SECRETIONS WITH COPD--PHYSIOLOGICAL EFFECTS OF VIGOROUS INHALATION THERAPY AND PHYSIOTHERAPY ON THE HOSPITALIZED PATIENT

A THESIS

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We hereby recommend that the thesis prepared under our supervision by Joyce L. Dillard entitled "Secretions with COPD--Physiological Effects of Vigorous Inhalation Therapy and Physiotherapy on the Hospitalized Patient"

be accepted as fulfilling this part of the requirements for the Degree of Master of Science.

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TABLE OF CONTENTS

ACKNOWLEDGMENTS iii

LIST OF TABLES. vi

Chapter

I. INTRODUCTION. 1

Statement of Problem
Purpose
Background and Significance
Hypothesis
Definition of Terms
Delimitations
Assumptions
Summary

II. REVIEW OF LITERATURE. 14

Introduction
Chronic Obstructive Pulmonary Disease
Postural Drainage, Percussion, and Coughing
Humidification
Intermittent Positive Pressure Breathing
and Bronchodilators
Summary

III. PROCEDURE FOR COLLECTION AND TREATMENT OF DATA. 33

Introduction
Locale
Population
Methodology
Procedure for Analysis of Data
Summary

IV. ANALYSIS OF DATA. 38

Introduction
Results
Discussion
Summary

V. SUMMARY, RECOMMENDATIONS, IMPLICATIONS AND CONCLUSIONS 52

Summary
Recommendations
Implications
Conclusions

LITERATURE CITED. 58

CHAPTER I

INTRODUCTION

Authorities in pulmonary care have not agreed on the treatment regimen most beneficial for the patient hospitalized with chronic obstructive pulmonary disease (COPD). In reviewing the literature, pro- and con-recommendations were found for the use of bronchodilators, humidity provided by ultrasonic mist, hand-operated medication nebulizers, intermittent positive pressure breathing (IPPB), and postural drainage. Some practitioners advocated a vigorous program of treatment including the use of bronchodilators administered by IPPB, humidity via ultrasonic mist, and postural drainage. Others utilized non-vigorous treatment consisting only of bronchodilators administered by hand-operated nebulizers or oral bronchodilators alone.

The incidence of COPD has increased yearly. The disease is a chronic, progressive one. Increasing numbers of medical man hours have been utilized in the care of these patients. Prescribed treatments are often both costly and time consuming for patients. Accordingly, it was felt that a critical evaluation of the beneficial effects of a specific treatment regimen was warranted.

Statement of Problem

This study was designed to investigate the value of a vigorous inhalation therapy and physiotherapy treatment regimen for patients hospitalized with COPD.

Purpose

The purpose of this study was to determine if there was measurable physiological improvement in pulmonary function of patients hospitalized with COPD after receiving a treatment regimen composed of ultrasonic mist, IPPB with bronchodilator, postural drainage with percussion, and controlled cough.

Background and Significance

The American Lung Association (ALA, formerly the National Tuberculosis and Respiratory Disease Association or NTRDA), in 1972, cited COPD as being the most common chronic pulmonary disease, making it an important public health problem. In 1970 deaths from emphysema, chronic bronchitis, and asthma combined approximated 30,000 in the United States. These conditions ranked ninth in the causes of death from disease. In the decade ending in 1970, deaths attributed to emphysema increased by 145 per cent and those from chronic bronchitis by 72 per cent. In recent years emphysema had been the second most frequent

primary diagnosis in patients who were awarded early disability allowances under the Social Security Administration, arteriosclerotic heart disease being first (NTRDA, 1972, pp. 20-23).

There has been disagreement among authorities in pulmonary care concerning the value of several types of treatment often administered to patients with COPD. Among those debated are: (1) the value of bronchodilators, (2) increasing the humidity of inspired gas with ultrasonic mist, (3) the use of IPPB, and (4) the value of postural drainage.

In treating patients with COPD, Bendixen (1965, p. 88), Miller (1966, pp. 230-32, 235; 1972, pp. 15-16), Petty and Nett (1971, pp. 92, 105-06; 1972, pp. 47-52), Secor (1965, pp. 76-78; 1969, pp. 11, 41-42, 47), Helming (1968, pp. 415-18), Kinney (1967, pp. 2528-29, 2532-33, 2535), Williams (1963, pp. 88-89; 1972, p. 10) and Egan (1969, pp. 166, 418) advocated nebulization of aerosolized bronchodilators, nebulized moisture, and postural drainage with percussion to clear the lungs of retained secretions. Barach (1967, pp. 44-48) utilized postural drainage as a means of teaching diaphragmatic breathing. He felt that bronchodilator aerosols had value for patients with bronchitis, but not for those with emphysema who did not have

bronchospasm, excessive mucus, or edema of the bronchial membrane. He stated strongly that IPPB devices should not be used in rehabilitating breathless patients and that their only role was in resuscitation and respiratory acidosis. VanArsdel (1961, p. 6) stated that bronchodilators may effect a five-to-ten per cent improvement at best in obstructive pulmonary emphysema. Hinshaw (1966) recommended liberal use of expectorants and bronchodilator drugs for treatment of emphysema. Cherniack (1972a) felt that bronchodilating agents played a key role in management of chronic bronchitis and emphysema, but that the effectiveness of postural drainage was not always predictable. He was against the routine use of IPPB and felt that it should not be used unless the patient was seriously impaired. Sheldon (1966, pp. 153-54) stated that in conscious patients with excessive secretions and ventilatory insufficiency hand nebulization was exhausting and of no practical use; that IPPB was therefore the treatment of choice. In two frequently cited references on postural drainage, nebulization and IPPB were not mentioned except for Thacker's reference to the patient with an endotracheal tube or tracheostomy (Brompton Hospital, 1967; Thacker, 1971). Kimbel (1970, p. 4) included postural drainage and chest percussion in the physical therapeutic measures he deemed beneficial for

patients with COPD but stressed that they should be only a part of a multidisciplinary program including drug and inhalation therapy (p. 12).

Comroe (1962, p. 301) wrote

> Until we know more, we assume, rightly or wrongly, that increasing the secretion of normal mucus somehow loosens, thins, or liquefies the sputum; that when a patient can cough effectively, more fluid is better than little fluid; that when a patient cannot cough (e.g. when anesthetized), little sputum, even though thicker, is better than larger amounts of thin fluid.

He went on to say that material in larger airways can be drained by gravity; that frequent change in position may result in faster travel of sputum into the trachea where it can be coughed up; but that "fluid in fine airways, like fluid in capillary glass tubes, is not influenced by gravity."

Much of this disagreement regarding treatment occurred because of the wide range of clinical, physiological, and roentgenological abnormalities which may be found in patients diagnosed as having COPD. Chronic obstructive pulmonary disease is a term which applies to those patients with chronic bronchitis, asthma, or anatomic emphysema who exhibit persistent obstruction of bronchial air flow (NTRDA, 1972, p. 11). Confusion in the literature and in diagnosis was compounded because other names were also applied to this disease entity--chronic obstructive lung disease; chronic airway obstruction; chronic, nonspecific,

respiratory disease; pulmonary emphysema; chronic nonspecific respiratory disease; chronic bronchitis (NTRDA, 1972, p. 11; American Thoracic Society, 1965, p. 513; Bendixen, 1965, p. 211). Even individual authors were not consistent. Petty included "chronic asthma" as a cause of chronic airway obstruction (CAO) in an outlined table (1971, p. 4), then later in the same book excluded it from a chapter on management of patients with CAO (p. 101) and included management of "bronchial asthma" in a chapter on reversible obstructive airway disease (p. 149).

