PREVENTION OF POST-OPERATIVE PULMONARY COMPLICATIONS
BY PREOPERATIVE TEACHING OF COUGHING
AND DEEP BREATHING

by
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Special acknowledgement is extended to my husband for his support and encouragement.
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ABSTRACT

A primary goal for the health team, in caring for the post-operative patient is the prevention of pulmonary complications. The most common of these complications is atelectasis, or alveolar collapse.

Many methods for maintaining good pulmonary toiletry have been researched and discussed in the literature. However, there is a lack of research and research findings to substantiate a relationship between coughing and deep breathing and the reduction in the incidence of post-operative pulmonary complications.

The purpose of this study is to investigate the effect of coughing and deep breathing on the prevention of post-operative atelectasis in patients having upper abdominal surgery.

Thirty patients admitted to Utah Valley Hospital in Provo, Utah for upper abdominal surgery during the months of March through June 1972 were used as subjects.

The subjects were divided into an experimental and control group. Patients in the experimental group were matched to the control group on points of sex, age and surgery.

Each patient in the study had a preoperative chest
x-ray and one on the fourth day following surgery. Likewise, each patient had a forced expiratory flow rate, one second vital capacity and total vital capacity taken using the McKessor Vitalor, preoperatively and daily for four days following surgery.

The control group was not taught to cough and deep breath prior to surgery, nor were they encouraged to cough and deep breath following surgery. The experimental group was taught a specific procedure for coughing and deep breathing before surgery. Following surgery the experimental group of patients were coughed and deep breathed every two hours for a four day period.

Using the computer, the data was subjected to a one way analysis of variance, a two way analysis of variance, and a Multiple Correlation Testing.

The one way analysis of variance analyzed such preoperative information as age, per cent overweight, maximum expiratory flow rate, one second vital capacity, and total vital capacity. Results showed that there was no significant difference between the control and experimental groups.

The results of the Multiple Correlation Testing showed a progressively stronger relationship in the post-operative period among the above mentioned variables.
Results of the two way analysis of variance showed that those who reduced pulmonary functions before surgery were in significant trouble during each of the four post-operative days.

The experimental group differed from the control group at the .05 level regarding one second vital capacity on the first post-operative day. The maximum expiratory flow rate became significant on the second post-operative day and was joined by the total vital capacity on the third day following surgery.

Thus, the conclusion can be drawn that teaching a patient to cough and deep breath before surgery and following him with a specific routine after surgery did reduce the incidence of post-operative atelectasis.
CHAPTER I
INTRODUCTION

A primary goal for the health team, in caring for the post-operative patient, is the prevention of pulmonary complications. The most common of these complications is atelectasis, or alveolar collapse, which diminishes the ventilating surface thereby resulting in a ventilation-perfusion abnormality. If extensive, this condition may result in carbon dioxide retention, hypoxia or both (Mitchell, 1962; Safar, 1965; Traver, 1967).

Traver, in 1967 reviewed the literature concerning the etiology and pathogenesis of atelectasis. She cites the classical causes of atelectasis as either bronchial obstruction or hypoventilation, a non-obstructive atelectasis (Traver, 1967). The pathology of obstructive atelectasis starts with an obstruction in the bronchus. When this obstruction is complete, gas in the segment supplied by the bronchus is absorbed into the blood stream leaving the lung airless and eventually collapsed. Concomitant with the mechanical obstruction, absorption of gas, loss of volume, and diminution of alveolar surface area, there is a decrease of surfactant in the affected area of the lung. Thus as the alveolar surface area decreases, there is an increase in surface tension which
probably contributes to the mechanism of collapse (Sodeman and Sodeman, 1968, Chapter 10; Jones, 1954).

Hypoventilation may result in reduced volumes of air entering into the alveoli, thus producing a decreased intraluminal air pressure and increased surface tension which causes collapse of the alveoli (Burbank, 1961, page 701; Pinck, 1965, page 909). Another factor contributing to the development of non-obstructive atelectasis is a decrease in the amount or activity of pulmonary surfactant, a lipoprotein material which has surface tension reducing properties. If this material is not periodically stretched, it becomes less effective and the surface tension rises resulting in alveolar collapse (Hamilton, 1965; Sodeman and Sodeman, 1968, Chapter 10).

Figures 1 and 2 summarize the factors which are involved in the production of post-operative atelectasis.

Post-operatively, the majority of patients are subject to a non-obstructive type of atelectasis. The patient tends to maintain a constant tidal volume, normally there is a periodic increase in inspiratory volume, which does not occur due to reduction in diaphragmatic movement caused by pain and sedation (Hamilton, 1964). Following the abdominal surgery, the patient's breathing pattern tends to be rapid, shallow and mainly in the expiratory position. This situation is in contrast to the normal individual who takes a breath three times his normal tidal volume ten times every
Thus the patient's hypoventilation following surgery may result in atelectasis (Egbert and Bendixen, 1964; Berecek and Jansom, 1972).

