COMPARISON OF VOLUNTARY DEEP BREATHING WITH INSPIRATORY HOLD
AND THE DEEP BREATHING EXERCISER ON INCREASING LUNG VOLUMES
IN POSTOPERATIVE UPPER ABDOMINAL SURGICAL PATIENTS

by

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STATEMENT BY AUTHOR

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APPROVAL BY THESIS DIRECTOR

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Date
This thesis is dedicated to my father who enriched my life with his love, laughter, and wisdom.
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ABSTRACT

The purpose of this study was to compare the effectiveness of the Triflo II Deep Breathing Exerciser and voluntary deep breathing with inspiratory hold on increasing lung volumes in postoperative patients who had undergone upper abdominal surgical procedures. Eight subjects were studied during the 48 to 72 hour postoperative period. Each subject participated in both respiratory maneuvers once and was randomly assigned to either receive the deep breathing exerciser or the voluntary deep breathing treatment first. The opposite maneuver was completed three to five hours later. The functional residual capacity (FRC) using a multiple breath helium dilution bedside method and the vital capacity (VC) were measured prior to, immediately after, and 30 minutes after the use of one treatment of each respiratory maneuver. Routine postoperative care was not interrupted during this study. Each subject served as his own control and the data were analyzed in terms of percent change from pretreatment values for the FRC and VC. No statistically significant changes in FRC or VC were found immediately after or 30 minutes after either maneuver. Pretreatment lung volumes were markedly reduced from predicted normals with the mean FRC 62.6 percent predicted and the VC 45.2 percent predicted. The mean percent predicted lung volumes remained essentially unchanged immediately after and 30 minutes after either maneuver. In conclusion, there was no significant measurable effect of
one treatment of either maneuver, but these findings do not negate the potential benefit of frequent deep breathing maneuvers during the post-operative period.
CHAPTER 1

INTRODUCTION

Numerous complications may plague a patient in the postoperative period following a seemingly "successful" surgical procedure. Despite the advances in surgical technique and postoperative care, complications remain a major problem. A postoperative complication may be defined as an untoward event which occurs in the patient within 30 days after the surgical procedure (Dunphy and Way, 1977). Complications may arise at the wound site or in any body cavity or organ adjacent to or far removed from the surgical site. Of the vast number of possible complications, a few of the more commonly seen are wound complications, cardiac complications, complications arising solely from the procedure, psychiatric problems, and pulmonary complications. Of all the possible postoperative complications, pulmonary complications remain the highest contributor of postoperative morbidity and mortality rates (Bartlett, Gazzaniga, and Geraghty, 1973).

The incidence of pulmonary complications depends on the criteria used to define a pulmonary complication and the type of surgical procedure involved. Significant pulmonary complications occur in 20 to 40 percent of patients following abdominal or thoracic surgery (Bartlett et al., 1973). Research has demonstrated that of all abdominal surgery performed, the upper abdominal surgical procedures exhibit the highest incidence of complications (Wightman, 1968; Ali et al., 1975).
Various factors may predispose a patient to the development of complications in the postoperative period. Leading the list are patients who have pre-existing pulmonary problems or those with marked abnormal pulmonary function prior to surgery. A history of acute or chronic pulmonary disease may increase a patient's complication risk at a rate of three to four times the normal (Hedley-Whyte et al., 1976). Other factors which increase the complication rate are age, obesity, cigarette smoking, and sex. Intraoperative factors such as duration of anesthesia may also affect the incidence of postoperative pulmonary complications (Hedley-Whyte et al., 1976).

Of the numerous pulmonary complications which may occur in the surgical patient, atelectasis or collapse of alveoli is the most prevalent. Atelectasis is usually precipitated by inadequate ventilation during surgery or in the postoperative period. In the postoperative patient, the pattern of ventilation is most commonly altered by the incisional site, anesthetics, narcotics, and pain (Hedley-Whyte et al., 1976). Postoperative patients maintain a shallow breathing pattern which in turn causes poor or incomplete alveolar inflation. Ultimately, this incomplete alveolar inflation progresses to atelectasis. If spontaneous deep breaths to maximum lung inflation are eliminated from the pattern of breathing, alveolar collapse begins within one hour and progresses rapidly to produce significant transpulmonary shunting (Burton, Gee, and Hodgkins, 1977). Therefore, the goal of prevention and treatment of pulmonary postoperative complications is to increase the patient's lung volumes overall and to periodically stimulate the patient
to take deep breaths to maximal inspiration, thus preventing alveolar collapse.

Various respiratory maneuvers have been designed to increase transpulmonary pressure, to prevent reduction of lung volumes, and to induce maximal inspiration in the postoperative patient. These maneuvers attempt to increase the inspiratory lung capacity to volumes which will possibly prevent alveolar closure or cause reexpansion of those alveoli which are collapsed. Among the maneuvers designed for this purpose are deep breathing, coughing, the deep breathing exerciser, Intermittent Positive Pressure Breathing (IPPB), incentive spirometry, and blow bottles. This study was designed to compare two of these maneuvers, the deep breathing exerciser and voluntary deep breathing with sustained inspiration, as to their efficiency in increasing lung volumes specifically the measurements of functional residual capacity (FRC) and vital capacity (VC) in the postoperative period.

Statement of the Problem

It is necessary to use a respiratory maneuver which has a maximal efficiency level and a minimal cost to promote adequate ventilation and avoid pulmonary complications. In the past, the nursing role has been to instruct and manually assist the patient in periodically taking deep breaths in the postoperative period. During the past few years various products have been marketed to assist the patient in periodic deep breathing exercises. These devices have become popular due to the visual feedback which they provide for the patient. Another marketing factor is that the devices are simple to use and require minimum
instruction and supervision by the nurse. The question proposed was whether a visual feedback device (deep breathing exerciser) would induce the patient to attain higher lung volumes as compared to the nurse verbally encouraging and manually assisting the patient to deep breathe with a sustained inspiration. The purpose of this study was to compare the deep breathing exerciser and voluntary deep breathing with sustained inspiratory hold as to their efficiency in increasing FRC and VC measurements in postoperative patients in the first 48 to 72 hours after upper abdominal surgery.

**Hypotheses**

1. Both the voluntary deep breathing with inspiratory hold treatment and the deep breathing exerciser treatment would result in significant increases in the FRC and VC as compared to the pretreatment measurements in postoperative patients after upper abdominal surgery.

2. The deep breathing exerciser treatment would result in a significantly greater increase in FRC and VC immediately posttreatment as compared to the voluntary deep breathing treatment with inspiratory hold and the pretreatment measurement.

3. Neither the deep breathing exerciser nor the voluntary deep breathing treatment with inspiratory hold would show sustained increase in FRC or VC at 30 minutes after the initial treatment as compared to the pretreatment values.
Theoretical Framework

Pulmonary problems occur in 20 to 40 percent of patients following abdominal or thoracic surgery (Bartlett et al., 1973). Of the abdominal procedures, upper abdominal surgical procedures exhibit the highest incidence of complications (Wightman, 1968; Ali et al., 1975). Marked changes in respiratory function in patients following upper abdominal surgery have been well documented in the literature (Ali et al., 1975; Latimer et al., 1971; Meyers et al., 1975). Reductions in total lung capacity, FRC, and inspiratory capacity are commonly seen postoperatively. The residual volume (RV) may remain the same or decrease as compared to the preoperative measurements. In addition, the closing volume or that volume at which small airways close during exhalation may remain similar or more commonly increases as compared to the preoperative measurement. Postoperatively, lung compliance is usually decreased indicating a stiffer lung, while the diffusing capacity may decrease or remain similar to that of preoperative measurement. Arterial blood gases may also exhibit changes following an upper abdominal surgical procedure. The pH may increase while both the carbon dioxide and oxygen tensions decrease. Relative to the decreased arterial oxygen tension, the alveolar-arterial gradient for oxygen may increase.

The effects of the alteration in the pattern of ventilation with low tidal volumes and the absence of periodic hyperinflations are the primary factors involved in the resulting postoperative atelectasis and hypoxemia. Most commonly the decreased volumes, specifically FRC and
VC, and the resulting atelectatic changes are seen dramatically in the first 48 to 72 hours after surgery (Hedley-Whyte et al., 1976).

As the lung volumes diminish, three changes occur. These changes are: (1) the transpulmonary pressure diminishes, (2) the small air passages become narrower and may become totally obstructed resulting in airway closure (that point in expiration where airways begin to close) and (3) alveoli develop a tendency to become airless and collapse (atelectasis) (Nunn, 1977:70). The transpulmonary pressure reflects that pressure difference between the alveoli and the pressure surrounding the lungs. As the lung volume decreases, so does the transpulmonary pressure.

The second change, earlier airway closure or elevated closing volume, is defined as that point during exhalation to residual volume when small, peripheral airways narrow or close (Hedley-Whyte et al., 1976). Even in a normal lung at residual volume, pleural pressure in the dependent lung zones exceeds the airway pressure which leads to airway closure. Gas is then trapped behind the closed airways (Bates, Macklem, and Christie, 1971:42). Postoperatively, this phenomenon appears to occur more frequently. With the reduction of the FRC and VC due to the shallow tidal volume in the postoperative patient, that volume at which airway closure occurs (the closing volume) tends to be increased. Airway closure may occur within tidal volume range and trap significant amounts of air behind the closed airways. Hence, over a short period of time this air is sequestered and the alveoli become airless (atelectasis).
In the recumbent position or semi-Fowler's position such as that frequently used for the postoperative patient, airway closure occurs mainly in the posterior lung segments or basilar lung segments which are dependent. This increase of closing volume is more significant in the recumbent position than in the upright position because the FRC is less in the supine position than in the upright posture (Guenter and Welch, 1977). When airway closure commences within or above the FRC, dependent lung zones cease to be ventilated but continue to be perfused. Therefore a ventilation/perfusion abnormality exists leading to physiologic shunting and arterial hypoxemia.

