 78284-7885

Department of Medicine
Division of Pulmonary Diseases/Critical Care Medicine

(210) 617-5256 (AMVAH)
(210) 567-6677 (FAX)
(210) 567-1901 (UT)
(210) 567-4654 (FAX)

San Antonio March 1, 1994

Barbara Herlihy, PhD
Incarnate Word College
San Antonio, Texas

Dear Dr. Herlihy:

In reference to Lea Sol Lopez-Fagin thesis proposal, using 80% of pre-op FVC as the patients target after surgery is appropriate and will help to support the proposed hypotheses. There is no data that indicates what is the "ideal" percentage that the patients should generate after CABG. Based on post-abdominal surgery, the patients that generated more than 70% have a significant improvement in lung function.

Hope that this information will be helpful, if you have any other questions please contact me,

Sincerely

ANTONIO ANZUETO, M.D.
Assistant Professor Medicine,
Pulmonary Medicine and Critical Care

APPENDIX C

INFORMED CONSENT

Department of Veterans Affairs

VA RESEARCH CONSENT FORM

Subject Name: _____ **Date** _____

Title of Study: CAN TARGET VOLUME BREATHING EXERCISES TAUGHT PREOPERATIVELY DECREASE PULMONARY COMPLICATIONS POSTOPERATIVELY FOR CORONARY ARTERY BYPASS GRAFT-VALVE PATIENTS?

Principal Investigator: Lea S. Lopez-Fagin, R.N.C. **VAMC:** San Antonio, TX

DESCRIPTION OF RESEARCH BY INVESTIGATOR

We are asking you to participate in a research study about the use of breathing exercises to prevent pulmonary complications, such as pneumonia, after heart surgery. Breathing exercises are routinely performed by patients after this type of surgery. We want to compare two preoperative teaching methods for breathing exercises to see if one way is better than the other. We are asking you to take part in this study because you are scheduled to have heart surgery as part of the treatment for your disease.

If you decide to participate in the study, you will receive one of two types of preoperative teaching the day before surgery. You will receive either the standard preoperative teaching for breathing exercises (control group) given by the cardiovascular nurse or the floor nurse or be taught breathing exercises with a target volume breathing goal for the incentive spirometer (experimental group) by the research investigator. Both groups will receive a booklet of procedures to observe after heart surgery. The experimental group will view a slide/tape focusing on breathing exercises concerning how to cough, deep-breathe on your own, and use a small device called an incentive spirometer. A target volume breathing goal to be reached on the incentive spirometer after surgery will be individually calculated for you. The breathing exercises will start immediately after the breathing tube is removed from your windpipe. The first day, you will need to use the incentive spirometer every hour during the day and every two hours during the night. The second and the third day, you will need to use the incentive spirometer every two hours during the day and every four hours during the night. The fourth to the seventh day, you will need to use the incentive spirometer four times a day and when awake at night. A schedule of times will be given to you.

Whether or not you view the film and have your target volume breathing goal calculated will be decided by chance, like flipping a coin. The study is so arranged that the nurse and the doctor will not know to which group you are assigned until after you sign the informed consent. During the course of the study, breathing tests will be performed to evaluate the effectiveness of your breathing: first, 24 hours after you have been using the incentive spirometer and, second, before you go home on the fifth to seventh postoperative day. The breathing tests will be the same as those you have

SUBJECT'S IDENTIFCATION (I.D. plate or give name-last, first, middle)

Signature of Subject

Department of Veterans Affairs

VA RESEARCH CONSENT FORM

Subject Name: _____ **Date** _____

Title of Study: CAN TARGET VOLUME BREATHING EXERCISES TAUGHT PREOPERATIVELY DECREASE PULMONARY COMPLICATIONS POSTOPERATIVELY FOR CORONARY ARTERY BYPASS GRAFT-VALVE PATIENTS?

Principal Investigator: Lea S. Lopez-Fagin, R.N.C. **VAMC:** San Antonio, TX

already learned before surgery. The risks involved are minimal; however, while doing the breathing tests or the breathing exercises, you might experience some lightheadedness and/or incisional pain or discomfort, but you may ask for pain medication to relieve the discomfort. Also, while in the intensive care unit, you will wear a finger or an ear clip attached to a pulse oximeter to measure your oxygenation.

The standard preoperative teaching which you may receive will be given by the cardiovascular nurse. The cardiovascular nurse will go over the breathing exercises of coughing, deep-breathing, and use of the incentive spirometer with you. We think that learning and practicing how to do the breathing exercises before surgery is important. Additionally, knowing the optimal individual goal for yourself on the incentive spirometer after heart surgery has the potential to reduce pulmonary complications after surgery.

We do not guarantee that you will benefit from taking part in this study. However, you may be able to provide us with answers that will help other patients with heart surgery. Participation in this study will be of no cost to you. Also, you will receive no monetary or other remuneration for participating in this study. If you are a veteran, your only cost for treatment as a research subject at the Veterans Affairs hospital will be the regular co-payment based on your category of veteran eligibility for medical care. If you are injured as a result of the research procedures, medical care will be provided. You will, however, be responsible for all charges. We are not able to give you money if you are injured.