The number of patients with COPD occupying hospital beds had been increasing yearly (NTRDA, 1972, pp. 21-23). It seemed logical to assume that nurses and other health workers would encounter an increasing number of patients with COPD and that these patients were going to demand an increasing amount of their times and energies. Disagreement on the value of different aspects of treatment was evident in the literature. A critical evaluation of the physiological effects of a total treatment program was warranted.

Hypothesis

It was hypothesized that pulmonary function of patients hospitalized with COPD would be significantly improved after patients received a treatment regimen

consisting of ultrasonic mist, IPPB with bronchodilator, postural drainage with percussion, and controlled cough.

Definition of Terms

For the purpose of this study, the following terms were defined:

1. Chronic obstructive pulmonary disease (COPD).--applied to those patients with chronic bronchitis, asthma, or emphysema who exhibited persistent obstruction of bronchial air flow as demonstrated by spirometric measurements.
2. Vigorous treatment regimen.--included (1) humidity provided by ultrasonic mist, (2) bronchodilator administered by IPPB, (3) postural drainage with percussion, and (4) controlled cough before and after each stage of treatment.
3. Bronchodilators.--drugs which cause expansion of the lumen of the air passages of the lung.
4. Intermittent positive pressure breathing apparatus (IPPB).--mechanical ventilator which administers a gas during the inspiratory phase of respiration.
5. Postural drainage.--procedure in which the patient is placed in various positions which

place involved bronchial segments in such a position that gravity will facilitate the mobilization of secretions.

6. Clapping or percussion.--technique of striking the patient's chest to loosen bronchial secretions as an aid to postural drainage.
7. Ultrasonic generator.--an electronic instrument that produces aerosol particles far smaller than ordinary nebulizers.
8. Spirometry.--pulmonary function study which determines various lung volumes. These include inspiratory capacity (IC), forced vital capacity (FVC), forced expiratory volumes in one-half and one second ($FEV_{0.5}$ and $FEV_{1.0}$), forced mid-expiratory flow ($FEF_{25-75\%}$), and percentage of FVC expired in one second ($FEV_{1.0\%}$).
9. Controlled cough.--patient is instructed to inhale slowly and deeply through the nose, place tip of tongue lightly behind upper incisors to assist in closure of glottis, and to cough two to three times on expiration.
10. Inhalation or respiratory therapy.--introduction of gases and/or medications into the lungs for

therapeutic purposes. In this study refers to ultrasonic mist and IPPB.

11. Chest physiotherapy or physical therapy.--the treatment of disease or injury by physical and mechanical means. In this study refers to postural drainage and percussion.

Delimitations

For the purpose of this study the following delimitations were selected:

1. Subjects were patients in the Chest Unit of a large non-proprietary metropolitan hospital.
2. Subjects were males between the ages of thirty-five and sixty-five years with a diagnosis of COPD. Characteristically, the patient with chronic bronchitis is a man in early middle age. The average age of men disabled with emphysema is fifty-five (Bates, 1971, p. 110; Hammond, 1957; Prime and Westlake, 1954; Borden, 1950, pp. 701-09). It has been shown that changes in arterial oxygen tension, the alveolar-arterial oxygen gradient, the physiological dead space, and lung volumes and capacities change in advancing age in otherwise normal subjects

(Bendixen, 1965, p. 34; Raine and Bishop, 1963; Robin, 1962).

3. Patients with orthopnea due to congestive heart failure or pulmonary involvement and patients with motor disability preventing the assumption of the head-down position of postural drainage were excluded.
4. Patients on bed rest status were excluded because treatments were administered in the Respiratory Therapy Center and pulmonary function tests were carried out in the Pulmonary Function Laboratory.
5. Patients were transported by wheelchair to the above areas to decrease the possibility of exercise affecting pulmonary function.
6. Obese patients were excluded. The reduced distensibility of the thorax in obese persons can, even in the absence of obvious pulmonary or cardiac disease, alter pulmonary function and predispose to marked abnormalities in gas exchange (Cherniack, 1972b, pp. 443, 409-12; Bendixen, 1965, pp. 219-26; Alexander, 1962). Those patients who were twenty per cent over their desired weight (Shafer, 1964, p. 52; Wintrobe, 1970, p. 268) were considered obese.

7. Patients demonstrating more than 10 per cent improvement in $FEV_{1.0}$ after administration of a bronchodilator administered with a hand-nebulizer were excluded. Improvement in the first-second volume of over 15 per cent is more likely to be seen in asthmatics than in those with COPD (NTRDA, 1972, p. 78; Bates, 1971, p. 177).

Assumptions

For the purpose of this study the following assumptions were offered:

1. Secretions retained in airways constitute a major potentially reversible component of the ventilatory insufficiency of COPD.
2. Patients with COPD who are hospitalized will usually have more of a problem with excess and retained secretions than they do when they are not in the hospital.
3. The treatment regimen will not be effective unless patients receive instruction and supervision in controlled coughing and in proper use of equipment.

Summary

Chapter I introduced the diversity of opinions to be found among authorities in pulmonary care concerning the efficacy of various treatment regimens for patients with COPD. The problem to be studied, purpose of the study, definitions of terms used, delimitations selected, and assumptions offered were included. It was hypothesized that pulmonary function of patients hospitalized with COPD would be significantly improved after patients received a treatment regimen consisting of ultrasonic mist, IPPB with bronchodilator, postural drainage with percussion, and controlled cough.

Chapter II, Review of Literature, is composed of a review of the literature pertinent to COPD and a review of studies performed in an attempt to evaluate the effectiveness of bronchodilators administered by hand-operated nebulizers or IPPB, humidification, postural drainage and percussion, and coughing.

Chapter III, Procedure for Collection and Treatment of Data, contains descriptions of the locale, patient population, methodology, and procedure for the analysis of data obtained.

Chapter IV, Analysis of Data, summarizes and analyzes the data obtained in the study.

Chapter V contains a summary of the completed study, gives recommendations for further study, and states the implications and conclusions of the study.

CHAPTER II

REVIEW OF LITERATURE

Introduction

In reviewing the literature, pro- and con-recommendations were found for the use of bronchodilators, humidity provided by ultrasonic mist, hand-operated medication nebulizers, IPPB, and postural drainage. Chapter II will review the literature pertinent to COPD and discuss studies performed in an attempt to evaluate the effectiveness of these treatment modalities.

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) is a disorder characterized by chronic, diffuse, irreversible airway obstruction. Such patients show a wide range of clinical, physiologic, and roentgenologic abnormalities. The syndrome includes patients with chronic bronchitis, pulmonary emphysema, and asthma. Once chronic airway obstruction has developed, these entities are often indistinguishable on clinical grounds (American Thoracic Society, 1965, p. 513).