Thirdly in the progression of changes resulting from decreased lung volumes is the tendency for alveoli to become airless resulting in atelectasis. With the increase in closing volume and decrease in FRC seen in the postoperative patient, increasing amounts of air are trapped in the lung behind the point of airway closure. At the continuous low tidal volume ventilation seen in the postoperative patient, in time, the sequestered gases are absorbed resulting in complete alveolar collapse.

Usually the alveolar collapse is so small that the resulting lesions do not produce pronounced physical or radiological abnormalities. Possible physical findings indicative of atelectasis include splinting or elevation of the diaphragm, scattered rales, or diminished breath sounds with bronchial breathing over the affected area which are most commonly observed at the lung bases or posterior lung segments (Dunphy and Way, 1977). Aside from the shallow tidal ventilation and the decreased breath sounds, the patient may show no other signs of
respiratory problems. The diagnosis of atelectasis may be made on physical signs, but reliance is usually placed upon chest radiography. The collapse of tissue seen on the x-ray is of very low density, therefore a large area in the lung will produce only a small area of shadow. These microatelectatic areas are usually labelled as patchy or miliary atelectasis. Hence, the chest radiograph may not be a precise diagnostic tool for atelectatic changes either.

Specific measurements such as FRC and VC in the postoperative patient may provide valuable information as to the possible collapse of airways and resulting atelectatic changes which may occur. Many factors may influence the FRC in a normal person. Some of these factors are body size, age, and posture. In the postoperative patient, the four major factors which seem to influence the decrease in the FRC are site of surgical incision, posture, pain, and anesthesia. All tend to precipitate the shallow breathing pattern in these patients which leads to increasing closing volumes and atelectasis.

It has been demonstrated by Ferris and Pollard (1960) that normal, unanesthetized humans develop a progressive fall in compliance when breathing at normal but continuous regular tidal volumes for a short period of time. This decrease in compliance can be reversed when the subjects are allowed to ventilate larger tidal volumes. Thus, with deep breaths the lung becomes less stiff and the alveoli may be more adequately inflated. This finding has led to the use of periodic deep breathing exercises in postoperative patients to fully aerate alveoli and help reverse changes in compliance. Recently the use of sustained maximal inspiration therapy has been instituted as a respiratory
maneuver in treating postoperative patients. The key points of successful sustained maximal inspiration therapy are to generate enough transpulmonary pressure to achieve large inflating volumes and to maintain inspiration for several seconds. This therapy can be performed using either a deep breathing exerciser of some type or voluntary deep breathing with inspiratory hold by the patient. During this sustained inspiratory maneuver, alveoli may be hyperinflated and collapsed alveoli may be reinflated although definite clinical evidence of this hypothesis is not available.

Measurements of FRC and VC immediately after a sustained inspiratory maneuver may demonstrate increased volumes in the lungs. At present, there are no good data available on the degree or duration of increased lung volumes after a sustained inspiratory maneuver.

In summary, it may be beneficial to periodically increase the transpulmonary pressure and the FRC in the postoperative upper abdominal surgical patient by using a sustained inspiratory maneuver. Therefore, by increasing lung volumes in these patients, atelectasis may be minimized or prevented.

Definitions

1. Deep Breathing Exerciser: A deep breathing exerciser is a device used to assist a postoperative patient to periodically breathe deeply after surgery. The deep breathing exerciser used was a plastic device named the Triflo II Deep Breathing Exerciser and is manufactured by Chesebrough-Pond's Incorporated. The Triflo II visually encouraged the subject to take a deep breath and maintain a prolonged inspiratory
phase. This device consisted of three chambers or columns each containing a small, blue ball. The Triflo II was designed so that each ball represents an approximate flow rate or volume of air being inspired per second when the ball is raised to the top of its chamber. With this device the subject received visual feedback and his progress was determined by the number of balls raised and the length of time they were kept suspended in the chamber.

2. **Voluntary Deep Breathing with Inspiratory Hold:** Voluntary deep breathing with inspiratory hold is a maneuver used to assist a postoperative patient to periodically breathe deeply after surgery. The voluntary deep breathing with inspiratory hold treatment included verbal encouragement and manual assistance by the investigator to aid the subject to take a deep breath and to hold it for as long as possible. The investigator placed her hands on both sides of the subject's lower chest to encourage movement of the chest in this area. On expiration, the investigator applied slight pressure to help the subject facilitate expiration.

**Limitations**

This study was limited by the following factors:

1. There was varying ability of the surgical patient to take an adequate deep breath during the measurement of TLC. This problem of reproducibility of maximal effort during the measurement may be due to factors such as incisional discomfort.

2. Only one or two measurements of FRC and VC were made for the pretreatment, posttreatment, and 30 minute posttreatment measurements
due to the time factor for washout of the helium would not allow for checks of validity.

3. Generalizations from the study cannot be extended to a population other than the sample studied.
CHAPTER 2

REVIEW OF LITERATURE

A summary of the literature pertinent to (1) pulmonary complications after abdominal surgery, (2) effects of surgery on lung volumes, and (3) sustained inspiration respiratory maneuvers is presented.

Pulmonary Complications After Abdominal Surgery

Wightman (1968) did a prospective survey of the incidence of postoperative pulmonary complications. In this study he demonstrated that 49 of 785 general surgical operations under general anesthesia were followed by pulmonary complications. Criteria for a pulmonary complication included a productive cough with a fever of 99 degrees Fahrenheit or above with physical signs on examination of the chest which were not present preoperatively. Evidence was obtained that upper abdominal surgical procedures exhibited a higher incidence of pulmonary complications than did non-abdominal surgical procedures. These data also suggested that cigarette smoking and pre-existing chronic respiratory disease were significant factors in increasing the incidence of postoperative pulmonary complications.

Ali et al. (1975) assessed preoperative and postoperative spirometry on 48 patients undergoing elective surgery in order to determine whether the lung volume changes were related to the type of operation.
and if the location of incision influenced the incidence of pulmonary complications. The patients were divided into three groups: upper abdominal (19), lower abdominal (9), and superficial (20). In the measurement of FRC, the upper abdominal surgical group demonstrated a significant fall ($p < 0.01$) on day one postsurgery which persisted until day seven postsurgery when the FRC returned to the preoperative level. The upper abdominal surgical group also showed a significant fall in VC postoperatively which continued throughout the first seven postoperative days. Six pulmonary complications occurred in the patient population. Five occurred in the upper abdominal surgical patients and one in the superficial surgical patients. The criteria for postoperative pulmonary complications were temperature greater than 100.4 degrees Fahrenheit associated with an abnormal chest x-ray and abnormal auscultatory findings or dullness to percussion. Other clinical features such as sputum production, tachypnea or dyspnea were not considered diagnostic of a pulmonary complication unless accompanied by one of the above findings.

**Effects of Surgery on Lung Volumes**

In 1975, Meyers et al. measured FRC by closed circuit helium equilibration method before and for five days after upper abdominal operations in 28 subjects. Measurements were obtained with the subject both sitting in bed and sitting in a chair. Vital Capacity, RV, forced expiratory volume in one second, and the FRC all decreased after surgery with the maximum decrease on days one and two and a gradual return toward preoperative values by day five. This study found that subjects
with 40 percent or less decrease in FRC after surgery did not develop complications. The change in position from bed to chair increased FRC 14.2 percent preoperatively and 17 percent postoperatively.

Over a three month period, Latimer et al. (1971) studied 46 subjects undergoing upper abdominal surgery to determine the incidence of postoperative pulmonary complications. All subjects were examined daily by the same physician and posteroanterior x-rays of the chest were taken on the first and third postoperative days. Criteria for a pulmonary complication consisted of abnormal chest x-ray, fever, physical signs, and productive cough. Using the above criteria, the subjects were placed into four categories: normal, macroatelectasis, microatelectasis, and miscellaneous pulmonary complications. Of the sample of 46 subjects, 24 percent were classified as normal, 37 percent as macroatelectasis, 28 percent as microatelectasis, and 11 percent as miscellaneous. Measurements of forced vital capacity, forced expiratory volume in one second, carbon dioxide tension, oxygen saturation, and pH were taken preoperatively and postoperatively on these subjects. Postoperatively, the forced vital capacity and forced expiratory volume in one second were reduced by 65 percent and all subjects demonstrated hypoxemia. The authors concluded that impairment of preoperative pulmonary function studies, obesity, smoking, and prolonged anesthesia time increased postoperative pulmonary complications.

Alexander et al. (1972) studied the effect of upper abdominal surgery on the relationship of point of airway closure to FRC. Thirty-one subjects were studied postoperatively. Nineteen subjects showed a greater fall in FRC than in the closing volume in the first and second
postoperative days. This study suggests that in the postoperative abdom-
inal surgical patient closing volume may occur during resting ventilation
due to the reduced FRC. Thus, this increased closing volume may be a
contributing factor to the known hypoxemia following abdominal surgery.

**Sustained Inspiration Respiratory Maneuvers**

In this section various devices which encourage the patient to
sustain the inspiratory phase of a deep breath will be discussed. By
sustaining the inspiratory phase of a deep breath, greater transpul-
monary pressures are obtained and larger inflating volumes are achieved.

Bartlett et al. (1973) compared expiratory maneuvers, carbon
dioxide hyperventilation, IPPB, and sustained inspiration in an effort
to determine the ideal respiratory maneuver to aid in the prevention of
postoperative pulmonary complications. Bartlett concluded that sustained
inspiration maneuvers do allow for a maximum inhaled volume and achieve
high inflating pressures for a longer period of time than do the other
maneuvers. This study also contended that sustained inspiration maneu-
vers have consistently been shown to decrease pulmonary complications.