Conflicting reports concerning the incidence of atelectasis following surgery can be attributed to the different measures used to detect this condition. Clinical examination of the chest only may demonstrate an incidence as low as one per cent, while the use of x-ray may increase the reported incidence to 50-70 per cent (Becker, 1960; Jones, 1954). However, x-ray is not capable of detecting small lesions, hence the development of arterial blood gas studies (Mitchell, 1962).

The analysis of arterial blood reflects ventilation efficiency, the ability of hemoglobin to carry oxygen and carbon dioxide, the rate of cellular metabolism, and the state of the buffer system (Bates and Christie, 1968, Chapter 10). At present there is disagreement among medical scientists as to how accurately blood gas studies document the incidence of atelectasis (Noehren, 1971).

The incidence of atelectasis post-operatively is influenced by several variables, such as the site of incision, the age, the degree of obesity, the general health, and the length of time of anesthesia.

Twenty to sixty per cent of patients having an upper abdominal incision develop atelectasis as compared to only 10-20 per cent of those having lower abdominal incisions.
Figure 1. Causes of obstructive atelectasis (Palmer and Sellick, 1953).
Figure 2. Causes of non-obstructive atelectasis (Sodeman and Sodeman, 1965, Chapter 15).
The difference in the incidence of atelectasis between the two sites of surgery is directly related to the decrease in vital capacity (Webb, 1960, page 326). The vital capacity of the patient who has undergone upper abdominal surgery, was 25-30 per cent of the preoperative volume, while the vital capacity of those having lower abdominal surgery was 50 per cent of the preoperative volume (Kurzeweg, 1953).

There is general consensus that atelectasis is more prevalent in the male than the female (Haight and Ransom, 1941; Kurzeweg, 1953). The respiratory pattern in the male is predominantly diaphragmatic while that in the female is intercostal (Kurzeweg, 1953). It should follow then, that an abdominal incision, because of its proximity to the diaphragm, results in a greater impairment of the respiratory pattern in the male than in the female. The higher incidence of atelectasis in the male may result from his inability to splint respirations due to a more highly developed intercostal and thoracic musculature (Hamilton, 1961; Kurzeweg, 1953).

The incidence of atelectasis increases directly with obesity. The obese patient at rest has a higher oxygen uptake and carbon dioxide output. Thus the obese patients need a higher level of alveolar ventilation than the patients of normal weight. Obese subjects also have considerably less expiratory reserve volume, particularly
when they lie flat, due to a higher diaphragm position and a more positive intra-abdominal pressure. These patients must exert more effort to remove a given volume of air than an individual of normal weight. This is a consequence of the increased work needed to move the chest wall, particularly in a recumbent position. Last, the obese patient may have a shorter thicker neck, making it difficult to maintain a good airway (Bates and Christie, 1965, Chapter 10).

An increase in age produces a decrease in the elastic properties of the lung, producing an increased resistance to expansion. Progressive calcification of the chondral cartilages with age leads to the formation of a barrel chest which decreases vital capacity. At age sixty, the total lung capacity of most people is ninety per cent of what it was at the age of twenty (Bates and Christie, 1965, Chapter 10).

Susceptibility varies inversely with the preoperative health status, and the skill of the anesthesiologist in administering anesthetic agents (Hamilton, 1961). The length of anesthesia as a factor affecting the susceptibility to the development of atelectasis is subject to controversy. The majority of authorities state that the susceptibility to atelectasis is directly related to the length of anesthesia (Rubin, 1962; Roe, 1960; Becker, 1960; Hamilton, 1961). Driggs and Deming, however, state that the length of anesthesia has no effect, while Kurzweg states
that it has no effect until the anesthesia time exceeds three hours (Dripps and Deming, 1966; Kurzeweg, 1962).

One of nursing's primary functions is to provide total patient care. Because of the nurse's constant association with the patient she has the opportunity to instruct him before surgery in procedures essential to his well being, and to provide follow through care in the post-operative period.

Noehren, in his research using Intermittent Positive Pressure Breathing in the prevention of post-operative atelectasis identifies the nurse's "stir-up" routine as essential in the prevention of pulmonary complications following surgery (Noehren, 1958). This "stir-up" routine, a term coined by Dr. Noehren, is defined as a group of medically accepted measures which the nurse can initiate on the patient. These measures are directed towards minimizing the possibility of the collection of tracheobronchial secretions, and toward increasing ventilation. Such measures include, judicious use of sedatives and narcotics, frequent turning of the patient, early ambulation and coughing and deep breathing (Lindeman, 1971; Noehren, 1958).