Bates (1971, p. 110) stressed the importance of having investigators indicate as clearly as possible the

detailed state of the patients on whom they are reporting the results of investigations or clinical trials. Although a great deal of attention has been devoted to the problems of the definition of chronic respiratory disease, the systems of differentiation and classification proposed by investigators have not been proven universally acceptable (Bates, 1971, p. 109; American Thoracic Society, 1965, p. 513; Fletcher, 1959, p. 286; Fletcher et al., 1964, p. 12).

The Ciba symposium on terminology produced proposals which have been followed in most survey work conducted since 1958 (Bates, 1971, p. 134). This group defined chronic bronchitis as follows:

> Chronic bronchitis refers to the condition of subjects with chronic or recurrent excessive mucous secretions in the bronchial tree. The diagnostic criterion is clinical, and is chronic or recurrent cough with expectoration which is not attributable to conditions excluded from chronic non-specific lung disease.
>
> Infection of the bronchi is frequently but not necessarily present.
>
> Not infrequently subjects who produce sputum deny cough. Such subjects are included as having bronchitis. Subjects who habitually swallow sputum should also be included as having chronic bronchitis.
>
> Opinion is divided concerning the significance of "dry" chronic bronchitis without hypersecretion, which is excluded by the proposed definition. Population surveys in Great Britain suggest that a persistent cough without expectoration is uncommon.
>
> The words "chronic or recurrent" may be defined as "occurring on most days for at least three months in the year during at least two years" (Fletcher, 1959, pp. 288-90).

"Asthma" literally means difficult breathing (Cherniack, 1972b, p. 329). A disease is usually defined on the basis of known etiology, but this is not possible with asthma because the basic etiology is not known. Asthma is actually a generic term for a symptom-complex of varied etiology. Relying on the pathophysiology for its definition, the American Thoracic Society maintains that asthma is "characterized by an increased responsiveness of the trachea and bronchi to various stimuli, and manifested by widespread narrowing of the airways that changes in severity either spontaneously or as a result of treatment" (NTRDA, 1973, p. 5).

Many authors call attention to the fact that since many health workers and patients consider wheezing to be synonymous with asthma, this condition is often misdiagnosed. Thus the adage, "all that wheezes is not asthma" (NTRDA, 1973, p. 50; Bates, 1971, p. 111; Cherniack, 1972b, p. 330; Crofton and Douglas, 1969, p. 70; Sweetwood, 1971, p. 152). Crofton and Douglas, while discussing the difficulties in the differential diagnosis of asthma and bronchitis, remind their readers that "all names given to diseases are merely labels for groups of phenomena and are necessarily oversimplifications" (1969, p. 394).

Two types of bronchial asthma are recognized clinically. Extrinsic (also known as atopic, exogenous,

immunologic, non-infectious) usually begins before age 35; is usually associated with the presence of specific reaginic allergies; attacks are triggered when the individual comes into contact with a specific antigen to which he is allergic; and the patient is usually symptom free between attacks. Intrinsic (also known as endogenous, non-allergic, nonimmunologic, infectious) asthma is usually manifested after the third decade; in many cases there is continuous evidence of airway obstruction with episodes of more intense bronchospasm superimposed thereon; and factors other than specific reaginic allergy seem to be relatively more important in triggering attacks (NTRDA, 1973, pp. 17-18; Crofton and Douglas, 1969, pp. 394-424; Holvey, 1972, p. 543; Middleton, 1965, p. 695).

The frequency and severity of attacks in both types may be greatly influenced by many factors: changes in temperature and humidity; exposure to noxious fumes such as chemicals, paints, or wax; by fatigue; by endocrine changes (puberty, menstruation, pregnancy, menopause); or emotional stress (Cherniack, 1972b, pp. 330-32; Holvey, 1972, p. 543). Although the chain of events leading to intrinsic asthma remains obscure, both types of asthma share essentially the same physiological pathological features (Middleton, 1965, p. 695).

While asthma and chronic bronchitis are defined in terms of their clinical manifestations, emphysema is defined as an anatomic alteration of the lungs characterized by an abnormal enlargement of the air spaces distal to the terminal bronchiole accompanied by destructive changes of the alveolar walls (American Thoracic Society, 1962).

The diagnosis of emphysema applies to those patients with: (1) history of progressive worsening of dyspnea precipitated by exertion; (2) posteroanterio chest roentgenogram showing radiologic hyperlucency, an abnormally increased--that is, more than three cm. between the anterior wall of the origin of the ascending aorta and the sternum--and translucent retrosternal space, and a flattened diaphragm; (3) blood gas determinations showing arterial pH below 7.36, arterial oxygen tension (Pa_{O2}) below 60 mm Hg., arterial carbon dioxide tension (Pa_{CO2}) above 45 mm Hg., arterial oxygen saturation (Sa_{O2}) below 88 per cent (Cherniack, 1972b, pp. 319-25; NTRDA, 1972, pp. 41-66; Bendixen, 1965, pp. 101, 214).

Clinicians have long suspected that hereditary factors can influence susceptibility to chronic obstructive pulmonary disease. In a recent issue of Heart and Lung Mittman (1973) discusses studies which suggest that a genetically determined plasma protein abnormality gives

rise to a significant number of cases of COPD through an interaction with various environmental factors.

Postural Drainage, Percussion, and Coughing

Postural drainage is a therapeutic means of draining the bronchi so that gravity is of the greatest assistance in promoting expectoration. The various positions required to produce effective drainage are based on the anatomy of each lung segment. They place the segmented bronchi in a vertical position so that gravity will be most effective in assisting drainage. Positions assumed during a treatment can vary from sitting upright to forty-five degrees head-down (Bendixen, 1965, p. 101; Brompton Hospital, 1967, pp. 9-11; Kimbel, 1970, pp. 5-7; Petty, 1971, pp. 85-92; Secor, 1969, pp. 147-52; Thacker, 1971, pp. 24-34). Chronic bronchitis is usually diffuse; drainage must therefore be applied to all areas until experience demonstrates the most productive positions. The drainage period should follow bronchodilator and humidifying aerosol treatments (Kimbel, 1970, p. 7; Secor, 1969, p. 176). Although set time limits for each position cannot be prescribed, it is estimated that from two to five minutes in each position should suffice for the patient with generalized lung disease (Kimbel, 1970, p. 7).

Percussion or "clapping" the chest during postural drainage is helpful in initiating the movement of secretions. To achieve effective percussion a pocket of air must be trapped over the lobe. This is achieved by "cupping" of the hands of the person administering the treatment. The two cupped hands rhythmically and alternately strike the chest with moderate force over the area being drained. The oscillatory movements produced are transmitted to the bronchi and help move secretions out of smaller airways into larger bronchi (Kimbel, 1970, pp. 7-8; Petty, 1971, pp. 92-93).

Mechanical devices that apply percussion have been devised. They are electrically operated, and though their original purpose was to provide an effective aid for home use in postural drainage procedures on children with cystic fibrosis, they have proven to be an excellent tool for clinical as well as home treatment of adult pulmonary disorders (Kimbel, 1970, p. 8; International Therapeutics, p. 1).