Van De Water et al. (1972) studied 30 subjects undergoing bi-
lateral adrenalectomy. The postoperative use of IPPB was compared to
the incentive spirometer. The study suggests that the incentive spi-
rometer is somewhat more effective than IPPB in preventing postoperative
pulmonary complications. Interestingly enough, Van De Water also stated
that the incentive spirometer was perhaps the best substitute for the
physiotherapist, physician or nurse who could not always be present to
encourage the patient to inhale deeply.
Ward et al. (1966) studied 10 unmedicated, healthy adults who were ambulatory. The study attempted to delineate the effects upon the arterial oxygen and carbon dioxide tensions of a deep breath, a deep breath held for three seconds, and multiple deep breaths. This study found that the oxygen tension was higher following breath holding than after a deep breath, and in eight out of 10 instances, the arterial oxygen tension was higher following a deep breath held than after multiple deep breaths. These findings suggest that a deep breath which is held is the most efficient way in which the body has to reduce the amount of atelectasis. A deep breath taken which is not held or multiple deep breaths taken are less efficient in preventing atelectasis.

Gale and Sanders (1977) assessed the effectiveness of the Bartlett-Edwards incentive spirometer as part of the postoperative treatment of 34 subjects after open-heart surgery. Its effects on atelectasis were assessed by measuring VC, arterial oxygen tensions, clinical signs, and graphic radiological signs. This study found that the VC fell after surgery to 41.5 percent of the preoperative level but rose 19.4 percent with the first treatment and 11.6 percent with the second treatment of the incentive spirometer as compared to the pre-treatment postoperative VC measurement. Arterial oxygen tensions were unaltered by the use of the incentive spirometer.

Gale (1978) compared the effectiveness of the Bartlett-Edwards incentive spirometer and IPPB treatments on 107 subjects after cardiopulmonary bypass surgery. Vital capacities before and after treatment and arterial oxygen tensions before, 10, and 60 minutes after treatment were measured. This study showed that the arterial oxygen tension falls
initially posttreatment after both the incentive spirometer and IPPB, but a smaller amount after the incentive spirometer as compared to IPPB. After the second treatment with incentive spirometry, the arterial oxygen tension rose 4.2 percent as compared with the pretreatment value. However, the blood gases on room air and x-ray evidence of atelectasis differed little between the incentive spirometer and IPPB groups. Gale states that the incentive spirometer has a small effect in preventing hypoxemia after cardio-pulmonary bypass surgery. Gale also contends that the incentive spirometer may be less effective after cardio-pulmonary bypass surgery than after laparotomy. He states that this may be related to the greater physiological impairment after cardio-pulmonary bypass surgery as compared to laparotomy.

Craven et al. (1974) studied 70 postoperative upper abdominal surgical patients. These patients were divided into two equal groups. One group received incentive spirometry postoperatively and the other group received routine chest physiotherapy. The type of chest physiotherapy was not defined in the study. The patients in the spirometry group received no chest physiotherapy, but instead were instructed in the use of the spirometer preoperatively and practiced its use. The physiotherapy group received the usual preoperative and postoperative therapy. This study suggests that the overall pulmonary complication rate, as measured by physical and radiological findings, was significantly reduced in the spirometer group as compared to routine chest physiotherapy.

Leigh et al. (1978) studied 145 patients who were treated with either IPPB, blow bottles, or incentive spirometry following cardiac
surgery. Pulmonary complications occurred in 30 percent of the patients receiving IPPB, 15 percent of those using an incentive spirometer, and eight percent of those using blow bottles. Gastrointestinal side effects occurred in 20 percent of the IPPB group and were rare in the other groups. Leigh et al. concluded that IPPB is not essential in prevention of atelectasis in postoperative cardiac surgical patients and may be inferior to other methods.

Dohi and Gold (1978) studied 64 postoperative abdominal surgical patients and their response to two techniques of respiratory care: the Triflo II Deep Breathing Exerciser and IPPB. They concluded that there were no significant difference (p<0.051) between the two methods of respiratory care, but 57 percent in the group receiving therapy with IPPB developed pneumonia, atelectasis, or bronchitis, while only 29 percent did so in the Triflo II group. Principal conclusions were that the deep breathing exerciser was equal to episodic therapy with IPPB and from an economic standpoint IPPB may be disadvantageous when compared to the cost of the deep breathing exerciser.
CHAPTER 3

METHODOLOGY

In this chapter the research design, sample, treatments, measurements, methodology, and analysis of the data are presented.

Research Design

An experimental research design was used to study the effects of the deep breathing exerciser versus voluntary deep breathing with inspiratory hold on the FRC and VC in postoperative upper abdominal surgical patients. Measurements were taken during the first 48 to 72 hours after surgery. Due to the variability between subjects, each individual served as his own control and the data were analyzed in terms of percent change from base line.

Sample

Eight subjects were selected from the surgical population of patients in two southwestern hospitals. The subjects chosen agreed to participate in the study and met the criteria listed below to be included in the sample.

Criteria for inclusion in the study were that the subjects:
1. had upper abdominal surgery
2. were alert and able to communicate using the English language
3. had received no continuous mechanical ventilation beyond the first eight hours of the postoperative period
4. could have received pain medication 30 minutes to one hour prior to the treatment, but had not received pain medication during the treatment and measurement period.

Preferably, subjects who met the above criteria were approached prior to surgery and the purpose and nature of the study were explained. If the investigator was unable to contact a subject preoperatively, a subject was asked postoperatively for his consent to participate. Subjects who consented to participate were informed of what their participation would involve and were given the Subject's Consent Form to sign (see Appendix A).

Treatments

Subjects were randomly assigned to first receive the voluntary deep breathing treatment with inspiratory hold or the deep breathing exerciser treatment. There was a three to five hour time lapse between each treatment and its respective measurements.

Deep Breathing Exerciser

The treatment with the deep breathing exerciser was performed using the Triflo II Deep Breathing Exerciser manufactured by Chesebrough-Pond's Incorporated. This plastic device consisted of three chambers each containing a small, blue ball. The Triflo II Exerciser was designed so that each ball represented an approximate volume of air being inspired per second when the ball was raised to the top of its chamber. By raising ball one to the top of its chamber, approximately 600 milliliters of air per second was being inspired by the patient. Ball two
and three represented 900 milliliters and 1200 milliliters of air per second respectively. The patient's progress was determined by the number of balls raised and the length of time they were kept suspended in the chamber.

Connected to the side of the device was a length of plastic tubing of approximately 12 inches with a mouthpiece attached. With the subject in a semi-Fowler's position in the bed and holding the Triflo II Exerciser in an upright position at approximately chest level, the subject was instructed to first exhale and inhale normally for two breaths and then place his lips tightly around the mouthpiece. The subject was then instructed to inhale at a sufficient inspiratory flow rate to keep as many of the balls suspended for as long as possible. This sustained inspiratory maneuver using the Triflo II Exerciser was repeated for five deep breaths.

**Voluntary Deep Breathing with Inspiratory Hold**

The voluntary deep breathing with inspiratory hold treatment was done with verbal encouragement and manual assistance from the investigator. With the subject in a semi-Fowler's position in the bed, the investigator situated herself standing next to the bed lateral to the patient. The investigator then instructed the patient on how to breathe deeply and to maintain an inspiratory hold for as long as possible. Next, the investigator placed her hands on both sides of the lower chest to encourage movement of the chest in this area as upper abdominal surgical patients tend to utilize a lateral thoracic pattern of breathing.
The subject was instructed to try to take a deep enough breath to move the investigator's hands laterally. With the investigator's hands in place, the subject was instructed to breathe normally for two complete breaths. Then, with the encouragement of the investigator he was instructed to take a deep breath and hold this for as many beats as possible. During inspiration the investigator articulated a rhythmic counting pattern. During the subject's expiratory phase, the investigator exerted slight pressure on the lower chest with her hands to facilitate expiration. Five deep breaths with inspiratory hold constituted this treatment.

**Measurements**

Measurements of functional residual capacity (FRC) and vital capacity (VC) were obtained using the helium equilibration or helium dilution method. This method involved having the subject breathe a mixture of 10 to 13 percent helium in oxygen from a closed spirometer for up to 12 minutes. The helium dilution system consisted of a portable Collins 13.5 liter Spirometer with a blower system to insure rapid mixing of the helium and oxygen. A helium analyzer permitted continuous analysis of the helium concentration inside the spirometer.

After the initial setting up and calibration of the system was completed, approximately three liters of oxygen was added to the closed system. Next, one liter of helium was added to the system to create a helium concentration of 10 to 13 percent as recorded by the helium analyzer. This helium concentration percentage was then recorded on the data sheet as the initial helium reading. At this time the subject
was instructed to tightly seal his mouth around the mouthpiece and a noseclip was applied. The subject was instructed to breathe normally. The subject was not asked to take a deep breath at this time as in a normal VC measurement as this would alter the base line for the FRC. After approximately two or three tidal breaths, the free breathing valve to the spirometer was then closed by the investigator at the end of the subject's observed expiratory phase. The subject was then breathing the helium-oxygen gas mixture. As the subject continued to breathe normally, oxygen was added to the system by the investigator to keep the volume of gas in the spirometer constant. During this period of normal breathing, helium percentages were recorded by the investigator at 30 second intervals until duplicate readings were obtained. This indicated complete mixing of the helium in the subject's lungs. Once the equilibration had occurred, the helium concentration was then recorded as the final helium concentration. Equilibration should occur in approximately three to five minutes. An increase in equilibration time indicates an uneven distribution of ventilation in the subject's lungs.

After equilibration had been recorded, the subject was then instructed to inhale as deeply as possible and then exhale as much of the air as possible out of his lungs (to residual volume). The subject then had the noseclip removed and was finished with the measurement.