Noehren believes that an increased ratio of patients to nurse has taken the nurse away from the bedside, thus necessitating the development of various mechanical devices to substitute for the nurse's role in decreasing the
collection of tracheobronchial secretions and increasing ventilation (Noehren, 1958). Today in most hospitals doctors depend on mechanical devices such as the Bird and Bennet respirators, blow bottles, and rebreathing tubes to prevent post-operative atelectasis. In hospitals where these devices are not used, the surgeons usually teach their own patients to cough and deep breath, and also work with them each day following surgery.

Several studies have been done evaluating the effectiveness of Intermittent Positive Pressure Breathing (IPPB) in preventing atelectasis. The findings in these studies are conflicting.

Anderson, (1963), Taver, (1967), and Noehren, (1958), in their research concluded that the use of IPPB reduced the incidence of post-operative pulmonary complications. Whereas, Racklin, (1968), Becker, (1960), and Dands, (1961) in their studies found that IPPB did not reduce the incidence of pulmonary complications.

Studies by Schwartz, (1957), Dale and Schwartz, (1960), Darin, (1960), Hamilton, (1964), investigated the use of the rebreathing tube in the prevention of post-operative atelectasis. Their results were positive. The rebreathing tube was effective in increasing the inspiratory volume, however, during the first two or three minutes of a five minute treatment the oxygen saturation of the arterial blood decreased 20-30 per cent, of normal, which could be
critical for a patient who already had respiratory compensation.

Two recent studies by Berecek and Jansom, (1971) and Lindeman and Van Aernam, (1971), have been reported in the literature using coughing and deep breathing as a technique in preventing post-operative atelectasis.

Berecek and Jansom in 1971, studied the "Influence of Postanesthetic Suggestion on the Prevention of Postoperative Pulmonary Complications." The Sample involved 52 surgical patients from 16-70 years of age, divided into three groups. Each group was taught the identical format for coughing and deep breathing. The first two groups were taught before surgery, the third group was taught during level three of the recovery from anesthetic. Measures used were the McKesson Vitalor, to measure forced expiratory volumes and chest x-rays. These measures were done on the day prior to surgery and on the fourth day following surgery. Analysis of the data showed no significant difference among the groups tested for forced expiratory volume and chest x-rays. In this study a large number of abnormal preoperative lung findings were discovered which may have distorted the results. In addition, there was no control group with which to compare their findings.

The results did reveal, that those subjects who were taught coughing and deep breathing in the third level of anesthesia performed the mechanics of deep breathing and
coughing as well following surgery as those who were preoperatively taught (Berecek and Jansom, 1971).

Lindeman and Van Aernam, in 1971 did a nursing study to evaluate the effectiveness of preoperative teaching on post-operative coughing and deep breathing. Their sample consisted of a control group of 135 surgical patients and an experimental group of 126 surgical patients. The control group received unstructured preoperative teaching. This kind of teaching situation let each nurse teach the patient her own method of coughing and deep breathing. The experimental group was taught a pre-determined method of coughing and deep breathing with the use of visual aids. Data collected consisted of maximal expiratory flow rates (MEFR), timed vital capacities, (TVC), length of hospital stay and the number of analgesics used.

Statistical results using a t-test were significant for the experimental group when looking at MEFR, TVC, and length of hospital stay. However, Lindeman felt that she did not have sufficient data to conclude if the preoperative teaching did prevent or reduce the incidence of post-operative atelectasis (Lindeman, and Van Aernam, 1971).

There is a lack of research and research findings to substantiate a relationship between coughing and deep breathing and the incidence of post-operative pulmonary complications.
All studies reported in the literature used chest x-rays, timed vital capacities, tidal volume and blood gas studies, single or combined to measure atelectasis. In this study the timed vital capacities and chest x-rays were used as a measure of atelectasis.

The purpose of this study was to investigate the effect of coughing and deep breathing on the prevention of post-operative atelectasis in patients having upper abdominal surgery.
CHAPTER II
METHODOLOGY

Utah Valley Hospital in Provo, Utah, was selected as the research facility in this study because the hospital has no specific procedure for teaching coughing and deep breathing before or following surgery. Also, few doctors order intermittent positive pressure treatments on their surgical patients following surgery.

Thirty patients admitted to Utah Valley Hospital for upper abdominal surgery during the months of March, April, May and June, 1972 were used as subjects for this study. Upper abdominal surgery was defined as cholecystectomy, gastric resection, gastric aneurysm, ventral herniorrhaphy, exploratory laparotomy, splenectomy, hiatus herniorrhaphy, pyloroplasty, vagotomy, bowel resection and abdominal perineal resection.