Everything we learn about you in the study will be confidential. If we publish the results of the study in a scientific journal or book, you will not be identified in any manner.

Your decision to take part in the study is voluntary. You are free to choose not to take part in the study or to stop taking part at any time. If you choose not to take part or to stop at any time, it will not affect the quality of your care at the Audie L. Murphy Memorial Veterans Hospital.

If you have any questions now, please feel free to ask. If there are any additional questions later or you wish to report a medical problem which may be related to this study, Lea Fagin, R.N., can be contacted at work at (210) 617-5300, Ext. 4573..or at home at (210) 653-2036. Any questions about your rights as a research subject will be answered by contacting the committees that review research on human subjects at Incarnate Word College: (210) 829-3882, and The University of Texas Health Science Center: (210) 567-2351.

We will give you a signed copy of this form to keep.

INSTITUTIONAL REVIEW BOARD 21095 Date Approved by IRB UTHSCSA

(Continuation page 2 of 3)

Signature of Subject

Department of Veterans Affairs

VA RESEARCH CONSENT FORM

Subject Name: _____ **Date** _____

Title of Study: CAN TARGET VOLUME BREATHING EXERCISES TAUGHT PREOPERATIVELY DECREASE PULMONARY COMPLICATIONS POSTOPERATIVELY FOR CORONARY ARTERY BYPASS GRAFT-VALVE PATIENTS?

Principal Investigator: Lea S. Lopez-Fagin, R.N.C. **VAMC:** San Antonio, TX

YOUR SIGNATURE BELOW INDICATES THAT YOU HAVE DECIDED TO TAKE PART IN THIS RESEARCH AND THAT YOU HAVE READ AND UNDERSTAND THE INFORMATION GIVEN ABOVE AND EXPLAINED TO YOU.

Signature of Subject	Signature of Witness
Signature of Investigator	Date/Time

INSTITUTIONAL REVIEW BOARD
2-10-95
Date Approved by IRB
UTHSCSA

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APPENDIX D

DATA-COLLECTION INSTRUMENTS

DATA-COLLECTION INSTRUMENT

PATIENT DEMOGRAPHICS

SS#_____ AGE_____

DOB_____ SEX: ___M ___F WEIGHT_____ RACE _____

Smoking History: Last time smoked_____ How many/day_____

Medical History: _____

_____

Past Surgery: _____

_____

PREOPERATIVE DATA

Ejection fraction____ SaO_2____ Training group: _____C _____E

Predicted FVC_____

FEV_1_____

FEF_____

PERIOPERATIVE DATA

Date of CABG_____ Graft Used: Saphenous_____

I.M.A._____

Length of surgery_____ Bypass time_____

POSTOPERATIVE DATA

24 hours postextubation: FVC_____ FEV_1_____ FEF_____

5th day postextubation: FVC_____ FEV_1_____ FEF_____

SaO_2_____

OXYGEN SATURATION 24 HOURS POSTEXTUBATION

Average before incentive spirometry_____

Average 30 seconds after incentive spirometry_____

DATA COLLECTION SHEET

Patient's random # CABG X Surgery date

Extubation time:

Oxygen: % Face mask or nasal cannula

Date Day # 1	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800
Incent. Spiro. Volume Achieved												
SA02 **Before,** and **After IS**												

Date Day #1	1900	2000	2100	2200	2300	0100	0300	0500	0700	0900		
Incent. Spiro. Volume Achieved										**FVC =** **FEVI= FEF =**		
SA02 **Before,** and **After IS**												

VITA

Lea Sol Lopez-Fagin was born in Picota, Peru, South America, on December 10, 1947, the daughter of Clara Cohen Lopez and the late Sixto Lopez Rodriguez. She completed her high-school education at Albert Leveau High School, Picota, Peru. In 1969, she graduated as a diploma nurse from the Anglo American Clinic School of Nursing in Lima, Peru. For the next two years, she worked as a nurse at Santo Tomas Hospital and the Children's Hospital in Panama City, Republic of Panama. After moving to San Antonio, Texas, in 1972, through the University of Texas School of Nursing Flex Process Program, she earned her degree of Bachelor of Science in Nursing, graduating in May, 1978. Her clinical expertise includes medical-surgical nursing, cardiovascular clinical research, and critical care nursing. She is currently employed at the South Texas Veterans Healthcare System-Audie L. Murphy Division, San Antonio, Texas, as a staff nurse in the Surgical Intensive Care Unit. Her dedication to and advocacy of quality nursing care and her community activities have been recognized by the awards of Nurse of the Month, Super Caring Person, and Caring Person and by induction into Sigma Theta Tau, Delta Alpha Chapter, as a community leader. She entered the Graduate Program in Adult Health Nursing at the University of the Incarnate Word in 1992 and graduated on May 11, 1996. Her academic achievement has been recognized through publication of an article in Critical Care and her induction into the Honor Society at the University of the Incarnate Word.

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This thesis was typed by Barbara Jones.