Cough is the major mechanism for removing mucus from small airways and maintaining a patent airway in patients with COPD. The simple act of controlled and coordinated coughing will in most cases remove secretions. A controlled cough is one which is produced by inspiring slowly and deeply and then applying expiratory muscle force

to produce a deep and gentle cough after the glottis is opened. Paroxysms of hard coughing should be avoided since this will cause bronchial collapse (Kimbel, 1970, p. 7; Petty and Nett, 1971, pp. 86-87, 89, 94 and 1972, pp. 48-51; Secor, 1969, pp. 40, 176-77; Rosenfeld, 1971, pp. 84-85).

Investigators studying the physiological effects of postural drainage carefully avoided administration of bronchodilators, nebulization, and IPPB before the studies were done. Only spontaneous coughing by patients was mentioned.

March (1971) found no significant change in FVC, $FEV_{1.0}$, $FEF_{200-1200}$, or $FEF_{25-75\%}$ in spirometries done pre- and post-postural drainage on twenty patients with COPD.

Fenton and Gieske (1969, p. 370) found that in a majority of twenty patients there was a decrease in lung function in the head-down position as determined by spirometric measurements of lung volumes and expiratory flow rates. Little or no change in subjective symptoms was noted and age of the patient did not seem to affect the reaction to the head-down position.

Barach and Beck (1954) found that striking relief of dyspnea was accompanied by increased diaphragmatic

excursion and a marked decrease in the minute volume of ventilation in twenty patients studied in the head-down position. They interpreted their findings as providing a physiologic basis for the clinical use of viscero-diaphragmatic breathing in patients with pulmonary emphysema (p. 60). Attinger and associates (1956), in the following year, studied twelve subjects with pulmonary emphysema and found that there was a significant decrease of compliance with increase in the respiratory rate in the head-down position.

The most significant finding of Erwin and associates (1966, pp. 869-70) was the reduction in the minute ventilation without any increase in the Pa_{CO2} or decrease in Pa_{O2} in ten patients with emphysema placed in the head-down position. They interpreted this finding as reflecting a more efficient pulmonary ventilation. Lorin and Denning (1971), in studying seventeen patients with cystic fibrosis, found that postural drainage produced over twice the volume of sputum as an equal period of cough alone.

Humidification

When dry gas is inhaled, approximately 650 ml. of water a day is added to the inspired gas by the upper respiratory tract, particularly the nasal mucosa. The nasal turbinates warm the inspired gas (Cherniack, 1972b,

p. 164). Administration of therapeutic gases subjects the respiratory tract to large volumes of vapor-free gas. The normal humidification process may be inadequate to cope with this load and may have to draw on the water content of the entire mucosal surface. Such failure will be hastened or aggravated by an associated dehydration incident to systemic disease. Egan (1969, pp. 218-19) commented that for the patient with chronic bronchopulmonary disease, the most important of all the aerosol medications is water. Patients with COPD often suffer from systemic dehydration due to excess water loss from the respiratory tract and decreased oral fluid intake. Cherniack (1972b, p. 440) and Secor (1965, p. 175) both recommend fluid intake of at least thirty to forty ml. per kilogram of body weight daily.

Warming and saturation of inspired gases with water vapor helps to liquify secretions and makes them easier to expectorate (Cherniack, 1972b, p. 440; Alan Pierce, 1968, pp. 15-16; Rosenfeld, 1971, p. 186; Safar, 1965, pp. 121, 206, 218, 274; Bendixen, 1965, p. 151). Body humidity is 53 mg. of water per liter of air in the tracheobronchial tree at 37^{0} C. at full saturation and exerts a pressure of water (PH_2O) of 47 mm. mercury. When humidity delivered by gas-powered equipment is measured in percentage of body humidity, only heated nebulizers exceed 100 per cent body humidity (Safar, 1965, p. 121).

The ultrasonic nebulizer is an electronic instrument which utilizes the high-frequency vibrations of a ceramic transducer to physically break water into a large volume of small particles (Egan, 1969, p. 224). Water droplets must be 1.0 micron or less in diameter in order to penetrate the bronchioles (Safar, 1965, p. 121). Clinical response testifies to the efficacy of ultrasonic nebulization and its ability to deposit water in the respiratory tract, but data varies regarding mean particle size produced.

The First Conference on Clinical Application of the Ultrasonic Nebulizer reported (Gauthier, 1966) that measured mean values varied from 1.0 to 10.0 microns in diameter. Stevens and Albregt (1966, p. 648) found that the mass of particles falls within the 0.8 to 1.0 micron range with probably 80 per cent deposition within the lung. Wolfsdorf, Swift, and Avery (1969) found that the mass median diameters of the aerosols produced by jet and ultrasonic nebulizers were 6.0 microns (geometric standard deviation = 2.5 microns) and 2.8 microns (geometric standard deviation = 2.1 micron) respectively; the densities of the aerosols produced were 8 and 34 microliters per liter of air. With nasal or normal mouth breathing, the volume of water, in aerosol form, that could be deposited per twenty-four hours in the lower respiratory tract of an adult was calculated

to be about 6 ml. and 49 ml. for the jet and ultrasonic nebulizer, respectively.

Cheney and Butler (1968) reported an increased in airway resistance in patients with COPD following inhalation of ultrasonic nebulization of water and saline. Alterations in alveolar-arterial oxygen gradient during chronic exposure to ultramist was reported by Modell (1966) in animal studies. Malik and associates (1970) demonstrated that inhalation of ultramist using water, normal saline, and 5 per cent saline and 10 per cent propylene glycol did not produce serious alterations in pulmonary function in normals or patients with COPD. They did observe slight increases in airway resistance in patients with COPD, especially with 5 per cent saline.

Rao and associates (1972) found that mist inhalation produced an average decrease in vital capacity of 1.33 liters. $FEV_{1.0}$, compliance, and arterial oxygen tension were reduced and airway resistance increased in a majority of patients.

Intermittent Positive Pressure Breathing and Bronchodilators

When disease interferes with normal pulmonary function intermittent positive pressure breathing therapy (IPPB) can be used to accomplish the following: (1) prevent

or correct atelectasis by deep lung inflations; (2) produce mechanical bronchodilation; (3) improve distribution of aerosols; (4) promote clearing of bronchial secretions; (5) counteract pulmonary congestion or edema; (6) decrease work of breathing; and (7) regulate inspiratory and expiratory gas flow patterns (Safar, 1965, p. 220).

Few authors disagree with the use of assisted ventilation in patients with severe pulmonary disease and respiratory failure, but there is considerable disagreement about using IPPB to administer bronchodilators to patients with COPD. Noehran (1971, p. 3) states that "It is paradoxic that many of the investigators whose studies have indicated the ineffectiveness of this type therapy admit to the continued use of IPPB by patients in their own practices."

Curtis and coworkers (1968) studied patients with chronic bronchitis and emphysema who were treated at home for a period of four years. Seventy-eight patients were supplied with IPPB machines, a control group of 109 was not. This study was unable to demonstrate that long-term home treatment with IPPB benefited patients with chronic bronchitis and emphysema. However, almost all of their patients stated that IPPB treatment helped them open their air passages and raise secretions. Most of these patients

brought their own machines with them when they returned to the hospital for periodic checkups. The authors commented that "psychologic support of the patient is suggested by their dependence on IPPB" (p. 1040).