Patients meeting the following criteria served as subjects:

1. Age of 17-75 years
2. Scheduled for general anesthetic
3. Had upper abdominal incision
4. Able to understand English
5. Had no known diagnosis of pulmonary impairment such as bronchiectasis, emphysema or asthma.
6. Able to co-operate with pulmonary function tests.

The subjects were divided into a control and experimental group. All patients meeting the above criteria during the months of March and April were used as the control group. Patients for the experimental group were matched to the subjects in the control group as to points of sex, age and surgery. This data was collected during the months of May and June 1972. Individual characteristics of the subjects in this study can be found in Appendix A.

The diaphragmatic coughing and deep breathing procedure from "Basic Techniques" in the *Treatment of the Non-surgical and Surgical Thoracic Patients* was used by this researcher. This procedure is found in Appendix B.

Coughing for this study was defined as a type of forced expiration which caused a forceful contraction of the abdominal viscera against the diaphragm, thereby decreasing the thoracic volume suddenly and creating a rapid expulsion of air and or sputum from the lungs (Sedor, 1969, page 25).

Deep breathing for this study was defined as the flattening of the dome of the diaphragm during inspiration with a resulting enlargement of the lower thoracic cavity as the air rushed in. The abdominal muscles and diaphragm are consciously contracted during expiration (Lindeman, 1971).

Under the direction of Wanta and Rasmussen, this researcher learned this procedure to the satisfaction of
the above mentioned individuals (Wanta and Rasmussen, 1968). The procedure was then taught by the researcher to a selected group of four student nurses who administered this procedure to all the patients in the experimental group.

To establish continuity and keep variables to a minimum, the researcher preoperatively interviewed and taught each subject in the project. The form used to instruct each patient in the experimental group is found in Appendix C.

Each subject in the experimental group was taught the coughing and deep breathing procedure in a supine recumbent position, with the head elevated from 10-45 degrees.

Bates and Christie cite that other than the standing position, the supine recumbent position allowed the most expansion of the lung parenchyme (Bates and Christie, 1965, Chapter 10). Because the post-operative patient is in a recumbent position for the first few days following surgery, this is the position that the patient was in when the procedure was administered pre and post-operatively. Likewise all measures were taken in this same position.

The researcher demonstrated the procedure to each patient in the experimental group and then had each patient return the demonstration until it was done satisfactorily.

Following surgery patients in the experimental group were asked to cough and deep breath, three times every two hours during the normal waking day, 8:00 A.M. until 10:00 P.M.
All patients were allowed to rest during the night. If a subject woke up during the sleeping hours of 10:00 P.M. until 8:00 A.M. they were asked to cough and deep breath.

Measures used to evaluate the presence of atelectasis, were pre and post-operative timed vital capacities and chest x-rays. Timed vital capacity is defined as the maximal volume of gas that can be expelled from the lungs following a maximal inspiration with expiration as forceful and rapid as possible at one, two and three seconds.

Normal subjects can exhale 83 per cent of vital capacity in the first second, 94 per cent in the second and 97 per cent within three seconds. This test, according to Sedor, is one of the most useful tests of pulmonary function (Sedor, 1969, page 21). From the timed vital capacity data a maximal expiratory flow rate (MEFR) was computed. Maximal expiratory flow rate is defined as the volume of maximal fast expiration expelled from a full inspiration.

Timed vital capacity tests were done using the McKesson Vitalor, a simple portable spirometer with an electric timer. The instrument consists of rubber bellows, the volume of which is indicated as an ordinate on pressure sensitive chart paper. The chart is moved laterally at two centimeters per second by a synchronized electric motor (Sedor, 1969, page 24).
All patients used as subjects in this study had timed vital capacity tests done the evening prior to surgery and at 10:00 A.M. daily for four days following surgery.

Each subject was placed in a recumbent position for each measurement. The subject was asked to inhale as much air as he could hold. Then he was instructed to place his lips securely around the mouth piece on the McKesson Vitalor and exhale as rapidly and completely as possible. This procedure was done a total of three times at each measurement session. The best of the three measures was used as data for that day.

Anterior-posterior chest x-ray examinations were used as a primary index of pulmonary function. One film was taken preoperatively and a second film was taken on the fourth day following surgery. All x-rays were read by the same radiologist.