For the measurement of FRC, the subject began breathing on the spirometer at the end of a normal breath (at FRC) and breathed normally without ever expanding the chest cavity to include the inspiratory capacity. Therefore, the volume of helium mixture in the subject's
lungs being calculated by the initial and final helium concentrations was the FRC. This calculation was obtained by the formula shown in Figure 1. The VC was measured and calculated from the readings obtained from the kymograph paper.

It is preferable that the measurement of FRC by helium dilution be performed three times allowing 10 to 20 minutes between trials to allow for elimination of residual helium from the lungs. Due to the time limitation of this study, only one or two measurements were made before, after, and 30 minutes after each treatment. In the event that two measurements of FRC or VC were taken before, after, or 30 minutes after a treatment, the average of these measurements was recorded for use in data analysis.

Methodology

The treatment protocol outlined below was followed for each subject. The sequence of treatment order was determined earlier by random assignment of the subjects.

1. Fifteen to 30 minutes prior to the treatment, a FRC and VC measurement were obtained using the Collins 13.5 liter Spirometer by the multiple breath helium dilution method with the subject in the semi-Fowler's position.

2. The subject was then instructed to perform the deep breathing exerciser treatment with the Triflo II or the voluntary deep breathing exercise for a total of five maneuvers while in the semi-Fowler's position.
Figure 1. Formula Used for Calculation of Functional Residual Capacity (FRC) Using the Multiple Breath Helium Dilution Method

\[
\text{FRC} = \frac{\text{Helium added in milliliters}}{\text{Initial Helium(\% concentration)}} \times \frac{\text{Initial Helium(\% concentration)} - \text{Final Helium(\% concentration)}}{\text{Final Helium(\% concentration)}} + \text{"Turn In" Temperature Correction} - 100 \text{ milliliters}
\]
3. Immediately after the treatment was performed, a FRC and VC measurement were obtained using the multiple breath helium dilution method with the subject in the semi-Fowler's position.

4. The subject was instructed to remain in bed until the final measurements were taken (in approximately 30 minutes).

5. The 30 minute measurement (calculated from the end of the treatment regime) was obtained by the multiple breath helium dilution method with the subject in the semi-Fowler's position.

This protocol was again used three to five hours later using the alternately described treatment maneuver.

**Data Analysis**

The Wilcoxon Matched-Pairs Signed-Ranks test (Hollander and Wolfe, 1973) was used to analyze the data obtained pretreatment, posttreatment, and 30 minutes posttreatment for both the deep breathing exerciser and the voluntary deep breathing with inspiratory hold treatment. The percent predicted measurements of FRC and VC were compared pretreatment to posttreatment and pretreatment to 30 minutes posttreatment for each deep breathing treatment. Then, the deep breathing exerciser results were compared with the voluntary deep breathing with inspiratory hold results.

Two other statistical tests were also used to analyze the data. Gart's test for order effect (Everitt, 1977) was used to test if the order in which a subject received the breathing exercises had any effect on the pretreatment to posttreatment changes in percent predicted FRC or
VC. Fisher's Exact test (Everitt, 1977) was also used to test if the variables of smoking history, sex, age, or type of surgery were dependent or independent of the results obtained for the pretreatment to posttreatment changes of percent predicted FRC and VC for either the deep breathing exerciser or the voluntary deep breathing treatment.
CHAPTER 4

PRESENTATION AND ANALYSIS OF DATA

Characteristics of the Sample

The sample consisted of eight subjects all of whom had undergone an upper abdominal surgical procedure. The total group consisted of five females and three males whose ages ranged from 28 to 60 years of age with a mean age of 39.4 years. Four of the subjects had a history of smoking with a range of a 10 to 45 pack year history. These four subjects were currently smokers prior to their surgery. According to the radiology reports, six of the subjects had normal chest x-rays prior to surgery; subject two had an old calcified lesion in the periphery of the right upper lobe and subject seven had evidence of recent pulmonary parenchymal or pleural disease. Subjects two and eight had preoperative pulmonary function screening tests, while the other subjects had no reported past or present pulmonary function testing on their charts. None of the subjects had a documented history of lung disease of any type. All of the subjects received anesthesia via an endotracheal tube; the duration of the anesthesia ranged from 180 to 395 minutes with a mean of 298.8 minutes. The anesthetic agents used were similar for all subjects. At the time of the study, all subjects were ambulatory to the bathroom or in the hospital corridors with help and none were receiving supplemental oxygen. The subjects were studied
anywhere from 49 to 66 hours after surgery with a mean of 67.6 hours. Table 1 gives a summary of the characteristics of the sample.

**Statistical Analysis**

Pretreatment, posttreatment, and 30 minute posttreatment measurements of FRC and VC were obtained on each subject for each treatment session (see Raw Data in Appendices F and G). Five subjects had one measurement of FRC and VC taken pretreatment, posttreatment, and 30 minutes posttreatment for each respiratory maneuver. Three subjects had two measurements of FRC and VC taken pretreatment for each respiratory maneuver and one measurement of FRC and VC posttreatment and 30 minutes posttreatment. In the case of two measurements of FRC and VC being taken pretreatment, the average of the two measurements for FRC and VC were used in data analysis. The range in the difference between the two FRC measurements pretreatment for the subjects was 58 to 150 cubic centimeters. For the VC measurement, the range in the difference between the two measurements was 25 to 50 cubic centimeters. Data obtained from the pretreatment measurements, immediate posttreatment, and 30 minute posttreatment measurements were reported as percent predicted based on the predicted normals for each subject in accordance with their sex, age, and height (Bates et al., 1971, pp. 93-94). Tables 2 and 3 show all results in percent predicted calculations. All subsequent data analyses were done in terms of percent predicted.

**Pretreatment Results**

The deep breathing exerciser pretreatment FRC measurements were markedly reduced from predicted normals with a range of 39.5 to 96.3
Table 1. Characteristics of Subjects--Age, Sex, Height, Weight, Smoking History, Duration of Anesthesia, Type of Surgery, and Number of Hours After Surgery When Study was Conducted

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>Sex</th>
<th>Ht. (cm.)</th>
<th>Wt. (Kg)</th>
<th>Smoking History</th>
<th>Duration of Anesthesia (min)</th>
<th>Type of Surgery</th>
<th>Hours After Surgery</th>
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<td>175</td>
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<td>Exploratory Laporotomy</td>
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<tr>
<td>2</td>
<td>28</td>
<td>F</td>
<td>165</td>
<td>99.5</td>
<td>no</td>
<td>370</td>
<td>Gastroplasty</td>
<td>54</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>F</td>
<td>155</td>
<td>81.8</td>
<td>yes 10 year</td>
<td>285</td>
<td>Cholecystectomy</td>
<td>49</td>
</tr>
<tr>
<td>4</td>
<td>49</td>
<td>M</td>
<td>185</td>
<td>89.8</td>
<td>yes 45 pack years</td>
<td>395</td>
<td>Cholecysto-jejunostomy</td>
<td>66</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
<td>F</td>
<td>173</td>
<td>133.0</td>
<td>no</td>
<td>370</td>
<td>Gastroplasty</td>
<td>51</td>
</tr>
<tr>
<td>6</td>
<td>30</td>
<td>M</td>
<td>175</td>
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<td>yes 12.5 pack years</td>
<td>285</td>
<td>Cholecystectomy</td>
<td>64</td>
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<tr>
<td>7</td>
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<td>F</td>
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<td>Cholecystectomy</td>
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<tr>
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<td>F</td>
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<td>180</td>
<td>Gastroplasty</td>
<td>49</td>
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</table>
Table 2. Percent Predicted FRC for All Subjects--Pretreatment, Posttreatment, and 30 Minute Posttreatment Percent Predicted FRC for Each Subject During the Deep Breathing Exerciser Treatment and the Voluntary Deep Breathing with Inspiratory Hold Treatment

Deep Breathing Exerciser Treatment

<table>
<thead>
<tr>
<th>Subject</th>
<th>Pretreatment Percent Predicted</th>
<th>Posttreatment Percent Predicted</th>
<th>30 Minute Percent Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>95.2</td>
<td>148.0</td>
<td>150.0</td>
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<tr>
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<td>53.1</td>
<td>41.6</td>
<td>42.0</td>
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<tr>
<td>4</td>
<td>57.4</td>
<td>63.1</td>
<td>65.4</td>
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<tr>
<td>5</td>
<td>39.5</td>
<td>48.0</td>
<td>45.1</td>
</tr>
<tr>
<td>6</td>
<td>44.7</td>
<td>43.0</td>
<td>41.4</td>
</tr>
<tr>
<td>7</td>
<td>53.1</td>
<td>48.6</td>
<td>47.7</td>
</tr>
<tr>
<td>8</td>
<td>96.3</td>
<td>105.0</td>
<td>99.1</td>
</tr>
</tbody>
</table>

Voluntary Deep Breathing with Inspiratory Hold Treatment

<table>
<thead>
<tr>
<th>Subject</th>
<th>Pretreatment Percent Predicted</th>
<th>Posttreatment Percent Predicted</th>
<th>30 Minute Percent Predicted</th>
</tr>
</thead>
<tbody>
<tr>
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<td>143.0</td>
<td>125.0</td>
<td>148.0</td>
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<tr>
<td>2</td>
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<td>39.9</td>
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<td>64.2</td>
<td>61.4</td>
<td>51.3</td>
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<tr>
<td>5</td>
<td>44.8</td>
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<td>31.3</td>
<td>40.1</td>
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<tr>
<td>7</td>
<td>53.5</td>
<td>56.0</td>
<td>51.9</td>
</tr>
<tr>
<td>8</td>
<td>98.6</td>
<td>109.1</td>
<td>112.0</td>
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</table>
Table 3. Percent Predicted VC for All Subjects—Pretreatment, Posttreatment, and 30 Minute Posttreatment Percent Predicted VC for Each Subject During the Deep Breathing Exerciser Treatment and the Voluntary Deep Breathing with Inspiratory Hold Treatment