John Pierce (1968), in discussing office management of COPD, made the statement that "for patients' mental depression, intermittent positive pressure breathing two or three times weekly is helpful."

Birnbaum (1966) showed that on a short-term basis IPPB improved ventilation and arterial blood gas levels for patients hospitalized with COPD.

Jameson and co-workers (1959) studied two emphysematous patients and concluded that when IPPB is used on a long-term basis blood gas levels can return to normal values and be maintained by continued use of the respirator.

On the basis of a study in which conditions found in chronic obstructive emphysema were simulated, Jones, MacNamara and Gaensler (1960, pp. 181-82) suggested that IPPB could result in air-trapping and overdistention of the lung, its use markedly aggravate expiratory resistance, and that the work of breathing is increased when high pressures are used. Pierce (1967, p. 5) states that

> The experimental model [used by Jones et al.], however, does not simulate chronic obstructive lung

> disease in a reasonable way. The results obtained were due to this fallacious model, and there is no reasonable application of their results to clinical medicine.

Ayres and associates (1963, p. 375) found that the mechanical work of breathing decreased during IPPB in the patient with normal or diseased lungs and tended to approach zero in the relaxed individual. They concluded, however, that the amount of respiratory work performed by the subject while on IPPB is variable. If he actively leads the apparatus, he may perform more work in attaining a given tidal volume than he does in breathing spontaneously. This may be one of the factors responsible for the intolerance to the apparatus manifested by poorly instructed or anxious patients. Ayres and Giannelli (1966) later conducted studies that supported the concept that properly administered IPPB decreases the mechanical work and oxygen consumption of the respiratory muscles while increasing the rate of alveolar ventilation.

Leslie and associates (1956) reported that the improvement in pulmonary function following bronchodilator administered with IPPB was no different from that following bronchodilator administered by an oxygen-driven nebulizer.

Goldberg and Cherniack (1965), in carefully controlled studies, found no difference between the beneficial effects of a bronchodilator delivered with positive

pressure breathing or with a hand nebulizer. They found no evidence of air-trapping and over-distention of the lungs following IPPB. Despite their first finding they made the following statements in the discussion of their findings.

> A considerable number of patients with obstructive emphysema are unable to use a nebulizer efficiently, particularly when they are admitted to the hospital with acute exacerbation of respiratory insufficiency. In such cases it is apparent that the use of IPPB to deliver the nebulized bronchodilator may well be of considerable benefit, and a valuable adjunct in their management. . . . It is suggested that the beneficial effect of the hand nebulizer would not be as great as that of IPPB for most patients who are in moderately severe respiratory distress, and that bronchodilators delivered to these patients by IPPB would be of greater benefit (pp. 18-19).

IPPB is used extensively in surgical patients for the prevention of post-operative pulmonary complications, but there is disagreement as to its effectiveness. Becker and associates (1960), Sands and associates (1961), and Baxter and Levine (1969) failed to demonstrate the ability of IPPB to prevent post-operative atelectasis in patients undergoing upper abdominal surgery. Baxter and Levine suggested that

> The fault may lie not with the modality of IPPB itself, but with the manner in which such treatment is provided for the individual patient. Closer physician supervision of the progress and needs of each patient, i.e., individually tailored post-operative pulmonary care as opposed to routine

> care, may be the ingredient required to obtain the greatest benefit from IPPB (pp. 797-98).

Anderson and associates (1963) found a pulmonary complication rate of only 2.5 per cent in patients receiving IPPB as compared to 19.5 per cent in their control group. The one difference that stands out between the author who got the good results and those that did not was that the former administered IPPB pre-operatively as well as post-operatively. Pierce (1967) states that

> The only likely benefit of IPPB in post op patients is the administration of deep breaths. It is unlikely that a post op patient already in pain and under the influence of narcotics would respond to IPPB by relaxing and allowing the machine to passively inflate his lungs unless he was already trained in its use. . . . One would conclude that IPPB is probably beneficial in post op cases if the patient has been adequately instructed in its use preoperatively (p. 8).

Kamat, Dulfano, and Sego (1962) studied the effects of IPPB on eighteen severely disabled patients with chronic bronchitis and pulmonary emphysema. Sixteen felt tired after breathing on IPPB, five became exhausted. Arterial PCO_2 increased significantly in almost one-third. These investigators administered IPPB treatments at only five and ten cm. H_2O mask pressure. The volume of air that a patient with obstructive disease moves per unit of pressure is depressed (Egan, 1969, p. 92). The increase in airway resistance found in patients with COPD would cause these low pressures to be inadequate (Pierce, 1967, p. 9).

Cohen, Hemingway, and Hemingway (1961) studied the effects of IPPB and of bronchodilator drugs on alveolar ventilation in twelve patients with emphysema. Alveolar ventilation, as judged by nitrogen clearance, was less improved by IPPB without isoproterenol that by IPPB with isoproterenol. Nitrogen clearance was not improved by intravenously administered aminophylline.

Summary

There are few instances when a patient hospitalized with COPD is treated with postural drainage alone. Even if this were a common practice, a majority of studies that have been carried out include assessment of the patient only during the actual postural drainage period, with no indication of evaluation done after the treatment was completed. This isolation of one aspect of total therapy does little to help the practitioner evaluate the effectiveness of his prescribed treatment program.

The literature is steadily increasing with reports that IPPB is both beneficial and useless in treating patients with COPD; that ventilation is increased and decreased; that blood gases are favorably or unfavorably affected; and that patients are subjectively better or worse. Reports of studies on the effects of ultrasonic nebulization are equally varied.

The answer to the continuing question of whether IPPB, bronchodilators, postural drainage with percussion, and ultrasonic mist are appropriate in the treatment of COPD becomes less simple as experience with all of them increases.

CHAPTER III

PROCEDURE FOR COLLECTION AND TREATMENT OF DATA

Introduction

In this study seven patients with COPD were treated with ultrasonic mist, IPPB with bronchodilator, postural drainage with percussion, and controlled cough to determine if this treatment regimen would result in significant improvement in pulmonary function as determined by spirometric measurements.

Locale

The subjects for this study were selected from the Chest Unit of a large non-proprietary metropolitan hospital. The sixty-five bed Chest Unit, which treats patients with diseases such as emphysema, pneumonia, lung cancer, and tuberculosis, is composed of two thirty-bed wards and a five-bed Intensive Therapy Unit.

The hospital has active Physical Therapy and Respiratory Therapy Departments which are responsible for administering treatments to patients in both the Chest Unit and a thirty-six bed Extended Care Facility. In 1971 the

Physical Therapy Department administered a total of 11,598 treatments, of which 2,926 were postural drainage with percussion (Physical Therapy Records, 1971). The Respiratory Therapy Department administered a total of 85,466 treatments (Dallas County Hospital District, 1971, p. 18). Table 1 shows the type and number of specific treatments.