The control group consisted of 15 patients, six men and nine women, ranging in ages from 18-68 years. All members of this group met the specific criteria as described in the beginning of this chapter. Each subject in this group had the described measures taken before surgery and daily for four days following surgery. No mention was made of coughing or deep breathing prior to or following surgery. The patients were subject to the routine pre and post-operative care used in the hospital.
The experimental group consisted of 15 patients, six men and nine women ranging in ages 18-68 years. All members of this group met the specific criteria as mentioned in the beginning of the chapter, and were matched to the control group. The measures for the group were the same as those used in the control group. Each subject in this group was taught how to cough and deep breath prior to surgery as described in this chapter and Appendix A and B. Following surgery each subject was coughed and deep breathed every two hours during the waking day, for four days.

The data concerning timed vital capacity measures was subjected to a one way and two way analysis of variance and multiple correlation testing.
CHAPTER III

RESULTS

It was hypothesized that teaching a patient to cough and deep breath before surgery and following the patient during the post-operative period would reduce the incidence of atelectasis.

Using the computer to reduce the margin of error in mathematical calculations, the data was first subjected to a one-way analysis of variance, to show equality between the experimental and control groups. This test analyzed such preoperative information as age, per cent overweight, maximum expiratory flow rate (MEFR), one second vital capacity, and the total vital capacity (TVC). Table I represents the various P values for the one-way analysis of variance.

No significant differences were seen between the experimental and control groups. However, the analysis of the per cent overweight column verged on being significant. Closer analysis of the individual members of the control group revealed that two individuals accounted for 141 per cent of the overweight problem. Upon removal of these individuals from the group, the significance of per cent overweight between the experimental and control group was reduced to a nonsignificant level.
# TABLE I

ONE WAY ANALYSIS OF VARIANCE ON PREOPERATIVE MEASURES TO SHOW EQUALITY BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS

<table>
<thead>
<tr>
<th>Item</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>P Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>29</td>
<td>7447.3672</td>
<td>.335</td>
</tr>
<tr>
<td>Overweight</td>
<td>29</td>
<td>13077.047</td>
<td>.931*</td>
</tr>
<tr>
<td>MEFR (a)</td>
<td>29</td>
<td>176096.69</td>
<td>.073</td>
</tr>
<tr>
<td>1 Second VC (b)</td>
<td>29</td>
<td>13.033669</td>
<td>.189</td>
</tr>
<tr>
<td>Total VC</td>
<td>29</td>
<td>18.358425</td>
<td>.737</td>
</tr>
</tbody>
</table>

*Significant above the .05 level.

*a Maximum expiratory flow rate in units of liters/min.

*b Vital capacity in units of liters/minute.
TABLE II
THE F VALUES FOR THE TWO WAY ANALYSIS OF VARIANCE

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>1st Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age</td>
<td>% Heavy</td>
</tr>
<tr>
<td>Experimental vs. Control</td>
<td>.34</td>
<td>.93*</td>
</tr>
<tr>
<td>Trouble vs. O.K.</td>
<td>.84</td>
<td>.31</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2nd Day</th>
<th>3rd Day</th>
<th>4th Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MEFR</td>
<td>1 Sec</td>
<td>TVC</td>
</tr>
<tr>
<td>Experimental vs. Control</td>
<td>.76</td>
<td>**</td>
<td>.99</td>
</tr>
<tr>
<td>Trouble vs. O.K.</td>
<td>**</td>
<td>**</td>
<td>*</td>
</tr>
</tbody>
</table>

*Significant level greater than .05.

**Significant level greater than .01.
The data was next subjected to Multiple Correlation Testing. This test first analyzed all variables on the experimental and control groups individually and then the test was conducted on the combined results from the groups. The results showed progressively stronger relationship in the post-operative period among the variables of MEFR, one second vital capacity, and TVC.

It is interesting that the items of age and per cent overweight produced an inverse correlation. Many of these readings are significant above the .05 level. This seems to show that as the weight and age increase there is a decrease in pulmonary function.

Last, the data was subjected to a two way analysis of variance. This test analyzed all data for each of the four post-operative days. In order to isolate the effect of patients with reduced lung volumes in the preoperative period from those with normal lung volumes, another column was added to this analysis labeled trouble or o.k. All subjects who had a MEFR of 240 liters or below were placed in the trouble group. All subjects who had a MEFR of 245 or above were placed in the o.k. group. Table II represents all the p values for the two way analysis of variance mentioned above.

The analysis revealed that the group labeled as trouble was significantly different from the o.k. group at the .05 significance level on the preoperative readings for MEFR,
Figure 3. Summary of means for the maximum expiratory flow rate from the two way analysis of variance.
Figure 4. Summary of means for the one second vital capacity from the two way analysis of variance.
Figure 5. Summary of means for total vital capacity from two way analysis of variance.
one second vital capacity and TVC. There was also a significant difference between the trouble and o.k. groups on each of the above mentioned items for each of the four post-operative days.