### Deep Breathing Exerciser Treatment

<table>
<thead>
<tr>
<th>Subject</th>
<th>Pretreatment Percent Predicted</th>
<th>Posttreatment Percent Predicted</th>
<th>30 Minute Percent Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>43.8</td>
<td>53.3</td>
<td>50.7</td>
</tr>
<tr>
<td>2</td>
<td>22.8</td>
<td>19.0</td>
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<tr>
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<td>47.8</td>
<td>51.8</td>
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<td>66.7</td>
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<tr>
<td>8</td>
<td>59.3</td>
<td>55.3</td>
<td>63.2</td>
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### Voluntary Deep Breathing with Inspiratory Hold Treatment

<table>
<thead>
<tr>
<th>Subject</th>
<th>Pretreatment Percent Predicted</th>
<th>Posttreatment Percent Predicted</th>
<th>30 Minute Percent Predicted</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>56.9</td>
<td>46.0</td>
<td>57.3</td>
</tr>
<tr>
<td>2</td>
<td>24.5</td>
<td>19.0</td>
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<td>47.6</td>
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<td>52.0</td>
<td>56.0</td>
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<td>57.0</td>
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<td>8</td>
<td>51.4</td>
<td>63.2</td>
<td>57.7</td>
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</table>
percent predicted and a mean of 60.0 percent. The range for the pre-
treatment measurements of FRC with the voluntary deep breathing treat-
ment were 31.8 to 143.0 percent predicted with a mean of 64.6 percent.
Using the Wilcoxon Matched-Pairs Signed-Ranks test (Hollander and Wolfe,
1973), there was no significant difference (p = .546) between the pre-
treatment measurements of percent predicted FRC before the deep breath-
ing exerciser and the voluntary deep breathing with inspiratory hold
treatment.

Pretreatment VC measurements were also markedly reduced from
predicted normals for both treatments. The deep breathing exerciser
treatment had a pretreatment VC range of 22.8 to 66.7 percent predicted
and a mean of 45.4 percent; the voluntary deep breathing treatment had
a VC range of 24.5 to 57.1 percent predicted with a mean of 45.0 percent.
Using the Wilcoxon Matched-Pairs Signed-Ranks test (Hollander and Wolfe,
1973), there was no significant difference (p = .946) between the pre-
treatment measurements of percent predicted VC for each respiratory
maneuver.

Posttreatment Results

The FRC measurements immediate posttreatment remained similar
to the pretreatment values after the deep breathing exerciser treatment
and the voluntary deep breathing treatment. Immediate posttreatment
measurements of FRC after the deep breathing exerciser treatment had a
range from 36.6 to 148.0 percent predicted with a mean of 66.7 percent.
Functional residual capacity measurements after the use of the voluntary
depth breathing treatment with inspiratory hold ranged from 31.3 to 125.0
percent predicted and a mean of 64.0 percent. The range for the difference between the pretreatment and posttreatment measurements after the use of the deep breathing exerciser was -11.5 to +52.8 percent predicted FRC with a mean of +6.8 percent. With the voluntary deep breathing treatment, the range for the difference between the pretreatment and posttreatment measurements was -18.0 to +10.5 percent predicted FRC and a mean of +1.0 percent. Using the Wilcoxon Matched-Pairs Signed-Ranks test (Hollander and Wolfe, 1973), there was no significant difference between the pretreatment and posttreatment measurements of percent predicted FRC after the use of the deep breathing exerciser (p = .273) or the voluntary deep breathing treatment (p = .234). There was also no significant difference (p = .273) between the posttreatment measurements of percent predicted FRC for either treatment. It should be noted that subject one exhibited much higher percent predicted FRC measurements (range 95.2 to 150.0 percent) as compared to the other seven subjects in the study (range 31.3 to 112.0 percent) both immediately posttreatment and at 30 minutes posttreatment after the use of both treatments.

Vital capacity measurements immediate posttreatment remained similar to the pretreatment values after both the deep breathing exerciser treatment and the voluntary deep breathing treatment. The VC measurement immediately after the use of the deep breathing exerciser ranged from 19.0 to 67.6 percent predicted with a mean of 46.9 percent. After the use of the voluntary deep breathing treatment with inspiratory hold, the range of percent predicted VC was 19.0 to 67.9 percent with a mean of 47.1 percent. The range for the difference between the pretreatment and posttreatment percent predicted VC measurements after the
use of the deep breathing exerciser was -5.2 to +9.5 percent with a mean of +0.9 percent. With the voluntary deep breathing treatment, the range for the difference between the pretreatment and posttreatment measurements was -10.9 to +11.8 percent predicted VC and a mean of +2.1 percent. Using the Wilcoxon Matched-Pairs Signed-Ranks test (Hollander and Wolfe, 1973), there was no significant difference between the pretreatment and posttreatment measurements of percent predicted VC after the use of the deep breathing exerciser \((p = .397)\) or the voluntary deep breathing with inspiratory hold treatment \((p = .252)\). Also, there was no significant difference \((p = .234)\) between the posttreatment measurements of percent predicted VC for either treatment.

It had been hypothesized that both voluntary deep breathing with inspiratory hold and the deep breathing exerciser treatment would result in significant increases in the FRC and VC as compared to the pretreatment measurements. Findings demonstrated that there was no significant difference between pretreatment and posttreatment measurements of percent predicted FRC following the use of the deep breathing exerciser \((p = .273)\) or the voluntary deep breathing treatment \((p = .234)\). Also, there was no significant difference in pretreatment and posttreatment percent predicted VC following the use of the deep breathing exerciser \((p = .397)\) or the voluntary deep breathing treatment \((p = .252)\). Thus, the hypothesis that both treatments would result in significant increases in FRC and VC in the postoperative upper abdominal surgical patient was rejected.

The deep breathing exerciser treatment had been hypothesized to result in a greater increase in FRC and VC immediately posttreatment as
compared to the voluntary deep breathing with inspiratory hold treatment. Findings revealed no significant difference between pretreatment and immediate posttreatment measurements of percent predicted FRC \((p = .273)\) or VC \((p = .234)\) in comparing either treatment. Therefore, the hypothesis that the deep breathing exerciser treatment would result in a significant increase in FRC and VC posttreatment as compared to the voluntary deep breathing with inspiratory hold treatment was rejected.

**Thirty Minute Posttreatment Results**

The FRC measurements at 30 minutes after the use of the deep breathing exerciser ranged from 35.9 to 150.0 percent predicted with a mean of 65.8 percent. Measurements of FRC 30 minutes after the use of the voluntary deep breathing treatment ranged from 31.3 to 148.0 percent predicted with a mean of 64.8 percent. The range for the difference between pretreatment and 30 minute posttreatment measurements after the use of the deep breathing exerciser was \(-11.1\) to \(+8.0\) percent predicted FRC with a mean of \(+5.9\) percent. With the voluntary deep breathing treatment, the range for the difference between pretreatment and 30 minute posttreatment measurements was \(-12.9\) to \(+13.4\) percent predicted FRC with a mean of \(+0.3\) percent. The Wilcoxon Matched-Pairs Signed-Ranks test (Hollander and Wolfe, 1973) demonstrated no significant difference between the pretreatment and 30 minute posttreatment measurements of percent predicted FRC for either the deep breathing exerciser treatment \((p = .844)\) or the voluntary deep breathing with inspiratory hold treatment \((p = .946)\).
The percent predicted VC measurement 30 minutes after either
treatment showed no significant change from the pretreatment values of
percent predicted VC. The VC measurements 30 minutes after the use of
the deep breathing exerciser ranged from 23.1 to 67.6 percent predicted
with a mean of 47.6 percent. Measurements of VC 30 minutes after use
of the voluntary deep breathing treatment ranged from 20.4 to 70.2 per-
cent predicted and a mean of 46.4 percent. With the deep breathing
exerciser treatment, the range for the difference between pretreatment
and 30 minute posttreatment percent predicted VC was -1.6 to +10.1
with a mean of +2.5 percent. The range for the difference between the
pretreatment and 30 minute posttreatment percent predicted VC after the
use of the voluntary deep breathing treatment was -7.0 to +13.1 percent
predicted with a mean of +1.4 percent. Using the Wilcoxon Matched-
Pairs Signed-Ranks test (Hollander and Wolfe, 1973), there was no sig-
nificant difference between the pretreatment and 30 minute posttreatment
measurements of percent predicted VC for either of the deep breathing
exerciser (p = .078) or the voluntary deep breathing treatment (p =
1.00).

It was hypothesized that neither the deep breathing exerciser
nor the voluntary deep breathing treatment with inspiratory hold would
show sustained increase in FRC or VC at 30 minutes after the initial
treatment as compared to the pretreatment values. Findings demonstrated
no significant change between the percent predicted measurements of FRC
or VC pretreatment, posttreatment, or 30 minutes posttreatment after
using either the deep breathing exerciser or the voluntary deep breath-
ing with inspiratory hold treatment. Therefore, the hypothesis that
neither the deep breathing exerciser nor the voluntary deep breathing treatment with inspiratory hold would show sustained increase in FRC or VC at 30 minutes posttreatment was rejected since there was no increase in either percent predicted FRC or VC immediately posttreatment with either respiratory maneuver.

**Order of Treatment Results**

Using Gart's test for order effect (Everitt, 1977), the treatment order for all subjects was analyzed in an attempt to distinguish whether treatment order had any effect on the results obtained. It was demonstrated that there was no significant difference ($p = .5$) in the percent predicted FRC measurements obtained between the group which received the deep breathing exerciser treatment first or the group which received the voluntary deep breathing treatment first. It was also found that the order of treatments had no effect on the change of percent predicted VC from the base line to the posttreatment measurement ($p = .33$).