TABLE 1

1971 RESPIRATORY THERAPY TREATMENTS, CHEST UNIT AND EXTENDED CARE FACILITY

Intermittent	Number
Nebulization	15,320
Intermittent Positive Pressure Breathing	61,023
Humidified Oxygen	1,363
Ultrasonic	4,498
Total	82,204
Constant	
Nebulization	2,471
Intermittent Positive Pressure Breathing	245
Humidified Oxygen	532
Ultrasonic	14
Total	3,262

Population

The subjects for this study were men selected from the Chest Unit of a large non-proprietary hospital. They were selected on the basis of: (1) having a diagnosis of COPD; (2) having less than 10 per cent improvement in

$FEV_{1.0}$ following administration of aerosolized bronchodilator; (3) ambulatory or wheelchair status; and (4) age limited from thirty-five to sixty-five years of age. Patients were excluded from the study on the basis of: (1) orthopnea due to congestive heart failure or pulmonary involvement; (2) motor disability preventing the assumption of the head-down position; and (3) obesity.

Methodology

All respiratory therapy and postural drainage treatments which were part of the medical regimen for the subjects were withheld for eight hours prior to the study to ensure that pre-treatment spirometries would reflect the base line pulmonary function of the subjects.

Subjects were transported to the Pulmonary Function Laboratory and to the Respiratory Therapy Center by wheelchair.

Spirometries were performed in the Pulmonary Functions Laboratory with a Stead-Wells 10.0 liter spirometer on each patient before and after the treatment program was administered.

The treatment regimen, approved by the Medical Director of the hospital, was administered in the Respiratory Therapy Center in the following order:

1. Ultrasonic mist with the DeVilbiss Model 900 Nebulizer was administered for fifteen minutes;
2. IPPB was administered with Aerolone 1cc:normal saline 4cc in the sidearm nebulizer until the medication was completely nebulized. Tidal volumes on IPPB were maintained equal to or more than patients' inspiratory capacity as determined by spirometric measurement. The Bird Mark 7 IPPB was used. Tidal volumes were measured with the Emerson Dry Gas Meter;
3. Percussion was applied to appropriate lobes with the ITI (International Therapeutics, Inc.) Percussor for two minutes in each position of postural drainage;
4. Subjects were instructed in controlled coughing and coughed after each step of the treatment regimen.

Pre- and post-treatment spirometries were performed by the same Pulmonary Function Technician. All treatments were administered by the investigator.

Procedure for Analysis of Data

The pre- and post-treatment measurements of IC, FVC, $FEV_{0.5}$, $FEV_{1.0}$, $FEF_{25-75\%}$, and $FEV_{1.0\%}$ were compared

on each subject. Statistical analysis was by the Paired Student's t Test for significance of the differences.

Summary

Seven patients with COPD were selected from the Chest Unit of a large non-proprietary metropolitan hospital. They were treated with ultrasonic mist, IPPB with bronchodilator, postural drainage with percussion, and controlled cough to determine if this treatment regimen would result in significant improvement in pulmonary function as determined by spirometric measurements. The locale, patient population, methodology, and procedure for analysis of data used in the study were discussed.

CHAPTER IV

ANALYSIS OF DATA

Introduction

Seven patients from the Chest Unit of a large non-proprietary metropolitan hospital were studied pre- and post-treatment regimen consisting of ultrasonic mist, IPPB with bronchodilators, and postural drainage with percussion. Subjects were instructed in controlled coughing and coughed after each step of the treatment regimen. Spirometries were performed pre- and post-treatment. It was hypothesized that pulmonary function of patients hospitalized with COPD would be significantly improved after they received this treatment regimen.

Results

Spirometric measurements obtained pre- and post-treatment are shown in Table 2.

Statistical analysis for pre- and post-treatment spirometric measurements was established by the Paired Student's t Test for the significance of the differences

TABLE 2

SPIROMETRIC MEASUREMENTS PRE- AND POST-TREATMENT

	Predicted	Pre	Per Cent of Predicted	Post	Per Cent of Predicted
			Subject 1		
IC	3041	1433	47%	1359	45%
FVC	3862	2686	70%	2719	70%
$FEV_{0.5}$	2626	627	24%	513	20%
$FEV_{1.0}$	3244	918	28%	802	25%
$FEF_{25-75\%}$	3590	310	9%	267	7%
$FEV_{1.0\%}$	>75%	34%		30%	
			Subject 2		
IC	3762	1872	50%	2085	55%
FVC	4750	2362	50%	2684	57%
$FEV_{0.5}$	3230	802	25%	998	31%
$FEV_{1.0}$	3990	1248	31%	1553	39%
$FEF_{25-75\%}$	4417	624	14%	754	17%
$FEV_{1.0\%}$	>70%	53%		58%	
			Subject 3		
IC	2656	1567	59%	1477	56%
FVC	3776	2910	77%	2910	77%
$FEV_{0.5}$	2568	1388	54%	1365	53%
$FEV_{1.0}$	3172	1836	58%	1836	58%

TABLE 2--Continued

	Predicted	Pre	Per Cent of Predicted	Post	Per Cent of Predicted
Subject 3--Continued					
$FEF_{25-75\%}$	3510	940	27%	850	24%
$FEF_{1.0\%}$	>76%	63%		63%	
Subject 4					
IC	4162	1738	42%	1939	47%
FVC	4280	2050	48%	2630	61%
$FEV_{0.5}$	2911	668	23%	780	27%
$FEV_{1.0}$	3596	958	27%	1181	33%
$FEF_{25-75\%}$	3980	330	8%	400	10%
$FEV_{1.0\%}$	>77%	47%		45%	
Subject 5					
IC	3041	1248	41%	1760	58%
FVC	3916	1783	46%	2184	56%
$FEV_{0.5}$	2663	490	18%	668	25%
$FEV_{1.0}$	3290	713	22%	936	28%
$FEF_{25-75\%}$	3164	250	7%	310	9%
$FEV_{1.0\%}$	>75%	40%		43%	
Subject 6					
IC	4162	1805	44%	2228	54%
FVC	4607	2451	53%	3098	67%

TABLE 2--Continued

	Predicted	Pre	Per Cent of Predicted	Post	Per Cent of Predicted
Subject 6--Continued					
$FEV_{0.5}$	3133	824	26%	890	31%
$FEV_{1.0}$	3870	1137	29%	1426	37%
$FEF_{25-75\%}$	4280	335	8%	450	10%
$FEV_{1.0\%}$	>74%	46%		46%	
Subject 7					
IC	3041	1248	41%	1560	51%
FVC	3916	1694	43%	2095	53%
$FEV_{0.5}$	2663	535	20%	646	24%
$FEV_{1.0}$	3290	780	24%	914	28%
$FEF_{25-75\%}$	364	360	10%	360	10%
$FEV_{1.0\%}$	>75%	46%		44%	

between the means. Table 3, showing actual spirometric measurements, and Table 4, showing spirometric measurements expressed as the percentage of their predicted value, both indicated improvement at the .05 level of significance in the following parameters: IC, FVC, $FEV_{1.0}$. Improvement in

TABLE 3

SPIROMETRIC MEASUREMENTS (IN MILLILITERS)
PRE- AND POST-TREATMENT

Subject	IC		FVC		$FEV_{0.5}$		$FEV_{1.0}$		$FEF_{25-75\%}$	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	1433	1359	2686	2719	627	513	918	802	310	267
2	1872	2085	2362	2684	802	998	1248	1553	624	754
3	1567	1477	2910	2910	1388	1365	1836	1836	940	850
4	1738	1939	2050	2630	668	780	958	1181	330	400
5	1248	1760	1783	2184	490	668	713	936	250	310
6	1805	2228	2451	3098	824	980	1137	1426	335	450
7	1248	1560	1694	2095	535	646	780	914	360	360
t value[a]	2.463		2.731		1.718		2.554		1.112	

[a] t value significant at .05 level = 2.447.