When observing the result of the analysis between the control and experimental groups, it was noted that the one second vital capacity was significant on the second post-operative day at the .05 level and moved to the .01 level on the third and fourth days following surgery.

The MEFR results between the two groups approached significance on the second post-operative day and was significant at the .05 level on the third and fourth day following surgery.

Results regarding TVC between the two groups approached significance on the third day after surgery, and was significant on the fourth day following surgery. Figures 3, 4 and 5 represent the graphed means for the MEFR, one second vital capacity, and the TVC preoperatively and during the four post-operative days.
CHAPTER IV
DISCUSSION

This study evaluated the effectiveness of coughing and deep breathing in preventing post-operative atelectasis in patients having upper abdominal surgery. The study measured changes in maximal expiratory flow rate (MEFR), one second vital capacity, and total vital capacity (TVC). Chest x-rays were also taken before surgery and on the fourth day following surgery to document the presence of atelectasis.

The data was subjected to various analysis using the computer. The results of the multiple correlation test as reported in the previous chapter showed that there was a strong relationship among the items of MEFR, one second vital capacity and TVC during the post-operative period.

Items regarding age and per cent overweight demonstrated an inverse relationship, meaning that an increase in these items produced a decrease in pulmonary lung function. This conclusion is supported by the literature discussed in Chapter I.

The two way analysis of variance showed several important results. First, those designated as a trouble group were in trouble regarding pulmonary functions before
surgery, and remained so throughout the four day post-operative period of this study. Second, the experimental group was significantly different from the control group on the first post-operative day regarding one second vital capacity and remained as such throughout the four day post-operative period. The MEFR was significant for the experimental group on the second post-operative day and was joined by the TVC on the fourth post-operative day.

The analysis of the data between the experimental and control groups shows that the difference in performance of pulmonary function tests in the post-operative period is directly related to preoperative teaching of coughing and deep breathing and the consistent follow through care after surgery.

Comparison of the readings of the chest x-ray taken preoperatively and on the fourth day following surgery documented that eight patients had some degree of atelectasis. Six of these subjects were in the control group and two were in the experimental group. Seven of these eight subjects were in the group labeled "trouble" as described in the previous chapter.

Using the x-ray data documenting the number of patients with atelectasis, these figures were then converted to percentage. The results were that 40 per cent of the control group developed atelectasis following surgery as compared to 13 per cent of the experimental group. This
difference, between the experimental and control groups as documented by x-ray further substantiated that pre-operative teaching of coughing and deep breathing and use of a consistent follow through plan after surgery can reduce the incidence of atelectasis.

Of the eight subjects that developed atelectasis, five were female and three were male. Six of the eight subjects were above fifty years of age as compared to two who were below. Six of the eight had a mean per cent overweight of 14.69 pounds, the heaviest being 100 pounds overweight and the least being two pounds overweight.

The multiple correlation as discussed before, substantiated what Bates and Christie had said in Chapter I regarding the relationship between age, weight and pulmonary function. Bates and Christie stated that with an increase in age and obesity, patients were more prone to the development of atelectasis.

Previous studies have shown that men have a greater tendency toward atelectasis because of their abdominal breathing patterns, than women. However, this was not born out in this study, as more women than men developed atelectasis.

One of the significant findings of this study was that most preoperative pulmonary problems are predictable and preventable. As the researcher worked with each patient in this study preoperatively, she was able to predict that
five of the eight who developed atelectasis following surgery, would develop some kind of pulmonary problems following surgery. These predictions were based upon information obtained from the patient preoperatively such as timed vital capacity, age, weight, prior pulmonary problems and smoking habits. When the above information was compiled, conclusions could be drawn as to the patient's current pulmonary status and predictions could be made as to the post-operative effects of surgery. The observation and compilation of information took approximately ten to fifteen minutes and could have saved the nursing personnel time in caring for the patient post-operatively. However, this particular point was not investigated in this study, but would be important for future research.

During the four months of this study, the researcher observed the hospital's reaction to the preoperative teaching of coughing and deep breathing to surgical patients. When patients were admitted to the hospital for surgery, the unit admission and any preoperative instruction given was rendered by the nurse's aide, the practical nurse or the student nurse. The registered nurse, who would be the person with the most experience and expertise to make a nursing diagnosis concerning the patient's status was usually busy noting doctor's orders, administering medications, checking intravenous infusions or solving the problems of the post-surgical patient.
The registered nurses on the units used in this study were asked their opinions about preoperative teaching of coughing and deep breathing to surgical patients. Most of these nurses questioned placed preoperative teaching as a high priority item on their list of nursing duties. All agreed that they needed to teach patients how to cough and deep breath and exercise before surgery, rather than after. However, the researcher found the enthusiasm for these ideas to be inconsistent with the practice of the same.