**Other Variables**

Four of the eight subjects were smokers. All were presently smoking prior to surgery. Using Fisher's Exact test (Everitt, 1977), it was demonstrated that there was no significant difference in the percent predicted changes in FRC from pretreatment to posttreatment using the deep breathing exerciser treatment ($p = .143$) or the voluntary deep breathing treatment ($p = .243$) in comparing the smoking and nonsmoking subjects. The percent predicted changes in VC from pretreatment to posttreatment were also found to be nonsignificant when comparing the
smoking group and nonsmoking group after the use of either the deep breathing exerciser treatment \((p = .5)\) or the voluntary deep breathing treatment \((p = .429)\). Thus, it was found that pretreatment to post-treatment changes in percent predicted FRC and VC using either maneuver were independent of the variable of smoking.

The stimulation of a cough following the use of the deep breathing exerciser or the voluntary deep breathing with inspiratory hold treatment followed no appreciable pattern in this study. Two subjects coughed after the deep breathing exerciser treatment. One had a productive cough, while the other had a nonproductive cough. The same was true for the voluntary deep breathing with inspiratory hold treatment. These were different subjects from those who coughed following the use of the deep breathing exerciser.

Using Fisher's Exact test (Everitt, 1977), sex, age and the different types of surgery were analyzed to see if they contributed to the results obtained after either the deep breathing exerciser treatment or the voluntary deep breathing with inspiratory hold treatment. It was found that pretreatment, posttreatment, and 30 minute posttreatment changes in percent predicted FRC and VC for either respiratory maneuver were independent of the variables of sex, age, or type of surgical procedure.

**Summary**

The Wilcoxon Matched-Pairs Signed-Ranks test (Hollander and Wolfe, 1973) revealed no significant differences in the responses of individual subjects to either the deep breathing exerciser treatment
or the voluntary deep breathing with inspiratory hold treatment. The changes from pretreatment percent predicted FRC or VC to immediate post-treatment or 30 minutes posttreatment showed no significant differences for either deep breathing maneuver. Therefore it was demonstrated in this study that neither treatment showed any significant effect on increasing the percent predicted FRC or VC as compared to pretreatment baseline data.

Using Gart's test for order effect (Everitt, 1977), it was demonstrated that the order in which a subject received the deep breathing exerciser treatment or voluntary deep breathing treatment had no effect on the pretreatment to posttreatment change of percent predicted FRC or VC. Also, changes in percent predicted FRC and VC after either treatment were independent of the variables of sex, age, or type of surgical procedure.
CHAPTER 5

DISCUSSION AND CONCLUSIONS

The findings of this study are compared and contrasted with those of other investigators and the mechanisms which may have contributed to the findings will be suggested. The implications for health professionals directly responsible for postoperative care are discussed. Lastly, recommendations are made for further study on the effects of respiratory maneuvers in postoperative care.

Postoperative Lung Volumes

As found in previous investigations (Ali et al., 1975; Meyers et al., 1975), postoperative lung measurements of FRC and VC 48 to 72 hours after surgery are reduced as compared to predicted normals or preoperative measurements. Ali et al. (1975) demonstrated a fall in FRC and VC in subjects who had undergone upper abdominal surgical procedures as compared to their preoperative measurements. The 19 subjects with upper abdominal surgery demonstrated a significant fall in FRC ($p < 0.01$) on day one after surgery which persisted until day seven when it returned to the preoperative level. In 11 of these 19 subjects, the FRC did not change significantly in the first 12 hours postoperatively, but there was a distinct fall 16 to 20 and 22 to 24 hours after surgery ($p < 0.05$). Changes after the first 24 hour postoperative period were not noted in this study. Ali et al. (1975) also measured VC
preoperatively and postoperatively in these 19 subjects. The upper abdominal group had a significant decrease \( (p \leq 0.01) \) during the first seven postoperative days. The greatest decrease in VC was seen four to eight hours after surgery when the mean decrease was 63 percent of the preoperative value. The range of the mean percent change in VC through the first seven postoperative days was -26 to -63 percent of the preoperative value. Ali et al. (1975) stated that not all patients with significant depression of the VC showed a corresponding fall in FRC, but those with the greatest fall in VC did show a significant fall in FRC.

Meyers et al. (1975) also found that the FRC was markedly reduced postoperatively as compared to preoperative values with the maximum reduction occurring on the first postoperative day. On postoperative day one, the FRC measured 69.3 percent of the preoperative value, day two 74.4 percent, day three 82.8 percent, and day five 90.5 percent. Thus in a majority of the subjects, there was a progressive return of the FRC to the preoperative values by the fifth postoperative day. Five of the 28 subjects who developed severe reductions in FRC (48 to 58 percent) on postoperative day one were found to have obvious clinical manifestations of pulmonary dysfunction (temperature elevation, abnormal chest x-ray, hypoxemia) and were slow to return to their preoperative FRC values. Meyers et al. (1975) noted that three of these five subjects with complications were markedly overweight and over the age of 50 years. Similar to the FRC findings, the VC in the 28 subjects showed a decrease following surgery as compared to preoperative measurements. The maximum changes in VC (mean 46.4 percent of preoperative
value) occurred during the first postoperative day. On day two and three postoperatively, the mean VC of the 28 subjects remained at 51.4 to 60.0 percent of preoperative values.

In the present study, postoperative measurements of FRC and VC were markedly reduced as compared to predicted normals for subjects. The mean FRC ranged from 60.0 to 64.6 percent predicted and the VC ranged from 45.0 to 45.4 percent predicted prior to receiving either respiratory maneuver. These FRC findings were lower as compared to predicted normals than were Meyer's findings at 48 to 72 hours which were reported in terms of percent of preoperative value. The VC measurements as compared to predicted normals were also slightly lower than Meyer's findings of VC findings during this same period. It must be noted that Meyer's findings were reported in terms of percent of preoperative values while the present study was reported in terms of percent predicted of normal values.

Several factors may be suggested as contributing to the lowered percent predicted FRC and VC measurements. In the present study, the reduced percent predicted FRC and VC may be attributed to those factors which commonly alter ventilation in the postoperative upper abdominal surgical patient. In the postoperative patient, the shallow pattern of ventilation is most commonly caused by the incisional site, narcotics, pain, and the lack of ambulation. The maintenance of a shallow breathing pattern in turn causes poor or incomplete alveolar inflation. Ultimately, this incomplete alveolar inflation progresses to atelectasis and pulmonary complications. Other factors which may predispose a patient to a more shallow pattern of breathing and pulmonary complications are age, obesity, cigarette smoking, and sex.
In the present study all subjects had undergone upper abdominal surgical procedures. Upper abdominal surgical procedures have been demonstrated to have a higher rate of pulmonary complications (Wightman, 1968). Due to the proximity of the incisional site to the diaphragm, a shallower breathing pattern is adapted by the patient because of the pain which is caused by a deep inspiration. Thus, due to the alteration in the breathing pattern and lack of the normal sighing pattern in breathing, this facilitates the progression of atelectasis or collapse of one or more alveoli. Pain as a factor affecting the breathing pattern cannot be directly assessed in the present study population. The frequency at which the subjects were receiving pain medications was not noted. All subjects had pain medications of Morphine Sulfate or Demerol available to them every three to four hours for pain. When the FRC and VC measurements were taken on these subjects, they had received pain medications either intravenously or intramuscularly anywhere from two to 12 hours prior to the measurements. Whether the pain medications had any effect on the pattern of ventilation or the subjects' ability reproduce a maximal effort with each FRC and VC measurement was not known. At the time of this study, all subjects were ambulatory. The amount of ambulation and ambulation in relation to the time of the FRC and VC measurements may have had some bearing on the measurements obtained. Subjects were instructed to stay in bed after the first pretreatment measurement for each respiratory maneuver, but the time of ambulation prior to participating in the study was not known. Ambulation stimulates the patient to breathe more deeply, thus this may help to reinflate collapsed or
atelectatic alveoli and assist in the prevention of postoperative complications.

In this study, three of the eight subjects were morbidly obese and had undergone Gastroplasty for this condition. It has been suggested that perhaps the characteristic of obesity may have attributed to the decreased percent predicted FRC and VC measurements which were obtained (Meyers et al., 1975). Obese individuals usually have reduced lung volumes as compared to predicted normals because of the restriction in movement of the thorax due to excessive weight and the increased work of breathing. The mean percent predicted FRC and VC for these three individuals pretreatment were 60.0 and 46.9 percent, respectively. These were similar to those mean percent predicted values of FRC and VC, 63.5 and 50.4 percent, found in the other five subjects of the sample. Although Meyers et al. (1975) found obesity to be a significant factor in the development of pulmonary complications, this study did not suggest that obesity had a significant role in the reduction of percent predicted FRC and VC as compared to the nonobese subjects.

Subject one exhibited an exceptionally large FRC as compared to predicted normals both pretreatment and posttreatment. This subject had no history of lung disease, although the FRC measurements of this study suggested that perhaps some degree of airway obstruction may have been present in this patient. Patients with obstructive lung disease demonstrate an increase in FRC resulting from air trapping distal to the obstructed airways and diseased portions of the lungs. With progressive lung destruction, increased numbers of bronchioles tend to collapse during exhalation leading to further air trapping and an even greater increase
in FRC. In patients with obstructive lung disease, the helium dilution method of calculating FRC may result in inaccurate measurements due to the poorly ventilated areas of the lung prolonging the time for the helium equilibration to occur. Subject one ranged between five and one-half to eight minutes to equilibrate using the helium dilution method. The remaining seven subjects took between two and one-half and five and one-half minutes to equilibrate. Thus, it was suggested that the unusually large FRC measurements as compared to predicted normals found in subject one may be attributed to the fact that the subject had underlying obstructive lung disease which was not documented.