TABLE 4

SPIROMETRIC MEASUREMENTS (EXPRESSED AS PERCENTAGE OF PREDICTED) PRE- AND POST-TREATMENT

Subject	IC		FVC		$FEV_{0.5}$		$FEV_{1.0}$		$FEF_{25-75\%}$		$FEV_{1.0\%}$[a]	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	47	45	70	70	24	20	28	25	9	7	34	30
2	50	55	50	57	25	31	31	39	14	17	53	58
3	59	56	77	77	54	53	58	58	27	24	63	63
4	42	47	48	61	23	27	27	33	8	10	47	45
5	41	58	46	56	18	25	22	28	7	9	40	43
6	44	54	53	67	26	31	29	37	8	10	46	46
7	41	51	43	53	20	24	24	28	10	10	46	44
t value[b]	2.250		3.571		1.988		2.625		0.669		0.0	

[a]Expressed as actual value, not percentage of predicted.

[b]t value significant at .05 level = 2.447
.02 level = 2.143.

$FEV_{0.5}$ and $FEF_{25-75\%}$ was not significant. There was no improvement in $FEV_{1.0\%}$.

These data reject the hypothesis that pulmonary function of patients hospitalized with COPD would be significantly improved after patients received a treatment regimen consisting of ultrasonic mist, IPPB with bronchodilator, postural drainage with percussion, and controlled cough.

Discussion

Chronic obstructive pulmonary disease (COPD) is a disorder characterized by chronic, diffuse, irreversible airway obstruction. The syndrome includes patients with chronic bronchitis, pulmonary emphysema, and asthma.

In assessing a patient with pulmonary disease, one is interested in the volume of air the patient is capable of moving into and out of his lungs and the velocity with which he can move this volume of air. These measurements are helpful in diagnosing the type of lung disease present, assessing the severity of the disease, and in following the course of the disease and its modification with therapy (ALA, 1972, p. 1).

An analysis of data obtained in the present study (Tables 2 and 4) showed that all subjects demonstrated

spirometric evidence of COPD. A classification method recommended by the American Lung Association (NTRDA, 1972, p. 46) is shown in Table 5.

$FEV_{0.5}$, $FEV_{1.0}$, and $FEF_{25-75\%}$

Measurement of the degree of expiratory airway obstruction is the most valuable laboratory aid in the diagnosis of COPD and estimation of its severeity (NTRDA, 1972, p. 41; Cherniack, 1972b, p. 145). The effect of obstruction to air flow is best shown if the time-volume relationship is measured during forced expiration.

Any assessment of flow resistance which is based predominantly on expiratory rate of air flow at high degress of lung inflation, such as $FEV_{0.5}$, may be unreliable because the value obtained may be related more to patient cooperation and effort than to alterations in pulmonary mechanics. Conversely, when the flow rate is measured over a large range of lung volume, such as $FEV_{1.0}$, or the measurement of flow rate ignores the first portion of the expiration during which flow is primarily effort dependent, such as the $FEF_{25-75\%}$, the values obtained may provide better indices of alterations in the mechanical resistances (Cherniack, 1972b, p. 145). It has been suggested that the $FEF_{25-75\%}$ is the most sensitive simple method of assessing

TABLE 5

SUBJECTS CLASSIFIED ACCORDING TO SEVERITY OF LUNG IMPAIRMENT[a] PRE- AND POST-TREATMENT

	IC		FVC		$FEV_{0.5}$		$FEV_{1.0}$		$FEF_{25-75\%}$	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Normal over 80%	0	0	0	0	0	0	0	0	0	0
Mild Impairment 65-80%	0	0	2	3	0	0	0	0	0	0
Moderate Impairment 50-64%	2	5	2	4	1	1	1	1	0	0
Severe Impairment 35-49%	5	2	3	0	0	0	0	2	0	0
Very Severe Impairment below 35%	0	0	0	0	6	6	6	4	7	7

[a]Based on per cent of predicted volume.

small airway obstruction and that it may be reduced before other measurements of air flow in patients with diseases of small airways such as bronchitis and emphysema (ALA, 1972, p. 2; Bates, 1971, p. 22; Dawson, 1966).

The data obtained appear to support the previous statements. $FEV_{1.0}$ was significantly improved after treatment. There was improvement in $FEF_{25-75\%}$, but it was not significant. This may support the concept of it being more responsive than the $FEV_{1.0}$ to small airway disease. The nonsignificant improvement in $FEV_{0.5}$, considering that it is the first half of the significantly improved $FEV_{1.0}$, may be due to poor effort of the patient as suggested by Cherniack (1972b, p. 145).

FVC and IC

The forced vital capacity (FVC) is the largest volume that a patient can exhale rapidly and forcefully after taking the deepest inspiration possible. The inspiratory capacity (IC), part of the FVC, is the maximal volume inspired from the resting expiratory level (ALA, 1972, p. 1; NTRDA, 1972, p. 42; Bates, 1971, p. 12). If the patient's FVC is not 80 per cent or more of the predicted vital capacity the patient is said to have a restrictive lung disease.

The amount of gas that remains in the lungs after maximal exhalation is the residual volume (RV). Therefore, the FVC plus the RV equals the total lung capacity (TLC).

In pure restrictive lung disease the RV remains approximately normal; therefore, the TLC is also reduced. The volume of gas in the lungs will appear small on roentgenogram. In patients with obstructive diseases, however, the TLC is normal or increased and the chest roentgenogram shows an increased volume of gas in the patient's lungs.

Many patients with severe obstruction are said to have a combined defect; that is, a restrictive defect caused by their severe obstructive defect. This occurs because the residual volume becomes so large that the FVC is decreased despite normal or large TLC. That the decreased FVC (restriction) is caused by airway obstruction is determined by: (1) examination of chest roentgenogram which reveals a large, not small, volume of gas in the lungs; and (2) the $FEV_{1.0}$ as a percentage of its predicted volume is more severely impaired than the FVC as a percentage of its predicted volume (ALA, 1972, pp. 2-3).

Examination of Table 5 shows restrictive defects, determined by reduced FVC, classified as mild impairment in two subjects, as moderate impairment in two subjects, and as severe impairment in three subjects. Obstructive defects,

determined by decreased $FEV_{1.0}$, consisted of one subject with moderate impairment, the remaining six having very severe impairment. Table 4 shows spirometric measurements expressed as percentage of their predicted volumes.

It is interesting to note that subjects 1 and 3, the two patients with the least serious restrictive defect, were the two patients whose volumes and percentages of predicted volumes worsened or remained stable after treatment was administered (Tables 2, 3, and 4). This lack of improvement appears to support the observance of an increase in airway resistance reported in some patients with COPD after administration of ultrasonic mist (Cheney and Butler, 1968; Malik and associates, 1970; Rao and associates, 1972). This may be an indication of mobilization of secretions from smaller to larger airways resulting in increased airway resistance or of bronchospasm caused by irritation because of the heavy mist.