One of the underlying reasons for preoperative teaching was to reduce the patient's fear of the unknown and involve him in his hospitalization. The staff commented several times how co-operative the experimental group was to work with following surgery. Several doctors asked if the researcher would teach other surgical patients this procedure for coughing and deep breathing. The staff also noted a difference between the control and experimental patient groups regarding their ability to co-operate and regarding their attitudes toward post-operative activities.

Previous studies have neglected the aspect of follow through applied to coughing and deep breathing after surgery. In this study patients in the experimental group were encouraged to cough and deep breath every two hours following surgery. The first 24 hours were the most difficult in getting patient co-operation. During this time the patients were very lethargic and slow to respond and
their breathing pattern was rapid and shallow. It was felt by the researcher that the lingering effects of anesthesia and analgesics were the primary causes of the above mentioned signs during the first 24 hours.

Both the experimental and control groups had greatly reduced lung volumes during the first 24 hours following surgery. The one second vital capacity was the only measure that was significant between the experimental and control groups. This particular measure requires the patient to forcefully expire in a given time period. The results showed that the patients who were taught to cough and deep breath before surgery were better able to use their diaphragm and abdominal muscles in the process of coughing and deep breathing, than those in the control group.

It required a great effort on the researcher's behalf to get the experimental group to co-operate during this first 24 hour period. It would be easy for a busy nurse to neglect coughing and deep breathing the surgical patient in the first 48 hours, because of the effort she must exert to elicit co-operation. It must be noted that this first 48 hours is felt to be the most critical period. It is during this time that hypoventilation leads to millinary collapse of the alveolae, retention of secretions, atelectasis, and then pneumonia.

The answer to prevention of atelectasis during this time period may lie in a combination of activities, such as
judicious use of analgesics and narcotics, encouraging the
patients to move every hour during the waking period, and
possible use of a rebreathing device.

When the procedure of coughing and deep breathing was
applied during the second through fourth days a significant
difference was seen between the experimental and control
groups regarding MEFV, one second vital capacity and TVC.
On the fourth day many patients in the experimental group
were ambulating with help for short periods of time. It is
suggested that when the patient begins to ambulate that the
patient be encouraged to do the coughing and deep breathing
procedure every four hours instead of every two. The
increase in time intervals between treatments works well
with increased activity. A decrease in activity calls for
shorter time intervals between treatments.

The researcher firmly believes that the incidence
of atelectasis can be reduced by effective preoperative
teaching of coughing and deep breathing, with a follow
through program after surgery. Just as important as a
specific procedure is the nurse's attitude concerning the
relevance of coughing and deep breathing to the patient's
recovery, and the skill with which the nurse interviews the
patient and teaches the procedure.

If the nurse is positive and enthusiastic as she
approaches the patient to teach him in the preoperative
period, he will likewise be more receptive to learning
and more willing to co-operate in the procedure. If the nurse also understands the dynamics and physiology of the respiratory system she will find it easier to teach the patient at his level of understanding, and also be able to make a more accurate diagnosis concerning the patient's respiratory status. In addition the nurse needs skill in examining the chest and distinguishing breath sounds to make a more accurate diagnosis.

The nursing implications from this study indicate that the nurse can be an effective instrument in preventing pulmonary complications following surgery. If nursing fails to assume the challenge and responsibility of developing and demonstrating diagnostic techniques and implementing appropriate preventive nursing measures, then various mechanical devices will be introduced to provide this important function.
The Null Hypothesis in this study was that preoperative teaching of coughing and deep breathing with a consistent follow up program after surgery would not reduce the incidence of post-operative atelectasis in patients having upper abdominal surgery.

The analysis of the data showed that there was a significant difference between the control and experimental group regarding MEFR, one second vital capacity and TVC. Therefore, the Null Hypothesis must be rejected. Pre-operative teaching of coughing and deep breathing with a consistent follow up program does reduce the incidence of atelectasis following surgery.

Along with a planned program of coughing and deep breathing the surgical patient, the nurse must also understand the importance of the procedure, the importance of knowing the underlying physiology of the respiratory system. Besides understanding these things, the nurse must be able to demonstrate her skills in applying this knowledge to each surgical patient.

One conclusion to be drawn from this project is that the first 24 hours is the most difficult time for the nurse to get maximum co-operation from the patient. Yet at
the same time this is the most likely time for atelectasis to develop.