The percent predicted VC measurements found in subject one were similar to those found in the other subjects. The VC may be reduced in airways obstruction or loss of lung elasticity, but certain patients with a normal VC may have definite obstructive pulmonary disease. Thus, the VC is a nonconclusive test for suggesting the possibility of obstructive lung disease in a patient such as subject one.

Posttreatment Lung Volumes

In the following discussion of previous investigations as compared to the present study, the incentive spirometer was considered a comparable device to the deep breathing exerciser. The incentive spirometer is a device so designed that the patient must take a prolonged inspiration at a flow rate and depth sufficient enough to trigger a battery-operated light. Its designed objective is to induce the patient to create a maximum transpulmonary pressure. The main difference between the incentive spirometer and the deep breathing exerciser is that
the deep breathing exerciser is a semiquantitative flow measuring
device which does not have a preset volume which the patient must achieve
in order to receive visual feedback. With the deep breathing exerciser,
if the patient is able to inspire as little as 600 milliliters of air
per second, he will receive visual feedback by raising ball one to the
top of its chamber. Although the main difference between the two de-
vices is volume versus flow measurement, they are both designed to en-
courage the patient to take a deep and sustained inspiration.

Gale and Sanders (1977) studied the effects of the incentive
spirometer on patients which had undergone cardiopulmonary bypass sur-
gery. The VC was measured before and after preoperative training in
13 patients; and before and after the first and second treatments on
the first postoperative day in all patients. In 21 patients, the mean
VC was reduced to only 41.5 percent of the preoperative level in the im-
mediate postoperative period prior to use of the incentive spirometer.
The mean VC when measured before and after incentive spirometry on the
first postoperative day in 34 patients had increased by 19.4 and 11.6
percent respectively with the first and second treatments as compared
to the pretreatment postoperative value. In 13 patients, VC was mea-
sured before and after treatment both preoperatively and postoperatively.
The increase in VC posttreatment was similar and significant both before
and after surgery by 14.6 and 12.9 percent, respectively.

Meyers et al. (1975) noted in a few instances of his population
that when an incentive spirometer was used, large increases in the FRC
were noted on the second and third postoperative days. Specific data
on the exact increases in FRC and the frequency with which the incentive
spirometer was used were not reported. Other investigations have been reported on the effectiveness of the deep breathing exerciser and incentive spirometer in reducing postoperative pulmonary complications, although these studies did not measure FRC and VC. These other studies mainly used physical signs and chest radiography as a measurement of the effectiveness of the maneuvers in preventing postoperative complications.

In the present study there were no statistically significant changes demonstrated in percent predicted FRC (p = .273) or VC (p = .234) immediately after the use of a single treatment of the deep breathing exerciser as compared to the pretreatment measurements. Even though this study does not replicate the findings of Gale and Sanders (1977) or Meyers et al. (1975), these present findings do not negate the importance of postoperative respiratory maneuvers in an attempt to increase lung volumes. It is suggested that the cumulative effects of repeated, systematic use of the deep breathing exerciser during the postoperative period can only be beneficial to the patient in assisting him to return to his preoperative level of lung function.

Limitations of the Study

Several factors may have contributed to the outcome of this study. First, only one or two measurements of FRC and VC were made pretreatment, posttreatment, and 30 minutes posttreatment due to the time factor involved in removing residual helium from the system after a measurement of FRC and recalibrating the machine prior to the next measurement. Also, the measurement of FRC via the multiple breath helium dilution
method has some variance in reproducibility. Meyers et al. (1975:576) reported a variance of five to six percent in the measurement of FRC when doing two to three successive measurements. Secondly, there were no preoperative measurements of FRC or VC taken on each subject to enable the investigator to determine the actual decrease in lung function postoperatively as compared to the preoperative levels. Thus, this study could only suggest that the FRC and VC were reduced as compared to predicted normals. Also with the measurements of FRC and VC being taken before and after only one treatment of each respiratory maneuver, it was difficult to assess the cumulative effects of continued use of the treatments throughout the postoperative period. Lastly, with a larger sample the likelihood of replicating previous findings of other investigations would be greater.

**Clinical Implications**

The purpose of conducting this study was to evaluate the deep breathing exerciser and voluntary deep breathing with inspiratory hold as to their effectiveness in increasing FRC and VC postoperatively. Although this study did not demonstrate an increase in FRC or VC immediately after or 30 minutes after the use of the deep breathing exerciser or the voluntary deep breathing with inspiratory hold treatment, their importance in postoperative care should not be underestimated. While it may be impossible to determine which method of respiratory care truly prevents atelectasis, it can be assumed that a patient with adequate tidal volume and periodic hyperinflation of the lungs is less likely to develop atelectasis than a patient with inadequate tidal volume and a monotonous shallow pattern of breathing.
The nurse is responsible for supportive measures in patient care to assist and encourage the patient in any type of deep breathing maneuver. Some type of deep breathing is usually ordered about every two hours in routine postoperative care of patients having upper abdominal surgery. The frequency of deep breathing which is most effective in preventing postoperative atelectasis has not been investigated to the knowledge of this investigator. It is suggested that the frequency of postoperative deep breathing may be inversely related to the possible occurrence of postoperative atelectasis. Thus, if the nurse is able to assist or encourage the patient in deep breathing more frequently than what is routinely ordered for postoperative care, the increased repetitions of deep breathing maneuvers would be helpful to the patient. It is suggested that if the nurse explains the rationale of deep breathing and properly instructs the patient in the technique, then perhaps this patient education may result in the patient independently practicing deep breathing.

Another important aspect of nursing care is the administration of pain medications at appropriate intervals to assist the patient in deep breathing with minimal discomfort. Patients are often reluctant to deep breathe due to the pain it causes at the incision site. Thus by giving adequate pain medication, the patient may more readily cooperate in a deep breathing maneuver. Although, it must be remembered that too much pain medication may depress the patient's respiratory drive. Therefore, it is the nurse's responsibility to judiciously administer pain medications at a frequency which offers relief of pain without impairing the patient's respiratory function. Body position is also an aspect of
care which should be considered in helping the patient to breathe deeply and prevent postoperative atelectasis. Early ambulation in the postoperative period and frequent changing of body position helps to stimulate the patient to take deeper breaths. Thus, the nurse should encourage ambulation as early in the postoperative period as possible to help prevent atelectasis and pulmonary complications.

If the deep breathing exerciser or some similar device is used in postoperative care, the nurse should monitor its use and help the patient establish goals. With the deep breathing exerciser the patient receives visual feedback when using the device by seeing the movement of the balls in the chambers, but it may be helpful to record the progress and the frequency with which any respiratory maneuver is used.

This study did demonstrate that at 48 to 72 hours after surgery, the FRC and VC were still markedly depressed as compared to predicted normals. Patients tend to be discharged from the hospital three to five days after uncomplicated upper abdominal surgical procedures. Thus, it is important for the nurse to instruct and encourage the patient to deep breathe after he has returned home in an attempt to reestablish his lung volumes to the preoperative levels.

Whether or not a device is necessary to encourage the patient to take a voluntary deep breath remains an unanswered question. Perhaps an important point to be made is that the most effective "device" available to encourage a patient to perform an inspiratory maneuver is an interested and motivated nurse or therapist.
Suggestions for Further Study

Further studies in comparing postoperative respiratory maneuvers are important for continued improvement in patient care. Similar research could provide useful information as to the effectiveness of other respiratory maneuvers. It would be valuable to obtain preoperative measurements on patients to better evaluate their decrease in lung function postoperatively. Also, assessing the cumulative effects of a respiratory maneuver would be more helpful than assessing a single treatment. The measurements of oxygen tension possibly using an ear oximeter both pre-treatment and posttreatment would be helpful in assessing the effectiveness of certain respiratory maneuvers. Other lung measurements could be used to assess the effectiveness of a respiratory maneuver. This study suggested that the simple VC measurement may be as accurate in assessing postoperative progress with deep breathing as a more complicated measurement such as FRC. Perhaps a subjective assessment by the patient about certain respiratory maneuvers would also provide useful information. Lastly, it would most certainly be helpful to have a larger sample in assessing the effectiveness of certain methods of respiratory care.
CHAPTER 6

SUMMARY

Of all possible postoperative complications, pulmonary complications remain the highest contributor of postoperative morbidity and mortality rates (Bartlett et al., 1973). Atelectasis or collapse of alveoli is the most prevalent of the pulmonary complications in the postoperative period. Various respiratory maneuvers have been used to induce maximum inspiration in the postoperative patient in an attempt to increase transpulmonary pressure, to prevent reduction in lung volume, and to reopen atelectatic areas of the lung. The purpose of this study was to compare the effectiveness of two of these respiratory maneuvers, the Triflo II Deep Breathing Exerciser and voluntary deep breathing with inspiratory hold, on increasing lung volumes in postoperative upper abdominal surgical patients. The measurements of functional residual capacity and vital capacity were chosen to measure the effectiveness of the deep breathing exerciser and voluntary deep breathing with inspiratory hold on increasing lung volumes in the postoperative patient. In the study, these measurements were reported in percent predicted normals for each subject in accordance with their sex, age, and height (Bates et al., 1971:93-94).

The sample consisted of eight subjects who had undergone an upper abdominal surgical procedure. Between 48 to 72 hours after surgery, each subject participated in two treatment sessions which were held three to
five hours apart. The treatment orders were randomly assigned for the subjects to either receive the deep breathing exerciser treatment or the voluntary deep breathing with inspiratory hold treatment first. During each treatment session, the measurements of FRC and VC were obtained prior to, immediately after, and 30 minutes after the use of the deep breathing exerciser treatment and the voluntary deep breathing with inspiratory hold treatment.