$\underline{FEV_{1.0\%}}$

The $FEV_{1.0\%}$ (percentage [of FVC] expired in one second) is another way of expressing the presence or absence of airway obstruction (NTRDA, 1972, pp. 42, 47-48). It is obtained by using the following formula:

$$\frac{\text{Observed } FEV_{1.0}}{\text{Observed FVC}} \times 100 = FEV_{1.0\%}$$

A normal person expires between 69 and 82 per cent of his FVC in one second. A patient with a pure restrictive disease may have a remarkedly reduced FVC, but may expire this reduced volume rapidly. A patient may have an FVC of over 80 per cent of the predicted volume, but exhale only a small percentage of this volume in one second, indicating airway obstruction.

Analysis of the data shown in Table 4 shows that $FEV_{1.0\%}$ values ranged from 34-63 per cent. Even though both FVC and $FEV_{1.0}$ were significantly improved post-treatment, there was no change in the $FEV_{1.0\%}$. In fact, three of the seven subjects showed a decrease in this value. This would indicate that the obstructive defect was not improved as much as the secondary restrictive defect by the treatment regimen.

Summary

Seven patients with COPD from the Chest Unit of a large non-proprietary metropolitan hospital were treated with a treatment regimen consisting of ultrasonic mist, IPPB with bronchodilator, postural drainage with percussion, and controlled cough. It was hypothesized that pulmonary function of patients hospitalized with COPD would be significantly improved after patients received this treatment regimen.

Spirometric measurements were performed pre- and post-treatment. Statistical analysis was established by the Paired Students t Test for significance of the differences between the means. The results indicated improvement at the .05 level of significance in the following parameters after treatment: IC, FVC, and $FEV_{1.0}$. Improvement in $FEV_{0.5}$ and $FEF_{25-75\%}$ was not significant. There was no change in $FEV_{1.0\%}$; therefore, the hypothesis was rejected.

CHAPTER V

SUMMARY, RECOMMENDATIONS, IMPLICATIONS AND CONCLUSIONS

Summary

Authorities in pulmonary care have not agreed on the treatment regimen most beneficial for the patient hospitalized with COPD. In reviewing the literature, pro- and con-recommendations were found for the use of bronchodilators, humidity provided by ultrasonic mist, hand-operated medication nebulizers, IPPB, and postural drainage. Because of the increasing numbers of medical man hours utilized in administering these treatments and the cost and time devoted by patients, it was felt that a critical evaluation of the beneficial effects of a specific treatment regimen was warranted.

Seven patients with COPD from the Chest Unit of a large non-proprietary metropolitan hospital were studied in an attempt to test the hypothesis that their pulmonary function would be significantly improved after they received treatment consisting of ultrasonic mist, IPPB with bronchodilator, postural drainage with percussion, and controlled cough.

Spirometric measurements were performed pre- and post-treatment. Statistical analysis was established by the Paired Student's t Test for significance of the differences. The results indicated improvement at the .05 level of significance in the following parameters after treatment: IC, FVC, and $FEV_{1.0}$. Improvement in $FEV_{0.5}$ and in $FEF_{25-75\%}$ was not significant and there was no change in $FEV_{1.0\%}$.

The two subjects who had the least impairment of FVC showed decreases in IC, $FEV_{0.5}$, and $FEF_{25-75\%}$ post-treatment. Both demonstrated no change in FVC. One of these subjects showed a decrease in $FEV_{1.0}$ and $FEV_{1.0\%}$, while the other had no change in these two parameters.

On the basis of these data the hypothesis was rejected.

It is recognized as a definite limitation of this study that the effect of the treatment regimen was measured only one time, so there is no indication of whether the patients would respond in identical fashion if treated another time. It would also be beneficial to know if the treatment regimen, administered regularly during the entire hospital stay, would result in more significant and/or more rapid improvement than that observed in a control group of

patients who did not receive treatment. Unfortunately, that was beyond the scope of this research project.

Although the selected parameters are designed to demonstrate relief of obstruction, determination of other parameters such as the work of breathing and alveolar ventilation might produce additional information.

Recommendations

Based on the results of this study the following recommendations for further research are offered:

1. The Response of Patients in a Pulmonary Outpatient Clinic to a Treatment Regimen Consisting of Ultrasonic Mist, IPPB with Bronchodilator, Postural Drainage with Percussion, and Controlled Cough.
2. A Comparison of Changes in Pulmonary Function of Patients with Emphysema and Chronic Bronchitis After Treatment with Respiratory Therapy and Chest Physiotherapy.
3. COPD: The Effectiveness of Respiratory Therapy and Chest Physiotherapy in Reducing the Length of Hospitalization Periods.
4. The Role of Patient Instruction in Improving the Effectiveness of IPPB Treatments.

5. The Role of the Nurse in Administering Respiratory Therapy and Chest Physiotherapy: A Survey.
6. Testing the Knowledge of the Nurse Regarding the Principles Utilized in Respiratory Therapy and Chest Physiotherapy.
7. Conduct a study similar to the present one in a different geographic locale using a larger sample size.

Implications

All health team members involved with patients receiving respiratory therapy and chest physiotherapy need to be aware of individual patients' responses to therapeutic measures employed. The fact that response of patients to treatment is not consistent is demonstrated by data presented in Chapter IV. The need for definitive criteria as indications for treatment is becoming increasingly apparent. There are still none to indicate which patients will benefit from specific treatments.

After working with these patients the investigator noted that out of the seven, all of whom had been receiving IPPB treatments for at least one-and-a-half days, only two were aware of the importance of taking slow, deep breaths with IPPB and of performing controlled coughing to aid in expectoration of secretions mobilized by treatment. Tidal

volumes are measured during IPPB at least once daily in this institution, but this is usually done for just a few breaths and usually at the end of a treatment. The tidal volumes achieved during the study were consistently higher than those recorded during routine treatments. If patients are to receive the full benefits of any treatment program it is imperative that some delegated member of the health team be responsible for teaching them the purpose of treatments and the proper way to carry them out. The cost is too high, in terms of both time and money, for both patients and health workers to waste time with ineffective treatments.

Spirometric measurements can be performed on patients before treatment is instituted and at later intervals to determine if treatment results in improvement in pulmonary function. Auscultation of lungs can be performed before, during, and after treatment to determine how air movement is affected. Subjective status and other objective data such as quality and quantity of mucus production can be assessed. All health team members participating in the care of the patient should possess adequate knowledge of assessment.

Conclusions

Significant improvement in IC, FVC, and $FEV_{1.0}$ occurred in patients hospitalized with COPD after they

received treatment consisting of ultrasonic mist, IPPB with bronchodilator, postural drainage with percussion, and controlled cough. Two subjects did, however, show decreases in IC, $FEV_{0.5}$, and $FEF_{25-75\%}$ post-treatment. Both subjects demonstrated no change in FVC. One of them showed a decrease in $FEV_{1.0}$ and $FEV_{1.0\%}$, while the other had no change in these two parameters.

Additional studies using the different aspects of the treatment regimen as dependent variables and testing of larger populations are needed so that criteria for indications for treatment can be obtained.

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