At no time during the post-operative period did the measured lung volumes on any patient return to their preoperative values. On the fourth post-operative day the lung volume measures for the experimental group were 67 per cent of their preoperative values, as compared to 57 per cent for the control group.

This researcher makes the following recommendations regarding future studies.

1. This study should be repeated using a longer post-operative period so as to document when the post-operative lung volumes return to preoperative values.

2. A new study should be done to investigate the possibility of predicting patients who will develop post-operative atelectasis.

3. A new tool needs to be designed that will more accurately measure air volumes in the alveolar duct.

4. This project should be repeated using a pediatric population.

5. A study needs to be designed to evaluate the effect of the nurse's attitude on the success of preventing post-operative atelectasis.
REFERENCES


Noehren, T. Consultation on use of blood gases for this research project.


Wanta, J. and Rasmussen, C. Consultation on procedure for coughing and deep breathing used in this project.


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<th>Subject</th>
<th>Age</th>
<th>Sex</th>
<th>Weight</th>
<th>Height</th>
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<th>Type of Surgery</th>
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<td>Height</td>
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**TABLE IV**

**INDIVIDUAL CHARACTERISTICS OF SUBJECTS IN EXPERIMENTAL GROUP**

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<th>Height</th>
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<th>Type of Surgery</th>
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APPENDIX B

DEEP BREATHING AND COUGHING
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DEEP BREATHING AND COUGHING

Breathing exercises retrain the use of the diaphragm, abdominal muscles and lower rib cage muscles and prevent the use of the accessory muscles of respiration, mainly the shoulder and neck muscles. The use of the diaphragm instead of the accessory muscles will help counteract shortness of breath, loosen mucus, and obtain a controlled cough. These exercises are not designed to alter the respiration rate and depth.

DIAPHRAGMATIC BREATHING

A. Principle

The principle behind diaphragmatic breathing is the bellow action. By moving the handles of the bellow (ribs) outward, the chamber (chest) becomes enlarged, and a vacuum is created. The air is then sucked into the empty space. The air itself is not pushing the sides of the chamber out. As the handles relax or are forced inward the air goes out. This is the same principle used in breathing. By moving the ribs outward and contracting the diaphragm, there is a gentle filling (swelling around the waist) and inspiration occurs. As the shoulders and upper chest sink, the ribs move downward; expiration occurs. However, in some lung
conditions such as emphysema, abdominal muscles must be trained to contract to allow full expiration. Lung expansion is dependent upon the rib movement. If there is little rib cage movement as in splinting, there will be less expansion of the lungs.

B. Technique of teaching

Diaphragmatic breathing is taught:

1. In the upright position for two reasons:
   a. This is the normal position during the course of the day.
   b. This is often the patient’s position on the first post-operative day.

2. Within normal limits. It is not:
   a. The slow, deep respiration which tires you in five to ten minutes, or causes dizziness.
   b. The forced respiration which obstructs airflow evermore.
   c. The rapid shallow respiration which causes excessive work against airway and tissue viscous resistance.

3. With the use of the hands to guide the patient to breathe with his diaphragm. Rest one hand on each side at the subcostal angle of the rib. If using one hand place the thumb on the one side and the fingers on the other.
   a. Inspiration
To guide the patient to spread his ribs apart and thus encourage inspiration, spread hands apart and tell the patient to swell around the waist. On inspiration the abdominal muscles are relaxed and the lower ribs are gently expanded or spread apart.

b. Expiration

After inspiration move your hands in such a way as to guide the ribs downward and together, and instruct the patient to "let go" or relax and expiration occurs.

4. With commands which are given in counts:
   a. "Swell" (inspiration) one count.
   b. "let go" (expiration) two counts.
   c. "hold" (phase) one count.

The patient is not told to hold, rather the therapist pauses for one count before beginning the count for inspiration.

COUGHING

Coughing is important to help free the lungs of secretions. If they are lodged in the bronchus, the air is unable to pass up or down; and if they remain for a short period of time, the residual air in the obstructed passageway will be absorbed leaving a collapsed lobe or segment of a lobe. Once absorbed, suction bronchoscopy will have to be done. Remember that suction bronchoscopy may irritate the
membranes, causing them to secrete. Thus there may be secretions afterward.

Coughing is achieved through the use of the diaphragm. Following deep inspiration through diaphragmatic breathing, the glottis and vocal cords close over the trachea entrapping the air in the lungs. With strong contraction of the diaphragm and abdominal muscles, pressure within the lungs builds up. When the glottis and cords open widely, air is expelled outward. The mouth should be wide-open during coughing.

The principle here is to get the air to the bottom or underneath the secretions to lift it up, not the air on top as in apical breathing which pushes it farther down.
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