Data were analyzed in terms of percent predicted change in FRC and VC from pretreatment values to immediate posttreatment and 30 minute posttreatment values for the deep breathing exerciser and the voluntary deep breathing with inspiratory hold treatment. No statistically significant changes in percent predicted FRC or VC were demonstrated immediately after the use of the deep breathing exerciser or the voluntary deep breathing treatment. There were also no differences found in percent predicted FRC and VC 30 minutes after the use of either treatment. Therefore, in this study, neither the deep breathing exerciser treatment nor the voluntary deep breathing treatment were found to increase lung volumes immediately after or at 30 minutes after one treatment session.

Although this study did not demonstrate an increase in percent predicted FRC or VC after the use of one treatment of either respiratory maneuver, these findings do not negate the potential benefit of frequent deep breathing treatments during the postoperative period. The importance of some type of deep breathing maneuver after surgery should not be underestimated. It remains the nurse's responsibility to encourage and support the postoperative patient in frequent deep
breathing exercises of some type and to assess which respiratory maneuver would be most beneficial to him.

The need to answer the question of which respiratory maneuver is most effective in increasing lung volumes in the postoperative period remains important. This study should be repeated using these maneuvers and other respiratory maneuvers to assess the effectiveness of each. Modifications in the design of this study would be necessary to better assess the effectiveness of the deep breathing exerciser treatment, voluntary deep breathing with inspiratory hold treatment, and the other currently used respiratory maneuvers.
APPENDIX A

SUBJECT'S CONSENT

Project Title: Comparison of Voluntary Deep Breathing with Inspiratory Hold and the Deep Breathing Exerciser on Increasing Lung Volumes in Postoperative Upper Abdominal Surgical Patients

I, Jo Ann Brooks, R.N., am conducting a study about how to best help patients fully ventilate their lungs after surgery by taking deep breaths. Taking deep breaths periodically during the postoperative period may prevent problems from occurring in your lungs. These problems are usually caused from lying in bed for extended periods of time and not adequately breathing deeply. I am interested in studying you and other patients who have had upper abdominal surgery at the University Hospital, Tucson, Arizona. I would like to record with a machine your breathing volumes before and after you do each breathing treatment.

The breathing treatments consist of:

1. **Deep Breathing Exerciser**—This device consists of three tubular columns about five inches high with hollow, blue plastic balls resting at the bottom of each and a short flexible hose attached. You will be instructed to inhale at a sufficient enough rate to raise as many of the blue balls as possible and keep them suspended in the air for as long as possible. This breathing exercise will be done for a total of five times.

2. **Voluntary Deep Breathing with Inspiratory Hold**—In this treatment I will verbally encourage and manually assist you in taking a deep breath. I will place my hands on both sides of your lower chest to encourage movement of the chest in this area when you breathe. With my hands on your lower chest wall, you will be instructed to try to take a deep enough breath to move my hands. You will be instructed to take a deep breath and hold this for as long as possible. While you are taking a deep breath, I will be counting rhythmically to help you sustain this breath for as long as possible. When you exhale, I will exert slight pressure to your lower chest with my hands to help you expel as much of the air as possible. These deep breaths will be done for a total of five times.

Your participation would also include:

1. Approximately 1.5 hours of your time divided into two 45 minute sessions during the first 48 to 72 hours after surgery.
2. Prior to the first treatment you will be asked to breathe normally into a recording device and inhale deeply and then exhale as much of the air from your lungs as possible when instructed. This measurement will be done one or two times.

3. You will then be asked to perform one of the treatments which will be demonstrated to you.

4. Immediately after the treatment, you will again be asked to breathe normally into the recording device and inhale deeply and then exhale as much air from your lungs as possible when instructed. This measurement will be done one or two times.

5. After this measurement, you will be asked to remain in bed until the next measurement of your breathing which will be in about 20 minutes.

6. Approximately three to five hours later, you will again be asked to follow the same procedure as outlined above using the other treatment which will be demonstrated.

I also ask that you not take any pain medications, if possible, during each treatment and measurement period. You may take pain medications 30 minutes to one hour prior to either treatment if this is necessary.

You can be assured of the confidential handling of the information obtained in this study. Your name will not be used. The information will be recorded and analyzed by a computer. Your participation also includes permitting the investigator to record pertinent information from your chart. This information will also be used in analyzing the results obtained in this study.

There are no known medical, social, or psychological risks involved in participation in this study and there is no added cost to you for your participation. Temporarily you may experience discomfort at the incisional or surrounding site due to the deep breathing. A cough may follow the deep breathing and may also cause temporary discomfort. A feeling of fullness in your head may also follow taking the deep breaths. All of these symptoms are temporary and will quickly pass. A physician will be available at all times if any of these symptoms should persist. You may also have a temporary voice change after breathing into the recording device but this too will quickly return to normal.

One of the benefits of the study will be the information provided for better postoperative care of patients such as yourself. Also after completion of the treatments and measurements, the Deep Breathing Exerciser will be given to you to keep.

If you decide not to participate in the study, it will not affect your relationship with any doctor or nurse or the care you receive while
being in the hospital. I will answer any questions you may have about the study at any time. You may withdraw from this study at any time.

If you understand what is involved and you consent to participate in this study, please sign your name below.

The nature, demands, risks and benefits of the project have been fully explained to me and I fully understand what my participation involves. I also understand that I may ask questions and that I am free to withdraw from the study at any time without incurring ill will (or affecting my medical care).

I also understand that this consent form will be filed in an area designated by the Human Subjects Committee with access restricted to the principal investigator or authorized representatives of the particular department.

__________________________
Subject's Signature

__________________________
Date

__________________________
Witness' Signature

__________________________
Date
APPENDIX B

PHYSICIAN'S CONSENT

Permission has been given to Jo Ann Brooks, R.N., to utilize my patient, ________________________, in the collection of data for a research study conducted through the University of Arizona, College of Nursing, Graduate Division. This consent is given with the provision that the researcher also obtains the consent of the individual patient and the approval of the University Hospital, Tucson, Arizona.

I also understand that this consent form will be filed in an area designated by the Human Subjects Committee with access restricted to the principal investigator or authorized representatives of the particular department.

Signature________________________

Date______________________________
LETTER GRANTING APPROVAL FOR RESEARCH—
HUMAN SUBJECTS COMMITTEE

THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85724

HUMAN SUBJECTS COMMITTEE
Arizona Medical Center 2305

June 5, 1978

Ms. Jo Ann Brooks
College of Nursing
Arizona Health Sciences Center

Dear Ms. Brooks:

I have reviewed your project entitled, "Comparison of Voluntary Deep Breathing With Inspiratory Hold and the Deep Breathing Exerciser on Increasing Lung Volumes in Postoperative Upper Abdominal Surgical Patients," and concur in the opinion of the College Review Committee that this is a minimal risk project. Therefore, administrative approval is granted effective June 5, 1978, with the understanding that no changes will be made in the procedures followed or the consent forms used (copies of which we have on file) without the knowledge and approval of the Human Subjects Committee and the College Review Committee. Any physical or psychological harm to any subject must be reported to each committee.

A university-wide policy requires that all signed consent forms be kept in a permanent file in the College Office to assure their accessibility in the event that university officials need the information and the principal investigator is no longer on the staff or unavailable for some other reason. One exception involves those subjects who are hospitalized or outpatient. In such cases, the consent form may be filed with the patient's chart. For those patients at the Veterans Administration Hospital, consent forms should be sent to the Chief of the Pharmacy Service.

Sincerely yours,

Milan Novak, M.D., Ph.D.
Chairman
Human Subjects Committee

xc: Ada Sue Kinshaw, Ph.D.
College Review Committee

AGOS #151 - Mrs. Snow
Tucson VAH
LETTER GRANTING APPROVAL FOR RESEARCH—
VETERANS ADMINISTRATION HOSPITAL

Ms. JoAnn Brooks, R.N.
2440 E. Glenn, F4
Tucson, Arizona 85719

SUBJ: Research proposal entitled, "Comparison of Two Post-Operative
Respiratory Maneuvers," by JoAnn Brooks, R.N., Principal Investigator

1. At its meeting of May 24, 1978, the Research and Development reviewed
your proposed research project. The Committee felt that the project is a
potentially useful one and should be conducted. A copy of an ad hoc review
is included for your information and conveys many of the questions raised
by the Committee. In addition, the Committee noted that Human Subjects
Committee approval (apparently pending) has not yet been obtained. Also,
the Committee requested that a budget describing all the resources that
would be allocated to the project be included.

2. The Committee voted to approve the project pending submission of the
Human Subjects Committee approval and submission of a satisfactory budget
page. Good luck on your proposal. Please let me know if the Research
Service can be of additional assistance to you in carrying out this project.

Sincerely,

STANTON G. AXLINE, M.D.
Associate Chief of Staff for Research

Enclosure
# APPENDIX E

## DATA COLLECTION SHEET

### Patient Profile Data

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- DEEP BREATHING EXERCISER
- VOLUNTARY DEEP BREATHING
APPENDIX F

FUNCTIONAL RESIDUAL CAPACITY MEASUREMENTS REPORTED IN LITERS (BTPS)*
FOR EACH SUBJECT PRETREATMENT, POSTTREATMENT, AND 30 MINUTES POST-
TREATMENT USING THE DEEP BREATHING EXERCISER TREATMENT AND THE
VOLUNTARY DEEP BREATHING WITH INSPIRATORY HOLD TREATMENT

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*BTPS—Body Temperature Pressure Saturation
VITAL CAPACITY MEASUREMENTS REPORTED IN LITERS FOR EACH SUBJECT PRETREATMENT, POSTTREATMENT, AND 30 MINUTES POSTTREATMENT USING THE DEEP BREATHING EXERCISER TREATMENT AND THE VOLUNTARY DEEP BREATHING WITH INSPIRATORY HOLD TREATMENT

### Deep Breathing Exerciser Treatment

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### Voluntary Deep Breathing with Inspiratory Hold Treatment

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REFERENCES


Gale, George D. Faculty of Medicine, Department of Anesthesia, University of Toronto. Based on personal correspondence March 1978.


